CONFIDENTIAL

GULF CANADA RESOURCES INC.

MOUNT KLAPPAN COAL PROJECT

1982

MINE ASSESSMENT

VOLUME 2

GEOLOGY

Coal Licence Number 7118 to 7177

7381 to 7392

and

7416 to 7432 inclusive

Cassiar Land District

NTS Map Number 104 H

Latitude Between 57°11' and 57°22'N
Longitude Between 128°39' and 129°05'W

BY

PHILLIPS BARRATT KAISER
Engineering Ltd.
Vancouver, B.C. Canada

DECEMBER 1982

PBK Project No. 82054

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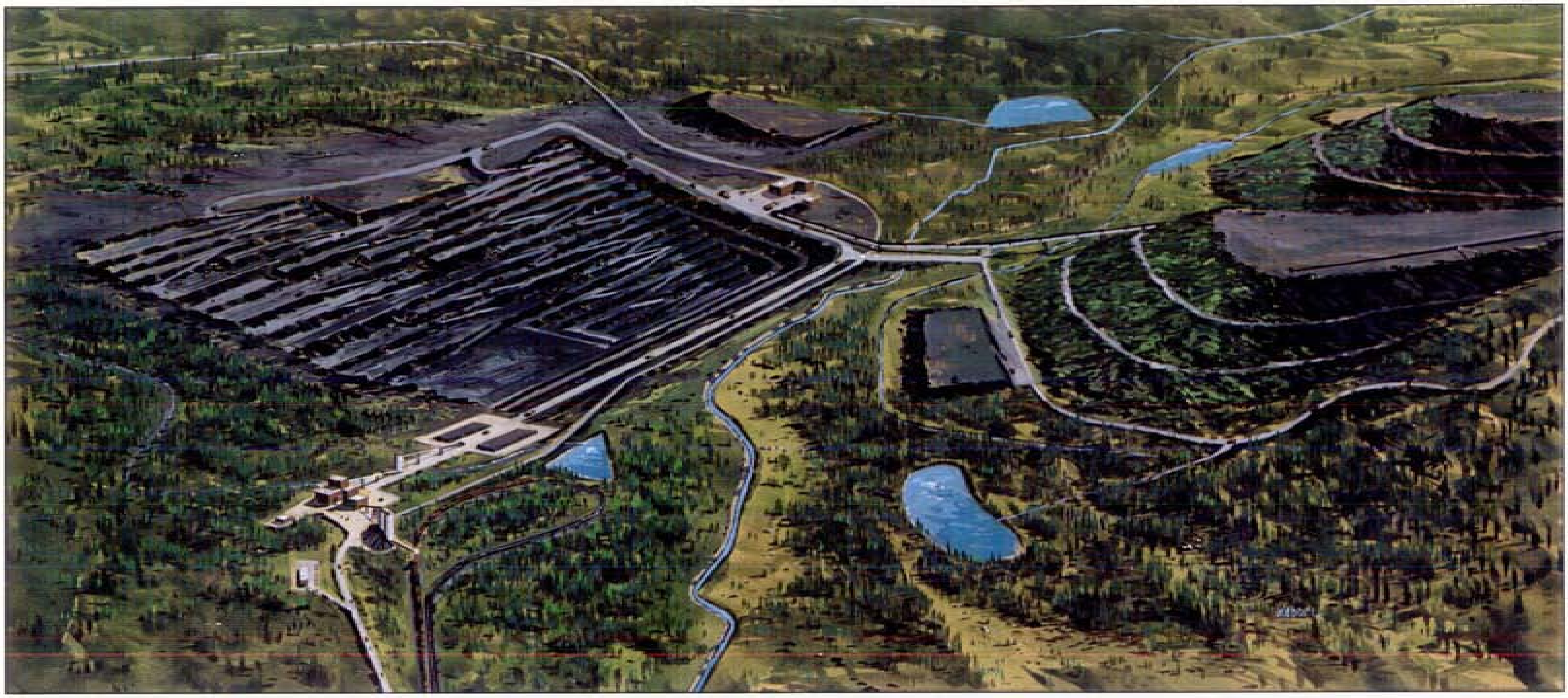

MOUNT KLAPPAN COAL PROJECT

Phillips Barratt Kaiser Engineering Ltd.

GULF CANADA RESOURCES INC.

MOUNT KLAPPAN COAL PROJECT LOCATION MAP

Phillips Barratt Kaiser

MOUNT KLAPPAN COAL PROJECT

MINE ASSESSMENT

VOLUME 1	SUMMARY
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VOLUME 2

GEOLOGY

GULF CANADA RESOURCES INC.

MOUNT KLAPPAN COAL PROJECT GEOLOGICAL REVIEW

1982

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PREFACE

The 1982 Mount Klappan Geological Review presents Gulf Canada Resources Inc.'s first major drilling and mapping programme on the Mount Klappan Anthracite Property in northwestern British Columbia.

This review, which covers the period September 1, 1981 to September 1, 1982, provides a current assessment of the geology, coal quality and resource potential of the property, as well as a more detailed examination of two specific resource areas containing surface mineable coal. The geological and coal quality data presented in this report forms the basis for a concurrent mining assessment.

This volume presents work, evaluations and opinions of Gulf Canada Resources Inc.

Phillips Barratt Kaiser Engineering Ltd. was responsible for the format, typing, printing, and binding for inclusion in the overall mining assessment.

MOUNT KLAPPAN COAL PROJECT

VOLUME 2

GEOLOGY

TABLE OF CONTENTS

MOUNT KLAPPAN COAL PROPERTY

SUMMARY

INTRODUCTION

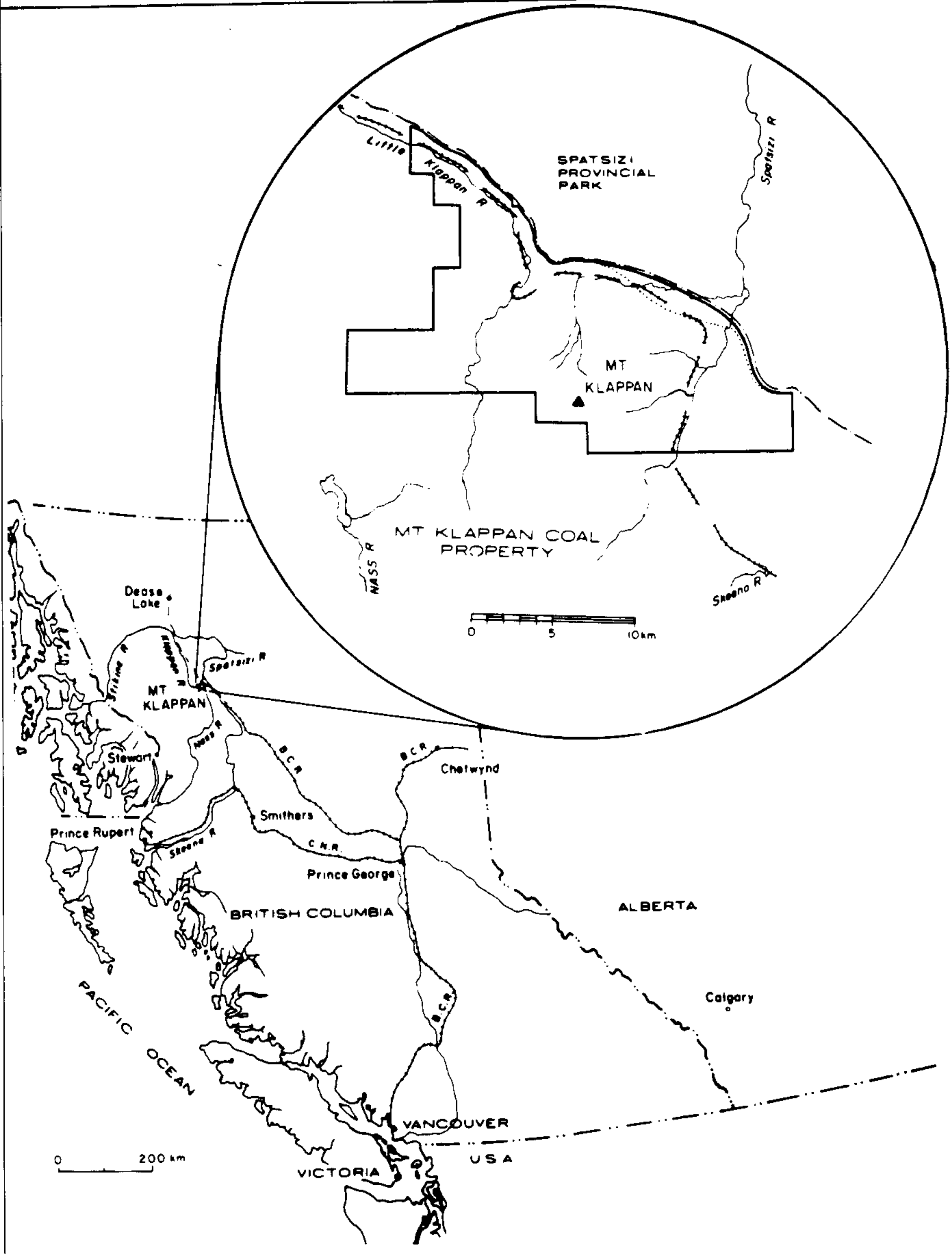
The Mount Klappan coal property is situated in northwestern British Columbia. The property is underlain by the coal bearing Upper Jurassic to Lower Cretaceous Klappan Sequence.

A total of 12 seams with an aggregate average thickness of 25.2 metres occurs within the 300 - 350 metre interval of the Middle Klappan Sequence.

The property is estimated to have a resource potential of 3 billion tonnes of coal of which 890 million is calculated to be inferred resources.

The Mount Klappan coal is an anthracite from which clean coal products with ash levels as low as 5% can be produced.

MT. KLAPPAN COAL PROPERTY
LOCATION MAP



LOCATION

The Mount Klappan coal property is situated in northwestern British Columbia approximately 336 km northeast of Prince Rupert. The licences, just north of the Groundhog coalfield at the northern end of the Bowser Basin, are located at the headwaters of the Little Klappan and the Spatsizi Rivers. The topography is characterized by broad open subalpine valleys and generally subdued mountains with elevations ranging from 1 100 to 2 000 metres.

ACCESS

By completing one bridge and constructing another two smaller bridges on the British Columbia Railway subgrade, road access to the property could be established. The route extends northwards along Highway 37, from the Prince George - Prince Rupert Yellowhead Highway, to just south of Dease Lake and then along the existing British Columbia Railway subgrade. The property is also accessible by air to a 1000 metre airstrip on the property.

PROPERTY DESCRIPTION

The licences cover 22 371 hectares of land. As a result of the 1982 exploration a further 15 901 hectares are under application to the government of British Columbia resulting in a combined total of 38 272 hectares. The Mount Klappan licences are wholly owned by Gulf Canada Resources Inc. of Calgary, Alberta.

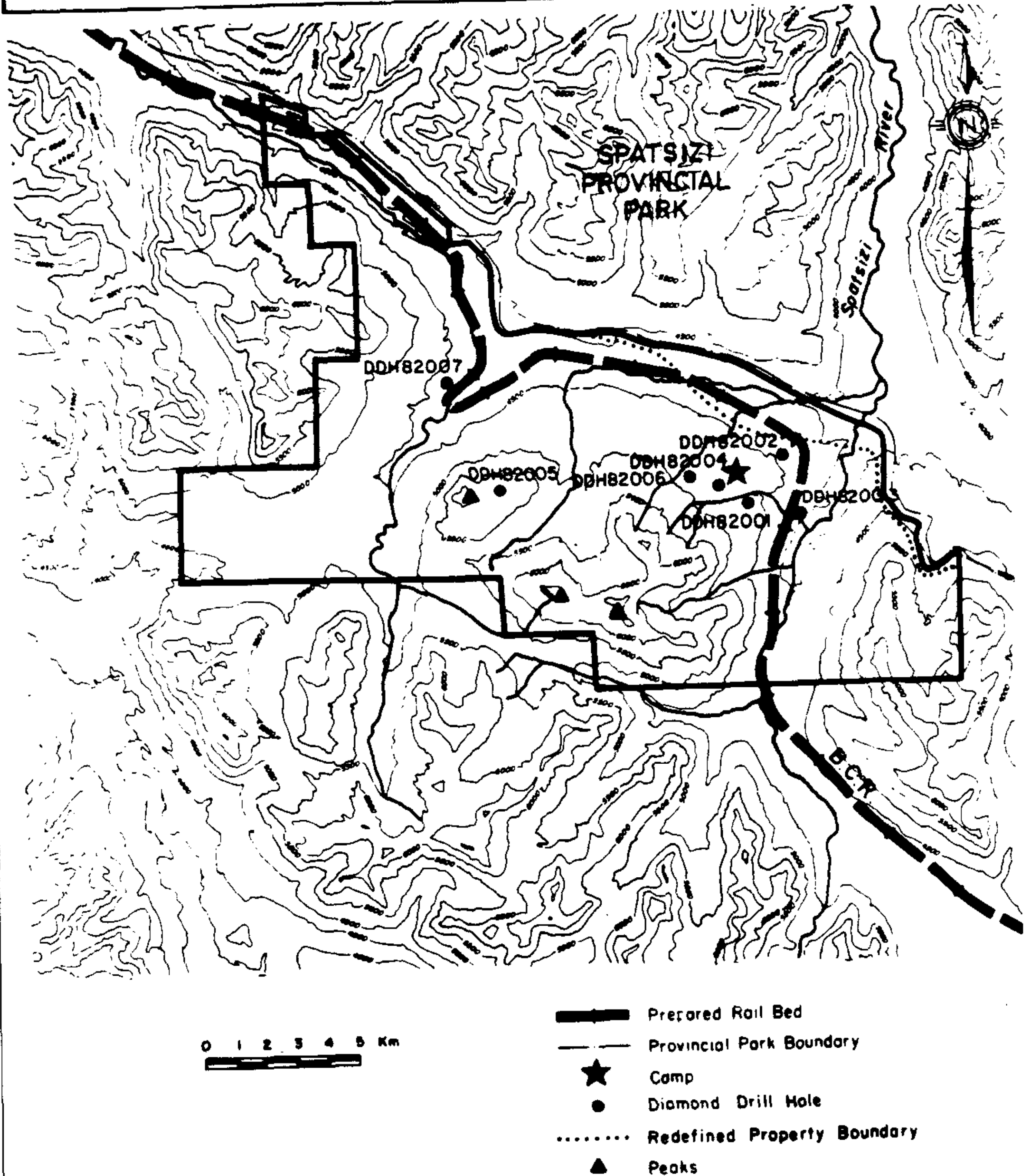
HISTORY

The coal occurrences of the Bowser Basin have attracted interest since the mid to late eighteen hundreds. However, only in the last few years has serious attention been directed to the search for anthracite in the northern portion of the basin.

Since 1979 Gulf Canada Resources Inc. has undertaken a systematic programme of exploration of the north portion of the Bowser Basin. This work culminated in the acquisition of the Mount Klappan coal property in 1981.

MT. KLAPPAN COAL PROPERTY

DIAMOND DRILL HOLES



EXPLORATION

1981 Programme

An initial geological assessment of the property was made in the late summer and early fall of 1981. Data gathered from the assessment guided the design of the 1982 exploration programme.

1982 Programme

Based on the 1981 results, a detailed geological mapping, trenching and diamond drilling programme was conducted during the summer of 1982. Fifty hand trenches, with an aggregate length of over 285 metres, were dug in coal exposures, and 7 core holes were drilled for a total of 1223 metres. Coal samples taken during the coring programme were subjected to detailed analytical testing and washability studies.

STRATIGRAPHY

The Klappan area is underlain by Upper Jurassic to Lower Cretaceous sediments which Gulf geologists have subdivided into four sequences. In ascending order they are: an unnamed unit, the Klappan, Malloch and Rhondda Sequences with the Klappan Sequence being the main coal-bearing unit. The licenses are underlain by the Klappan Sequence with Malloch occuring off the southeastern and southwestern boundaries.

KLAPPAN SEQUENCE

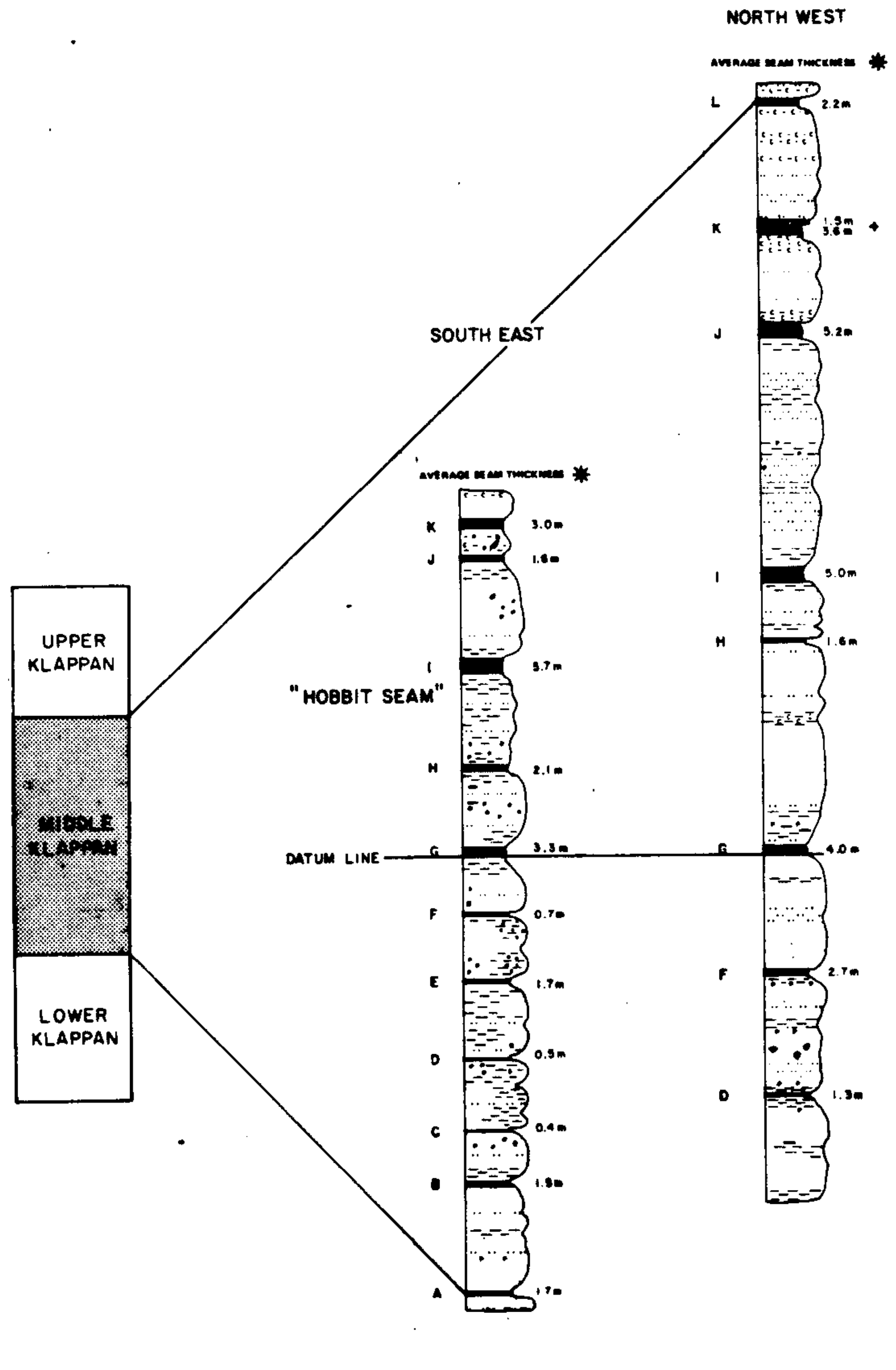
The Klappan Sequence, which comprises interbedded sandstones, siltstones, claystones and coal, is subdivided into a lower, middle and upper unit on the basis of coal seam distribution within the sequence. The Middle Klappan Unit, which varies from 300 to 350 metres, contains the bulk of the coal resources on the property. Twelve seams with an aggregate average thickness of 25.2 metres were intersected. The seams, which are named A to L in ascending order, vary from less than one metre to seven metres in thickness, although local structural thickening has resulted in thicknesses close to eight metres.

STRUCTURE

The property can be subdivided into three structural blocks, the upper, middle and lower, separated from each other by the Mount

MT. KLAPPAN COAL PROPERTY

MIDDLE KLAPPAN UNIT



SCALE - 1:2000 ✱ INCLUDES SEAM INTERSECTIONS < 0.5 m
+ EXCLUDED FROM SEAM STATISTICS DUE TO LOW COAL/ROCK RATIO

NOV., 1982

Klappan and B.H.G. Thrusts. The structural blocks are characterized by folds which become increasingly overturned, both northeast and northwest. Minor faulting was noted on each block. Typically, the overturned folds have long gently dipping southwest limbs and short vertical to overturned northeast limbs. Regular plunge changes maintain the Middle Klappan close to the surface.

RESOURCES

The Mount Klappan property has a resource potential of 3 billion tonnes, (rounded down to the nearest billion tonnes) of which 890 million tonnes is classified as inferred, 1.2 billion tonnes as speculative resources, and in excess of 1 billion tonnes as a potential resource. The inferred resource is contained within three areas, the Hobbit-Broatch, Lost-Fox and Summit Resource Areas, comprising 15% of the property. The Hobbit-Broatch area, with an inferred resource of 620 million tonnes, is the largest, followed by the Lost-Fox area with 240 million tonnes, and the Summit area with 30 million tonnes. Most of this resource is extractable by surface mining methods.

COAL QUALITY

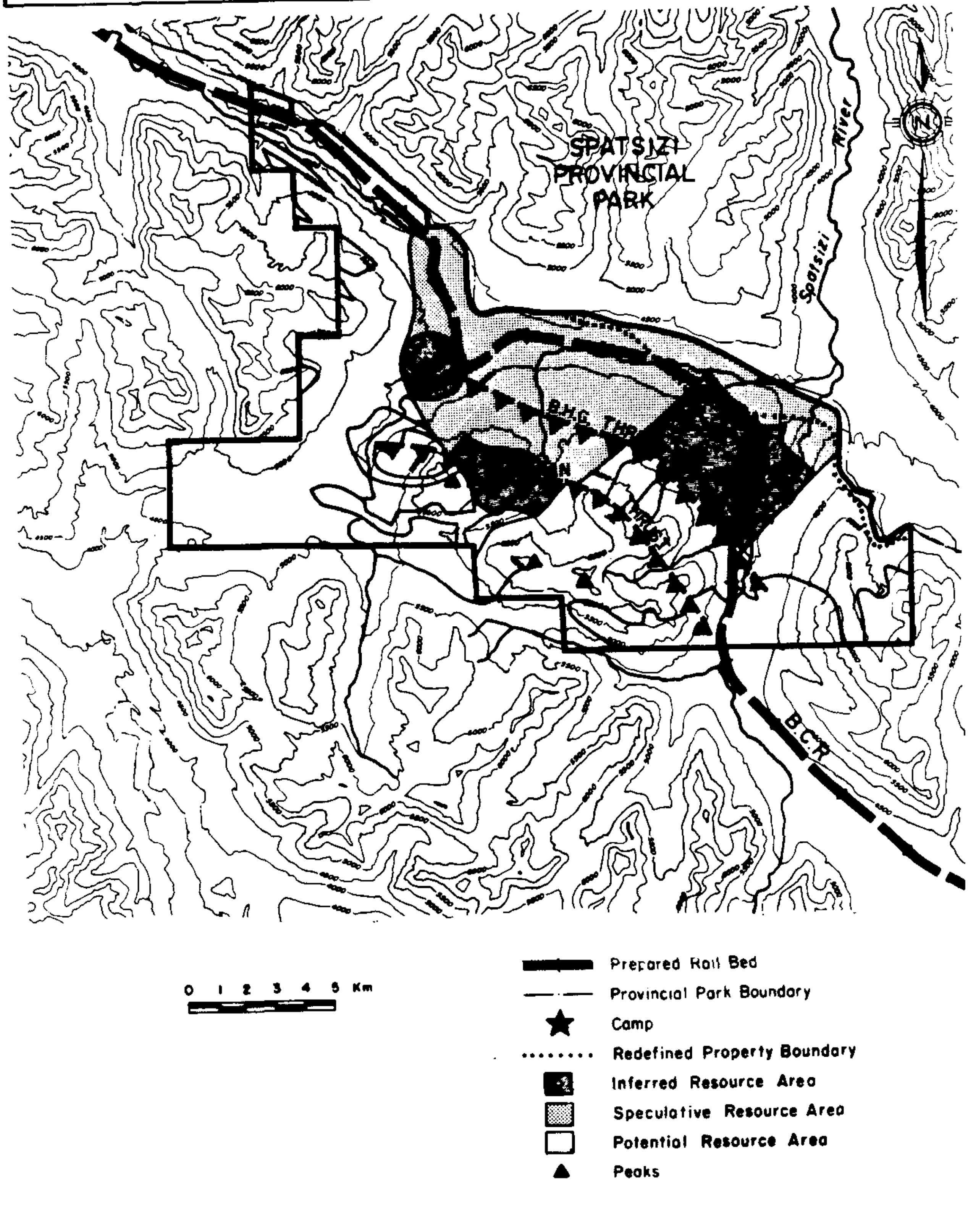
The Mount Klappan property is underlain by anthracite which can be washed to produce a variety of product coals. Low sulphur, clean coal products, ranging from low ash anthracites, (5 to 6% and 9 to 11% ash) to briquetting coal (20% ash) are available from the property.

PREMIUM COALS

Selected seams can be washed to produce anthracites with ash levels as low as 5% to 6%, and calorific values of 7 800 calories per gram, and greater. These low ash coals have an average simulated washplant yield of 40% although a yield of 61% was achieved for one seam in the Lost-Fox Resource Area. Sulphur is consistently low; coals have an average total sulphur content of less than 0.6%. The coal is hard with average Hardgrove Indices of 35 for the 5% to 6% ash products, and 44 for the 9% to 11% ash coals.

MT. KLAPPAN COAL PROPERTY

RESOURCE AREAS



BRIQUETTING COAL

Briquetting coal can be produced from most seams on the property. At a 19% ash level, a simulated washplant yield of 82% of 0.6% sulphur coal was attained. The calorific value for briquetting coal would average in excess of 6 500 calories per gram.

Quality parameters for both the low ash and briquetting coal are presented in the table on the following page.

PRODUCT SPECIFICATIONS
(air dried basis)

AVERAGE VALUES*

PREMIUM COALS

5% - 6% Ash

Simulated Washplant Yield (%)	40.0
Proximate Analysis	
Residual Moisture (%)	0.6
Ash (%)	4.9
Volatile Matter (%)	6.2
Fixed Carbon (%)	88.3
Total Sulphur (%)	0.5
Calorific Value (cal/g)	7956
Hardgrove Index	35
Volatile Matter (dmmf) (%)	6.0

9% - 11% Ash

Simulated Washplant Yield (%)	46.0
Proximate Analysis	
Residual Moisture (%)	0.9
Ash (%)	9.6
Volatile Matter (%)	6.9
Fixed Carbon (%)	82.6
Total Sulphur (%)	0.6
Calorific Value (cal/g)	7462
Hardgrove Index	44
Volatile Matter (dmmf) (%)	6.7

BRIQUETTING COAL

Simulated Washplant Yield (%)	82.0
Proximate Analysis	
Residual Moisture (%)	1.6
Ash (%)	18.6
Volatile Matter (%)	8.2
Fixed Carbon (%)	71.6
Total Sulphur (%)	0.6
Calorific Value (cal/g)	6515
Hardgrove Index	48
Volatile Matter (dmmf) (%)	8.3

* Averages weighted by clean coal tonnage; results reported on an air dried basis.

PART 1

INTRODUCTION

PART 1 - INTRODUCTION

CONTENTS

1.1 LOCATION

The Mount Klappan coal licences are located in northwestern British Columbia approximately 930 kilometres north of Vancouver, 530 kilometres northwest of Prince George and 336 kilometres north-northeast of Prince Rupert (Plate 1.1). Situated in the northern extremity of the Skeena Mountains between 57°11' and 57°22' north latitude, and 128°39' and 129°05' west longitude, the property covers the headwaters of the Klappan, Little Klappan and Spatsizi Rivers.

The nearest community is the Indian village of Iskut (population 500) which lies 100 kilometres northwest of the property, on the Stewart - Cassiar Highway.

1.2 ACCESS

The property lies on the partially completed British Columbia Railway line from Prince George to Dease Lake (Plate 1.2). Prior to cessation of work on the line, steel was laid from Prince George to within 85 kilometres of the southern end of the licences and, with the exception of a 24 kilometre stretch north of the Kluatantan River, the subgrade was constructed through and past the property to the Stikine River, just south of Dease Lake.

The northern portion of the subgrade, which is linked to Highway 37 by the Ealue Lake Road, provides vehicle access to the property in the fall and winter. Year round travel by this route would require the completion of a bridge across the Klappan River, the construction of two smaller bridges and the clearing of minor mud slides blocking the subgrade. Road distances on the existing road systems to Smithers and Prince Rupert from Mount Klappan are 670 and 800 kilometres respectively. Presently, the most convenient access to the property is by fixed wing aircraft to a 1 000 metre long airstrip (Summit airstrip) located on the railway subgrade in the northern part of the licences. Both charter fixed wing aircraft and helicopter service are available from Terrace, Smithers and Stewart. In addition, a scheduled twice weekly airline service exists between Terrace and Iskut.

1.3 PROPERTY DESCRIPTION

The Mount Klappan coal property comprises licences acquired through three separate applications made by Gulf in 1981 and 1982. The original licence block, which covered the majority of known coal occurrences, was granted on September 1, 1981 and comprised 14 784 hectares of land represented by 60 whole and partial British Columbia coal licences.

Two further applications for 17 coal licences covering 4 771 hectares and 12 coal licences covering 2 816 hectares were granted on March 15 and March 18, 1982 respectively, bringing the grand total to 22 371 hectares of land (Plate 1.3).

As a result of the 1982 programme a further application for 53 coal licences covering 14 901 hectares was made on August 16, 1982. This application is presently being processed by the Government of British Columbia and, when granted, will increase the property size to 37 272 hectares. The area covered by the new application was reconnoitred during the programme and is discussed briefly in this report.

A redefinition of the northeastern boundary of the property has occurred where Gulf reapplied to the Government of British Columbia, on November 16, 1982, for approximately 1 000 hectares of land. The land was previously applied for but not granted to Gulf Canada Resources Inc. due to the inaccurate positioning of the Spatsizi Park's southwestern boundary. When granted this land will increase the property size to 38 272 hectares. This area is, for the purpose of this report, included in all discussions of the geology, structure and resources of the Mount Klappan property.

1.4 OWNERSHIP

The issued Mount Klappan coal licences are wholly owned by Gulf Canada Resources Inc., as are the coal licence applications.

1.5 BIOPHYSICAL ENVIRONMENT

The Mount Klappan coal licences are located near the northern end of the Skeena Mountains physiographic region, at the headwaters of the Little Klappan and Spatsizi Rivers (Plate 1.4). A broad, east-west trending valley occupies the northern part of the licences, paralleling the border of the Spatsizi Wilderness Park.

The coal licences are located in a climatic regime known as the Northern and Central Plateau and Mountains Zone. The long-term mean daily temperatures are similar to those for Fort Nelson and Prince George. Precipitation values average approximately 300 mm per year, which is close to that reported for Calgary, Alberta.

Topographic relief is approximately 1 000 metres within the property. Elevations range from less than 1 100 metres in Didene Creek in the north, to over 2 000 metres on Mount Klappan and the adjacent ridge tops at the south end of the property.

Tree line in the area is at an elevation of 1 500 metres. Scattered coniferous forest exists in the valley bottoms interspersed with grass, shrub meadows and bogs. The higher elevations are characterized by alpine tundra, giving way to weathered bedrock.

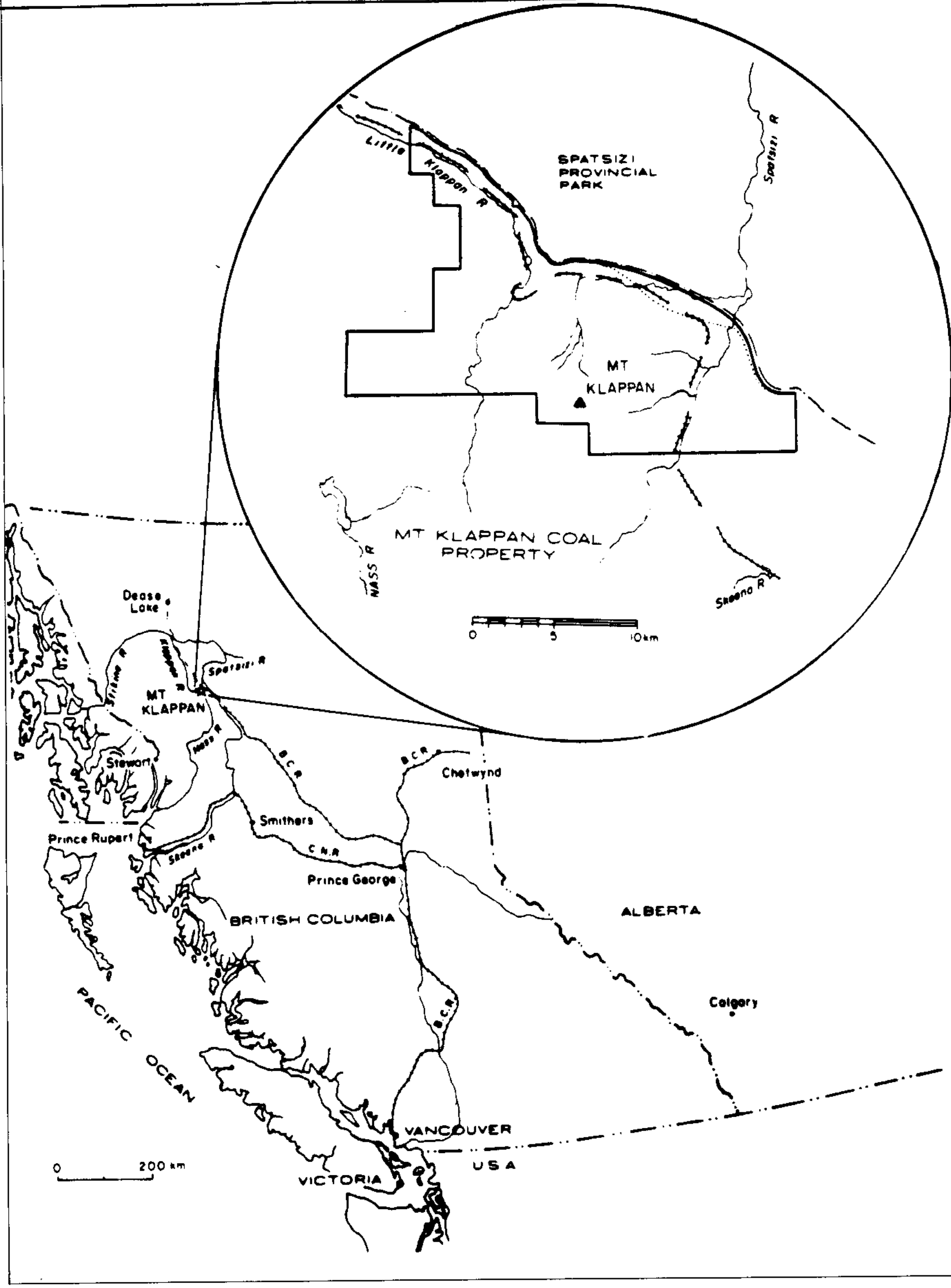
Occasionally, wildlife such as moose, caribou, goat, grizzly bear, black bear and wolves is sighted moving through the property. Area usage by these animals during winter appears to be minimal. The presence of game fish within the area is limited due to the heavy sediment load in the Little Klappan and Spatsizi Rivers.

A weather station, maintained by the British Columbia Government, is located on the northeastern edge of the property. The station has been in place for three years and is monitored monthly.

MT. KLAPPAN COAL PROPERTY

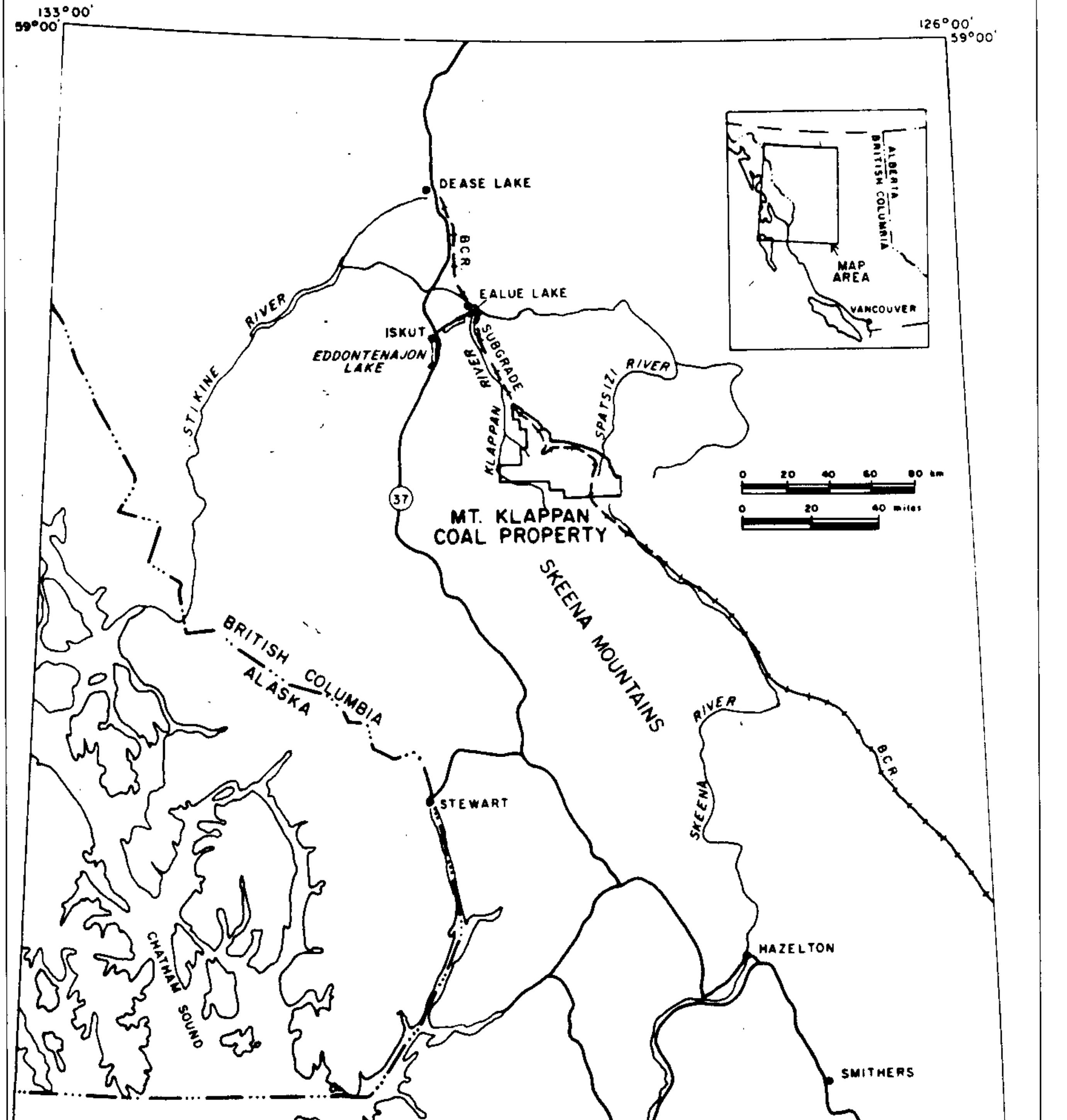
LOCATION MAP

Plate 1.1



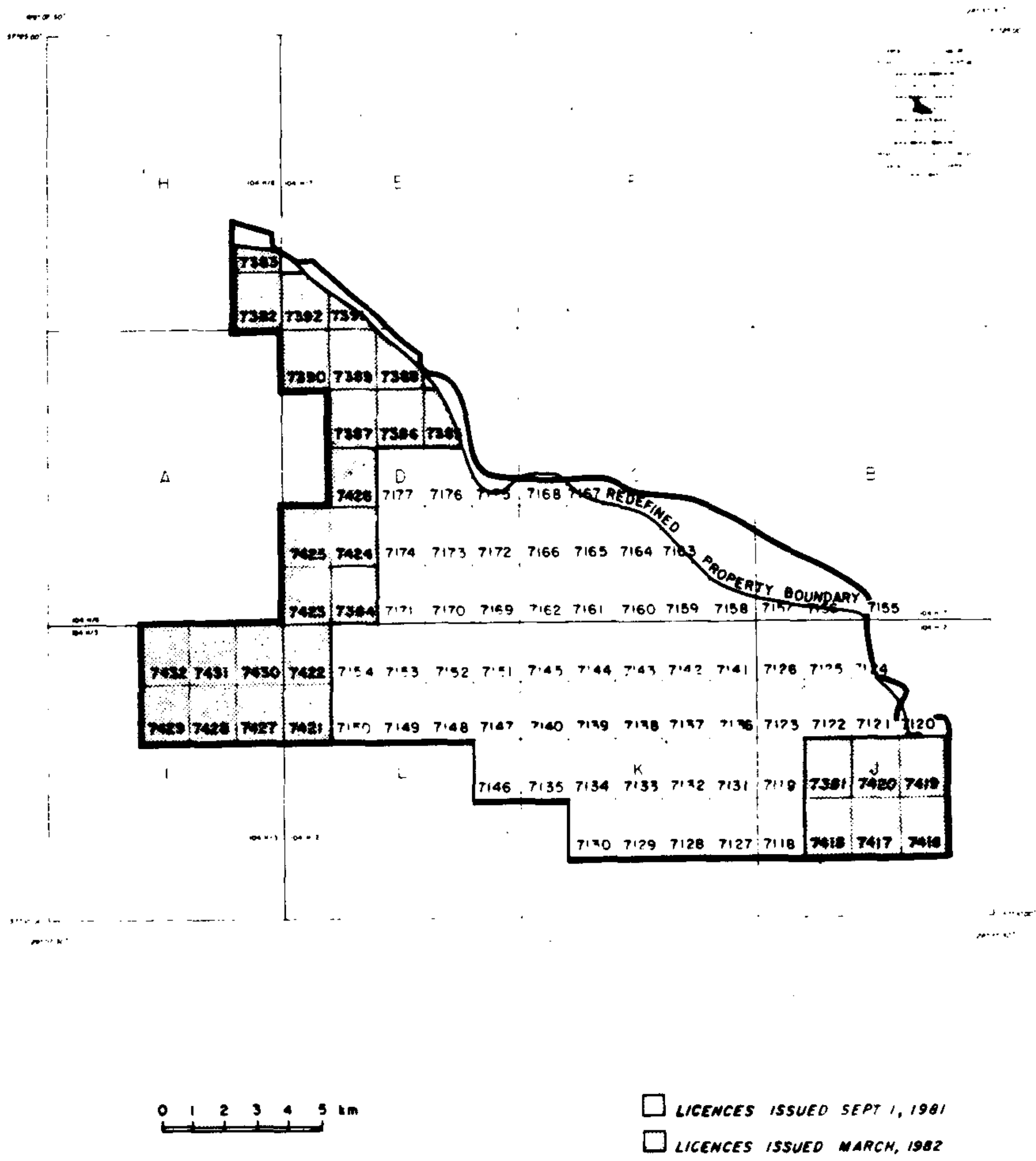
MT. KLAPPAN COAL PROPERTY

PROPERTY ACCESS Plate 1.2



MT. KLAPPAN COAL PROPERTY

LICENCE AREA Plate 1.3



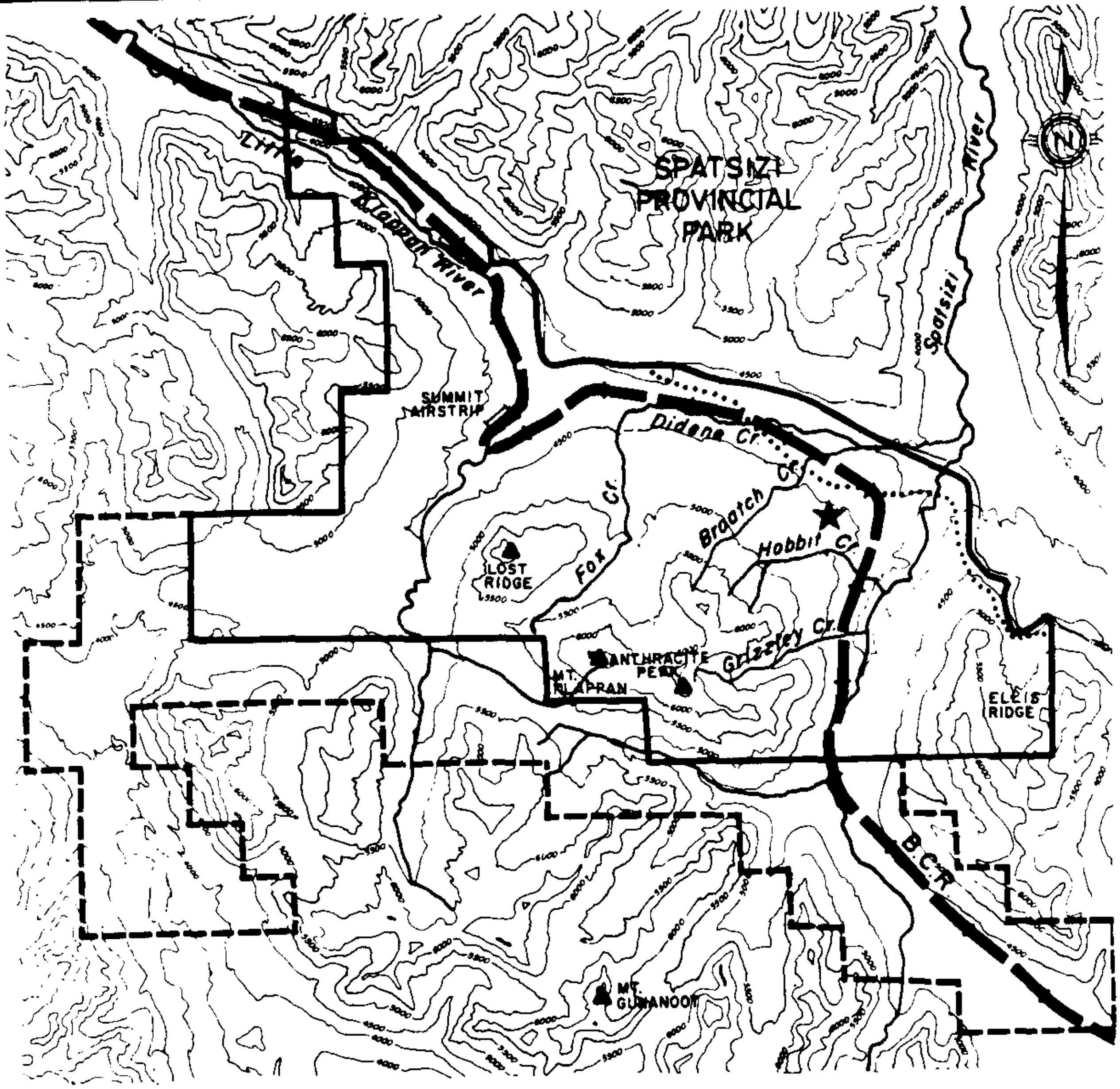
LICENCES ISSUED SEPT 1, 1981

LICENCES ISSUED MARCH, 1982

MT. KLAPPAN COAL PROPERTY

PROPERTY GEOGRAPHY

Plate 1.4



0 1 2 3 4 5 Km

- Prepared Rail Bed
- Provincial Park Boundary
- Camp
- Redefined Property Boundary
- Licences Under Application
- Peaks

PART 2

PROPERTY HISTORY

PART 2 - PROPERTY HISTORY

CONTENTS

2.1 SYNOPSIS

The first published description of coal in the northern Bowser Basin (Plate 2.1) was made in a report prepared by V.H. Dupont (1900) for the Canadian Department of Railways and Canals. The report describes a coal outcrop near the confluence of Didene Creek and the Spatsizi River, which is now recognized to be part of the Klappan coal occurrences.

In 1911, a Geological Survey of Canada (GSC) exploration party, led by G.S. Malloch, undertook a geological evaluation (Malloch, 1914) of the Bowser Basin sediments concentrating on the Groundhog coal occurrences, 55 kilometres to the south of the Klappan coal occurrences. A later programme of the Geological Survey in 1948, led by Buckham and Latour, also concentrated on the Groundhog area. Their report (Buckham and Latour, 1950) summarizes the history of exploration of the Klappan and Groundhog coal measures.

Regional geological mapping was undertaken by the Geological Survey of Canada during Operation Stikine in 1957. Eisbacher (1974, 1981), also with the GSC, published some of the first stratigraphic studies which broadly covered the Klappan coal measures and related the depositional history of the Bowser Basin to the tectonic history of the area.

Broad stratigraphic studies by Richards and Gilchrist (1979) dealt primarily with the Groundhog area but also included reference to the coal sequence of the northern Bowser Basin.

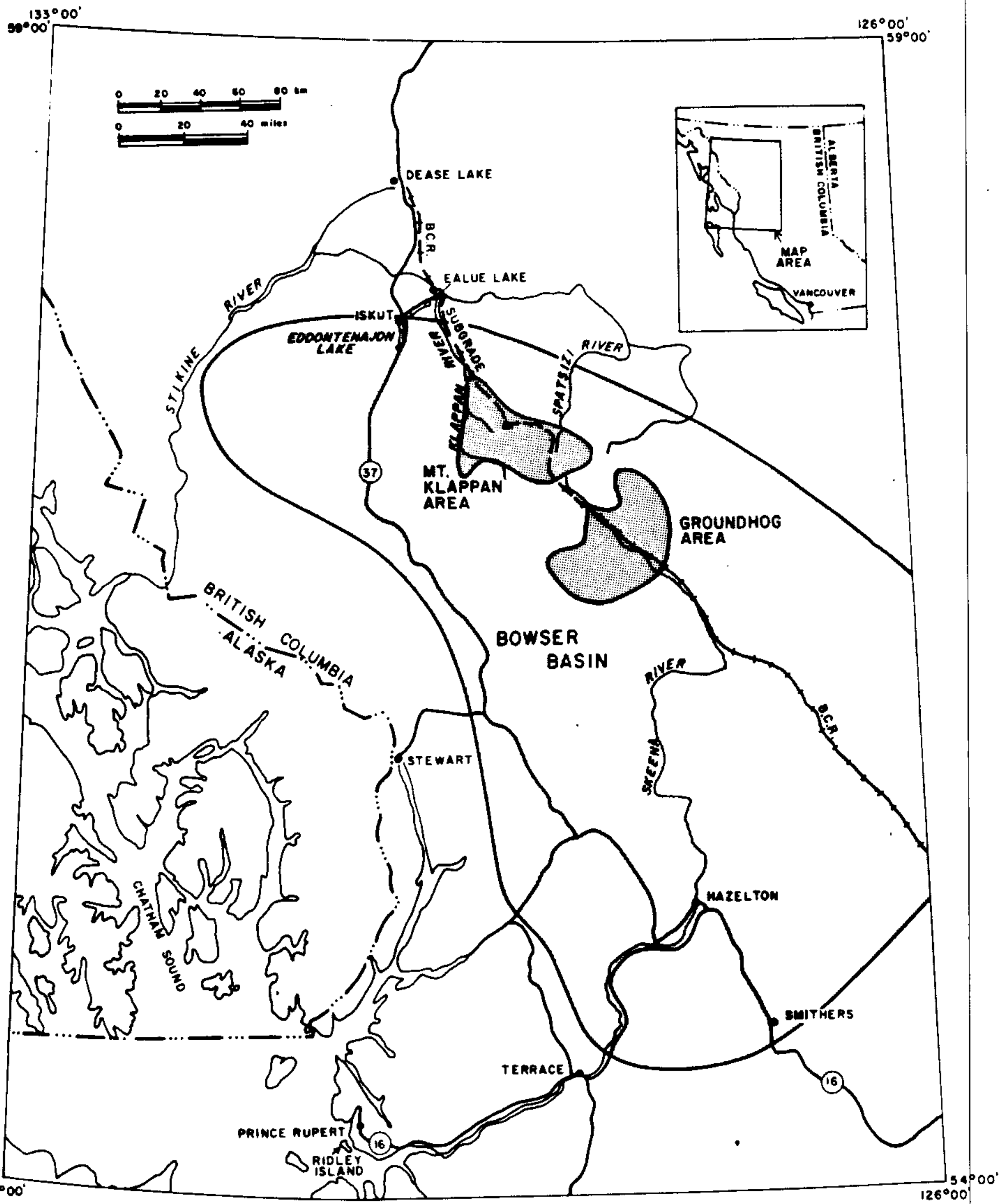
Interest in the Klappan coal occurrences increased during the late 1970's when Esso Minerals Canada and Petrofina both acquired coal licences in the area. After minimal geological evaluation both companies allowed their respective licences to lapse in 1980.

Gulf geologists have been active in the northern Bowser Basin primarily in the general Panorama area since 1979. Initially, work concentrated on the Groundhog coal occurrences and surrounding area. However, in 1981, based on data accumulated through work on the Panorma licences and in Regional Exploration Programmes, combined with other data then available, Gulf Canada Resources Inc. acquired the Mount Klappan property.

A reconnaissance examination of the property in the late summer of 1981 confirmed the opinion that the area was a very favourable prospect for surface mine development. The area was then given priority in Gulf's exploration programme.

MT. KLAPPAN COAL PROPERTY

BOWSER BASIN Plate 2.1



PART 3

EXPLORATION

PART 3 - EXPLORATION

CONTENTS

3.1 SUMMARY OF 1981 EXPLORATION PROGRAMME AND RESULTS

Gulf Canada Resources mounted a brief reconnaissance mapping and coal trench sampling programme on the licences in the late summer of 1981 which indicated that the property could have the potential to produce from one to five million tonnes per year of anthracite product coal over a 20 year period.

An interpretation of the stratigraphy, structure and coal seam distribution indicated that up to six seams with a cumulative thickness of 18 metres of coal could occur over an interval of 200 metres.

Based on the assumption that only two seams might be present, a speculative resource of 95 million tonnes of coal was estimated within a 24 square kilometre area in the southeastern part of the property (Plate 3.1). In addition, the resource potential of the total area covered by the licences was estimated to be in excess of 1 billion tonnes. Analyses of coal taken from a number of trenches indicated that the coal was of anthracite rank. The 1981 assessment included a preliminary examination of the infrastructure requirements for transportation, power and townsite development.

3.2 1982 EXPLORATION PROGRAMME

The greater portion of the 1982 exploration programme was directed to the eastern half of the property. Work was concentrated particularly on the Hobbit-Broatch area in the southeast, where the 1981 geological assessment indicated the presence of substantial quantities of anthracite. The programme spanned the period May to November, 1982, a total of 7 months. Of this period, 2-1/2 months, late June to early September, were spent in the field. The remaining time was divided between preparation for the field season prior to late June, and to data compilation, evaluation and report writing from early September onwards.

321 PROGRAMME OBJECTIVES AND METHODOLOGY

.1 Objectives

The objectives of the 1982 Mount Klappan coal exploration programme were as follows:

To confirm the existence of six seams totalling 18 metres in the Hobbit-Broatch area;

To define a surface mineable inferred resource in the Hobbit-Broatch area;

To identify other surface mineable resource areas;

To determine coal quality and washability characteristics of the coal from fresh samples.

.2 Methodology

To achieve the objectives set out above, an exploration programme comprising detailed geological mapping, trenching, diamond drilling and an in depth coal quality evaluation was designed in the late spring of 1982.

Exploration work on the property was divided into two phases. During the first phase, which spanned late June and July, detailed mapping and coal seam trenching were completed on the eastern half of the licences.

In the second phase, which extended through August into early September, seven diamond drill holes were completed in the eastern part of the property at sites defined by the first phase work. In addition, geological mapping and coal seam trenching were carried out on the western licences.

Additional studies undertaken during these two phases included an assessment of the depositional environment by Gulf sedimentologists as well as the funding of the first year of a Ph.D. thesis on the structure of the area.

Data compilation, evaluation, and report writing were undertaken at Gulf Canada's Calgary office. Extensive use was made of an in-house coal data base for the storage and presentation of geologic and coal quality data, as well as processing and interpretation of the coal washability results.

322 CARTOGRAPHY

Specially prepared 1:10 000 scale topographic maps with a contour interval of 10 metres were utilized for geological mapping. To further assist in the control of the geological mapping, 213 photo identified points were plotted on the 1:10 000 sheets.

In the early part of September the property was flown to provide 1:30 000 aerial photography coverage for the later production of 1:5 000 topographic maps and for geological interpretation.

Inclement weather during the last week of the programme delayed until 1983 the survey of control points for the 1:5 000 maps as well as the exact surveying of the locations and elevations of the diamond drill holes. (Current locations are based on chain and compass surveys from known points).

323 LOGISTICS

.1 Field Camp

The field camp, set up on June 21, 1982, was located on a roughly cleared BCR communication site centrally located in the Hobbit-Broatch area (Plate 3.2). The camp comprised 6 trailers, set up by the BCR when work on the line was in progress, as well as 12 personnel tents and three 16 x 14 foot frame tents. The trailers, rented from BCR, provided kitchen, dining, office and storage facilities while all personnel were housed in the tents. The exploration and support staff averaged 20 people for the duration of the programme.

The camp, geological equipment and two Toyota trucks were mobilized from Smithers and transported to the Summmit airstrip on the Mount Klappan property by a DHC-4 Dehavilland Caribou aircraft. The Toyota four wheel drive trucks were then used to move the equipment to the camp site approximately 10 kilometres to the south (Plate 3.2). A second, totally self contained camp, established by the diamond drilling company, was mobilized during the last week of July and located at the Summit airstrip itself. This camp housed a total of five persons; four drillers and a cook.

An expeditor was retained in Smithers to coordinate the supply and servicing of the Gulf camp initially and, later, the drill camp as well. All supplies were flown to the Summit airstrip on the property by fixed wing aircraft.

The Gulf camp was demobilized on September 14, and the drill camp the following day. The wooden frames of the drillers' four 16' x 14' tents were left standing to provide temporary shelter, should the need arise.

.2 Mapping and Drill Support

The mapping and drilling programmes were supported by the 2 four wheel drive trucks and a Hughes 500 D helicopter. The British Columbia Railway subgrade provided excellent road access in the eastern half of the property and enabled all geological mapping activities, as well as two drill holes in this area, to be serviced by trucks.

To facilitate the mapping of the western half of the property and the movement and support of the drill in the eastern area, a Hughes 500 D helicopter was contracted for 1-1/2 months in late July.

Initial concern that the Hughes would have difficulty moving the heavier pieces of the drill rig at elevations in excess of 1 500 metres proved unfounded. The use of the same helicopter to undertake rig moves and to position mapping crews contributed greatly to the success of the programme.

324 GEOLOGICAL MAPPING

The 1982 exploration programme involved detailed geological mapping at a scale of 1:10 000. Four crews, each consisting of a geologist and a geological assistant, were assigned specific mapping blocks from a total of 11 blocks within the property (see Plate 3.3). The crews accessed their traverse locations by four wheel drive truck, Hughes 500 D helicopter, or by walking from the centrally located camp. A modified plane table method of mapping was utilized to control traverse station positions. This technique uses a 50 metre chain and a Silva compass attached to a portable mapping board. Errors induced by steep slopes were corrected in the field by use of a hand held clinometer.

Traverses were tied to known topographic points or to one or more of the 213 control points on the 1:10 000 base maps. These control points, picked for their ease of identification in the field, included distinctive outcrop patterns and lone trees or shrubs. The positions of the control points on the air photos were determined photogrammetrically and plotted on the 1:10 000 map sheets. At times, field positioning was assisted by 1:10 000 orthophotographs. Field observations were transferred onto 1:10 000 base maps in the field office.

In areas of good outcrop, sections were measured by the mapping teams, and drafted to true thickness at a scale of 1:200.

325 HAND TRENCHING

Fifty trenches were excavated by hand, logged and sampled during the 1982 exploration programme. Two-man crews under the supervision of geologists were responsible for particular mapping blocks (Plate 3.3). Seams within these blocks were trenched, wherever spoil indicated the possibility of a seam thickness greater than 1 metre.

The trenches averaged 0.8 metres in width, 1.0 metre in depth and 5.7 metres in length. In total 285 metres of trenching were completed of which 64% was sampled. All trenched seams were measured in true thickness and described in detail. Locations of the trenches were surveyed by the chain and compass method, and plotted on the 1:10 000 base map.

326 DIAMOND DRILLING

A Longyear Super 38 diamond drill, capable of being broken down for transportation by a Hughes 500 D helicopter, was utilized for the drilling. The rig was mobilized to the Summit airstrip from Dease Lake in the Caribou aircraft and then air lifted by helicopter to the drill sites. The drill rig, which has a vertical depth capacity of over 360 metres, was adequate for the programme requirements which did not exceed 250 metres in any one hole.

A total of 1 223 metres of drilling in seven holes was completed in a 38 day period (Plate 3.4). The rig was operated on a two shift, 24 hour a day basis with a driller and a helper on each shift. Table 3.1 summarizes the results of the programme. All drill holes have been surveyed in by chain and compass, and appear on all appropriate geological maps and cross-sections.

At the completion of the drilling programme, the drill rig was air lifted to the Summit airstrip where it was prepared for winter storage.

327 GEOPHYSICAL LOGGING

With the exception of DDH82001 all holes were geophysically logged. Caving, which occurred in DDH82001, during a delay in receiving a replacement geophysical logging unit, prevented logging of this hole. The original logging unit was destroyed during transportation by helicopter. Unstable drill hole conditions encountered in DDH82004, 82005 and 82007 resulted in the holes being logged with gamma ray, neutron and density tools only, for part of the hole.

The following is a list of the full suite of logs run during the programme.

Gamma Ray

Neutron

Sidewall Density

Focused Beam Resistivity

Caliper

Direction Deviation

The logs were run at a general scale of 1:200. Detailed logs were produced at a scale of 1:40 over the coal seams utilizing the density-resistivity, gamma ray and caliper responses. A digital geophysical logging system was employed; the information from probe readings down-hole was recorded directly onto magnetic tape. Paper prints of the logs were produced in the field to assist in core logging and correlation.

328 DRILL CORE LOGGING AND SAMPLING

The drill core was logged and sampled by Gulf geologists who described the following parameters in detail: basic lithologies, fossil occurrences, sedimentary structures, stratigraphic marker beds, and any structural features such as larger scale folds and faults. The bedding to core angle (BCA), the angle between bedding and a line parallel to the core axis, was recorded for use in determining the true thickness of the strata intersected.

Coal core logging was based upon the percentage of the coal maceral vitrain (bright coal) contained within a measured unit of core, and upon any rock splits found contained within the coal. The following is a breakdown of the coal core description.

Bright	80%	Vitrain	C-1
Bright banded	60-80%	Vitrain	C-2
Dull/bright	40-60%	Vitrain	C-3
Dull banded	20-40%	Vitrain	C-4
Dull	20- 0%	Vitrain	C-5
Bone or stone	0%	Vitrain	C-6

All coal core in excess of 0.5 metres apparent thickness, was sampled and sent to laboratories for detailed coal quality and washability tests. Samples were selected on the basis of geophysical log traces, cross-matched with the written log. Samples were taken in intervals small enough to assist in later compositing. Rock samples were taken of the main lithologies in each drill hole for further analysis. Whenever possible, the core was photographed prior to sampling.

Strip logs illustrating the core description as drilled and as corrected to true thickness were drafted at a scale of 1:200. The core was stacked at the camp site and covered to protect it against the elements.

329 DRILL CORE AND TRENCH SAMPLE ANALYSIS

All drill core coal samples were submitted for preliminary analysis to an independent laboratory. The coal samples were subjected to detailed washability studies from which a variety of product coals were produced. Each product coal then underwent extensive analytical testing.

3210 DATA MANAGEMENT

A majority of the data collected for the 1982 Mount Klappan Exploration Programme is stored in the coal data base on Gulf's AMDAHL V6 computer. The data stored includes all drill core descriptions, detailed records of each drill hole and trench, complete descriptions of all samples collected and all coal quality and washability data. The coal data base utilizes the System 2 000 data base management system and Act 1 software to provide easy on-line date entry and screen retrieval of stored data.

3211 RECLAMATION

The drilling programme, undertaken with helicopter support, resulted in minor disturbance to the seven drill sites as only minimal clearing of subalpine trees and shrubs was necessary for site preparation. All equipment and garbage has been removed from the sites. Coal seam hand trenches remain open for further inspection and back-filling will be undertaken at a later date.

The camp area utilized an existing BCR communication relay site. All camp equipment and most materials have been shipped to Smithers for winter storage, although some material has been packed inside the BCR trailers on the site. All garbage has been removed and an erosion berm on the access road was replaced.

3212 SPECIAL PROJECTS

.1 Depositional Environments

In early August two sedimentologists from Gulf Canada's Geological Services Department visited the Mount Klappan property. The purpose of their visit was to initiate studies which would lead to a paleoenvironmental interpretation of the Mount Klappan property. Outcrops and drill core were reviewed and sampled with special attention being paid to sedimentary structures, fossil content and lithologic relationships. Samples were obtained for petrologic and X-ray diffraction studies, and micro and macro fossil identification was undertaken.

.2 Regional Structure

Gulf has sponsored the first year's field work for a Ph.D. thesis on the regional structure of the northern Bowser Basin. The Ph.D. candidate is working under the supervision of the Geology Department of the University of British Columbia.

TABLE 3.1

GULF CANADA RESOURCES INC. - COAL DIVISION

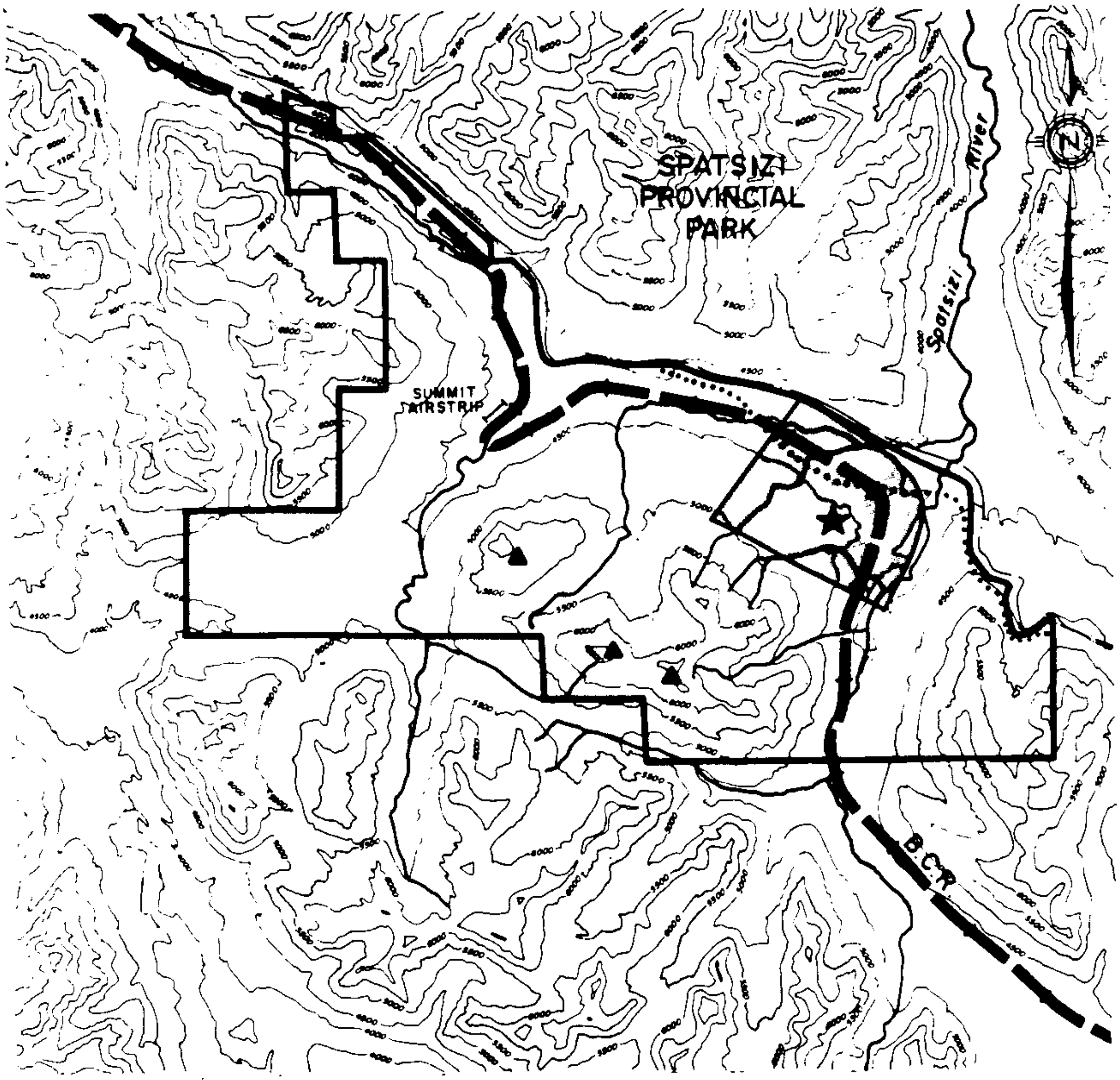
PROJECT DATA SOURCE SUMMARY

Data Source	Area	Location Northing Easting	Elevation (m)	Length (m)	Angle	Azimuth	Geophysical Logs
KPNHCDDH82001	Hobbit Creek	6 343 645.0 514 375.0	1 400.0	124.1	90.0	0.0	Not Logged
KPNHCDDH82002	Hobbit Creek	6 345 134.0 515 445.0	1 342.0	179.0	90.0	0.0	Open Hole
KPNHCDDH82003	Hobbit Creek	6 343 325.0 515 540.0	1 271.0	215.5	90.0	0.0	Open Hole
KPNBCDDH82004	Broatch Creek	6 344 510.0 513 515.0	1 470.0	157.6	60.0	40.0	Thru Rods
KPNLRDDH82005	Lost Ridge	6 344 340.0 506 120.0	1 815.0	243.6	60.0	55.0	Thru Rods
KPNBCDDH82006	Broatch Creek	6 344 865.0 512 650.0	1 489.0	173.0	60.0	345.0	Open Hole
KPNSSDDH82007	Summit South	6 347 475.0 504 420.0	1 315.0	130.2	70.0	5.0	Mostly Open Hole

MT. KLAPPAN COAL PROPERTY

1981 SPECULATIVE RESOURCE AREA

Plate 3.1

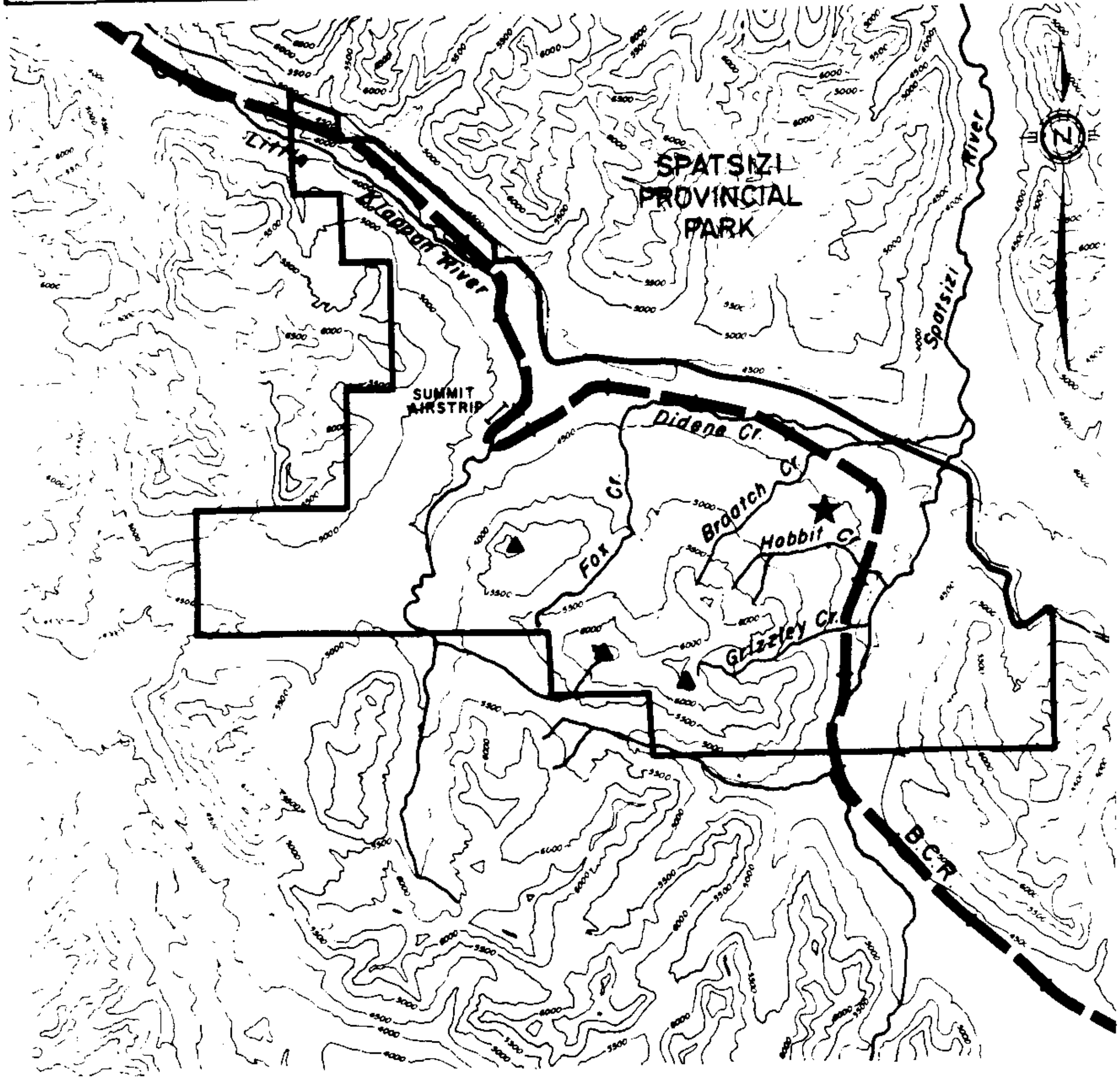


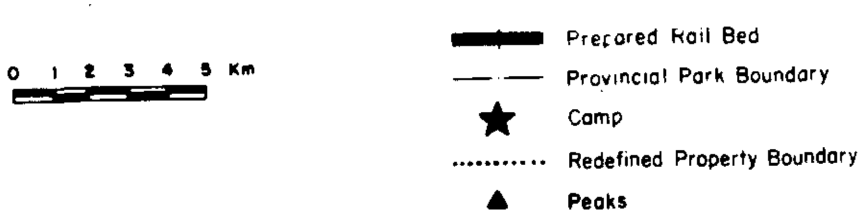
0 1 2 3 4 5 Km

Prepared Rail Bed
Provincial Park Boundary
Camp
Redefined Property Boundary
Peaks

MT. KLAPPAN COAL PROPERTY

CAMP LOCATION Plate 3.2

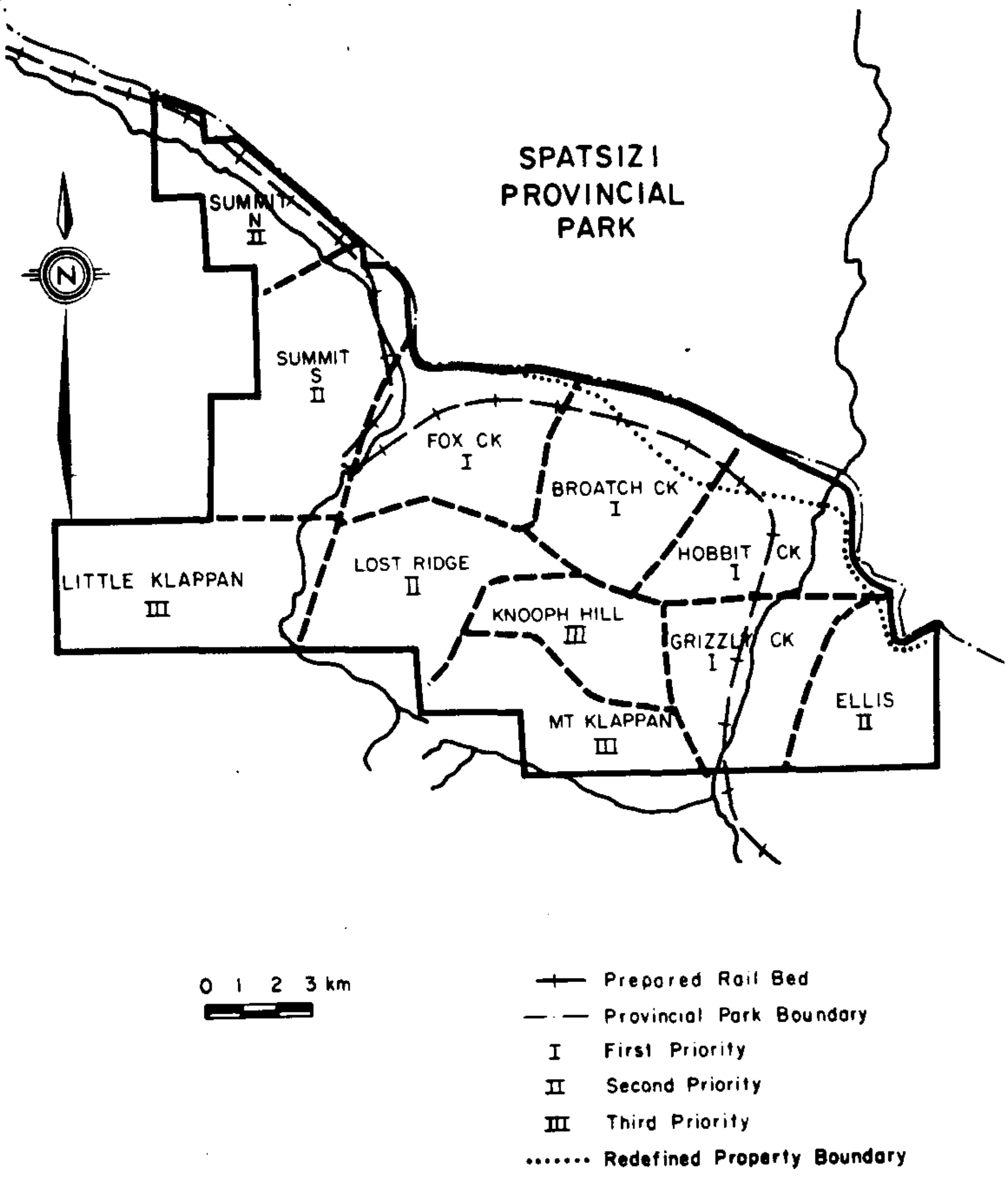




MT. KLAPPAN COAL PROPERTY

1982 EXPLORATION MAPPING AREAS

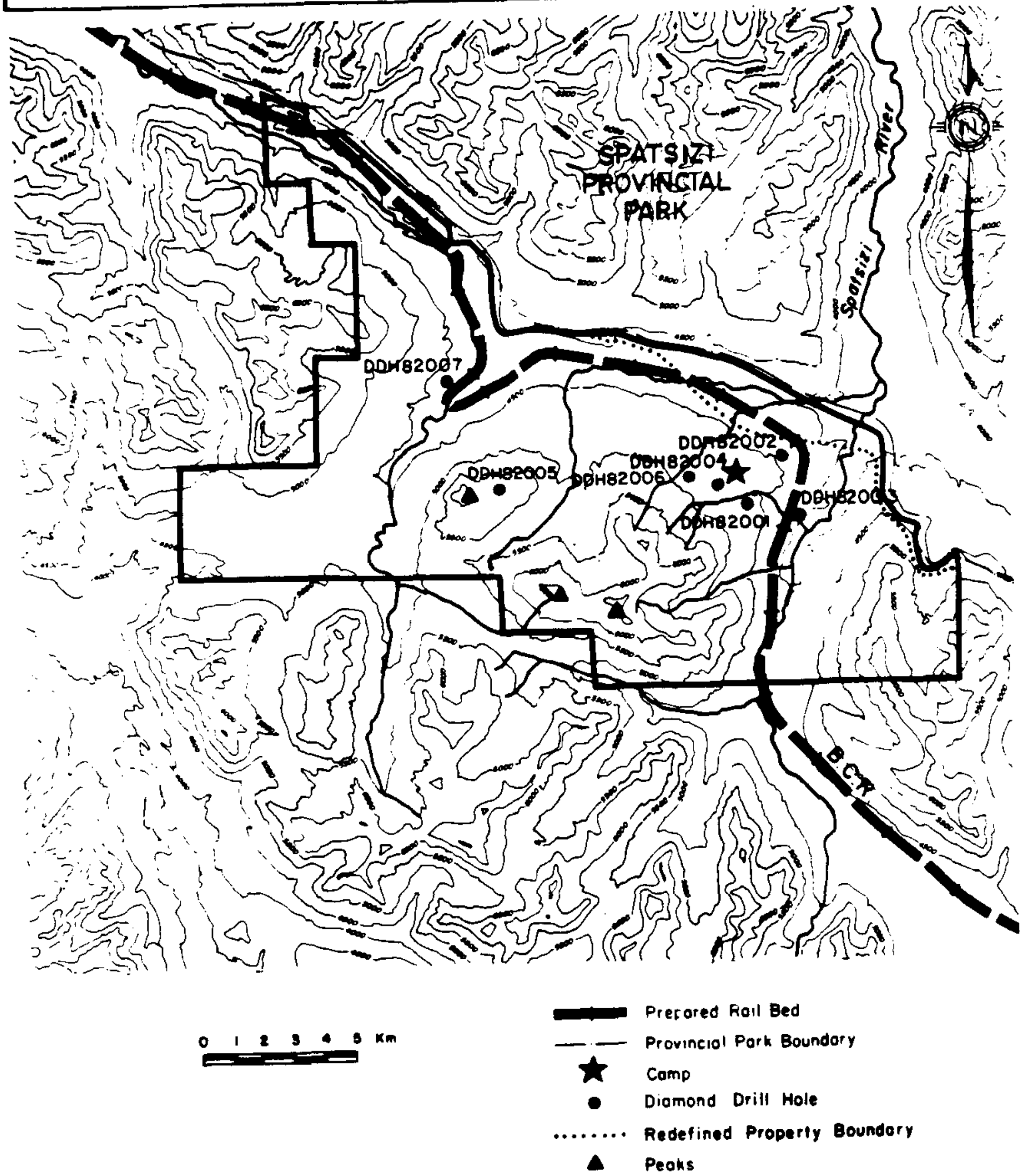
Plate 3.3



MT. KLAPPAN COAL PROPERTY

DIAMOND DRILL HOLES

Plate 3.4



PART 4

GEOLOGY

PART 4 - GEOLOGY

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Plate

4.1 GEOLOGY

While the bulk of the property is underlain by coal bearing Middle Klappan sediments, the concentration of exploration activity: mapping, drilling, coal quality evaluation and detailed resource calculations, has to date mostly been directed towards two areas covering less than 15% of the property. These areas are the Hobbit-Broatch and Lost-Fox Resource Areas. The concentration of activity in the two areas is in direct proportion to the number of coal seam exposures. These seam exposures have allowed a quantitative and qualitative examination of the Middle Klappan coals, and the structure affecting the coal measures.

As most of the available data is from these two areas, the report will, to a large extent, focus on the Hobbit-Broatch and Lost-Fox areas, However, placed in perspective, the remaining 85% of the property which is interpreted to be mostly underlain by Middle Klappan sediments, may, with further work and drilling, prove to be equivalent to or better than the Hobbit-Broatch and Lost-Fox areas in terms of coal quality, reserves and amenability of structure to surface mining

An indication of the coal potential of this area is examined in Part 5, Resources.

4.2 REGIONAL GEOLOGY

421 GEOLOGIC SETTING

The coal measures of the Mount Klappan property are contained within a series of sediments deposited during middle Jurassic to early Cretaceous times in the Bowser Basin (Figure 4.1). The Bowser Basin conforms, in terms of its depositional setting, to the classical model of the "successor basin" (Eisbacher, 1974b, p. 274). The establishment of the Bowser Basin succeeded a period of eugeosynclinal marine volcanic activity and sedimentation. Uplift due to crustal collision from the west caused the basin to become at least partially enclosed and initiated a southwesterly progradation of coarse marine to non-marine deposits.

The Bowser Basin is bounded by the Stikine Arch to the north, in the area now occupied by the Stikine River; by the Skeena Arch to the south; and by the Columbia Orogen (Omineca Crystalline Belt) to the east (Figure 4.1). The western margin is thought to have been open to the sea at the time of Bowser sediment deposition. Paleocurrent measurements indicate a centripetal flow into the basin with material being drawn from the respective highlands to the north, south and east.

A progression through distal deltaic facies and turbidites, prodelta subsea fans, distal to proximal distributary channels and finally to paralic coal swamps and alluvial fans is interpreted for the sedimentary environments of the Bowser Basin (Eisbacher, 1974b).

422 REGIONAL STRATIGRAPHY

In the southern portion, the assemblage contained within the basin has been subdivided into three groups by Tipper and Richards (1976). These groups, in ascending order are: the Early Jurassic to Middle Jurassic Hazelton Group, the Upper Jurassic Bowser Lake Group and the Early Cretaceous Skeena Group. In the area discussed by Tipper and Richards (1976), the Skeena Group contains the major coal occurrences with some coal occurring at the top of the Bowser Lake Group.

In the northern Bowser Basin no such comprehensive work has been done, and the sedimentary package associated with the coal in the Klappan-Groundhog area has been variously named the Skeena Series (Malloch, 1914); Upper Hazelton; (Buckingham and Latour, 1950); Groundhog-Gunanoot (Eisbacher, 1974) and has been dated as Lower Cretaceous (Malloch, 1914; Buckham and Latour, 1950) and Upper Jurassic to Lowest Cretaceous (Eisbacher, 1974) Table 4.1.

Gulf's geologists, until September 1982, adopted the name Skeena for the coal sequence of the Klappan-Groundhog area because of the widespread use of this term in the southern part of the basin. At that time, lacking specific fossil evidence to the contrary, Malloch's assignment of the name Skeena to the Lower Cretaceous was also accepted for the Klappan area.

In the fall of 1982, micropaleontological evidence (Gulf Laboratory -personal communication) indicated a Jurassic age for the Klappan sediments which would place these beds within the Bowser Lake Group as defined by Tipper and Richards (1976). Petrographic analyses further supported a possible Bowser Lake Group affiliation.

Pending more extensive work it was decided not to assign a specific age or group status to the Klappan coal measures.

.1 Klappan-Groundhog Area Stratigraphy

In the Klappan area the Upper Jurassic to earliest Cretaceous sedimentary package is subdivided into four sequences, which, in ascending order, are an unnamed sequence, the Klappan, Malloch, and Rhondda Sequences with the Klappan being the main coal-bearing unit (Figure 4.2). The subdivision is in many respects equivalent to the four-fold subdivision established in the Groundhog area (Gulf Canada Resources Inc. 1981 Panorama Geological Report). While the Malloch and Rhondda have been tentatively traced from the Klappan area south to the Groundhog area, correlation of the Klappan and the unnamed Sequences with the equivalent units in the south is tenuous at best (Figure 4.3).

Thus, while it is realized that, with much more work, the Klappan Sequence may be proven to be the same as the Groundhog Sequence, marked differences in coal thickness, frequency and continuity, as well as in coal quality between the two sequences have resulted in Gulf treating them as separate units.

The strata underlying the coal beds at Klappan are not well exposed, consequently it is not known if these beds correlate with the Panorama Sequence to the south. Thus, this sequence at Klappan remains unnamed at this time.

423 STRUCTURE

Structural deformation of Bowser Basin sediments resulted from intermittent tectonic stresses at the western craton margin from Cretaceous to recent time. The deformation caused an extensive, shallow decollement, recumbent folds, and local thrust faults extending a few kilometres along strike (Eisbacher, 1976).

The large scale forces resulting from collision of a remnant volcanic arc and cratonic margin subjected the area to northeast-southwest compression creating the general structural trend of northwest-southeast. This trend is recognized in fold axial planes, cleavages and thrust surfaces which regionally tend to dip to the southwest. Later positioning of the former volcanic arc terrain northward along interlaced right lateral high angle faults (Eisbacher, 1981) may account for a later north-south compressional event. The final deformational event which produced strike slip and some dip slip faulting may have resulted from a change in the rotational component of the western crustal block, terminating compression.

4.3 PROPERTY GEOLOGY

The Mount Klappan Property is underlain almost exclusively by the coal-bearing Klappan Sequence (Table 4.2). Malloch sediments are exposed in the extreme southeast of the property with both Malloch and Rhondda Sequences outcropping off the southwestern boundary of the licences. Thus, while the lithologies of the Klappan Sequence are described in detail, discussion of the Malloch, Rhondda and the unnamed Sequences will be brief.

431 UNNAMED SEQUENCE

Below the coal measures in the Groundhog area lies a succession of fine to medium-grained, medium to thick-bedded, grey sandstone, gradationally associated with subordinate interbeds of recessive claystone and siltstone. The coarser units may exhibit primary sedimentary structures, such as ripple-marks and cross-bedding, whereas the finer units are sometimes carbonaceous and occasionally contain coal. Both fossil bivalves and fossil plants are observed locally. Interpretation of collected field data suggests that strata from below the Klappan Coal Sequence outcrop at some points on the property, although specific note was not made of them in the field. Consequently this unit cannot be described in detail.

432 KLAPPAN SEQUENCE

The Klappan Sequence comprises sandstone, siltstone, claystone, coal and minor conglomerate and contains the majority of the potentially economic coal which occurs on the property. Sandstone, which is the dominant lithology, occurs in fine to medium-grained units that may sometimes be quite thick (in excess of 20 metres). Gradation upward to a grit or conglomerate is observed fairly frequently but the coarser-grained bodies are generally lenticular and do not appear continuous. Conglomerates are composed of sub-rounded pebbles which are matrix supported. Carbonaceous plant fossils are noted throughout the sequence, mostly in finer-grained lithologies. Pelecypod and gastropod fossils are found lower in the sequence.

Petrographic analyses of the sandstones in section give some indication of the lithologic source of the Mount Klappan sediments. The sands are uniformly dominated by detrital chert and some quartz grains with minor feldspar and virtually no muscovite. X-ray diffraction testing of rock mineral composition reveals a predominance of ankerite cement (calcium, iron, magnesium and maganese carbonate ($CaC0_3$ (Mg, Fe, Mn) $C0_3$)).

Coal seams are thickest, up to 7 metres, in the middle of the sequence with thinner seams, on the order of 0.5 metres, occurring both above and below this central zone. Although coal thicknesses vary laterally, and some splits develop, the seams appear to be continuous over large areas. The Klappan Sequence has been tentatively subdivided into Lower, Middle and Upper Units (Table 4.2), based primarily on the concentration of thick coals within the middle portion of the sequence. The total thickness of the Klappan Sequence is approximately 550 metres.

.1 Lower Klappan Unit

The top of the Lower Klappan Unit is at the base of the first coal seam in excess of 1 metre in thickness. At the west end of Lost Ridge this definition results in an estimated thickness for the Lower Klappan of 105 metres. The lithologies consist of massive, fine-grained well indurated sandstones, interbedded with nodular siltstones. Coal seams in the Lower Klappan Unit are less frequent and thinner than those in the Middle Klappan. Towards the base, the unit is lithologically similar to the unnamed lowest sequence described in the four unit hierarchy established for the Panorama property (Figure 4.3). Because of this transition of lithology, the base of the Lower Klappan unit has not yet been defined.

.2 Middle Klappan Unit

The Middle Klappan Unit, which conformably overlies the Lower Klappan sediments, ranges in thickness from 300 metres near Hobbit Creek to 350 metres in the Lost Ridge area.

The unit, which is best exposed on Lost Ridge, in the creeks draining east off Klappan Mountain and on Klappan Mountain itself, is interpreted to be present over most of the licences. All the major coal seams found to date on the property are contained within the Middle Klappan.

The boundaries of the Middle Klappan Unit have been arbitrarily defined by the presence of thick coal seams within the unit (Figure 4.4.). The first occurrence of a seam in excess of 1 metre determines the base of the unit while the top of the last seam greater than 1 metre defines the top of the unit. The presence of a seemingly persistent conglomerate 80 metres above the top of the first thick seam may, with further drilling, assist with the positioning of the Middle Klappan Unit within the Klappan Sequence.

Drill core indicates that sandstone comprises an average of 45% of the total section although the range is from 30% to 60%. Claystone - mudstone sequences comprise 25% and siltstone 17% of the total thickness, on the average.

Conglomerate is prominent in a five metre interval in one drill hole and pebbly intervals do occur within sandstone units in several holes. Although rare in drill holes, conglomerate is more apparent in outcrop in the alpine areas where it forms an extensive, traceable, resistant unit. Another minor but important constituent is bentonite, which occurs as thin beds 5 to 27 cm thick in four of seven holes.

.21 Coal Seam Development

The Middle Klappan Sequence contains up to 12 seams with a cumulative average thickness of 25.2 metres over a 300 - 350 metre interval, while the cumulative average thickness of seams greater than 0.5 metres is 24.3 metres (Table 4.3). The total of 12 seams and the general seam statistics to follow were derived primarily from drill hole intersections of the coal seams on the eastern half of the property. The seams, which have been labelled in ascending order A to L (Figure 4.5), range from a minimum average thickness of 0.43 metres to maximum average thickness of 5.42 metres (Table 4.3). Structural thickening of individual seams has resulted locally in thicknesses in excess of 7.4 metres (TRC820039 and TRC820027).

The cumulative average thickness of all seams (including those of less than 0.5 metre thickness) increases from an average of 2.0 metres in the southeast area to an average of 3.1 metres in the northwest area (Figure 4.5). Interseam intervals show a corresponding increase from an average thickness of 20 metres in the Hobbit-Broatch area to 40 metres on Lost Ridge. While the interseam interval thicknesses differ between the two areas, the intervals within each area are remarkably consistent, indicating a rhythmic deposition of the coal seams.

Detailed geological mapping and diamond drilling largely substantiated the concept of widespread coal seam continuity formulated as a result of the 1981 assessment. Within both the Hobbit-Broatch and Lost-Fox areas, individual seams have been traced for up to one kilometre while the correlation of a 40 metre sequence along Hobbit Creek (including seams I and J) with an almost identical sequence on Lost Ridge, suggests seam continuity over a distance of 9 km.

Diamond drilling and the relative profusion of coal seam exposures in the Middle Klappan Unit underlying the eastern portion of the property, have provided a wealth of data on coal seam thicknesses, continuity and morphology. At present this is not the case for Middle Klappan sediments underlying the western portion of the licences where extensive grass and sedge cover limits outcrop. However, the presence of thick seams, up to 3.5 metres, in the upper reaches of the Little Klappan River and in Tahtsedle Creek, suggests that seam distribution and frequency will be much the same as for the eastern portion of the property.

Where observed on Klappan Mountain the seam thicknesses were generally less than 2 metres; however, while coal bloom was frequently noted on the mountain, extensive trenching has not yet been undertaken.

.3 Upper Klappan Unit

The Upper Klappan Unit consists of sequences of interbedded sandstone, siltstone, claystone and minor coal. The sequence is approximately 100 metres thick and is best exposed on Ellis Ridge and just off the southeast edge of the property. The thickness was derived by estimating the thickness of strata between the coal seam which marks the top of the Middle Klappan Unit, and the last occurrence of coal in the section. Above this last coal, the sediments were assigned to the Malloch Sequence.

.4 Environment of Deposition

The preliminary interpretations of depositional environment by Gulf sedimentologists suggest a wave dominated deltaic environment with broad, back barrier lagoonal coal swamps. Coals developing in this setting would be laterally very widespread (in the longshore direction) though there is insufficient evidence to determine the extent of the swamp in the inshore direction. The interfingering sands and conglomerates are beach remnants and the siltstones and claystones between the major coals may be evidence of storm driven marine influxes which temporarily (and locally) interrupted the accumulation of plant material.

433 MALLOCH SEQUENCE

The Malloch Sequence, which conformably overlies the Klappan Sequence, is composed of a series of fining upward sequences of interbedded, medium-grey to tan, fine-grained sandstone, siltstone and mudstones. Thin coals were noted and plant fragments are abundant.

The sequence is best exposed east of Ellis Ridge and just off the property southeast of Tahtsedle Creek. On the Mount Klappan property the thickness has been estimated at less than 500 metres. In the Groundhog area, it is in excess of 2 000 metres.

434 RHONDDA SEQUENCE

The Rhondda Sequence, which overlies the Malloch sediments, is a thick accumulation of conglomerates and conglomeratic sandstones with occasional thin beds of siltstone, claystone and coal. The lower conglomerate beds previously assigned to the Malloch (1981 Klappan Geological Report) have been reassigned to the Rhondda in keeping with the definition of the Rhondda Sequence.

435 STRUCTURE

The overall structure of the Klappan area is that of a broad synclinorium - anticlinorium trending northwest - southeast (Figure 4.6). The synclinorium, named the Mt. Beirnes Synclinorium is well defined by the massive resistant conglomerates of the Rhondda Sequence capping the Gunanoot Mountain massif southwest of the property. The anticlinorium is mostly assumed. The less competent Klappan Sequence has been folded into a number of parasitic folds which are upright to overturned to the northeast on the northeast limb of the synclinorium, and overturned to the southwest on the southwest limb (Figure 4.7). The bulk of the property covers the northeast limb of the synclinorium (Figure 4.6).

Folding is the dominant deformational mechanism on the property with styles ranging from broad upright folds to overturned megascopic Z folds with axes inclined as much as 45° to the northeast.

A periodic fluctuation in the plunge of the fold axes (alternately northwest and southeast) is superimposed on the above described fold pattern. The magnitude of the plunge is generally around 10°, and seldom more than 20°. The plunge changes are best observed in the Hobbit-Broatch area where Hobbit Creek parallels the fold axis and where drill hole control is best. The alternating plunge changes keep the Middle Klappan Sequence relatively close to the surface in the eastern portion of the property.

Faulting has played a relatively minor role in the deformation of the Klappan sediments. Four southwest dipping thrust faults are recognized on the Mount Klappan property with only two, the Klappan and B.H.G. (Broatch, Hobbit, Grizzley) being continuous over the property (Figures 4.6 and 4.7). The Klappan Thrust, the larger of the two, with an estimated, though variable, displacement of about 350 metres, is well exposed on Grizzley Ridge and Lost Ridge. Over most of its length the fault has thrust lower Middle Klappan sediments over the upper Middle Klappan beds. An overall shallowing of the dip of this thrust, from 45° to 10° was recorded from Grizzley Ridge to Lost Ridge where the dip again increases to 45°.

The B.H.G. Thrust, with an estimated displacement of 325 m is not as well exposed in outcrop as the Klappan Thrust and, therefore, is less well documented. The thrust has brought the lower Middle Klappan Unit in fault contact with the upper sediments of the Middle Klappan and, locally, the Upper Klappan. Several minor normal faults have also been mapped.

The Klappan and B.H.G. Thrusts subdivide the property into 3 structural blocks (Figure 4.6). The upper or southwesterly structural block is bounded to the northeast by the Klappan Thrust and encompasses all of the western portion of the property including Klappan Mountain. The structure of the block is characterized by open upright folds of 200 - 300 metres wavelength. Fold axes are parallel and are oriented with the regional northwest-southeast trend. The folds are well exposed across Mount Klappan, Anthracite Peak and the southwestern ends of Grizzley and Cincies Ridge. Observed deformation is not intense with the exception of a recumbent isoclinal fold of several hundred metres amplitude on the northwest face of Mount Klappan.

The middle structural block lies between the Klappan and B.H.G. Thrusts and contains the Lost-Fox and Summit areas. Strata in this block outcrop in a band about 3 kilometres wide that includes the eastern ends of Cincies Ridge, Grizzley Ridge and Lost Ridge and the upper reaches of Fox Creek. The structural style of the southern portion of the block is similar to that of the upper structural block but, towards the northwest, the folds become progressively overturned to the northeast as is evident in the northwest face of Lost Ridge.

The tendency toward overturned folds is even more pronounced in the lowest structural block beneath the B.H.G. Thrust. The folds are characterized by long, gently dipping southwest limbs, which tend to flatten out near the hinge area, and by shorter, vertical or overturned northeast limbs (Figure 4.7). While the limbs are free of secondary structural complications, fracturing and structural thickening of the strata, including coal, are common in the hinges of the folds. Quartz filling of the fractures in the hinge area of folds was noted. The Hobbit-Broatch area covers the southern one third of the block.

While locally the structure can be complex, it would appear that the Mount Klappan property is located in the distal edge of the intensely deformed structural domain prevalent in the Groundhog area. The structures in the Mount Klappan area are relatively broad and can be traced over areas that are large enough to have substantial potential for open pit mining.

4.4 RESOURCE AREA GEOLOGY

441 HOBBIT-BROATCH RESOURCE AREA

The Hobbit-Broatch Resource Area which encompasses the southern portion of the lower structural block is bounded to the southeast by the Spatsizi River; to the southwest by the B.H.G. Thrust and by the British Columbia Railway subgrade along a portion of its northeast side (Figure 4.8). The extent of the resource area northwards is currently limited by outcrop and drill hole control and the boundary is placed just north of Broatch Creek (Figure 4.8). A total of 34 trenches has been excavated in coal and five diamond drill holes have been completed in the area.

The resource area is mostly underlain by the main coal bearing Unit, the Middle Klappan Sequence, which is estimated to be in the order of 300 metres thick, increasing to 320 metres to the northeast.

.1 Coal Seam Development

Coal seams A to K with a cumulative average thickness of 22.1 metres were intersected by drilling in the Hobbit-Broatch area. The cumulative average thickness of seams greater than 0.5 metres is 21.2 metres. The seams vary from a minimum average thickness of 0.43 metres (seam C) to a maximum average of 5.65 metres (seam I).

Individual seam thicknesses of up to 8 metres have been recorded in trenches, where seams have been structurally thickened in the noses of anticlines (seam I). The average seam thickness (including seams less than 0.5 metres) is 2.0 metres. Drilled coal seam intersections are summarized in Table 4.4 and illustrated in the composite section of Figure 4.9. Interseam thicknesses vary from 7 metres to 37 metres but are on average about 20 metres.

Correlation between drill holes was based on lithologic markers such as bentonite beds, concentrations of bivalves and geophysical profiles (Figure 4.10). Although the correlation is based on fairly widespread drill holes (1 to 2 km), results suggest that the seams are mostly continuous over the Hobbit-Broatch area.

Seams appear to thicken toward the southeast. This is best exemplified by seam G which increases from over 2.0 metres in DDH82006 to over 4.0 metres in DDH82003. Other seams, which were not intersected as frequently, also appear to thicken to the south.

.2 Structure

The resource area is dominated by three main anticlines named, from west to east, the Broatch, Hobbit, and Bluff Anticlines (Figures 4.11 and 4.12). Each of the folds is interpreted to strike across most of the resource area in a northwest-southeast direction. The folds are characteristically overturned to the northeast with long shallow-dipping southwest limbs and vertical to overturned northeast limbs.

A later stage compressional event has produced almost regular plunge changes, approximately perpendicular to strike. This secondary compression of the folds has imparted a plunge change wavelength of approximately 1 kilometre. Plunge changes are readily observed on the property in areas of good exposure. The amount of plunge along the axes varies from approximately 5° to 20° although, locally, the plunges may be steeper.

At Broatch Creek, the Broatch Anticline plunges 20° to the southeast. Elsewhere along Broatch Creek the structures plunge in the same direction but the amount of plunge is not as well documented. Minor plunge changes are visible along Hobbit Creek, but generally the plunge is gently to the southeast, with a major change to the northwest near the mouth of the creek. The end result of the plunge changes is to maintain the coal-bearing Middle Klappan Unit close to the surface.

The amplitude of the folding is in the order of 100 to 300 metres, while the fold wavelengths range from 300 to 900 metres. Superimposed on several folds are smaller parasitic folds which locally complicate the structure. Facies changes may be responsible for some of this local structure.

Thrust faults are the dominant fault type. The B.H.G. (Broatch, Hobbit, Grizzley) Thrust, a back limb thrust, is the major thrust in the Hobbit-Broatch area and defines the southwestern boundary. Movement along this fault is in the order of 325 metres, placing the lower part of the Middle Klappan Sequence against the upper part of the same sequence. Several forelimb thrusts of minor displacement are found in the vicinity of DDH82002 and DDH82003. These faults, where intersected, produce only minor disturbances in the drill core. Similar faults may occur elsewhere.

A normal fault was interpreted along the Spatsizi River outside the resource area. The amount of displacement along this fault is unknown.

442 LOST-FOX RESOURCE AREA

The Lost-Fox area, which essentially covers the eastern half of Lost Ridge, is confined by the Klappan Thrust along its southwest and southeastern boundaries and by a lack of outcrop and drill data to the northwest and northeast (Figure 4.8). Future exploration north and east of the latter two boundaries will likely expand the Lost-Fox area north to the Summit block and east to the British Columbia Railway subgrade. The resource area covers the northcentral portion of the middle structural block.

One diamond drill hole (DDH82005), spudded on top of Lost Ridge, and 11 trenches provide lithological and coal seam data. The thickness of the Middle Klappan Unit, estimated at 350 metres, is somewhat greater than in the Hobbit-Broatch area. Although the resource area is underlain mainly by the Middle Klappan Sequence, the Upper and Lower Klappan Sequences outcrop, as does the Malloch Sequence.

.1 Coal Seam Development

Exploration to date has proven the presence of seam G and I through L with a total aggregate seam thickness of 17.86 metres over an interval of 235 metres. Seam thickness varies from 1.5 to 5.2 metres with an average thickness of 3.57 metres (Table 4.5). Seams I to L were intersected in DDH82005 and seam G was trenched. While coal spoil indicated the presence of seam H, lack of an accurate thickness excluded it from both seam statistics and resource calculations (Figure 4.13). This also holds true for seam M, which is believed to be present 13 metres above L, but was not intersected in DDH82005 due to excessive hole deviation which necessitated premature drill hole shut down. (Seam M is not shown on any figures or diagrams in the report).

Seam continuity is readily observed in the excellent exposures. Seam 1, a seam with virtually no rock partings, can be traced along the north face of Lost Ridge for over 550 metres, then southeast, down the dip slope for over 800 metres. The lower seams of the Middle Klappan Sequence are not exposed and have not yet been drilled, but a tentative correlation of DDH82005 and the seams intersected by DDH82007 in the Summit area is illustrated in Figure 4.14.

Several seams outcropping along Fox Creek have tentatively been placed high in the stratigraphic section on the basis of structure. Additional work may indicate an extension of the Lost-Fox Resource Area to include more of Fox Creek. In general, the coal seams in the Lost-Fox area are thicker and, in places, cleaner than the equivalents in the Hobbit-Broatch area.

.2 Structure

Located within the middle structural block, the structure of the Lost-Fox area is characterized by a large southeasterly plunging anticline-syncline pair, named the Lost Ridge Anticline and Lost Ridge Syncline (Figure 4.15). The southwest limb of the anticline, as it begins to form a second syncline, has been truncated by the Klappan Thrust, which places lower Middle Klappan strata onto upper Middle Klappan sediments (Figure 4.16). Displacement on the thrust is estimated at 350 metres. An imbricate thrust, the Pond Thrust, is located to the west of the Klappan Fault.

The Lost Ridge Anticline is overturned as much as 45° to the northeast. The southwest limb, which is relatively flat, forms a dip slope down the back of Lost Ridge as a result of a combination of plunge (10° southeast) and topography (Figure 4.15).

The overturned Lost Ridge Syncline is located at the northeast end of Lost Ridge. The northeast limb of this fold is gently dipping to the southwest with a minor fold pair of small amplitude near the axis. The structure on this limb appears to be relatively uncomplicated as it plunges into the Fox Creek area where a second large overturned anticline, with an axis parallel to the folds on Lost Ridge, is seen. The core of the Lost Ridge Syncline is broken by the Lost Ridge Thrust which has placed older Middle Klappan on younger Middle Klappan. The fault has a displacement of 85 metres, and is traced for a distance of 3 kilometres before appearing to die out at both ends.

Of the two faults occuring in the areas, the Klappan and Lost Ridge Thrusts, only the Klappan Thrust is continuous across the property. Of note is the change in attitude of the Klappan Thrust as it trends through the resource area. The thrust strikes northwest and dips at 45° southwest as it crosses the ridge line of Lost Ridge. Further south it strikes almost due west and dips at only 8° (approximately). Several other local changes in the orientation of this fault are documented on Grizzley Ridge.

The only other fault of note in the Lost-Fox area is a normal fault named the Fox Fault. It down-drops strata on its north side and trends east-west, south of Lost Ridge in the Fox Creek Valley. Its presence and strike are interpreted largely from air photos and it loses definition in the area of the Klappan Thrust. Several small faults with normal displacement of several metres were noted on a cliff face at the extreme east end of Lost Ridge. These faults could be either slump features associated with the cliff or post-tectonic relaxation features.

443 SUMMIT RESOURCE AREA

The Summit Resource Area consists of the area within a one kilometre radius of DDH82007. The area is underlain entirely by Middle Klappan sediments.

.1 Coal Seam Development

Three seams, G, F and D, intersected in DDH82007, have a total thickness of 7.91 metres. Maximum and minimum thicknesses are 3.91 and 1.29 metres respectively with an average of 2.64 metres. Average interseam thickness at 35.4 metres is similar to that recorded in the Lost-Fox area (Table 4.6, Figure 4.13).

.2 Structure

DDH82007 intersected the southwestern limb of a syncline. Limited outcrop has hampered a complete structural interpretation of this area, hence the arbitary and limited 1 kilometre radius of the area.

REGIONAL STRATIGRAPHY
TABLE OF FORMATIONS

Table 4.1

AGE	SUBDIVISION OF AGE	GROUP	LITHOLOGY
TERTIARY	LOWER		QUARTZ PEBBLE CONGLOMERATE, TO PEBBLY SANDSTONE, SANDSTONE SUB QUARTZOSE FELDSPATHIC, DARK GREY TO REDDISH MUDSTONE, THIN COAL SEAMS, SHALE, AND ASH FALL TUFFS IN UPPER PORTION OF UNIT.
CRETACEOUS	UPPER		
	MIDDLE		
	LOWER	SKEENA	CHERT PEBBLE RICH; BROWN-GREY CONGLOMERATE, BLACK, BROWN, AND ORANGEY CLAYSTONE, SILICEOUS AND CLAYEY SANDSTONE, WITH SILTSTONE, CLAYSTONE AND COAL INTERBEDS. BASE OF UNIT DARK GREY TO BLACK TUFFS, TUFFACEOUS SANDSTONE AND CARBONACEOUS SHALE.
JURASSIC	UPPER	BOWSER LAKE	FELDSPATHIC TO QUARTZOSE SANDSTONE, DARK GREY TO BLACK SHALE, SILTSTONE, GREYWACKE, CHERT PEBBLE CONGLOMERATE AND MINOR COAL SEAMS.
	MIDDLE		
	LOWER	HAZELTON	REDDISH, PURPLE, GREY AND GREEN PYROCLASTIC AND FLOW VOLCANICS, WITH CALC-ALKALINE CHEMICAL AFFINITIES, REDDISH SANDSTONE, SILTSTONE, MUDSTONE, MINOR CONGLOMERATE, AND LIMESTONE AND THEIR TUFFACEOUS EQUIVALENTS.
TRIASSIC	UPPER	TAKLA	GREY–GREEN TO DARK GREEN FLOW AND PYROCLASTIC, BASALTIC AND ANDESITIC VOLCANIC ROCKS, PELITIC SEDIMENTARY ROCKS AND MINOR CARBONATE ROCKS.
	MIDDLE		

MT. KLAPPAN COAL PROPERTY

TABLE OF FORMATIONS

Table 4.2

MALLOCH SEQUENCE

JKm	Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal.

KLAPPAN SEQUENCE

JKku	Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal.
JKkm	Repeated coarsening upward sequences of fine to medium-grained sandstone, occasionally conglomeratic, siltstone, claystone and coal; sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base.
JKkl	Interbedded massive, fine grained sandstone and siltstones, containing bivalve fossils, with minor coal.
	Unnamed sequence

C C C

TABLE 4.3

COAL SEAM THICKNESS SUMMARY

	HOBBIT-BROATCH AREA						LOST-FOX AREA	SUMMIT AREA	
Seam	DDH 82001*	DDH 82002	DDH 82003	DDH 82004	DDH 82006	Average (m)	DDH 82005	DDH 82007	Total Property Average (m)
L	-	-	-	-	-	-	2.24	-	2.24
K	3.45	-	2.52	-	-	2.99	++1.46	-	2.48
J	0.93	-	2.33	-	-	1.63	5.16	-	2.81
I	6.97	-	4.32	-	-	5.65	4.98	-	5.42
H	1.73	-	2.57	-	2.01	2.10	-	-	2.10
G	2.77	++4.03	4.22	2.88	2.45	3.27	#4.02	3.91	3.38
F	-	0.35	2.17	0.04	0.16	0.68	-	2.71	1.09
E	-	3.16	+2.14	0.75	0.63	1.67	-	1.29	1.59
D	-	0.53	-	0.35	0.59	0.49	-	-	0.49
C	-	0.67	-	-	0.19	0.43	-	-	0.43
B	-	-	-	-	1.50	1.50	-	-	1.50
A	-	-	-	-	1.67	1.67	-	-	1.67
Aggregate						22.08			25.20
Aggregate of Seams greater than 0.5 m						21.16	17.86	7.91	24.28

* Net thickness exlude core loss
\+ Includes upper and lower portions
++ Upper seam only
\# Trenched thickness

TABLE 4.4

HOBBIT-BROATCH RESOURCE AREA SEAM INTERSECTION SUMMARY

Drill Hole	Seam	Drilled Interval	Seam True Thickness	Interseam True Thickness	Coal/Rock
++82001	K	19.39 - 22.84	3.45		1.63/0.72
P				7.19	
	J	30.08 - 31.02	0.93		0.85/0.08
				25.02	
	I	57.25 - 64.51	6.97		4.34/2.02
				27.34	
	H	93.95 - 95.86	1.73		0.94/0.66
				20.31	
	G	117.35 - 120.12	2.77		1.32/1.04
82002	G upper	36.03 - 40.08	4.03		2.57/1.46
				3.34	
	+G lower	43.42 - 44.55	1.13		0.56/0.57
				7.79	
	*F	52.54 - 52.89	0.35		0.35/0.00
				27.12	
	E upper	81.07 - 82.06	0.92		0.72/0.20
				4.05	
	E lower	86.51 - 89.00	2.24		1.64/0.60
				37.17	
	D	138.38 - 138.92	0.53		0.53/0.00
				25.59	
	C	165.97 - 166.66	0.67		0.67/0.00
82003	K	27.87 - 32.79	2.52		2.26/0.26
				9.84	
	J	44.06 - 46.62	2.33		2.21/0.12
				33.58	
	I	94.14 - 98.94	4.32		3.37/0.95
				27.80	
	H	127.24 - 129.81	2.57		2.23/0.34
				25.21	
	G	155.24 - 159.46	4.22		3.11/1.11
				22.75	
	F	182.38 - 184.56	2.17		1.70/0.47
				20.31	
	E upper	205.28 - 206.14	0.86		0.86/0.00
				2.01	
	E lower	208.17 - 209.45	1.28		1.16/0.12
82004	G	24.73 - 29.60	2.88		2.62/0.26
				16.39	
	*F	58.10 - 58.17	0.04		0.04/0.00
				16.85	
	E	90.39 - 91.67	0.75		0.68/0.07
				15.18	
	*D	114.46 - 114.96	0.35		0.35/0.00
				19.97	
	+D repeat	139.84 - 140.34	0.50		0.41/0.09
				9.82	
	+E repeat	150.36 - 150.81	0.45		0.45/0.00
82006	H	26.09 - 28.10	2.01		1.31/0.70
				22.58	
	G	51.15 - 53.60	2.45		1.84/0.61
				16.09	
	*F	69.75 - 69.91	0.16		0.16/0.00
				15.87	
	E	85.88 - 86.51	0.63		0.61/0.02
				12.77	
	D	99.38 - 99.97	0.59		0.52/0.07
				17.02	
	*C	117.15 - 117.34	0.19		0.19/0.00
				14.37	
	B	132.35 - 133.85	1.50		1.26/0.24
				14.61	
	A	166.31 - 168.37	1.67		1.62/0.05

* seam intersections less than 0.50 metres but applied to weighted average seam thickness
\+ not applied to any resource calculations due to thickness or low coal/rock ratio
++ coal/rock does not include core loss

TABLE 4.5

LOST-FOX RESOURCE AREA SEAM INTERSECTION SUMMARY

DATA SOURCE	SEAM	DRILLED INTERVAL	SEAM TRUE THICKNESS	INTERSEAM TRUE THICKNESS	COAL/ROCK
TRC82044	G		4.02		3.49/0.53
DDH82005	L	236.14 - 238.92	2.24		1.43/0.81
				34.11	
	K upper	192.09 - 193.81	1.46		0.97/0.49
				26.55	
	J	148.09 - 154.34	5.16		3.99/1.17
				69.72	
	I	54.02 - 60.30	4.98		4.26/0.72
		TOTAL	17.86		
		AVERAGE	3.57		

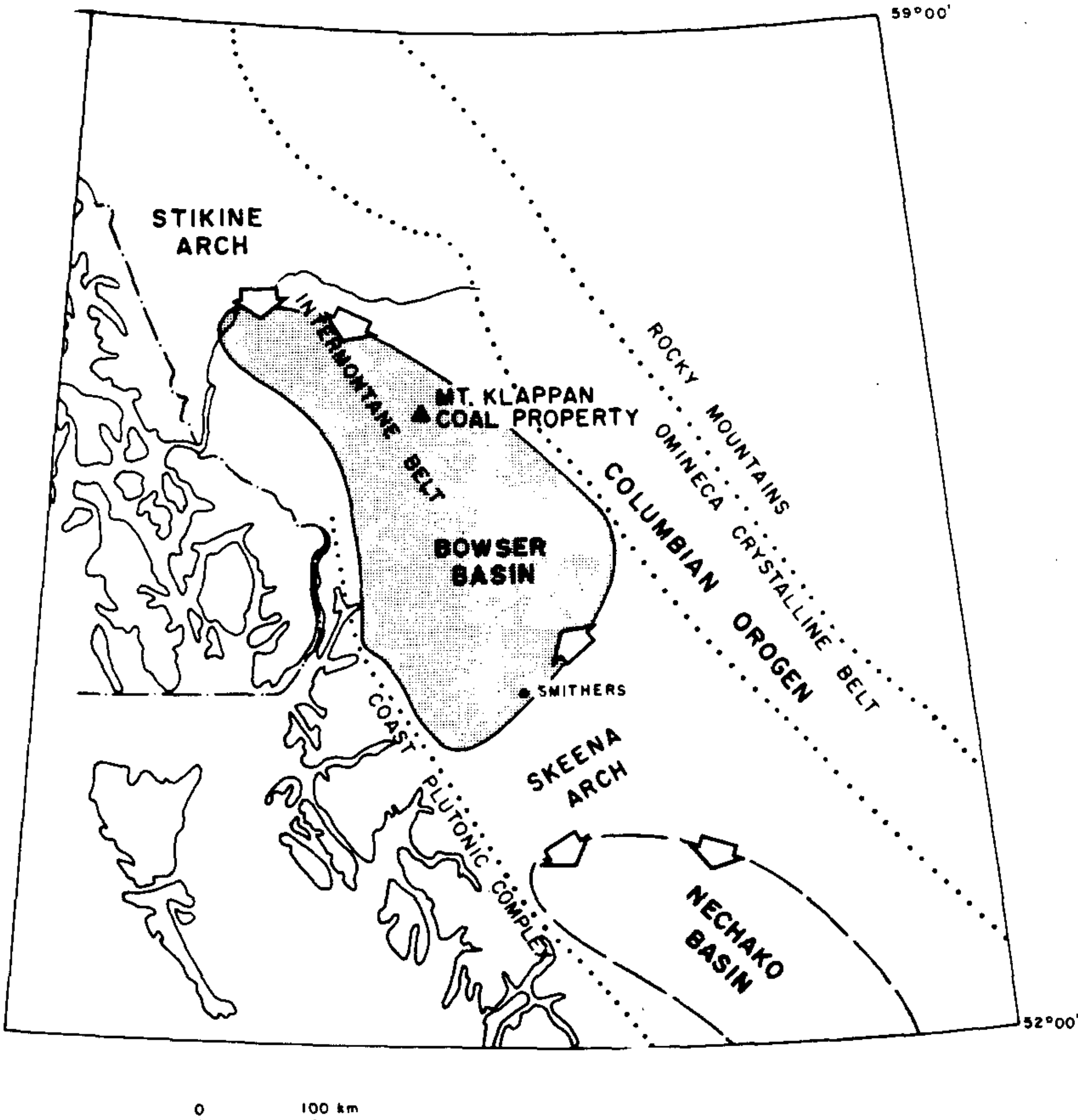
TABLE 4.6

SUMMIT RESOURCE AREA SEAM INTERSECTION SUMMARY

DRILL HOLE	SEAM	DRILLED INTERVAL	SEAM TRUE THICKNESS	INTERSEAM TRUE THICKNESS	COAL/ROCK
82007	G	19.19 - 23.10	3.91		2.31/0.60
				34.55	
	F	57.14 - 59.85	2.71		1.95/0.76
				36.22	
	D	96.56 - 97.85	1.29		0.80/0.49
		TOTAL	7.91		
		AVERAGE	2.64		

MT. KLAPPAN COAL PROPERTY
JURASSIC-CRETACEOUS BOWSER BASIN

Figure 4.1

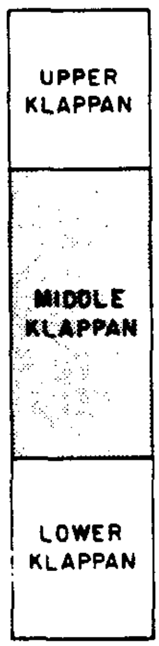


(AFTER TIPPER AND RICHARDS, 1976)

MT. KLAPPAN COAL PROPERTY

SCHEMATIC STRATIGRAPHIC COLUMN

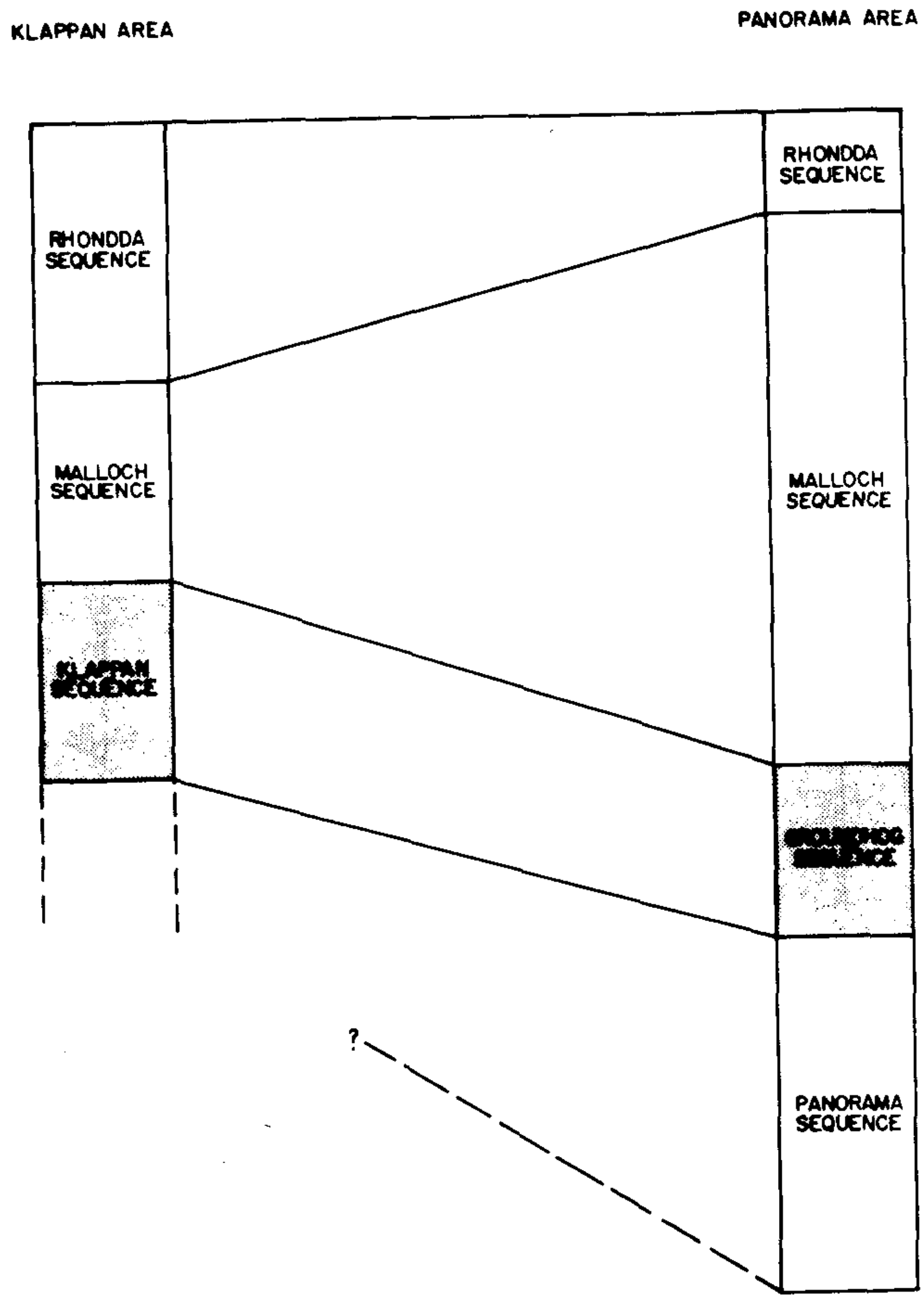
Figure 4.2



MT. KLAPPAN COAL PROPERTY

KLAPPAN–GROUNDHOG STRATIGRAPHY

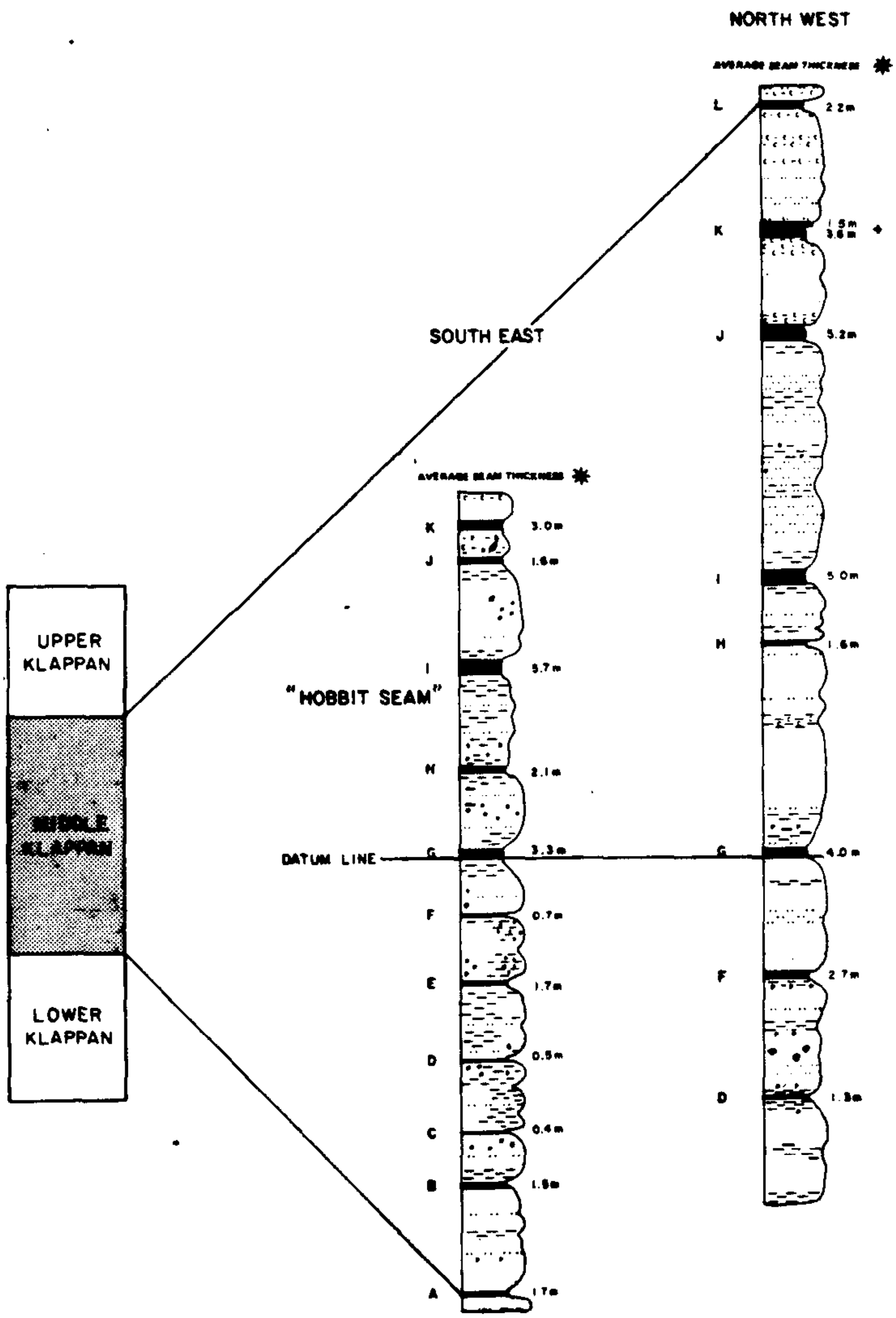
Figure 4.3



NOV., 1982

MT. KLAPPAN COAL PROPERTY

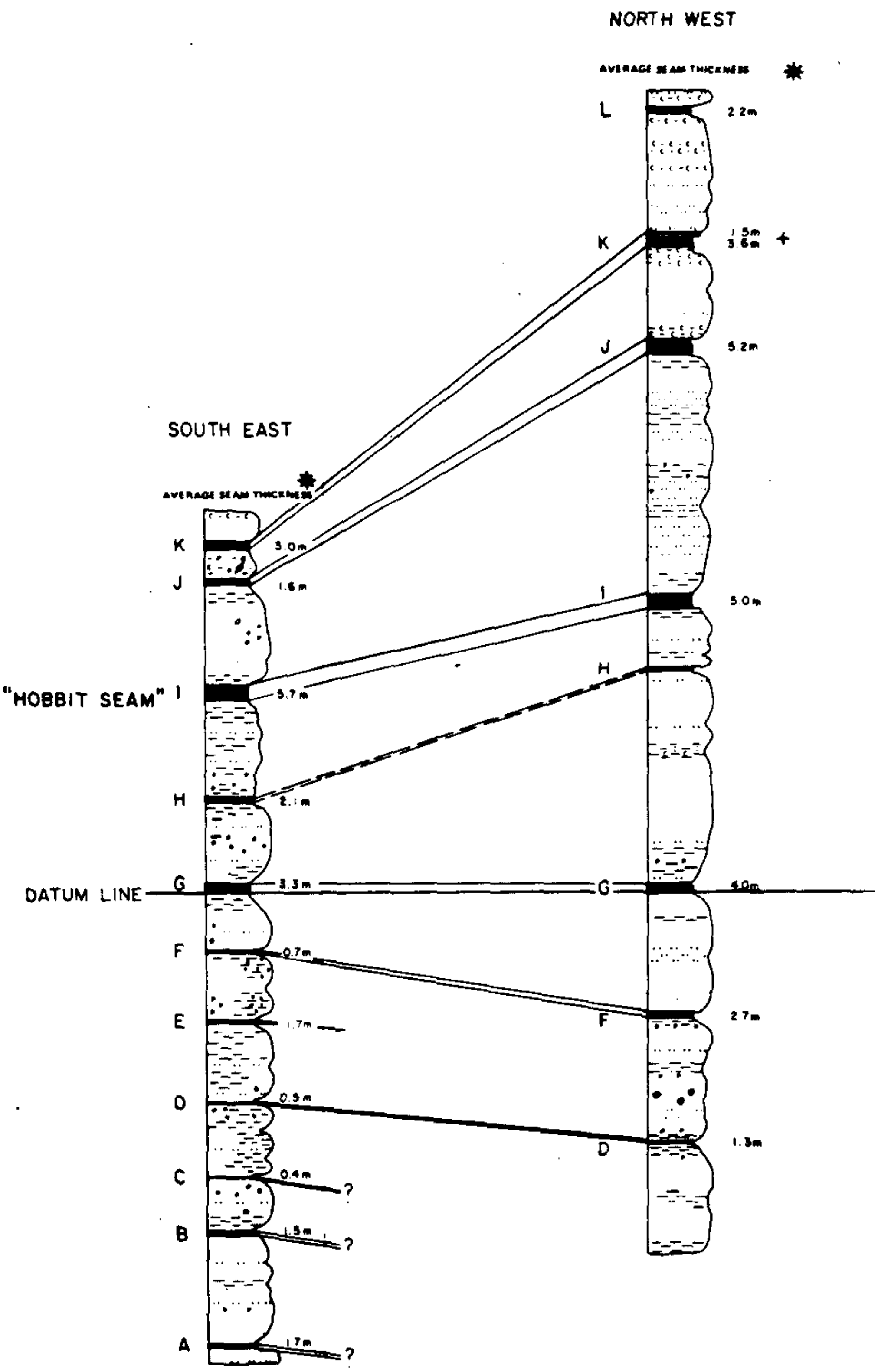
MIDDLE KLAPPAN UNIT Figure 4.4



SCALE - 1 2000 ✱ INCLUDES SEAM INTERSECTIONS < 0.5 m
\+ EXCLUDED FROM SEAM STATISTICS DUE TO LOW COAL/ROCK RATIO NOV., 1982

MT. KLAPPAN COAL PROPERTY

DISTRIBUTION OF COAL SEAMS Figure 4.5



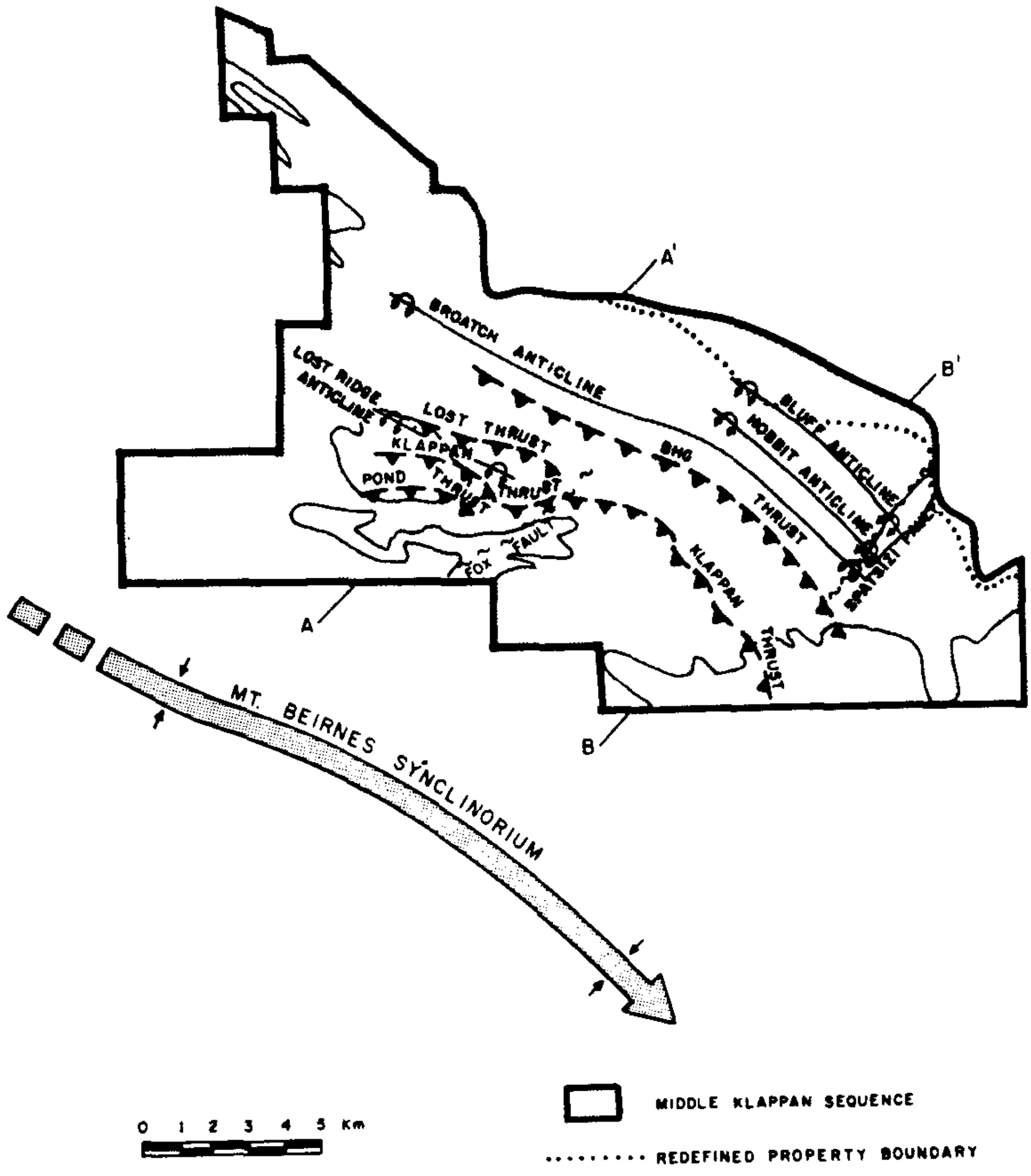
SCALE - 1 2000

+ EXCLUDED FROM STATISTICS DUE TO LOW COAL/ROCK RATIO
✱ INCLUDES SEAM INTERSECTIONS < 0.5m

NOV., 1982

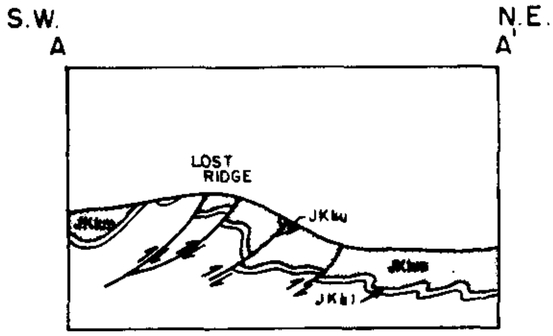
MT. KLAPPAN COAL PROPERTY

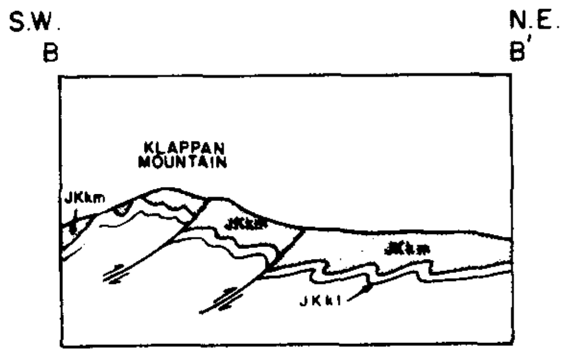
SCHEMATIC GEOLOGY MAP Figure 4.6



MT. KLAPPAN COAL PROPERTY

SCHEMATIC CROSS SECTION Figure 4.7





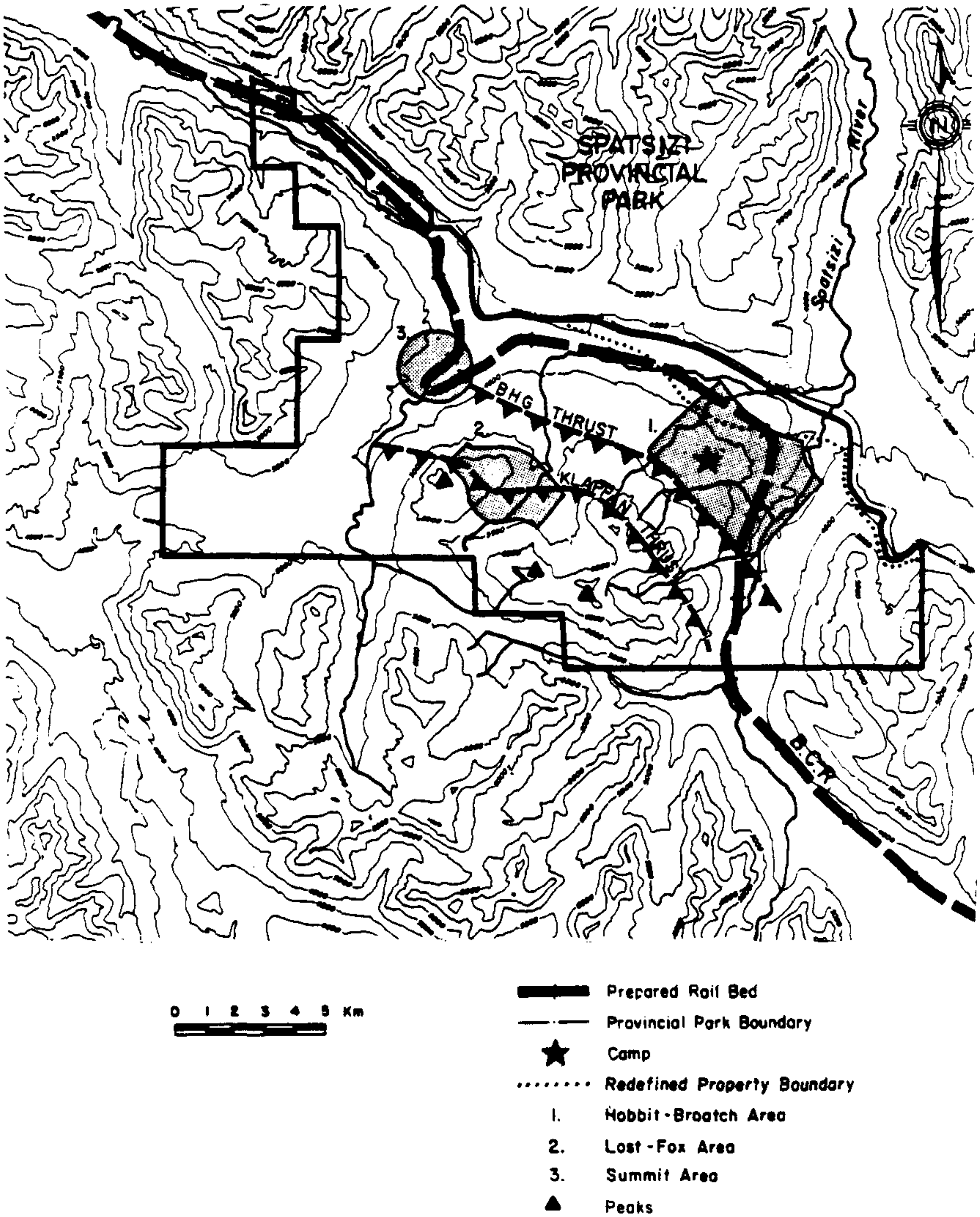
Moderate Vertical Exaggeration

JKku	Upper Klappan Sequence
JKkm	Middle Klappan Sequence
JKkl	Lower Klappan Sequence

MT. KLAPPAN COAL PROPERTY

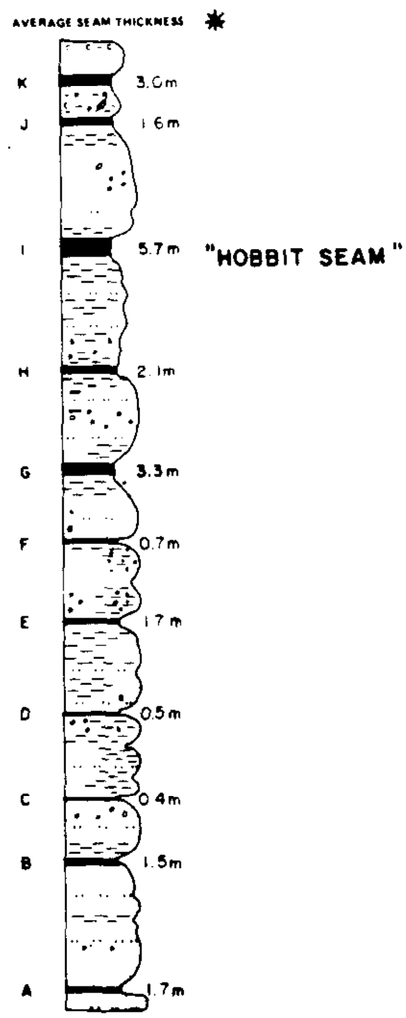
INFERRED RESOURCE AREAS

Figure 4.8



MT. KLAPPAN COAL PROPERTY

HOBBIT–BROATCH COAL SEAMS Figure 4.9



SCALE - 1 2000

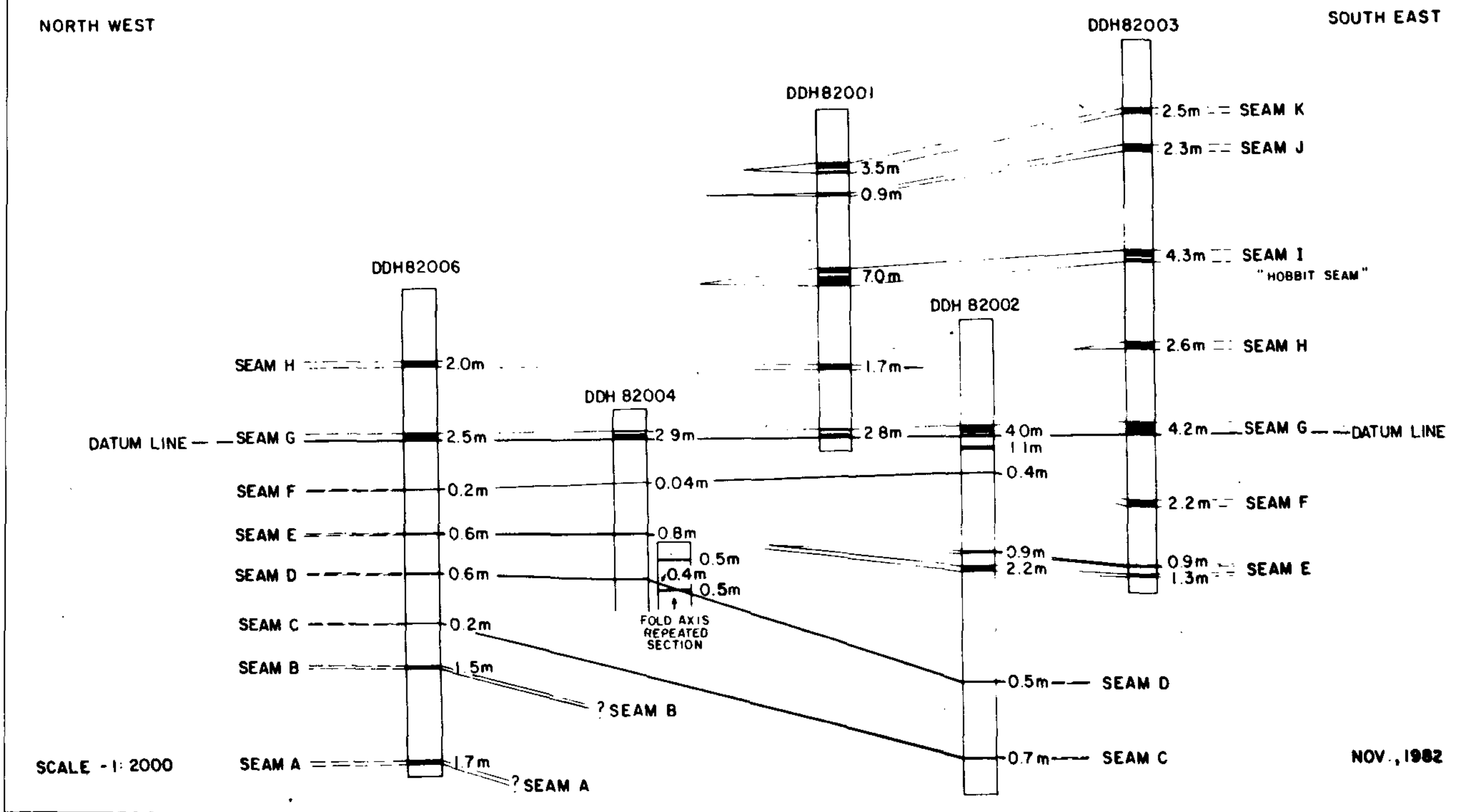
NOV, 1982

✱ INCLUDES SEAM INTERSECTIONS <0.5m

MT. KLAPPAN COAL PROPERTY

HOBBIT–BROATCH CORRELATION

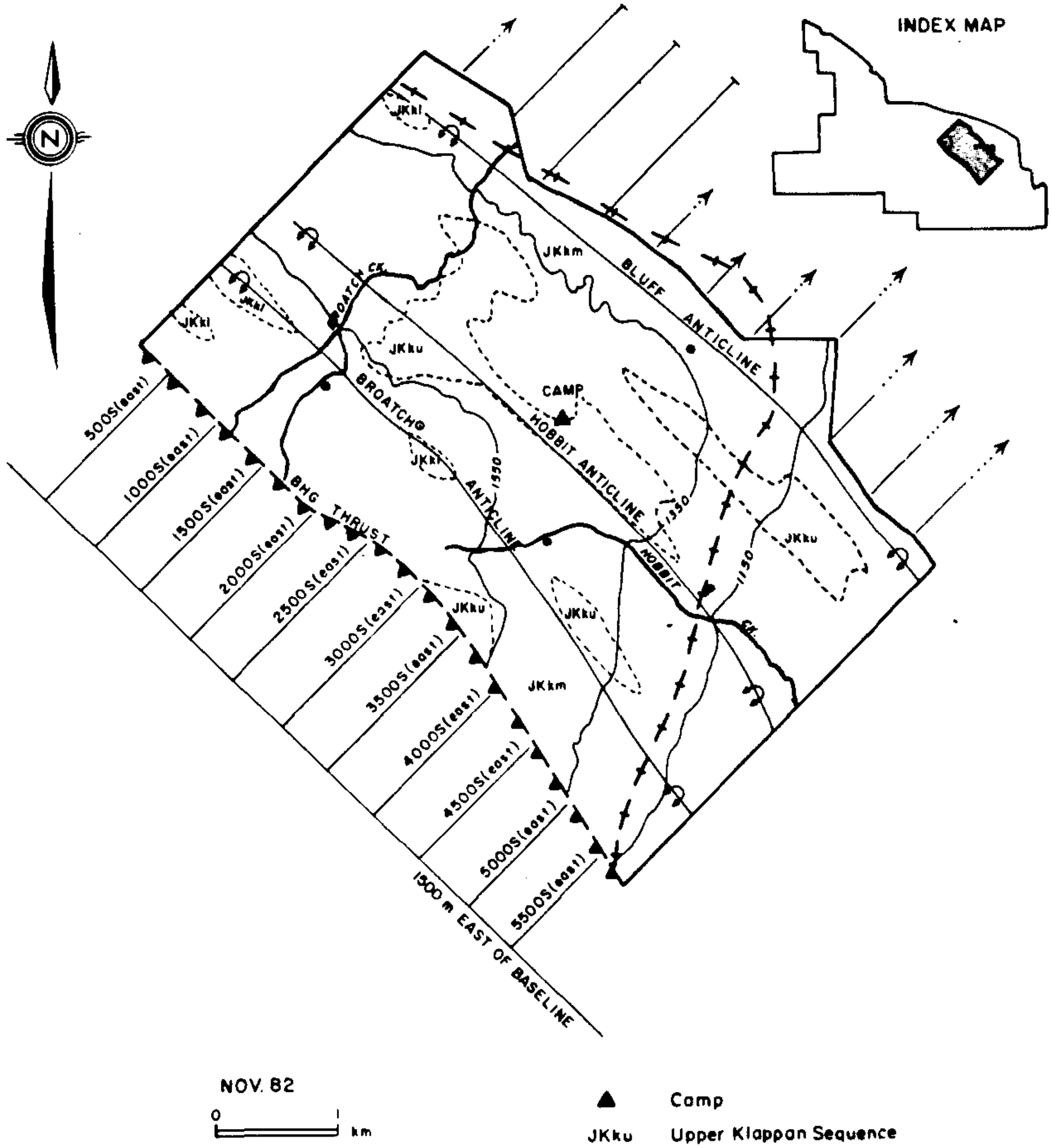
Figure 4.10



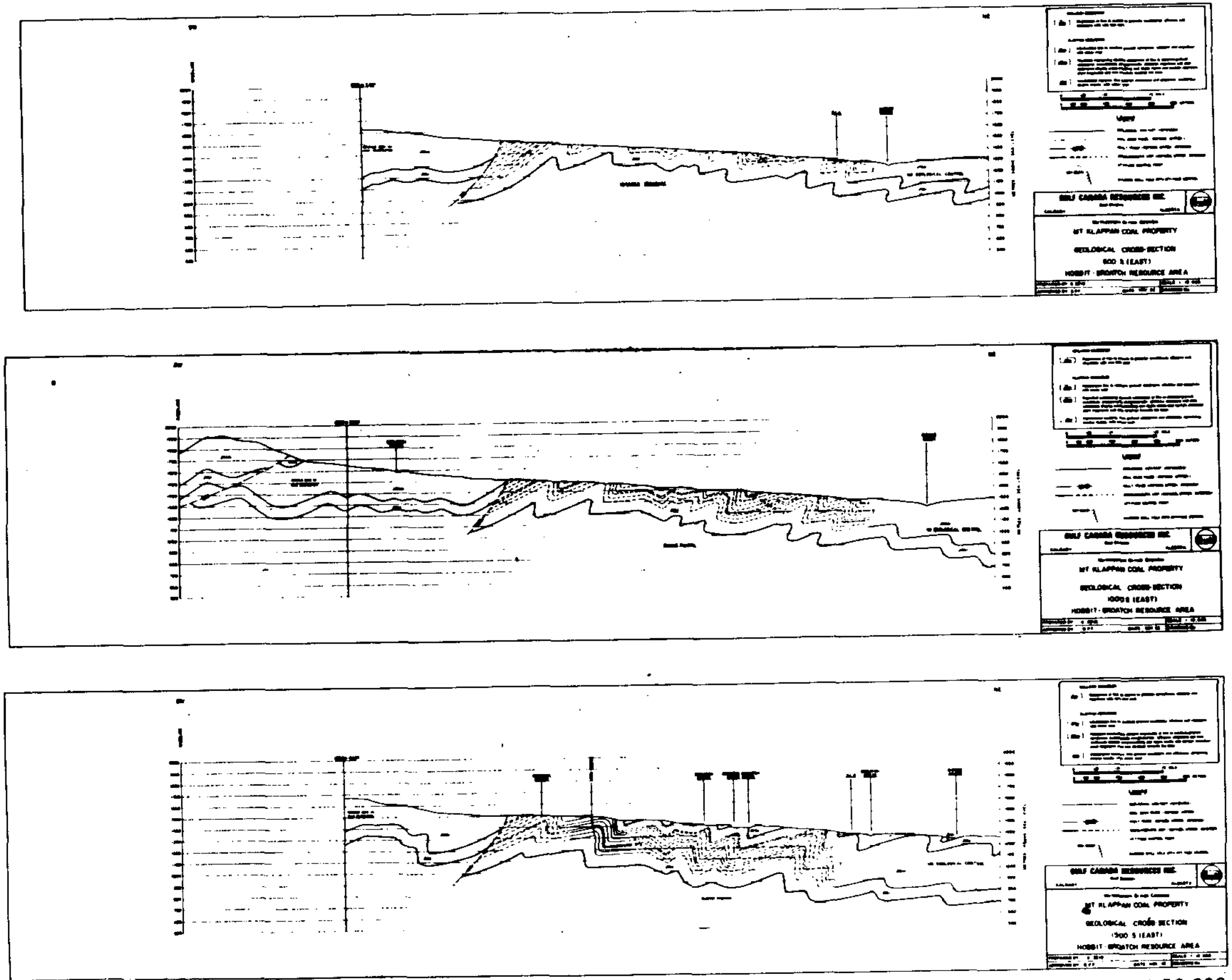
MT. KLAPPAN COAL PROPERTY

HOBBIT–BROATCH GEOLOGY

Figure 4.11

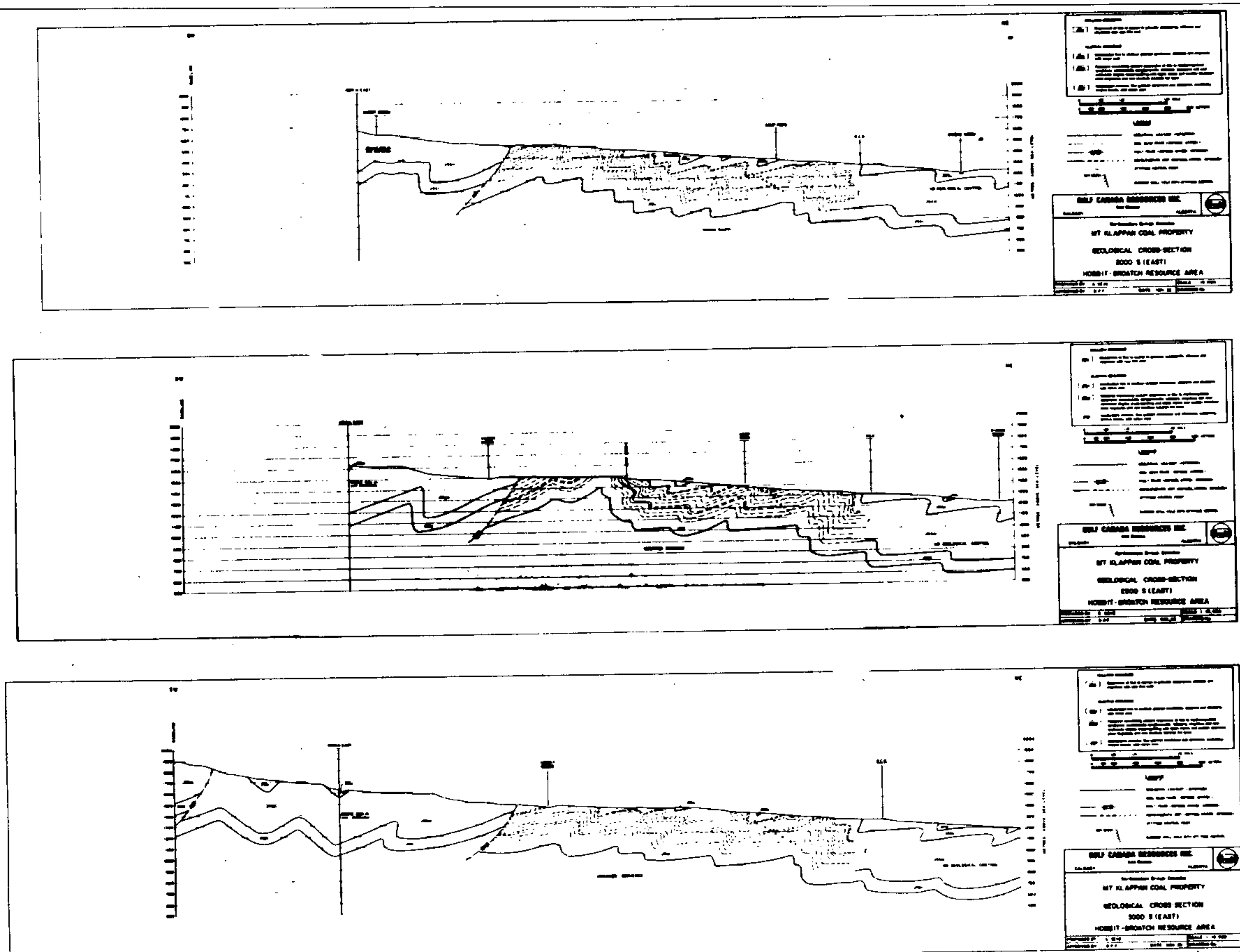


▲	Camp
JKku	Upper Klappan Sequence
JKkm	Middle Klappan Sequence
JKkl	Lower Klappan Sequence
—+—+—	Prepared Rail Bed
•	Diamond Drill Hole



HOBBIT-BROATCH RESOURCE AREA CROSS SECTIONS Figure 4.12a

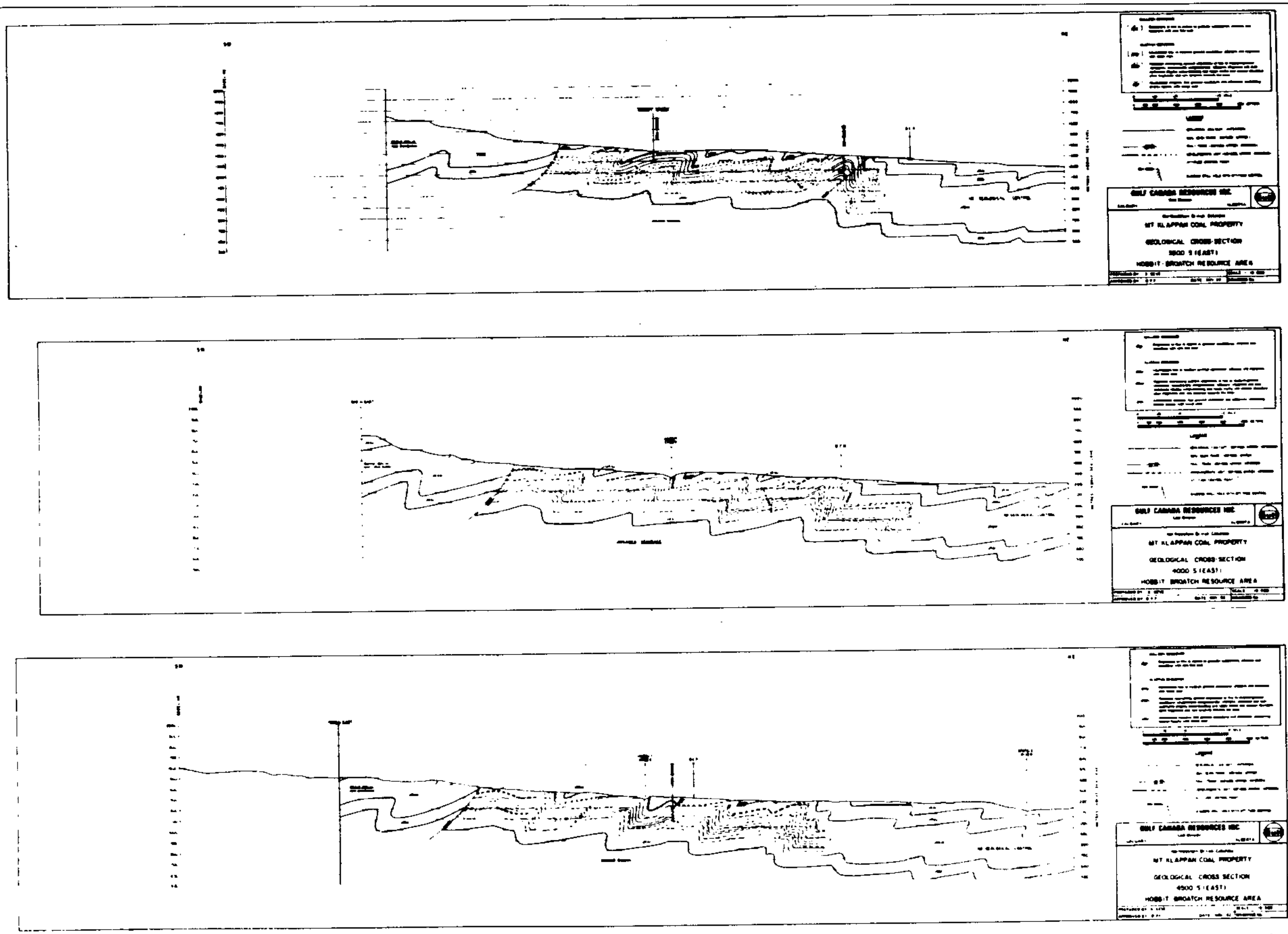
SCALE: 1:50,000



SCALE: 1:50,000

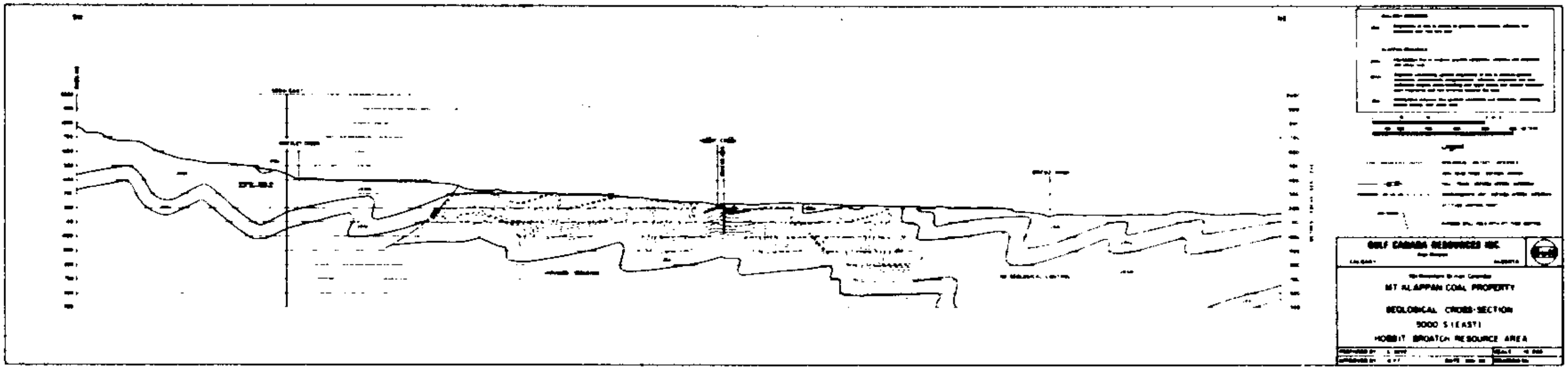
HOBBIT-BROATCH RESOURCE AREA CROSS-SECTIONS Figure 4.12b

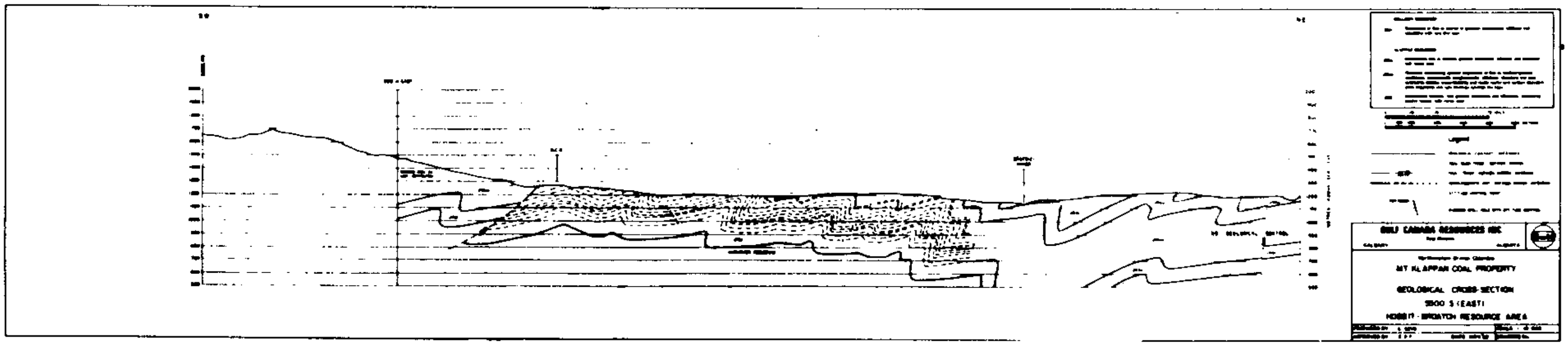
C C C



HOBBIT-BROATCH RESOURCE AREA CROSS-SECTIONS Figure 4.12c

SCALE: 1:50,000



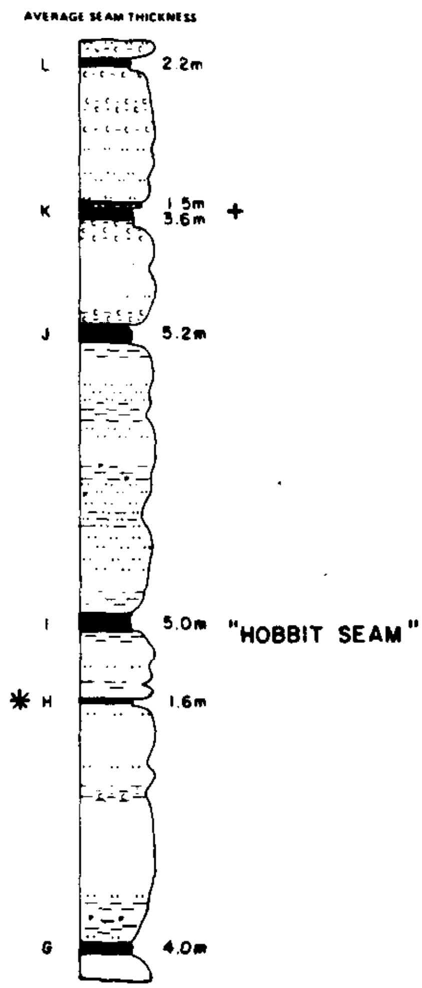


SCALE: 1:50,000

HOBBIT–BROATCH RESOURCE AREA CROSS–SECTIONS Figure 4.12d

MT. KLAPPAN COAL PROPERTY

LOST–FOX COAL SEAMS Figure 4.13



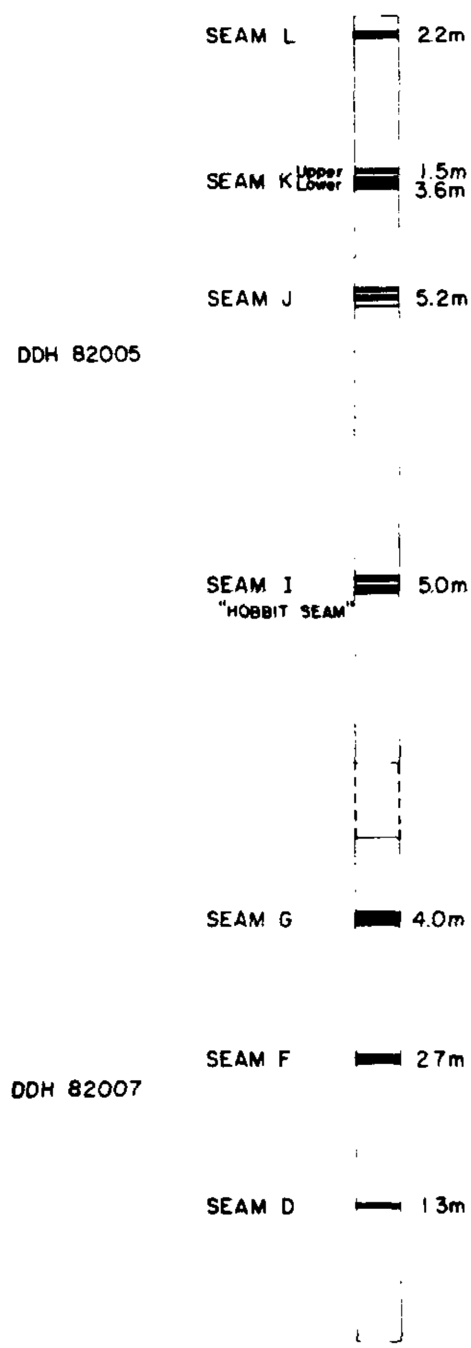
SCALE - 1: 2000

✱ SEAM NOT DRILLED OR TRENCHED

+ EXCLUDED FROM SEAM STATISTICS DUE TO LOW COAL/ROCK RATIO

MT. KLAPPAN COAL PROPERTY

LOST-FOX–SUMMIT CORRELATION Figure 4.14



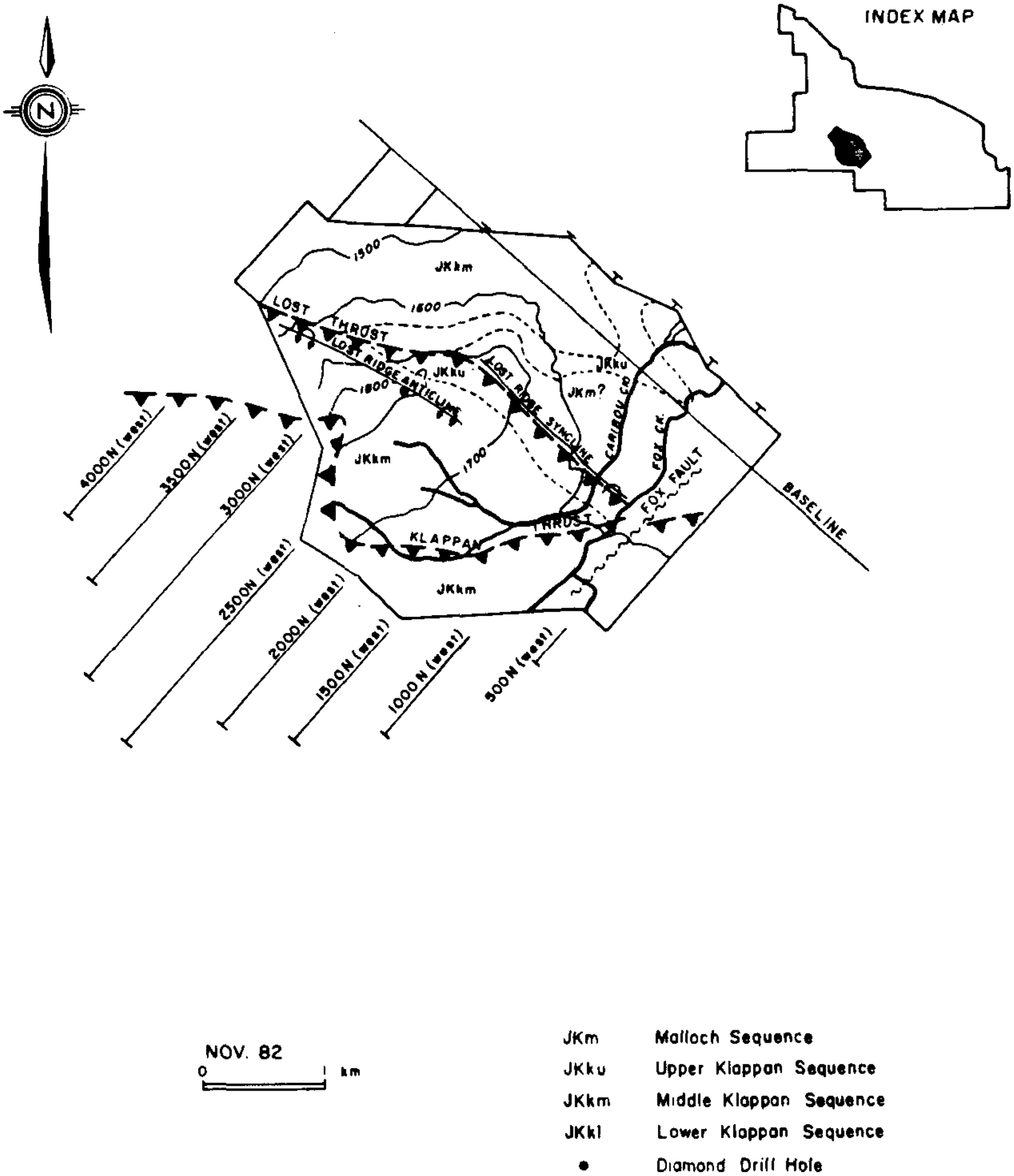
SCALE - 1:2000

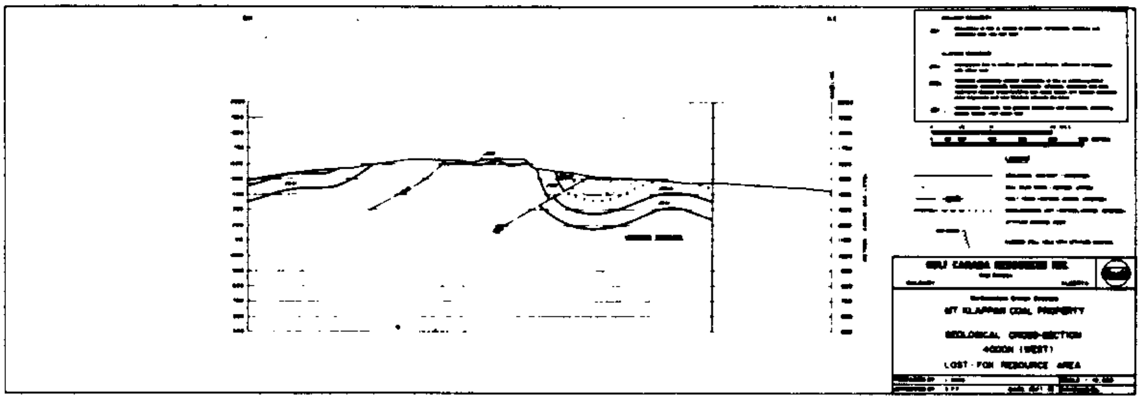
NOV., 1982

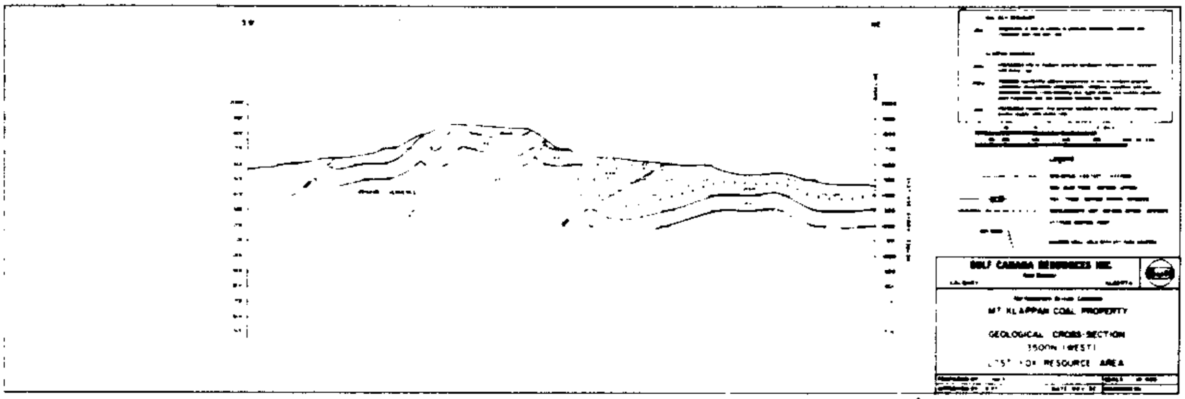
MT. KLAPPAN COAL PROPERTY

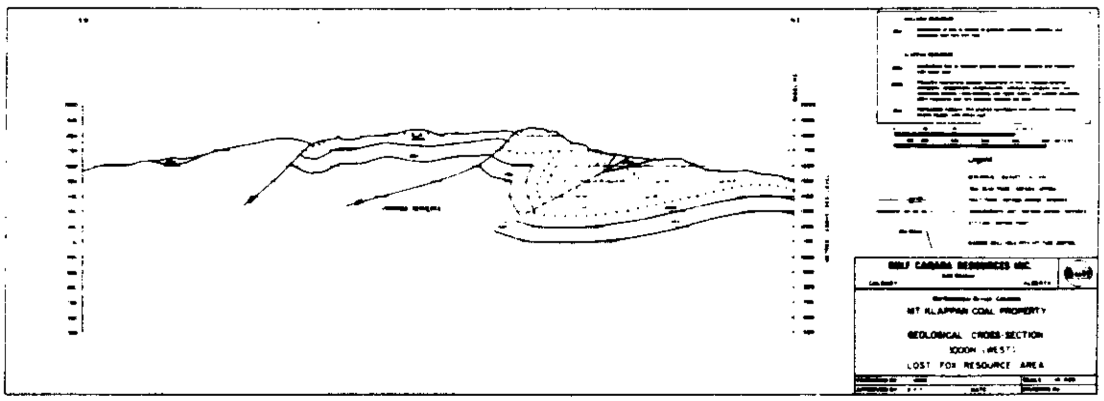
LOST–FOX GEOLOGY

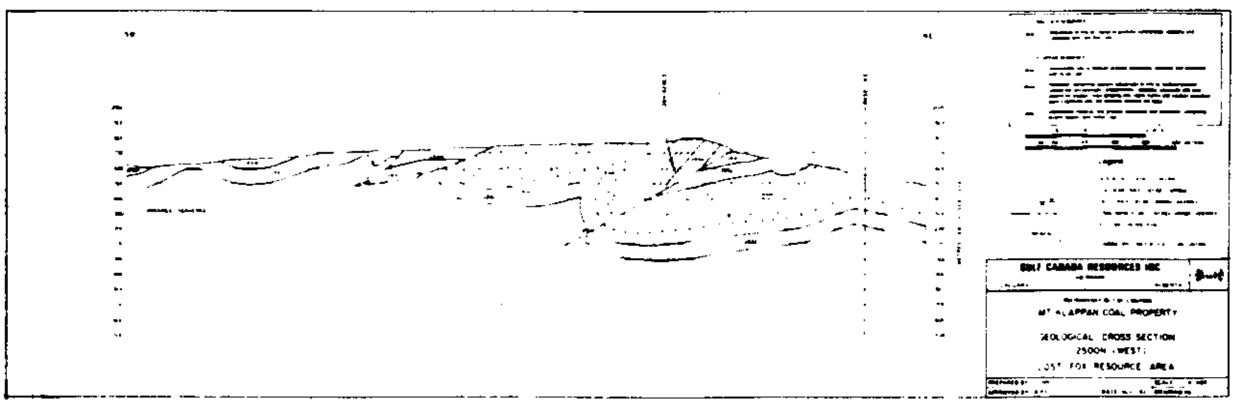
Figure 4.15



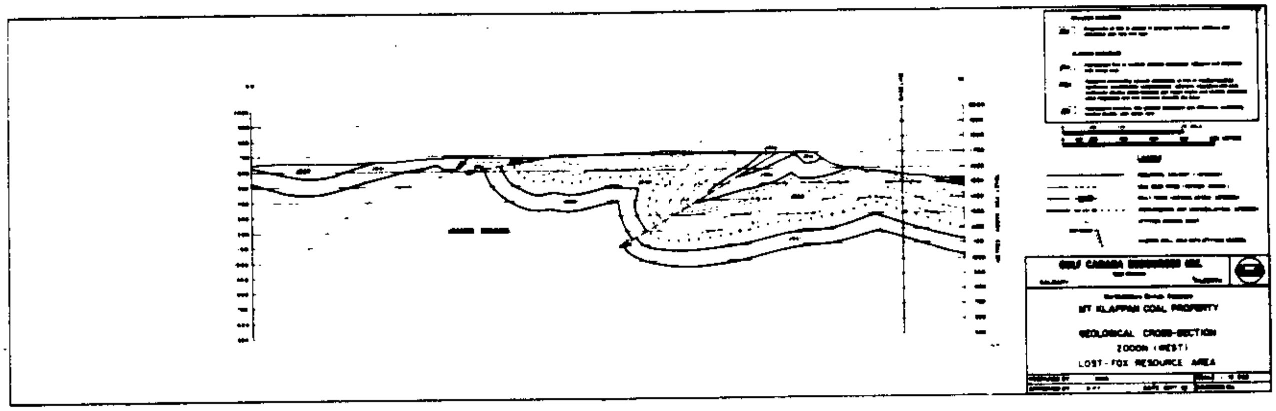


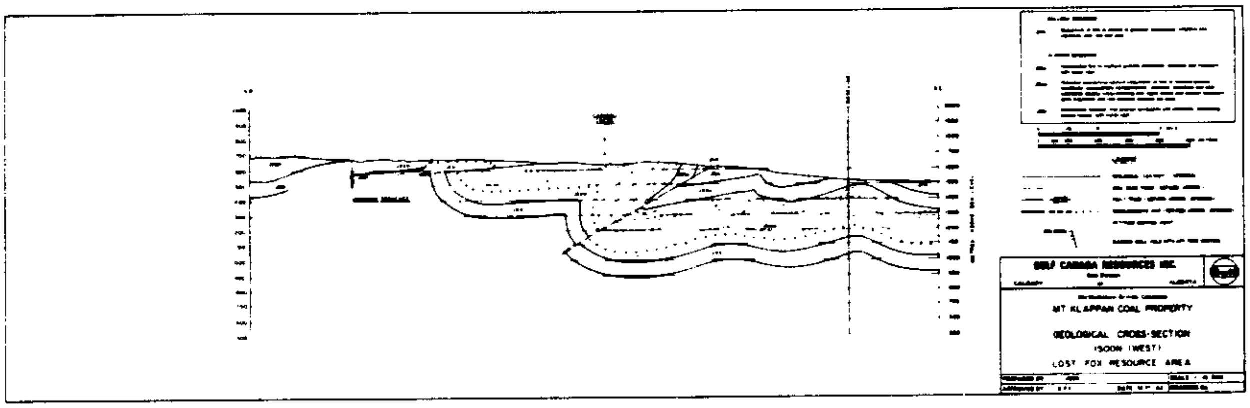


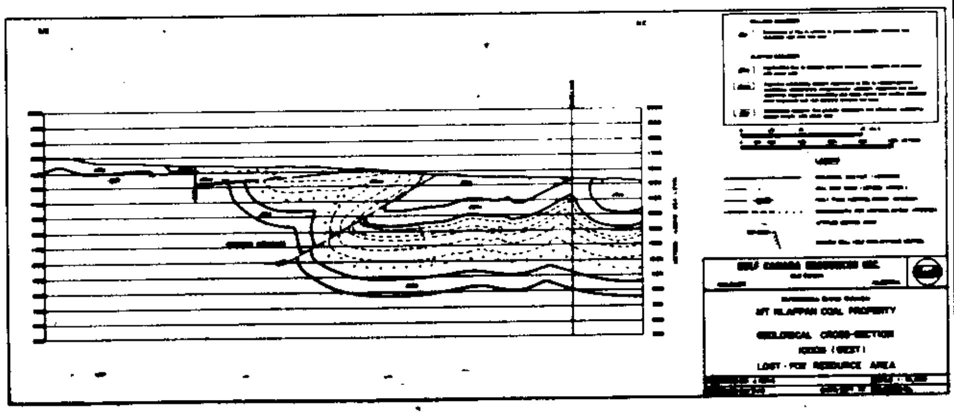


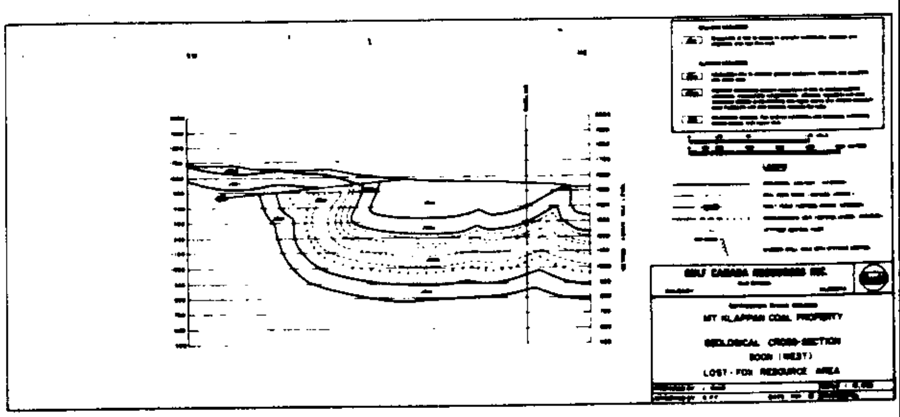


LOST–FOX RESOURCE AREA CROSS–SECTIONS Figure 4.16a SCALE: 1:50,000









LOST-FOX RESOURCE AREA CROSS-SECTIONS Figure 4.16b SCALE: 1:50,000

PART 5

RESOURCES

PART 5 - RESOURCES

CONTENTS

Table

Plate

5.1 SUMMARY

The Middle Klappan Unit, underlying the Mount Klappan property, is estimated to have an exploration resource potential of 3 billion tonnes (rounded down to the nearest billion) of anthracite to a depth of 500 metres. Of this amount, 890 million tonnes is classified as an inferred resource, 1.2 billion tonnes as a speculative resource, and in excess of 1 billion tonnes as a potential resource (Plate 5.1).

Resources	Billion Tonnes
Inferred	0.89
Speculative	1.23
Exploration Potential	1.33
Total Resource	3.45

These tonnage figures, at present, exclude about 900 million tonnes of the resource potential which may underlie the area presently under licence application.

5.2 INFERRED RESOURCE AREA

521 SUMMARY

The in situ inferred resources are contained within three areas, the Hobbit-Broatch Resource Area, delineated in the 1981 assessment, and two new areas, Lost-Fox and Summit, delineated as a result of the 1982 exploration programme (Plate 5.2). Of the 890 million tonnes, 620 million tonnes underlie Hobbit-Broatch, 240 million tonnes the Lost-Fox Resource Area and 30 million tonnes occur in the Summit Resource Area.

Resources	Million Tonnes
Hobbit-Broatch	620
Lost-Fox	240
Summit	30
Total	890

522 HOBBIT-BROATCH RESOURCE AREA

The 1982 drilling programme confirmed, and significantly increased, the tonnages of surface-mineable coal, calculated in the 1981 assessment, to underlie the Hobbit-Broatch Resource Area. The resources increased from 95 million tonnes in two seams to 620 million tonnes in nine seams in a 17.8 square kilometre area covering the southern one half of the lower structural block (Table 5.1). The area is defined by the B.H.G. Thrust to the southwest and, elsewhere, by boundaries assigned according to the level of geologic confidence (Plate 5.2).

Seam intersections in five diamond drill holes (DDH82001, DDH82002, DDH82003, DDH82004 and DDH82006) were used to calculate the resource located in this block. Numerous coal trenches were dug in this resource area, several in seams over 5 metres thick; however, seam thickness derived from the trenches were not used in determining weighted average seam thicknesses for resource calculation purposes. The resource includes seams A through K (excluding C and D) which have weighted average thicknesses less than 0.5 metres. Weighted average aggregate thickness of the seams is 21.75 metres (Table 5.2).

523 LOST-FOX RESOURCE AREA

The Lost-Fox area, located within the central structural block on the eastern portion of Lost Ridge, contains approximately 240 million tonnes in an area covering approximately 8.5 square kilometres (Plate 5.2). The area is defined by the Klappan Thrust Fault to the west and by diminishing outcrop control in the areas of low relief in the other directions (Plate 5.2).

An aggregate thickness of 17.86 metres from seams I through L, intersected by DDH82005, and seam G, which was trenced, was applied in the resource calculations (Table 5.3).

524 SUMMIT RESOURCE AREA

The Summit Resource Area is arbitrarily defined as having a one kilometre radius about DDH82007 (Plate 5.2). Only lack of data limits the continuation of this area in all directions. An inferred resource of 30 million tonnes, occurring in seams G, F and D, was calculated from an aggregate seam thickness of 7.91 metres (Table 5.4).

525 LOW ASH RESOURCE

Due to the superior nature of the Klappan coal quality, some seams in each of the inferred resource areas have the ability to produce a low ash anthracite product coal (Part 6). Washability results show that of the total in situ inferred resource of 890 million tonnes, 180 million tonnes of in situ coal can be utilized to produce a 5% ash product while an additional 320 million tonnes can be used to produce a 10% ash product (Table 5.5). Theoretical clean coal yields in both cases would vary from 40% to 70%.

Examining each of the inferred resource areas separately, the Hobbit-Broatch area, with a total inferred resource of 620 million tonnes, would contribute 130 and 225 million tonnes of in situ coal from which a portion could be produced as clean coal at 5% and 10% ash levels respectively. Of a total inferred resource of 240 million tonnes for the Lost-Fox area, 50 million tonnes could be cleaned to 5% ash and 85 million tonnes cleaned to a 10% ash coal. While not being able to produce a 5% ash clean coal with an acceptable yield, 10 million tonnes of the total inferred resource of 30 million tonnes in the Summit area could produce a 10% ash coal.

A theoretical yield of 40%, or greater, was the limiting parameter applied to each drilled seam intersection to determine its ability to produce tonnages of 5% and 10% ash coals. Coal seam intersections from which a 5% ash coal could be produced were excluded from those used to determine the tonnage of coal available to produce 10% ash clean coal. Details of the clean coal products are contained in Part 6.

5.3 SPECULATIVE RESOURCE AREA

An in situ speculative resource of 1.23 billion tonnes is calculated to underlie an area covering approximately 46 square kilometres (Plate 5.3). The speculative resource area encompasses the northern continuation of the Hobbit-Broatch Resource Area on the lower structural block and the northern extension of the Lost-Fox Resource Area to the Summit Resource Area, on the middle structural block.

Weighted average aggregate thicknesses from the Hobbit-Broatch composite section and seam thickness from the Lost-Fox, Summit composite section were averaged as shown in Table 5.6 and the resulting average of 21.78 metres was applied to the entire speculative resource area.

5.4 POTENTIAL PROPERTY RESOURCE

Preliminary exploration outside the inferred and speculative resource areas has indicated the potential for a substantial in situ resource of 1.33 billion tonnes to occur within the Middle Klappan Sequence. Numerous coal occurrences substantiate the existence of this resource which, as calculated, includes the entire area underlain by the Middle Klappan Sequence outside of the inferred and speculative resource areas (Plate 5.4). The entire upper structural block and the southern portion of the middle block constitute the bulk of the area for which potential resources were calculated. The thickness used for the potential resource (Table 5.5) is based on 50% of the average aggregate thickness used for the speculative resource area.

An additional potential resource underlying the area presently under licence application is estimated to be in the order of 900 million tonnes (Plate 5.5).

5.5 TOTAL PROPERTY RESOURCE

The total resource potential of the property has been calculated to be 3.45 billion tonnes of anthracite. The figure was derived by summing the inferred, speculative and potential resources. With the addition of the 900 million tonnes estimated for the area now under licence application, this total would increase to 4.35 billion tonnes or 4 billion tonnes rounded down to the nearest billion.

5.6 PROCEDURES AND PARAMETERS

The property is subdivided into five resource areas based on confidence in the stratigraphy, structure, coal seam distribution and coal thickness. Three of the areas are defined as containing inferred resources, one as containing speculative resources and the remaining one area as having potential resources (Plate 5.1).

All resources, inferred, speculative and potential, are calculated by the cross-section method, except the Summit inferred resource, where a planimetric projection method was utilized.

The planimetric projection method was applied in the Summit area due to the relatively isolated nature of DDH82007 and the limited surface control in the area. In this method the subsurfce planimetric extent of each intersected seam within a 1 kilometre radius of DDH82007 was planimetered. The respective drilled thicknesses were multiplied by the planimetered area and by the specific gravity to obtain the tonnage value for the resource area.

The cross-sectional method utilized cross-sections spaced at 500 metre intervals for the Hobbit-Broatch and Lost-Fox inferred areas, and 2 000 metre intervals for the speculative and potential resource areas.

Seam thickness, seam length, section width and specific gravity constituted the basic data for all resource calculations according to the following formula:

METRIC TONNES COAL =

THICKNESS x LENGTH x WIDTH x SPECIFIC GRAVITY

These parameters were applied in a similar manner for all resource tonnage calculations.

The seam thicknesses used were true thickness values. A seam was defined as a coal and inseam rock interval which contained greater than approximately 60% coal (Table 5.7). Where a coal zone contained two distinct seams the thicknesses were summed. Seam thicknesses were either weight averaged by area of drill hole influence, as in the Hobbit-Broatch Resource Area, applied directly to the seam length as in the Lost-Fox and Summit Resource Areas, or an average aggregate thickness was used as in the speculative and potential resource calculations. In the Hobbit-Broatch area, seam intersections less than 0.5 metres thick were included in the determination of the weighted average thickness for each seam. However, seams with a weighted average thickness of less than 0.5 metres were excluded from resource calculations.

Individual seam lengths were measured and the weighted average thickness for each seam was applied to calculate coal area related to individual cross-sections. A similar procedure was followed for the Lost-Fox area, with the exception that seam thicknesses derived from DDH82005 and from one trench were used. A different approach had to be taken for the speculative and potential resource calculations, where the level of confidence did not permit the precise positioning of the seams in the cross-sections. Based on coal seams being equally spaced within the Middle Klappan Unit, the volume of coal was determined by calculating the volume of the Middle Klappan Unit contained in each cross-sectional area of influence.

The area of influence of each cross-section used to determine coal volume was defined as the distance between the midpoints of adjacent cross-sections. The sections were spaced 500 metres apart in the Hobbit-Broatch and Lost-Fox areas, and at 2 000 metres over the remainder of the property.

A specific gravity of 1.70 for in situ coal was used throughout all resource calculations to determine coal tonnage. This figure was derived from average specific gravity determinations on the drill core samples which were available at the time of calculations.

All resources were calculated to a depth of 500 metres below ground level. Oxidation limits were not applied to any resource calculations.

Both the inferred and speculative resources are defined as in Appendix B of Coal Resources and Reserves of Canada, Report ER 79-9.

Potential resources are based on estimation of the resources that are contained within the Middle Klappan Sequence, and the interpreted distribution of this sequence over the western portion of the property and the area currently under licence application.

TABLE 5.1

SUMMARY OF HOBBIT-BROATCH RESOURCES

SEAM NAME	A	B	C	D	E	F	G	H	I	J	K	SECTION TOTAL TONNAGES (10^6)
Seam Thickness (metres)*	1.67	1.50	0.48+	0.40+	1.66	0.87	3.32	2.12	6.07	1.41	3.13	
Cross-Section												
500S	4.90	2.81	-	-	1.25	-	1.11	0.20	-	-	-	10.27
1000S	6.20	5.18	-	-	4.62	-	5.70	2.26	3.56	0.37	0.63	28.52
1500S	5.29	4.86	-	-	5.43	-	10.78	6.50	16.61	3.24	6.84	59.55
2000S	5.90	5.28	-	-	5.75	-	10.70	6.57	16.15	3.43	7.37	61.15
2500S	5.42	4.74	-	-	5.04	-	8.78	4.72	10.65	2.04	4.04	45.43
3000S	4.93	4.77	-	-	5.46	2.82	10.48	6.39	16.56	3.33	6.96	61.70
3500S	4.76	3.98	-	-	5.43	2.84	10.96	6.96	19.27	3.87	8.15	66.22
4000S	6.08	5.78	-	-	6.66	3.49	13.32	8.66	23.01	5.03	10.38	82.41
4500S	4.98	4.97	-	-	5.59	2.84	11.13	7.07	20.38	4.39	9.31	70.66
5000S	5.37	4.84	-	-	5.69	2.95	11.64	7.42	19.22	4.28	8.87	70.28
5500S	5.72	5.39	-	-	6.10	3.24	11.61	6.72	16.85	2.83	5.39	63.85
Seam Total Tonnages (10^6)	59.55	52.60	-	-	57.02	18.18	106.21	63.47	162.26	32.81	67.94	620.04

* Weighted average aggregate thickness is 21.75 m.

\+ Weight averaged thicknesses less than 0.5 m excluded from resource calculation.

TABLE 5.2

HOBBIT-BROATCH RESOURCE AREA WEIGHTED SEAM THICKNESSES

SEAM+	DDH82001 THICKNESS (m)	DDH82001 AREA OF INFLUENCE	DDH82002 THICKNESS (m)	DDH82002 AREA OF INFLUENCE	DD82003 THICKNESS (m)	DD82003 AREA OF INFLUENCE	DDH82004 THICKNESS (m)	DDH82004 AREA OF INFLUENCE	DDH82006 THICKNESS (m)	DDH82006 AREA OF INFLUENCE	WEIGHTED AVERAGE COAL THICKNESS (m)
K	3.45	.66	-	-	2.52	.34	-	-	-	-	3.13
J	0.93	.66	-	-	2.33	.34	-	-	-	-	1.41
I	6.97	.66	-	-	4.32	.34	-	-	-	-	6.07
H	1.73	.28	-	-	2.57	.34	-	-	2.01	.38	2.12
G	2.77	.15	4.03	.18	4.22	.27	2.88	.15	2.45	.25	3.32
F	-	-	0.35	.19	2.17	.35	0.04	.21	0.16	.25	0.87
E	-	-	0.92	.19	0.86	.35	0.75	.21	0.63	.25	1.66
	-	-	2.24	-	1.28	-	-	-	-	-	-
D	-	-	0.53	.40	-	-	0.35	.35	0.59	.25	0.48*
C	-	-	0.67	.43	-	--	-	-	0.19	:57	0.40*
B	-	-	-	-	-	-	-	-	1.50	1.00	1.50
A	-	-	-	-	-	-	-	-	1.67	1.00	1.67
									Aggregate Seam Thickness for seam greather than 0.5 metres		21.75 m*

* Values less than 0.50 metres omitted from resource calculations

\+ upper and lower seam portions summed if each had greater than 60% coal

TABLE 5.3

SUMMARY OF LOST-FOX RESOURCES

SEAM NAME	G	H	I	J	K	L	SECTION TOTAL TONNAGES (10^6)
Seam Thickness (metres)*	4.02	-	4.98	5.16	1.46	2.24	-
Cross-Section							
500N	3.07	-	9.74	8.82	2.49	3.66	27.78
1000N	6.65	-	14.67	13.19	3.13	4.72	42.36
1500N	11.99	-	15.78	11.71	3.24	4.58	47.30
2000N	11.22	-	15.56	10.92	3.08	3.07	43.85
2500N	11.02	-	16.08	11.82	2.33	3.05	44.30
3000N	8.58	-	6.43	4.52	1.12	1.12	21.77
3500N	5.64	-	3.37	2.04	0.37	-	11.42
4000N	1.62	-	0.93	-	-	-	2.55
Seam Total Tonnages (10^6)	59.79	-	82.56	63.02	15.76	20.20	241.33

* Aggregate thickness is 17.86 m

TABLE 5.4

SUMMARY OF SUMMIT RESOURCES

	D	F	G	Total
Seam Thickness (m)	1.29	2.71	3.91	7.91
Seam Tonnage (10^6)	6.89	13.80	12.76	33.45

TABLE 5.5

LOW ASH TONNAGE SUMMARY

AREA	MILLIONS OF TONNES AVAILABLE TO PRODUCE 5% ASH COAL	MILLIONS OF TONNES AVAILABLE TO PRODUCE 10% ASH COAL
Hobbit-Broatch	130.46	225.02
Lost-Fox	49.57	84.34
Summit	-	12.76
TOTAL	180.03	322.12

TABLE 5.6

SPECULATIVE AND POTENTIAL PROPERTY RESOURCE AREAS

COAL SEAM THICKNESSES

SEAM	HOBBIT-BROATCH WEIGHT AVERAGED COAL THICKNESSES	LOST-FOX - SUMMIT AVERAGE COAL THICKNESSES
L	Not Intersected	2.24
K	3.13	1.46
J	1.41	5.16
I	6.07	4.98
H	2.12	-
G	3.32	3.97
F	0.87	2.71
E	1.66	-
D	0.48*	1.29
C	0.40*	-
B	1.50	-
A	1.67	-
TOTAL	21.75 m	21.81 m

Average aggregate thickness for speculative resource area	21.78
Average aggregate thickness for potential property resource area	10.9

* Values less than 0.50 metres were omitted from resource calcuations.

TABLE 5.7

COAL SEAM THICKNESS SUMMARY

TOTAL SEAM THICKNESSES

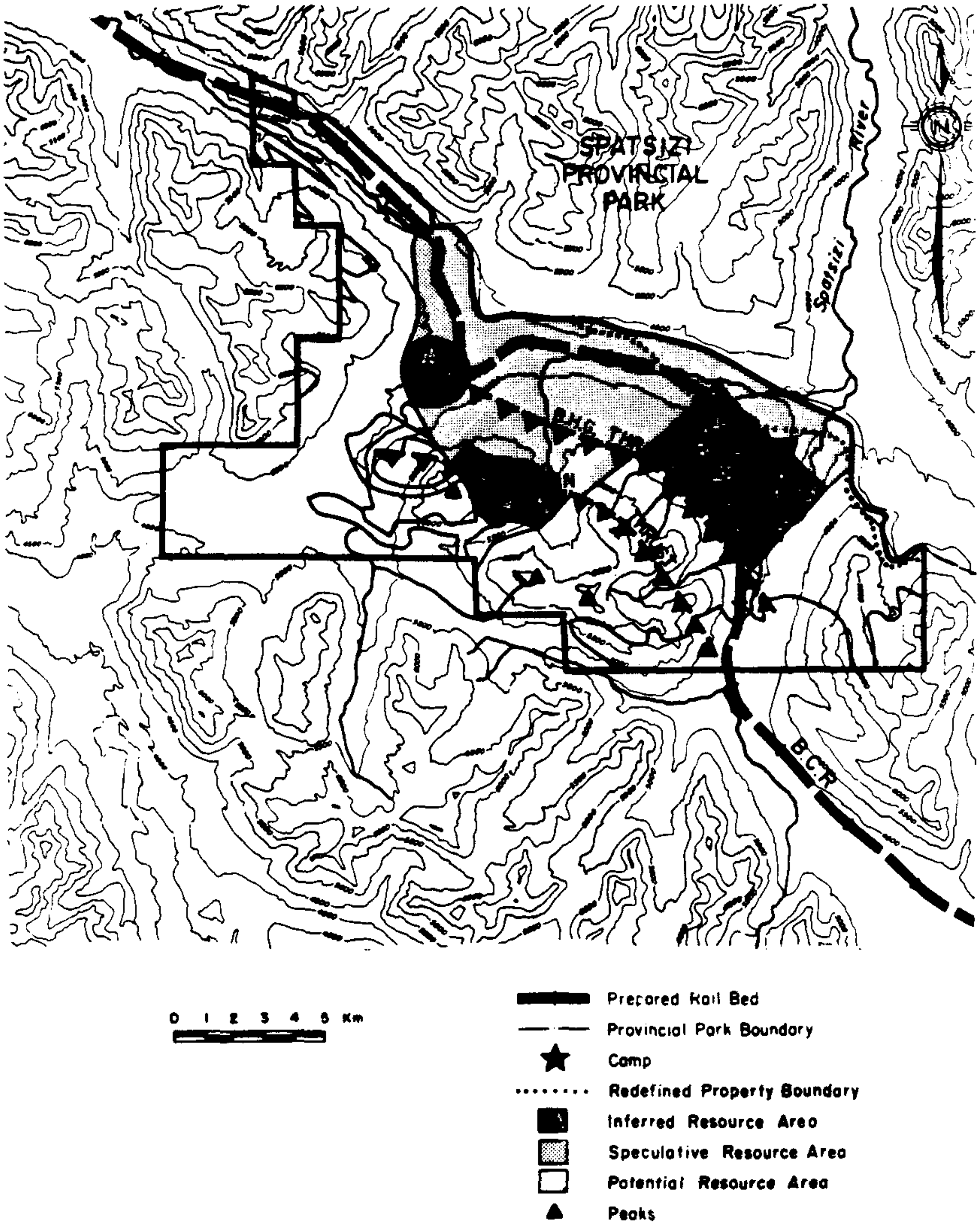
SEAM	DDH82001*	DDH82002	DDH82003	DDH82004	DDH82005	DDH82006	DDH82007	AVERAGE
L	-	-	-	-	2.24	-	-	2.24
K	3.45	-	2.52	-	1.46**	-	-	2.48
J	0.93	-	2.33	-	5.16	-	-	2.81
I	6.97	-	4.32	-	4.98	-	-	5.42
H	1.73	-	2.57	-	-	2.01	-	2.10
G	2.77	4.03**	4.22	2.88	-	2.45	3.91	3.38
F	-	0.35	2.17	0.04	-	0.16	2.71	1.09
E	-	3.16	2.14+	0.75	-	0.63	1.29	1.59
D	-	0.53	-	0.35	-	0.59	-	0.49
C	-	0.67	-	-	-	0.19	-	0.43
B	-	-	-	-	-	1.50	-	1.50
A	-	-	-	-	-	1.67	-	1.67
					Aggregate			25.20
					Aggregate of seams greater than 0.5 m			24.28

* Net thicknesses exclude core loss
** Upper seam only
\+ Includes upper and lower portions

MT. KLAPPAN COAL PROPERTY

RESOURCE AREAS

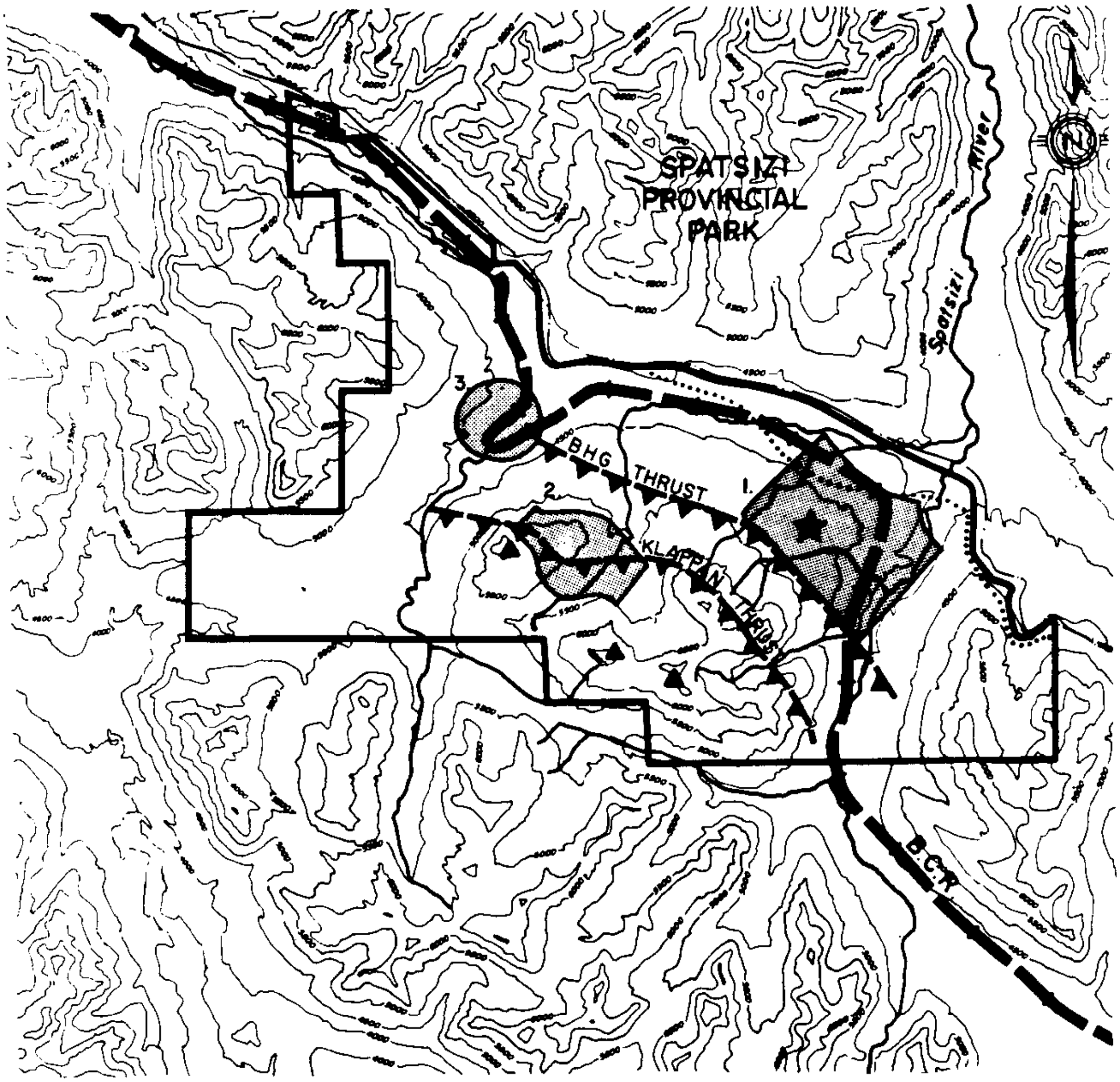
Plate 5.1



MT. KLAPPAN COAL PROPERTY

INFERRED RESOURCE AREAS

Plate 5.2



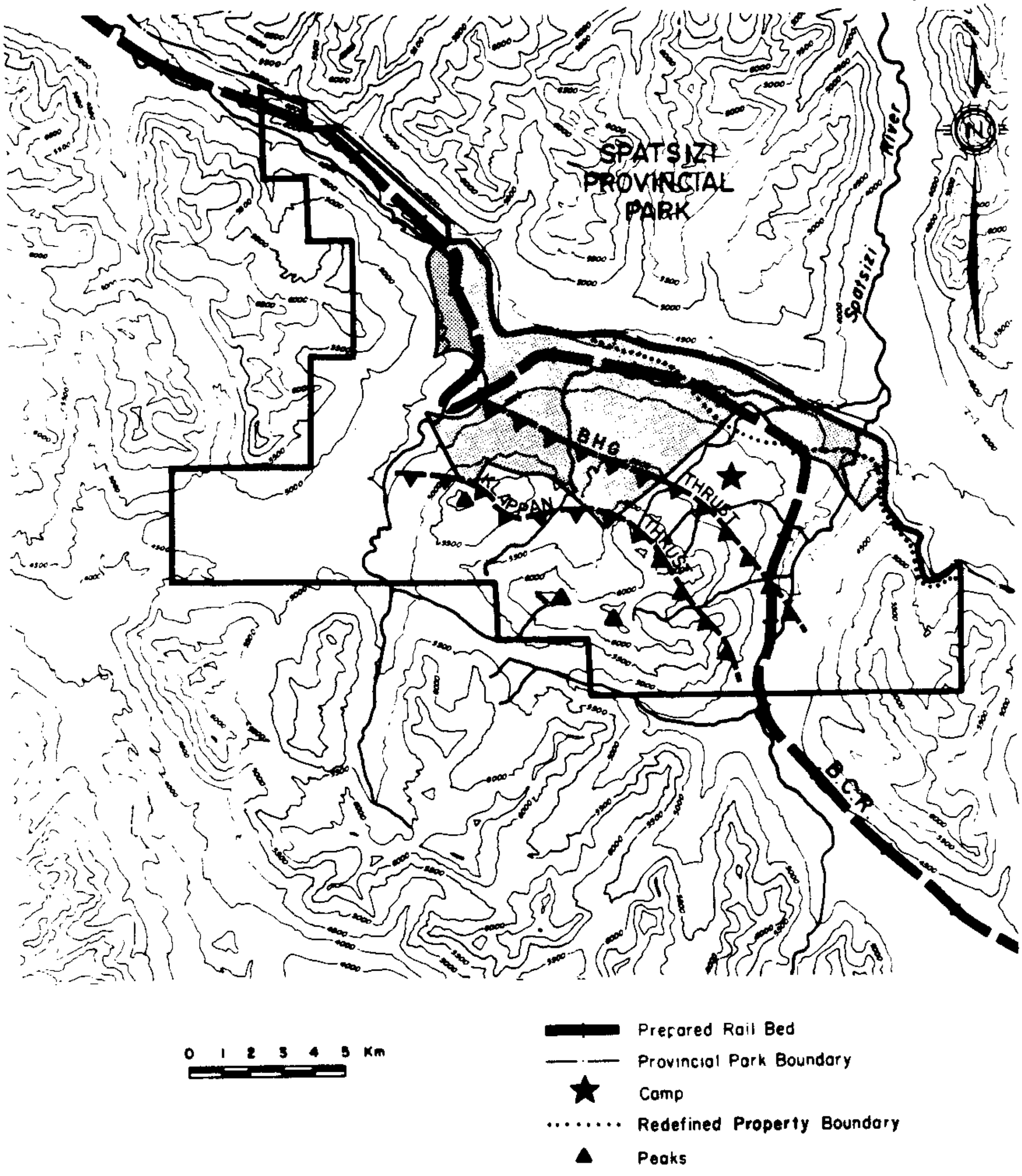
0 1 2 3 4 5 Km

	Prepared Rail Bed
	Provincial Park Boundary
★	Camp
....	Redefined Property Boundary
1.	Hobbit-Broatch Area
2.	Lost-Fox Area
3.	Summit Area
▲	Peaks

MT. KLAPPAN COAL PROPERTY

SPECULATIVE RESOURCE AREA

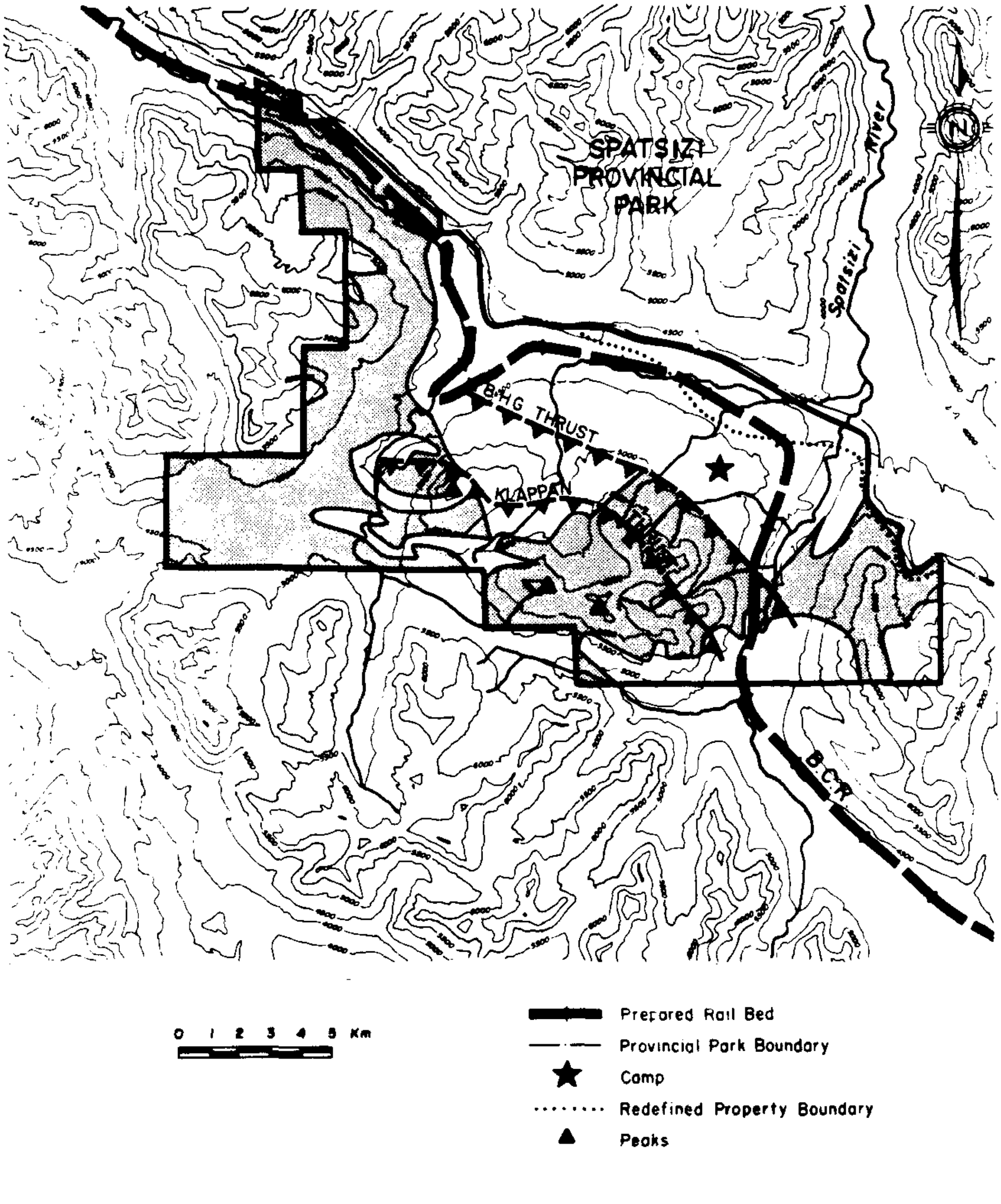
Plate 5.3



MT. KLAPPAN COAL PROPERTY

POTENTIAL RESOURCE AREA

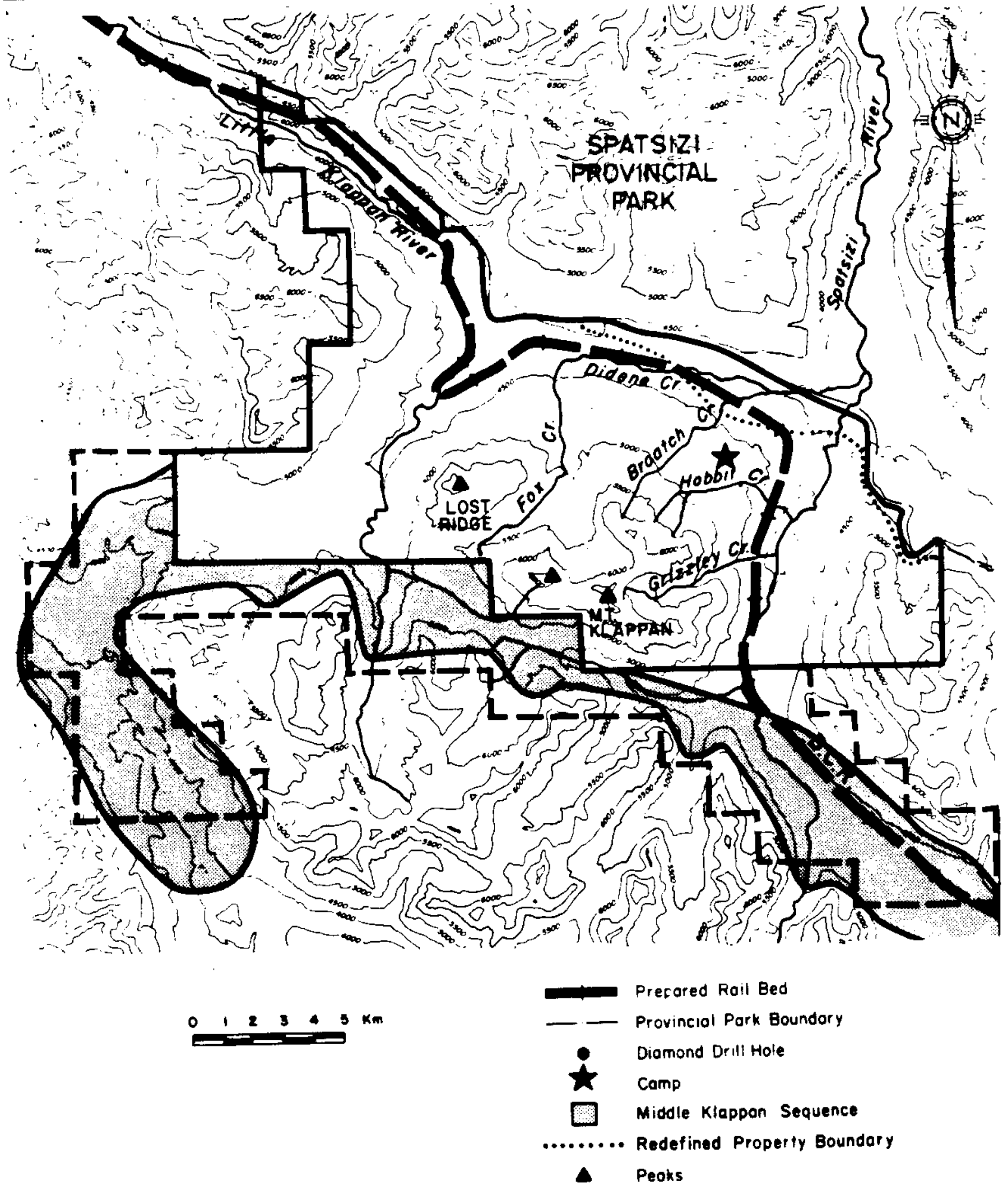
Plate 5.4



MT. KLAPPAN COAL PROPERTY

MIDDLE KLAPPAN SEQUENCE ON LICENCES UNDER APPLICATION

Plate 5.5



PART 6

COAL QUALITY

PART 6 - COAL QUALITY

CONTENTS

Table

Figure

6.1 SUMMARY

611 COAL QUALITY

The Mount Klappan property is underlain by anthracite which can be washed to produce a variety of product coals. Low sulphur clean coal products, ranging from premium quality anthracite (5 to 6% and 9 to 11% ash) to briquetting coal (19% ash), can be produced from the property.

612 PREMIUM COALS

Selected seams can be washed to produce low and medium ash premium quality anthracites. The low ash premium coals would have ash contents ranging from 5 to 6% and gross calorific values of 7 800 to just under 8 000 calories per gram on an air dried basis (a.d.b.). At an ash level of 5% a simulated washplant yield of 36% is obtainable with heavy medium cyclone cleaning equipment.

Medium ash premium coal, with ash levels of 9 to 11% and gross calorific values of 7 400 cal/g (a.d.b.), can also be produced. Simulated cleaning with heavy medium cyclone equipment will give a yield of 46% at 10% ash. Average total sulphur for both premium coals is 0.6% or less and the Hardgrove Grindability Index is in the range of 35 to 44. A middling product from both low and medium coals can be washed to around 25% ash to produce briquetting coal.

TABLE 6.1

LOW ASH PREMIUM COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Simulated Washplant Yield (%) (5% Ash)	32.0	61.0	36.0
Proximate Analysis			
Residual Moisture (%)	0.6	0.5	0.6
Ash (%)	4.8	5.0	4.9
Volatile Matter (%)	6.6	5.2	6.2
Fixed Carbon (%)	88.0	89.3	88.3
Total Sulphur (%)	0.6	0.4	0.5
Gross Calorific Value (cal/g)	7950	7950	7950
H.G.I.	36	33	35

All figures are averages weighted by clean coal tonnage; results recorded are on an air dried basis (a.d.b.).

TABLE 6.2

MEDIUM ASH PREMIUM COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Simulated Washplant			
Yield (%) (10% Ash)	45.0	59.0	48.0
Proximate Analysis			
Residual Moisture (%)	0.9	0.7	0.8
Ash (%)	9.6	9.8	9.6
Volatile Matter (%)	7.3	6.1	6.8
Fixed Carbon (%)	82.2	83.4	82.8
Total Sulphur (%)	0.6	0.4	0.6
Gross Calorific Value (cal/g)	7450	7450	7450
H.G.I.	46	38	44

All figures are averages weighted by clean coal tonnage; results recorded are on an air dried basis.

613 BRIQUETTING COAL

Briquetting coal can be produced from most seams on the property. At a 19% ash level, an average simulated washplant yield of 82% of less than 0.8% sulphur coal can be attained. The gross calorific value for briquetting coal would average in excess of 6 500 calories per gram (a.d.b.). The Hardgrove Index averages 48 for the briquetting coal.

Ultimate analyses indicate a carbon content of over 72% (a.d.b.) or over 90% (d.a.f.). Initial deformation temperature and fluid temperature of briquetting ash in an oxidizing atmosphere are respectively 1240°C and 1385°C.

TABLE 6.3

BRIQUETTING COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Simulated Washplant			
Yield (%) (19% Ash)	79.0	91.0	82.0
Proximate Analysis			
Residual Moisture (%)	1.5	2.0	1.6
Ash (%)	18.7	18.6	18.6
Volatile Matter (%)	8.4	7.7	8.2
Fixed Carbon (%)	71.4	71.7	71.6
Total Sulphur (%)	0.8	0.5	0.7
Gross Calorific Value (cal/g)	6500	6500	6500
H.G.I.	51	39	48

All figures are averages weighted by clean coal tonnage; results recorded are on an air dried basis.

6.2 PROCEDURES AND PARAMETERS

621 OBJECTIVES

The objectives of the 1982 coal quality analytical programme were threefold:

To characterize the Mount Klappan coal.

To examine the washability characteristics of the coal.

To determine the coal quality characteristics of the premium low ash anthracite and the briquetting coals.

622 METHODOLOGY

Diamond drill hole coal seam samples, logged in detail and sampled by increments, were subjected to a full programme of analytical tests and float-sink studies, outlined on the flowsheets (Figures 6.1 and 6.2).

A concurrent trenching programme provided back-up samples, but the 1982 quality analysis focussed on fresh coal seams intersected by drill holes.

All analyses were done by Cyclone Engineering Sales Ltd. of Edmonton, Alberta, as per the flowsheet (Figures 6.1 and 6.2). As a check for analytical accuracy, selected samples were sent to Geochemical Testing of Somerset, Pennsylvania, and Bituminous Coal Research of Monroeville, Pennsylvania.

623 ANALYTICAL PROCEDURES

The flowsheet is divided into four main portions:

Compositing
Size analysis
Detailed washability studies
Product analysis

.1 Compositing

Compositing of the incremental samples from each seam was guided by float-sink testing of a small portion of each sample to determine the yield and ash characteristics of the increment. Based on data available from the 1981 coal quality assessment, a specific gravity of 1.7 was chosen for this initial float-sink test.

.2 Size Analysis

Once composited, a portion of each composite sample was crushed to -3/8 inch and then screened on 28 mesh (0.6 mm) and 100 mesh (0.15 mm) screens. As the samples were from diamond drill core, which was broken up during detailed logging of the coal, an analysis of the larger size fractions will have to be done when a bulk sample is taken.

.3 Float-Sink Data

A total of 11 specific gravity fractions ranging from 1.4 to +2.3 g/cc was separated out of the +28 and 28 x 100 mesh size fractions of each composite. The 100 x 0 fraction underwent froth flotation for periods of 30, 45, 60, 90 and 120 seconds.

Yield, ash and calorific value determinations done on each specific gravity fraction were used to group the seams according to their ability to produce premium and briquetting quality products. In cases where a seam was capable of producing both a premium and a briquetting coal, each gravity fraction was split. Cut points were then determined for each composite to produce final product coals with desired ash contents.

.4 Product Analysis

The clean coal and raw coal products were subjected to extensive analytical tests, which included proximate analysis, total sulphur, calorific value and ash characteristics. Middlings from the premium quality products underwent only limited tests.

624 WASHPLANT SIMULATION

An in-house computer programme has been developed by Gulf Canada Resources Inc. that is capable of simulating coal preparation plant operation and of calculating potential plant yields from run-of-mine coal. The system takes into account the washability characteristics of the coal, and the efficiency of the equipment involved in cleaning. An adjustment for out-of-seam dilution to be included in the simulation is in the development stages and is nearing completion. The adjustment has not been included in the current discussion. The simulator also has the ability to calculate weight averaged quality data.

In the following coal quality discussion (Section 6.6) the average values for various quality parameters were calculated using the computer simulation and are weighted by clean coal tonnage. These are designated computed averages. The yields derived from washplant simulator runs are computed yields. The washplant simulator programme cannot directly compute washplant yields for the middlings product of the low and medium ash coals at present. These yields are manually calculated as differences between two simulation runs, at the premium ash level and at a higher ash level.

6.3 COAL RANK

The Mount Klappan coal is anthracite. The mean maximum reflectance of vitrinite in oil ranges from 2.71 to 4.70% and the dry mineral matter free (d.m.m.f.) volatile matter content of the purest washed coal available on the project, (2-5% ash) is 6% or less. A fuel ratio of 15, obtained by dividing the fixed carbon content by the volatile matter, is calculated for the same low ash coal.

Anthracite coal is characterized as having a mean maximum reflectance in excess of 2.5%, a d.m.m.f. volatile matter content of between 2% and 8% (American Society For Testing Materials - A.S.T.M.) and a fuel ratio in excess of 9 (Japan Industrial Standards Association - J.I.S.).

A special feature of the Mount Klappan anthracite is the abundance of carbonate in the ash and in partings within the seam. During tests to determine volatile matter content, the carbonates in the ash produce from 1 to 5% carbon dioxide, which is reported as a part of the total volatile matter. While this abundance of carbonate is beneficial in terms of its effect on combustible sulphur, it should be noted that when ranking coal by the A.S.T.M. methods, carbon dioxide in excess of 1% necessitates the direct measurement of the carbon dioxide to eliminate its influence in determining the true d.m.m.f. volatile matter content (A.S.T.M. D388) in the high ash anthracites.

6.4 SIZE DISTRIBUTION

The average size distribution for Mount Klappan coals is strongly skewed towards the coarse fraction. Some variation exists from area to area but the +28 mesh fraction generally contains more than 75% of total sample weight.

Coal in the Hobbit-Broatch area has the following average size distribution and Hardgrove Indices (H.G.I.):

HOBBIT-BROATCH AREA

	5% Ash	10% Ash	19% Ash	Raw
+28 (%)	68	77	76	76
28 x 100 (%)	19	15	15	15
-100 (%)	13	8	9	9
H.G.I.	36	46	51	51

In the Lost-Fox area seams in hole DDH82005 have an average size distribution and H.G.I. as follows:

LOST-FOX AREA

	5% Ash	10% Ash	19% Ash	Raw
+28 (%)	87	84	84	84
28 x 100 (%)	9	11	10	10
-100 (%)	4	5	6	6
H.G.I.	33	38	39	41

All distributions indicate a hard coal with a large coarse component. The Hardgrove Grindability Index shows a clear decreasing trend in lower ash coals indicating that the ash may be the softest part of the coal. The trend in size distribution follows the H.G.I. trend in the Lost-Fox area with a greater fine fraction at higher ash levels. The correlation is not so clear in the Hobbit-Broatch area.

Examination of the relationship between the finer fractions (minus 28 mesh) and the H.G.I., through regression curve analysis, indicates that the H.G.I. will be a good indication of the size distribution of the coals on the property. A general trend towards a lower H.G.I., and, therefore, harder coal, for the clean coal compared to the raw coal H.G.I. indicates that the coal is harder than the enclosing sediments.

6.5 FLOAT-SINK DATA

The results of the detailed float-sink studies indicate that the Mount Klappan anthracite is a multi-product coal. Clean coal products, ranging in ash content from 5% to 25% can be produced from the property at good yields. Gross calorific values range from just under 8 000 cal/g to about 6 000 cal/g (a.d.b.) for the 5% to 25% ash products, respectively.

A high confidence level is assigned to the washability data due to the good-to-excellent recovery of coal in the diamond drill core. Relatively subdued structure and the hardness of the coal resulted in an average recovery in excess of 80%. As detailed matching of the recovered portions of the seam with the geophysical logs indicates that the bulk of the lost core is coal, the washability will err slightly on the conservative side.

All seams on the property, with the exceptions of B, D and H, have washability characteristics allowing cleaning of the coal to very low ash contents. The overall average ash content of raw coals is in the vicinity of 30%, although individual coal intervals are encountered with a head ash as low as 14%. The Lost-Fox area has a greater proportion of low ash seams than the Hobbit-Broatch area. The average raw ash content of the Lost-Fox coals is 24%.

By selection of coal intervals from the total resource, a range of low ash products can be produced. Cut points chosen from listings of float-sink results were designed to yield a low ash premium product and a medium ash premium product with the balance of the coal intervals, and the rejects from premium coal production, being analyzed as a briquetting coal product.

An alternative utilization of all coal intervals to produce briquetting coal was also considered and a separate series of cut points was chosen to provide samples for overall briquetting coal quality analysis.

To obtain premium coals a cut point of 1.6 specific gravity or less is chosen while, for briquetting coals, the cut point will be 1.8 specific gravity or greater, especially for the 28 x 100 mesh size fraction. This range in cut points is mirrored by a variation in the percentage of near gravity material from 8% for coal cut at 1.8 g/cc to 25% or greater for coals cut at 1.6 specific gravity.

The type of equipment required to clean the coal will depend on the final ash level specified. With near gravity material of just over 7%, cleaning of the coarser fractions (+28 and 28 x 100 mesh) to produce briquetting coal, will be ideally suited to a combination of jig washer and water-only cyclones, with the fine fraction (100 x 0 mesh) passing through froth flotation cells. On the other hand, cleaning of the coarser coal fractions of the premium coal is more suited to heavy medium circuitry with the fine material being combined with the middlings coal.

6.6 PRODUCTS

A range of products from low and medium ash premium anthracites to briquetting coal can be produced from the Mount Klappan property. The low ash premium coals, with ash contents of 5 to 6%, and gross calorific values of 7 800 to just under 8 000 calories per gram (a.d.b.)can be produced with a computed or simulated washplant yield of 36%. The medium ash premium coal at 9 to 11% would have a gross calorific value in the order of 7 400 calories per gram (a.d.b.) with a computed yield of 46%. The middlings product of both the low and medium ash coals can be washed to about 25% ash to produce briquetting coals.

Alternately, all the coal on the property can be washed to produce briquetting coal at 19% ash. Average total sulphur for all products is less than 0.8% and the Hardgrove Grindability Index is in the range of 35 and 48 for the low ash premium coal and briquetting coal, respectively. Analytical results for the low and medium premium, briquetting and raw products are listed on Tables 6.4, 6.5, 6.6, and 6.7.

661 LOW ASH PREMIUM COAL PRODUCT

.1 Computed Yield

A 5% ash premium coal product can be produced from 4 seam intervals on the Mount Klappan property at a computed yield of 36%. At 6% ash the yield is over 51%.

The processing of rejects from low ash premium coal production can produce an additional briquetting coal product (19.4% ash) at an average yield of about 64%.

In the Hobbit-Broatch area, seams A, I (lower) and J produce a 32% computed yield of 5.0% ash premium coal. An additional 67% yield of 21% ash briquetting coal can be gleaned from low ash coal rejects.

The premium anthracite resource of the Lost-Fox area is wholly contained within Seam I. At this locality the low ash interval is 3 metres thick and exceptionally clean with no rock partings. A computed yield of 61% of 5% ash coal can be achieved; however, because of the large amount of near gravity material in the premium coal, an insignificant amount of middlings coal can be produced.

TABLE 6.4

LOW ASH PREMIUM COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Simulated Washplant Yield (%) (5.0% Ash)	32	61	36
Proximate Analysis			
Residual Moisture (%)	0.6	0.5	0.6
Ash (%)	4.8	5.0	4.9
Volatile Matter (%)	6.6	5.2	6.2
Fixed Carbon (%)	88.0	89.3	88.3
Total Sulphur (%)	0.6	0.4	0.5
Gross Calorific Value (cal/g)	7950	7950	7950
H.G.I.	36	33	35

.2 Washplant Simulation

The simulated washplant (computed) yield of the low ash premium coal was calculated using a computer generated simulation of the efficiency of a potential cleaning plant.

An efficiency factor for a heavy medium cyclone was applied to both the coarse (+28 mesh) and medium (28 x 100 mesh) size fraction in this simulation. The fine fraction (-100 mesh) was discarded.

The simulated washplant blending of all low ash premium coal on the property produced yields as follows:

Ash (%)	Computed Yield (%)
5.0	36
5.5	44
6.0	51
6.5	58

A significant improvement in yield at 6% ash relative to 5% ash is realized because of the higher percentage of near-gravity material at 5%. High yields may be achieved using the heavy medium cyclone, as, although the coal contains a relatively high percentage of near gravity material, the large amount of coal reporting to the coarse size fraction allows effective cleaning of the coal with this equipment.

Computed yields for the 5% to 6.5% ash coals in the Lost-Fox area are greater than the average, while higher head ashes in the Hobbit-Broatch resource area result in yields lower than the average. Computed yields are compared in the following table:

Ash (%)	Lost-Fox Computed Yield (%)	Hobbit-Broatch Computed Yield (%)
5.0	61	32
5.5	67	38
6.0	74	43
6.5	85	47

.3 Proximate Analysis

.31 Moisture

The overall average residual moisture for the low ash premium coals is 0.6%. Moisture levels in the Lost-Fox area, at 0.5%, are somewhat less than in the Hobbit-Broatch area.

.32 Ash

The target ash used for the washplant simulation runs was 5%. An overall computed average of 4.9% ash was achieved by the simulation. The range was from 4.8% (Hobbit-Broatch area) to 5.0% (Lost-Fox area).

.33 Volatile Matter

The average volatile matter content for the low ash premium Mount Klappan coals is 6.2% (a.d.b.) or 6.0% (d.m.m.f.). An increase in volatile content is noted in higher ash coals relative to lower ash coals. The contribution to total volatile matter of carbon dioxide by carbonates contained within the ash is responsible for this phenomenon. The low ash premium product derived from the slightly higher ash coal of the Hobbit-Broatch area has a volatile content of 6.6% a.d.b. (6.4% d.m.m.f.) compared with 5.2% a.d.b. (4.9% d.m.m.f.) for Lost-Fox.

.34 Fixed Carbon

The average fixed carbon content for low ash premium products for both areas is 88.3% a.d.b. (94.0% d.m.m.f.). Variation between the Hobbit-Broatch and Lost-Fox areas is as follows:

	F.C. (a.d.b.) (%)	F.C. (d.m.m.f.) (%)
Hobbit-Broatch	88.0	93.6
Lost-Fox	89.3	95.1

.4 Total Sulphur

The average total sulphur property-wide for low ash premium coals is 0.5%. In the Hobbit-Broatch area, sulphur values average nearly 0.6%, while a decrease to 0.4% is noted for the Lost-Fox area.

.5 Calorific Value

The washplant simulation programme approximates a calorific value for coal of a target ash through a linear regression calculation. The calculated gross calorific value for the computed average 4.9% ash coal is 7950 cal/g.

.6 Hardgrove Grindability Index

The tendency in the Mount Klappan anthracite is for low ash products to have correspondingly low Hardgrove Indices. Increasing ash content is accompanied by a decrease in hardness, indicating that the coal is harder than the ash. The average H.G.I. for low ash premium coals on the property is 35. The Hobbit-Broatch average H.G.I. is 36, while the Lost-Fox coal is especially hard at an H.G.I. of 33.

.7 Ultimate Analysis

Ultimate analytical results indicate a dry ash-free (d.a.f) carbon content for the premium coal of 93 - 94% and a nitrogen level around 1%. The low nitrogen conforms with preferred industrial limits for power generation.

	N (%)
Mount Klappan Anthracite	1.1-1.2
Japan Electric Power Industry (max.)	1.8
Japan Electric Power Industry (pref.)	1.6

.8 Ash Characteristics

For the premium products of Mount Klappan anthracite, the average initial deformation temperature and fluid temperature of ash, as measured in an oxidizing atmosphere, are above 1200°C and 1400°C, respectively - meeting the requirements for most boiler applications. Compared with the Hobbit-Broatch coal, the ash in the Lost-Fox coal has a slightly greater percentage of basic minerals, but there is no significant effect on ash fusion temperatures.

.9 Middlings Product

The middlings briquetting coal is cleaned to an average ash content of 20 - 25%. Average quality data for both resource areas is:

	Middlings Coal
Yield (%)	64
Ash (%)	19.4
Gross Calorific Value (cal/g)	6450

662 MEDIUM ASH PREMIUM COAL PRODUCT

.1 Computed Yield

Eighteen seam intervals property-wide can be cleaned to produce a medium ash premium coal product (10% ash) at a computed yields of 46%. The rejects from premium coal production can be washed to produce a briquetting coal product (ash approximately 25%) with an average yield of 12%.

The thirteen seam intervals in the Hobbit-Broatch area, capable of producing a 10% ash premium coal, have an average computed yield of 45%. Selected intervals in seams I, J, K and L in the Lost-Fox area have an average 59% computed yield at 10% ash. One additional interval, from seam G in the Summit Resource Area, contributes to the medium ash premium coal resource.

.2 Washplant Simulation

The washplant simulation for medium ash premium coal was also run using heavy medium cyclone equipment for the cleaning of the coarse and medium fractions. The fine fraction (-100 mesh) was discarded. The computed yields at various ash levels are as follows:

Ash %	Hobbit-Broatch Yield %	Lost-Fox Yield %	Total Yield %
9.5	43	56	46
10.0	45	59	48
10.5	48	62	51

Variation in yield against selected ash level is relatively small, demonstrating that the percentage of near gravity material is much less than for the low ash premium coal.

.3 Proximate Analysis

.31 Moisture

The average residual moisture for medium ash premium coal is 0.8%. There is not much variation between resource areas; the Lost-Fox moisture value (0.7%) is slightly lower than the Hobbit-Broatch value (0.9%).

.32 Ash

Computed ash values are based on a target ash of 10% and average 9.6% overall. They vary from 9.6% (Hobbit-Broatch area) to 9.8% (Lost-Fox area).

TABLE 6.5

MEDIUM ASH PREMIUM COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Simulated Washplant Yield (%) (10% Ash)	45	59	48
Proximate Analysis			
Residual Moisture (%)	0.9	0.7	0.8
Ash (%)	9.6	9.8	9.6
Volatile Matter (%)	7.3	6.1	6.8
Fixed Carbon (%)	82.2	83.4	82.8
Total Sulphur (%)	0.6	0.4	0.6
Gross Calorific Value (cal/g)	7450	7450	7450
H.G.I.	46	38	43

.33 Volatile Matter

The average volatile matter content for medium ash premium coals is 6.8% (a.d.b.) or 6.5% (d.m.m.f.). Some variation can be seen between the Hobbit-Broatch area (7.3% a.d.b., 7.1% d.m.m.f.) and the Lost-Fox area (6.1% a.d.b., 5.8% d.m.m.f.).

.34 Fixed Carbon

Fixed carbon levels for the medium ash coal are slightly lower than for the low ash premium coal on an air dried basis (82.8%) but in much the same range on a d.m.m.f. basis (93.5%).

.4 Total Sulphur

The average total sulphur content for the medium ash premium coals on the property is 0.6%. The average sulphur content in the Hobbit-Broatch area is raised to slightly over 0.6% by a single anomalously high value in an interval of seam J. In almost all other sampled intervals, sulphur levels are lower than this average.

In the Lost-Fox area the average sulphur content of the medium ash clean coal is 0.4% reflecting the generally low level of sulphur in raw coals of this area.

.5 Calorific Value

The calculated gross calorific value of the medium ash premium coal with a computed average ash content of 9.6% is 7450 cal/g.

.6 Hardgrove Grindability Index

An increase in the ash content of 5% from the low ash premium coal to the medium ash premium coal has resulted in a corresponding increase in the Hardgrove Index from an average of 35 to an average of 43. This clearly demonstrates the effect of an increase in ash on the hardness of the coal product. The average H.G.I. for the Hobbit-Broatch coal is 46.

.7 Ultimate Analysis

Ultimate analytical results for the medium ash premium anthracite are comparable to those for the low ash premium coal. Carbon content in all areas exceeds 9% (d.a.f. basis) and nitrogen levels are slightly lower at 1.0 - 1.1%.

.8 Ash Characteristics

The initial deformation temperature and fluid temperature of ash (in an oxidizing atmosphere) are indicated to be in excess of 1200°C and 1400°C, respectively.

.9 Middlings Product

A briquetting coal by-product can be derived from medium ash premium coal production everywhere except in the Lost-Fox area. The average quality reported is as follows:

	Middlings Product
Yield (%)	12
Ash (%)	25.1
Gross Calorific Value (cal/g)	5850

663 BRIQUETTING COAL PRODUCT

.1 Introduction

Briquetting coal can be produced from the Mount Klappan property either as an alternative to, or in addition to, the premium products. As an additional product, briquetting coal would be derived from the coal intervals not included in the premium coal production.

The quality of the additional briquetting coal products is represented by a suite of samples excluded from the premium coal resource with quality reported as cleaned to 19% ash and averaged by simulation. The overall average yield is about 55%. The average quality is as follows:

Proximate Analysis	
Residual Moisture (%)	1.4
Ash (%)	18.4
Volatile Matter (%)	8.2
Fixed Carbon (%)	72.0
Total Sulphur (%)	1.1
Calorific Value (cal/g)	6550
Hardgrove Index	52

TABLE 6.6

BRIQUETTING COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Washplant Yield(%) (19% Ash)	79	91	82
Proximate Analysis			
Residual Moisture (%)	1.5	2.0	1.6
Ash (%)	18.7	18.6	18.6
Volatile Matter (%)	8.4	7.7	8.2
Fixed Carbon (%)	71.4	71.7	71.6
Total Sulphur (%)	0.8	0.5	0.7
Calorific Value (cal/g)	6500	6500	6500
H.G.I.	51	39	48
Volatile Matter (dmmf) (%)	8.5	7.7	8.3

The average quality for this group of briquetting coal samples is very similar to the average quality obtained when all resources of the Mount Klappan property are devoted to the production of briquetting coal - see Table 6.6. The remainder of the discussion is based on the case where all of the resources in the Hobbit-Broatch and Lost Fox areas will be processed to produce briquetting coal.

.2 Computed Yield

Thirty-six seam intervals property-wide can yield a briquetting coal of 19% ash content, 6 of these without cleaning. The average computed yield of briquetting coals is 82%.

In the Hobbit-Broatch area 26 seam intervals can produce a briquetting quality coal with an average computed yield of 79%. The Lost-Fox briquetting coal resource is derived from 7 seam intervals, 2 of which have sufficiently low ash to be produced without cleaning. The average yield in this areas is 91%.

.3 Washplant Simulation

The washplant yields for briquetting coal can be tabulated as follows:

	Briquetting Product Yield (%)
Total Property	82
Hobbit-Broatch Area	79
Lost-Fox Area	91

At the ash level of the briquetting coal, the near gravity material for all size fractions in all areas dips to less than 7%. The equipment requirements are therefore simplified and cleaning is accomplished by jig washer for the +28 mesh fraction, 2 stage water cyclone for the 28 x 100 mesh fraction and froth flotation for the -100 mesh fraction.

.4 Proximate Analysis

.41 Moisture

The residual moisture content of the briquetting coal product is 1.6%. Moisture content of the Mount Klappan anthracite rises uniformly with ash content and it is thought that a large precentage of the residual moisture is bound in the clays of the ash rather than in the coal itself. The average value quoted above, however, is higher than that for the total average raw coal resource. Incomplete air drying of the briquetting coal samples prior to moisture determination is suspected; this possibility is currently being investigated. Average values for both the Hobbit-Broatch (1.5%) and the Lost-Fox area (2.0%) are affected, though the case in the Lost-Fox area seems more extreme.

.42 Ash

Washplant simulation runs were carried out with a target ash of 19%. The overall average ash content of the briquetting coal is 18.6%. The figure for the Hobbit-Broatch area is (18.7%) but the several low ash intervals in the Lost-Fox area reduce the average slightly in this area to 18.6%.

.43 Volatile Matter

As discussed previously, the measure of volatile matter content for higher ash products is strongly influenced by the carbon dioxide contribution from carbonates in the ash. The elevated average values for volatile matter content of 8.2% (a.d.b.) and 8.3% (d.m.m.f.) illustrate that the problem is equally evident in both resource areas.

.44 Fixed Carbon

The average fixed carbon content is reduced in the briquetting product to 71.6% (a.d.b.) but on a d.m.m.f. basis it is still found to exceed 90%.

.5 Total Sulphur

The average total sulphur content of the briquetting coal is 0.7%. As with the other product coals, slightly higher levels are seen in the Hobbit-Broatch area (0.8%) and somewhat lower levels in the Lost-Fox area (0.5%).

.6 Calorific Value

The average gross calorific value for briquetting coal from both resource areas exceeds 6500 cal/g (a.d.b.).

Area	Ash (%)	C.V. (a.d.b.) (cal/g)
Hobbit-Broatch	18.7	6 500
Lost-Fox	18.6	6 500
Total Property	18.6	6 500

.7 Hardgrove Grindability Index

A relatively high H.G.I. is expected at the ash level of the Mount Klappan briquetting coal. The average H.G.I. for both areas is 48. The H.G.I. of the Hobbit-Broatch coal is 51 while that for the lower ash Lost-Fox coal is 39.

.8 Ultimate Analysis

As with proximate analysis, the interference of the carbonate in ash disguises the true proportion of carbon measured by ultimate analysis of the briquetting coals. Representative average figures for briquetting coals of 70% carbon (a.d.b.) and 90% carbon (d.a.f.) are obtained from ultimate analyses.

Nitrogen levels are just below 1%.

.9 Ash Characteristics

The initial deformation temperatures and fluid temperatures of ash in an oxidizing atmosphere are above 1200°C and just under 1400°C, respectively. The ash composition analyses for Lost-Fox briquetting coals indicate a slight tendency towards more basic elements.

664 RAW COAL PRODUCT

The same seam intervals that comprise the briquetting coal product are considered, in an uncleaned state, as the raw product. Analytical results are summarized in Table 6.7. The raw coal analytical values are averages weighted by interval thickness and not weighted by tonnes of coal.

.1 Proximate Analysis

.11 Moisture

The total theoretical average residual moisture of raw Mount Klappan anthracite is 1.55%. This figure is slightly high for an anthracite but can be explained by the excess moisture contributed by clays in the ash.

The figure for the Hobbit-Broatch area, 1.42%, is also reasonable, but for the Lost-Fox area the reported average moisture content of 2.15% seems much too high, especially considering that ash levels are generally reduced in this area. Analytical results for these samples are being reviewed.

.12 Ash

The total theoretical average raw ash content is 30.19%. The ash level in the Hobbit-Broatch area (30.87%) dominates the average as most of the resource is contained in this area. Raw ash levels in the Lost-Fox area are significantly lower (24.21%).

TABLE 6.7

RAW COAL PRODUCT

	Hobbit-Broatch	Lost-Fox	Total
Proximate Analysis			
Residual Moisture (%)	1.42	2.15	1.55
Ash (%)	30.87	24.21	30.19
Volatile Matter (%)	8.36	7.98	8.13
Fixed Carbon (%)	59.35	65.66	60.12
Total Sulphur (%)	0.88	0.44	0.74
Calorific Value (cal/g)	5250	5950	5300
H.G.I.	54	42	50

Averages weighted by interval thickness, results reported on an air dried basis.

.13 Volatile Matter

Variation in volatile matter content across the property is minimal. Theoretical average levels are 8.13% (a.d.b.) or 8.30% (d.m.m.f.), again reflecting the inclusion of some carbon dioxide as a volatile.

.14 Fixed Carbon

Fixed carbon content measured on an air dried basis is 60.12% but, as with other products, the d.m.m.f. carbon content remains above 90% (though slightly reduced due to the inflated volatile content).

.2 Total Sulphur

The average total sulphur content of the raw coal is 0.74%, though there is considerable variation in sulphur from area to area. The Hobbit-Broatch theoretical average raw coal total sulphur content of 0.88% is elevated largely due to the inclusion of a very few coal intervals (in seams B, G, H and J) with sulphur levels up to 3.10%. The bulk of the sulphur in these high sulphur coals is pyritic sulphur and is therefore non-combustible and is removed with the ash when the coal is washed. The specific gravity of pyrite is high enough that even the slightest cleaning will remove it. The remaining combustible sulphur is controlled to some extent by the carbonate content of the ash.

The Lost-Fox raw coal has a 0.44% theoretical average total sulphur content. No seams in this area contain appreciable quantities of pyrite.

Generally, all seams with sulphur levels above 0.80% are found to contain more than 50% incombustible pyritic sulphur. Levels of combustible sulphur remain below 0.5% overall.

.3 Calorific Value

The raw coal of the Mount Klappan property, with an ash content of 30.19% has a theoretical average calorific value of 5 300 cal/g (a.d.b.). The calorific value of Hobbit-Broatch raw coal is comparable. The Lost-Fox raw coal at a theoretical average 24.21% ash level, has a theoretical average calorific value of 5 950 cal/g (a.d.b.). This coal may be mined for selected markets without cleaning.

.4 Hardgrove Grindability Index

As expected, since raw ash levels are only very slightly higher than ash levels in the briquetting coal, the theoretical average Hardgrove Index of the raw coal product is 50.

.5 Ultimate Analysis

The significance of raw coal ultimate analyses is reduced because of the high ash levels involved. The carbon content (d.a.f. basis) by ultimate analysis of the raw coal ranges from 85% to 95%. Nitrogen content of the raw coal is well below 1%.

.6 Ash Characteristics

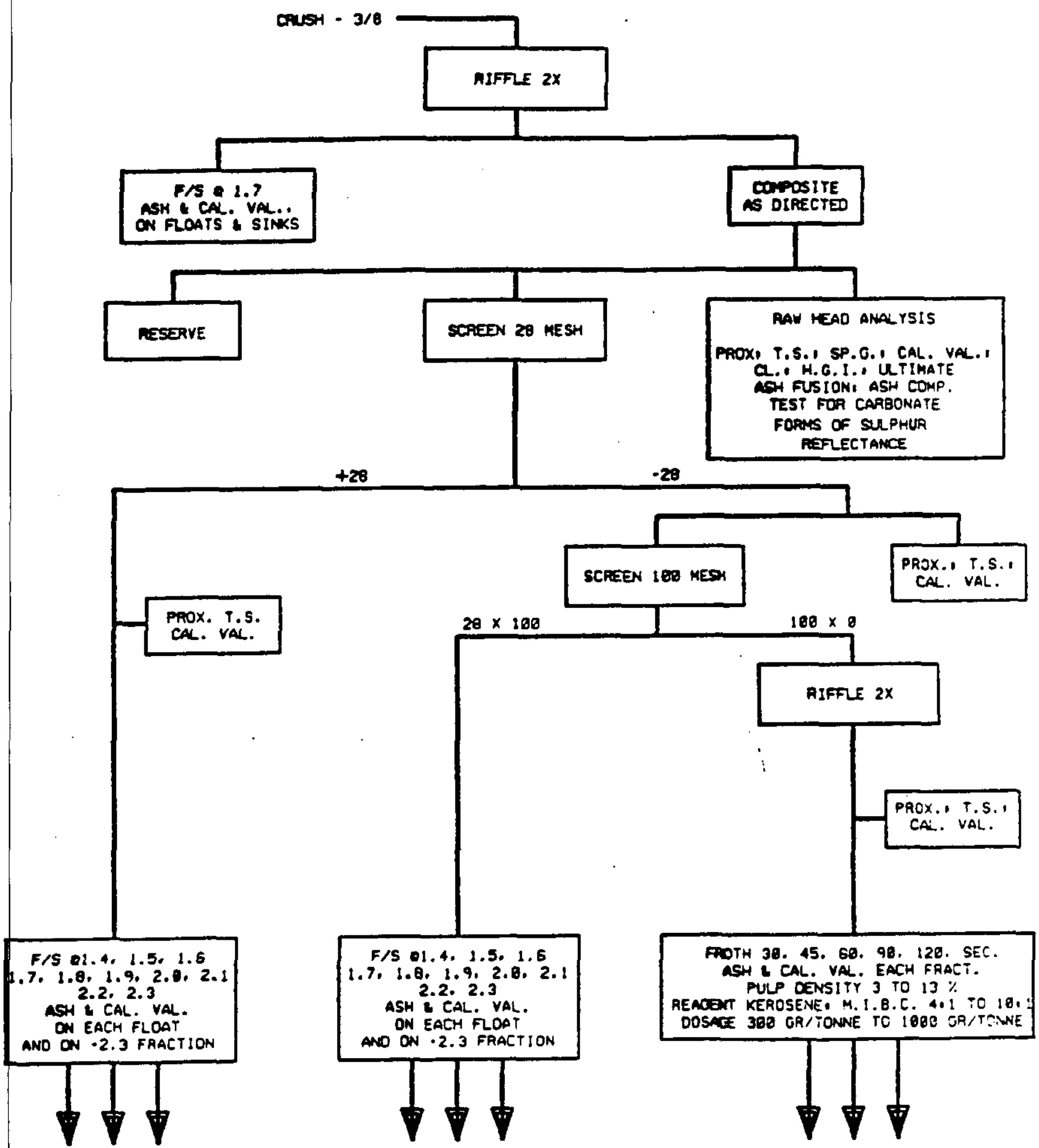
In all raw product coals, as with the other product coals, the ash fusion temperatures are quite acceptable: greater than 1200°C for oxidized atmosphere initial deformation temperature and greater than 1300°C for oxidized atmosphere fluid temperature. At the increased ash levels of raw coal, the proportion of basic minerals is also increased, but not sufficiently to adversely affect ash fusion character.

.7 Washplant

Some cleaning of the raw coal will be necessary to prepare a marketable product. Reduction of ash is necessary for a few seams. A large measure of sulphur control will be accomplished by the washplant in seams where pyrite concentrations are elevated.

Figure 6.1

MT. KLAPPAN
DIAMOND DRILL CORE COAL TESTING PROGRAM
1982
PART 1



CONTINUED ON FIGURE 6.2

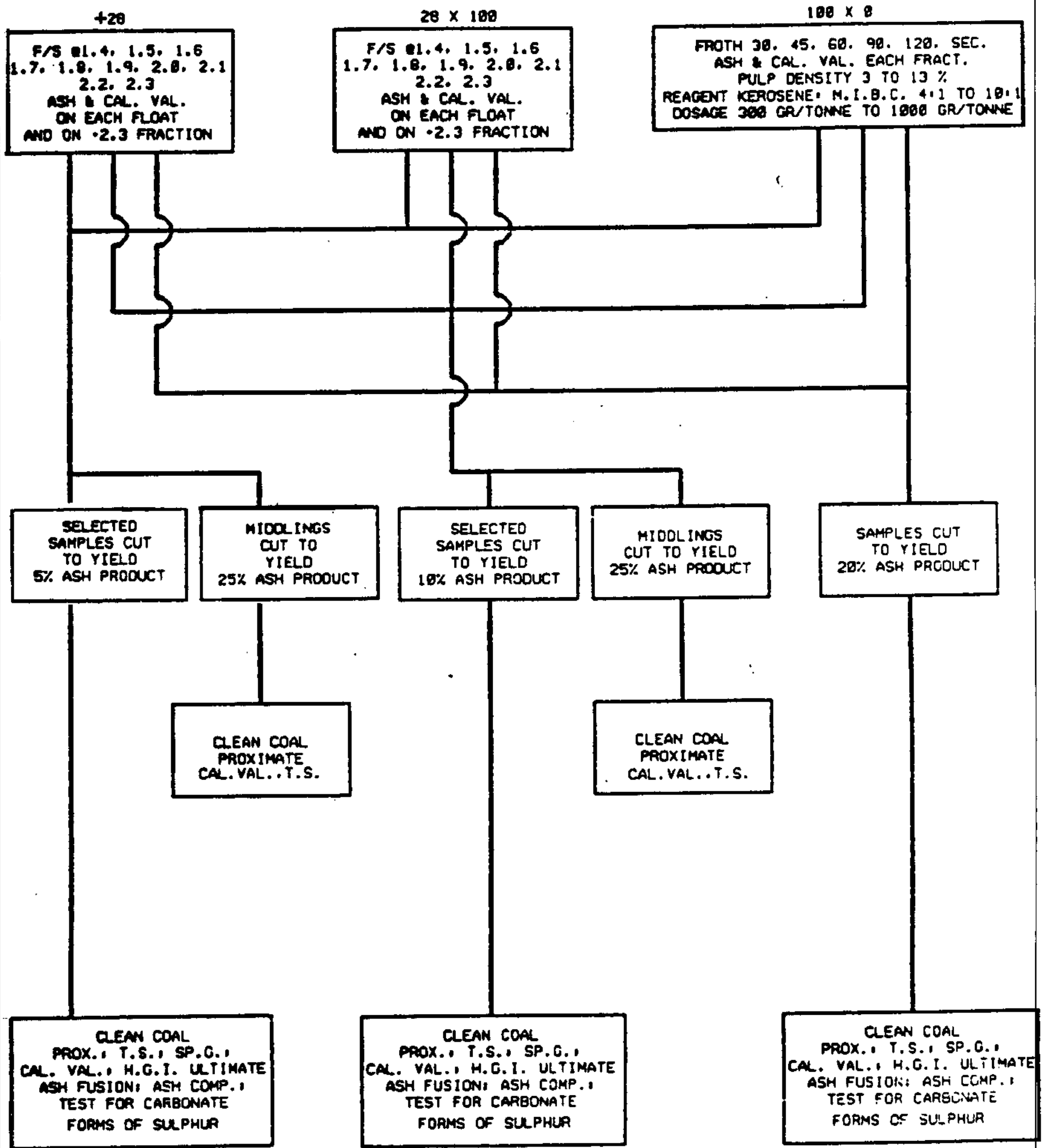
<u>PART 2</u>

SAMPLE PRODUCT ANALYSIS

Figure 6.2

MT. KLAPPAN
DIAMOND DRILL CORE COAL TESTING PROGRAM
1982

PART 2
SAMPLE PRODUCT ANALYSIS



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MOUNT KLAPPAN COAL PROJECT

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APPENDICES

APPENDICES

GEOLOGY

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APPENDIX

APPENDIX A

MOUNT KLAPPAN COAL PROJECT LICENCES

MT. KLAPPAN COAL PROJECT LICENCES - 1982

LICENCE NUMBER	DATE ISSUED	HECTARES	LAND DESCRIPTION SERIES	BLOCK	UNITS
7118	Sept.1/81	281	104-H-2	J	29, 30, 39, 40
7119	"	281	"	"	49, 50, 59, 60
7120	"	32	"	"	63, 64, 73, 74 PTN
7121	"	224	"	"	65, 66, 75, 76 PTN
7122	"	281	"	"	67, 68, 77, 78
7123	"	281	"	"	69, 70, 79, 80
7124	"	98	"	"	85, 86, 95, 96 PTN
7125	"	281	"	"	87, 88, 97, 98
7126	"	281	"	"	89, 90, 99, 100
7127	"	281	104-H-2	K	21, 22, 31, 32
7128	"	281	"	"	23, 24, 33, 34
7129	"	281	"	"	25, 26, 35, 36
7130	"	281	"	"	27, 28, 37, 38
7131	"	281	"	"	41, 42, 51, 52
7132	"	281	"	"	43, 44, 53, 54
7133	"	281	"	"	45, 46, 55, 56
7134	"	281	"	"	47, 48, 57, 58
7135	"	281	"	"	49, 50, 59, 60
7136	"	281	"	"	61, 62, 71, 72
7137	"	281	"	"	63, 64, 73, 74
7138	"	281	"	"	65, 66, 75, 76
7139	"	281	"	"	67, 68, 77, 78
7140	"	281	"	"	69, 70, 79, 80
7141	"	281	"	"	81, 82, 91, 92
7142	"	281	"	"	83, 84, 93, 94
7143	"	281	"	"	85, 86, 95, 96
7144	"	281	"	"	87, 88, 97, 98
7145	"	281	"	"	89, 90, 99, 100
7146	"	281	104-H-2	L	41, 42, 51, 52
7147	"	281	"	"	61, 62, 71, 72
7148	"	281	"	"	63, 64, 73, 74
7149	"	281	"	"	65, 66, 75, 76
7150	"	281	"	"	67, 68, 77, 78
7151	"	281	"	"	81, 82, 91, 92
7152	"	281	"	"	83, 84, 93, 94
7153	"	281	"	"	85, 86, 95, 96
7154	"	281	"	"	87, 88, 97, 98

LICENCE NUMBER	DATE ISSUED	HECTARES	LAND DESCRIPTION SERIES	BLOCK	UNITS
7155	Sept.1/81	25	104-H-7	B	5, 6, 15, 16 PTN
7156	"	67	"	"	7, 8, 17, 18 PTN
7157	"	87	"	"	9, 10, 19, 20 PTN
7158	"	151	104-H-7	C	1, 2, 11, 12 PTN
7159	"	274	"	"	3, 4, 13, 14 PTN
7160	"	281	"	"	5, 6, 15, 16
7161	"	281	"	"	7, 8, 17, 18
7162	"	281	"	"	9, 10, 19, 20
7163	"	95	"	"	23, 24, 33, 34 PTN
7164	"	244	"	"	25, 26, 35, 36 PTN
7165	"	280	"	"	27, 28, 37, 38 PTN
7166	"	280	"	"	29, 30, 39, 40 PTN
7167	"	54	"	"	47, 48, 57, 58 PTN
7168	"	142	"	"	49, 50, 59, 60 PTN
7169	"	281	104-H-7	D	1, 2, 11, 12
7170	"	281	"	"	3, 4, 13, 14
7171	"	281	"	"	5, 6,15, 16
7172	"	280	"	"	21, 22, 31, 32
7173	"	280	"	"	23, 24, 33, 34
7174	"	280	"	"	25, 26, 35, 36
7175	"	94	"	"	41, 42, 51, 52 PTN
7176	"	277	"	"	43, 44, 53, 54 PTN
7177	"	280	"	"	45, 46, 55, 56 PTN
TOTAL ISSUED		14 784			

MT. KLAPPAN COAL PROJECT - 1982 LICENCES

LICENCE NUMBER	DATE ISSUED	HECTARES	SERIES	BLOCK	UNITS
7381	March, 1982	281	104-H-2	J	47, 48, 57, 58
7382	"	280	104-H-6	H	1, 2, 11, 12
7383	"	108	"	"	21, 22, 31, 32
7384	"	281	104-H-7	D	7, 8, 17, 18
7385	"	204	"	"	63, 54, 73, 74
7386	"	280	"	"	65, 66, 75, 76
7387	"	280	"	"	67, 68, 77, 78
7388	"	172	"	"	85, 86, 95, 96
7389	"	275	"	"	87, 88, 97, 98
7390	"	280	"	"	89, 90, 99, 100
7391	"	115	104-H-7	E	7, 8, 17, 18
7392	"	260	"	"	9, 10, 19, 20
7416	"	281	104-H-2	J	23, 24, 33, 34
7417	"	281	"	"	25, 26, 35, 36
7418	"	281	"	"	27, 28, 37, 38
7419	"	278	"	"	43, 44, 53, 54
7420	"	281	"	"	45, 46, 55, 56
7421	"	281	104-H-2	L	69, 70, 79, 80
7422	"	281	"	"	89, 90, 99, 100
7423	"	281	104-H-7	D	9, 10, 19, 20
7424	"	280	"	"	27, 28, 37, 38
7425	"	280	"	"	29, 30, 39, 40
7426	"	280	"	"	47, 48, 57, 58
7427	"	281	104-H-3	I	61, 62, 71, 72
7428	"	281	"	"	63, 64, 73, 74
7429	"	281	"	"	65, 66, 75, 76
7430	"	281	"	"	81, 82, 93, 94
7431	"	281	"	"	83, 84, 93, 94
7432	"	281	"	"	85, 86, 95, 96
TOTAL ISSUED		**7 587**			

APPENDIX B

RESOURCE DATA AND CALCULATIONS

APPENDIX B

RESOURCE DATA AND CALCULATIONS

CONTENTS

COAL SEAM THICKNESS SUMMARY

APPLICATION	A	B	C	D	E	F	G	H	I	J	K	L	AGGREGATE*
	SEAM THICKNESS (m)												
DRILLED													
DDH82001							2.77	1.73	6.97	0.93	3.45		
DDH82002			0.67	0.53	0.92	0.35	4.03						
					2.24		1.13						
DDH82003					0.86								
					1.28	2.17	4.22	2.57	4.32	2.33	2.52		
DDH82004				0.35	0.75	0.04	2.88						
DDH82005									4.98	5.16	1.46	2.24	
											3.60		
DDH82006	1.67	1.50	0.19	0.59	0.63	0.16	2.45	2.01					
DDH82007					1.29	2.71	3.91						
Average	1.67	1.50	0.43	0.49	1.59	1.09	3.57	2.10	5.42	2.81	3.68	2.24	
INFERRED													
Hobbit-Broatch													
DDH82001							2.77	1.73	6.97	0.93	3.45		
DDH82002			0.67	0.53	0.92	0.35	4.03						
					2.24								
DDH82003					0.86	2.17	4.22	2.57	4.32	2.33	2.52		
					1.28								
DDH82004				0.35	0.75	0.04	2.88						
DDH82006	1.67	1.50	0.19	0.59	0.63	0.16	2.45	2.01					
Weighted Avg.	1.67	1.50	0.40	0.48	1.66	0.87	3.32	2.12	6.07	1.41	3.13		21.75
Lost-Fox													
DDH82005									4.98	5.16	1.46	2.24	
TRC82044							4.02						
Summit													
DDH82007				1.29		2.71	3.91						
Avg. Lost-Fox Summit				1.29		2.71	3.97		4.98	5.16	1.46	2.24	21.81
SPECULATIVE	Average of Hobbit-Broatch Area Weighted Average and Lost-Fox-Summit Average												21.78
POTENTIAL PROPERTY	50% of Speculative Average												10.9

* Excludes seams weight averaged to less than 0.5 m

COAL SEAM THICKNESS SUMMARY (cont'd...)

APPLICATION	SEAM COMPOSITE THICKNESS (m)*											
	A	B	C	D	E	F	G	H	I	J	K	L
LOW ASH RESOURCE												
Hobbit-Broatch												
5% Ash												
DDH82001									3.21	0.93		
DDH82006	1.67											
10% Ash												
DDH82001							1.68		1.84		3.45	
DDH82002			0.67*		0.82							
DDH82003					0.86	2.17	1.05		3.92	2.33		
					1.28							
DDH82006					0.63		2.45					
Lost-Fox												
5% Ash												
DDH82005									2.99			
10% Ash												
DDH82005									1.99	3.81		0.90
Summit												
10% Ash												
DDH82007							3.91					

* Not used in resource calculations as weight averaged seam thickness for seam C was less than 0.50 metres

Inferred Resource

Calculations

Summary

Hobbit-Broatch Resource Area

Seam	Resulting Total Seam Tonnage (million tonnes)
K	67.94
J	32.81
I	162.26
H	63.47
G	106.21
F	18.18
E	57.02
D	
C	
B	52.60
A	59.55
TOTAL	620.04

Hobbit-Broatch Resource Figure

Summary

Calculation of Inferred Resources

in the Hobbit-Broatch Resource Area

Section	Resulting Total Seam Tonnage (million tonnes)
500 S	10.27
1000 S	28.52
1500 S	59.55
2000 S	61.15
2500 S	45.43
3000 S	61.70
3500 S	66.22
4000 S	82.41
4500 S	70.66
5000 S	70.28
5500 S	63.85
TOTAL	620.04

Hobbit-Broatch Resource Figure

Section 500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K					
J					
I					
H	0.110	.500	2.12	1.70	0.20
G	0.395	.500	3.32	1.70	1.11
F					
E	0.885	.500	1.66	1.70	1.25
D					
C					
B	2.200	.500	1.50	1.70	2.81
A	3.455	.500	1.67	1.70	4.90
				TOTAL	10.27

Section 1000 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	0.235	.500	3.13	1.70	0.63
J	0.310	.500	1.41	1.70	0.37
I	0.690	.500	6.07	1.70	3.56
H	1.255	.500	2.12	1.70	2.26
G	2.020	.500	3.32	1.70	5.70
F					
E	3.275	.500	1.66	1.70	4.62
D					
C					
B	4.060	.500	1.50	1.70	5.18
A	4.370	.500	1.67	1.70	6.20
				TOTAL	28.52

Section 1500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.570	.500	3.13	1.70	6.84
J	2.700	.500	1.41	1.70	3.24
I	3.220	.500	6.07	1.70	16.61
H	3.605	.500	2.12	1.70	6.50
G	3.820	.500	3.32	1.70	10.78
F					
E	3.850	.500	1.66	1.70	5.43
D					
C					
B	3.810	.500	1.50	1.70	4.86
A	3.725	.500	1.67	1.70	5.29
				TOTAL	59.55

Section 2000 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.770	.500	3.13	1.70	7.37
J	2.860	.500	1.41	1.70	3.43
I	3.130	.500	6.07	1.70	16.15
H	3.645	.500	2.12	1.70	6.57
G	3.790	.500	3.32	1.70	10.70
F					
E	4.075	.500	1.66	1.70	5.75
D					
C					
B	4.145	.500	1.50	1.70	5.28
A	4.155	.500	1.67	1.70	5.90
				TOTAL	61.15

Section 2500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	1.520	.500	3.13	1.70	4.04
J	1.700	.500	1.41	1.70	2.04
I	2.065	.500	6.07	1.70	10.65
H	2.620	.500	2.12	1.70	4.72
G	3.110	.500	3.32	1.70	8.78
F					
E	3.575	.500	1.66	1.70	5.04
D					
C					
B	3.720	.500	1.50	1.70	4.74
A	3.820	.500	1.67	1.70	5.42
				TOTAL	45.43

Section 3000 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.615	.500	3.13	1.70	6.96
J	2.775	.500	1.41	1.70	3.33
I	3.210	.500	6.07	1.70	16.56
H	3.545	.500	2.12	1.70	6.39
G	3.715	.500	3.32	1.70	10.48
F	3.815	.500	0.87	1.70	2.82
E	3.870	.500	1.66	1.70	5.46
D					
C					
B	3.740	.500	1.50	1.70	4.77
A	3.475	.500	1.67	1.70	4.93
				TOTAL	61.70

Section 3500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.065	.500	3.13	1.70	8.15
J	3.230	.500	1.41	1.70	3.87
I	3.735	.500	6.07	1.70	19.27
H	3.865	.500	2.12	1.70	6.96
G	3.885	.500	3.32	1.70	10.96
F	3.845	.500	0.87	1.70	2.84
E	3.845	.500	1.66	1.70	5.43
D					
C					
B	3.540	.500	1.50	1.70	3.98
A	3.350	.500	1.67	1.70	4.76
				TOTAL	66.22

Section 4000 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.900	.500	3.13	1.70	10.38
J	4.195	.500	1.41	1.70	5.03
I	4.460	.500	6.07	1.70	23.01
H	4.805	.500	2.12	1.70	8.66
G	4.720	.500	3.32	1.70	13.32
F	4.715	.500	0.87	1.70	3.49
E	4.720	.500	1.66	1.70	6.66
D					
C					
B	4.530	.500	1.50	1.70	5.78
A	4.285	.500	1.67	1.70	6.08
				TOTAL	82.41

Section 4500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.500	.500	3.13	1.70	9.31
J	3.660	.500	1.41	1.70	4.39
I	3.950	.500	6.07	1.70	20.38
H	3.925	.500	2.12	1.70	7.07
G	3.945	.500	3.32	1.70	11.13
F	3.840	.500	0.87	1.70	2.84
E	3.965	.500	1.66	1.70	5.59
D					
C					
B	3.895	.500	1.50	1.70	4.97
A	3.510	.500	1.67	1.70	4.98
				TOTAL	70.66

Section 5000 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.335	.500	3.13	1.70	8.87
J	3.570	.500	1.41	1.70	4.28
I	3.725	.500	6.07	1.70	19.22
H	4.120	.500	2.12	1.70	7.42
G	4.125	.500	3.32	1.70	11.64
F	3.990	.500	0.87	1.70	2.95
E	4.030	.500	1.66	1.70	5.69
D					
C					
B	3.795	.500	1.50	1.70	4.84
A	3.780	.500	1.67	1.70	5.37
				TOTAL	70.28

Section 5500 S

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.025	.500	3.13	1.70	5.39
J	2.360	.500	1.41	1.70	2.83
I	3.265	.500	6.07	1.70	16.85
H	3.730	.500	2.12	1.70	6.72
G	4.115	.500	3.32	1.70	11.61
F	4.385	.500	0.87	1.70	3.24
E	4.320	.500	1.66	1.70	6.10
D					
C					
B	4.230	.500	1.50	1.70	5.39
A	4.030	.500	1.67	1.70	5.72
				TOTAL	63.85

Summary

Lost-Fox Resource Area

Seam	Resulting Total Seam Tonnage (million tonnes)
L	20.20
K	15.76
J	63.02
I	82.56
H	
G	59.79
TOTAL	241.33

Summary
Calculation of Inferred Resources
in the Lost-Fox Resource Area

Section		Resulting Total Seam Tonnage (million tonnes)
500 N		27.78
1000 N		42.36
1500 N		47.30
2000 N		43.85
2500 N		44.30
3000 N		21.77
3500 N		11.42
4000 N		2.55
	TOTAL	241.33

Section 500 N

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L	1.920	.500	2.24	1.70	3.66
K	2.010	.500	1.46	1.70	2.49
J	2.010	.500	5.16	1.70	8.82
I	2.300	.500	4.98	1.70	9.74
H					
G	.9000	.500	4.02	1.70	3.07
				TOTAL	27.78

Section 1000 N

L	2.48	.500	2.24	1.70	4.72
K	2.520	.500	1.46	1.70	3.13
J	3.007	.500	5.16	1.70	13.19
I	3.465	.500	4.98	1.70	14.67
H					
G	1.945	.500	4.02	1.70	6.65
				TOTAL	42.36

Section 1500 N

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L	2.410	.500	2.24	1.70	4.58
K	2.610	.500	1.46	1.70	3.24
J	2.670	.500	5.16	1.70	11.71
I	3.730	.500	4.98	1.70	15.78
H					
G	3.510	.500	4.02	1.70	11.99
				TOTAL	47.30

Section 2000 N

L	1.610	.500	2.24	1.70	3.07
K	2.485	.500	1.46	1.70	3.08
J	2.490	.500	5.16	1.70	10.92
I	3.675	.500	4.98	1.70	15.56
H					
G	3.285	.500	4.02	1.70	11.22
				TOTAL	43.85

Section 2500 N

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L	1.600	.500	2.24	1.70	3.05
K	1.880	.500	1.46	1.70	2.33
J	2.695	.500	5.16	1.70	11.82
I	3.800	.500	4.98	1.70	16.08
H					
G	3.225	.500	4.02	1.70	11.02
				TOTAL	44.30

Section 3000 N

L	0.590	.500	2.24	1.70	1.12
K	0.900	.500	1.46	1.70	1.12
J	1.030	.500	5.16	1.70	4.52
I	1.520	.500	4.98	1.70	6.43
H					
G	2.510	.500	4.02	1.70	8.58
				TOTAL	21.77

Section 3500 N

Seam	Seam Length (km)	Width of Influence (km)	Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L					
K	0.300	.500	1.46	1.70	0.37
J	0.465	.500	5.16	1.70	2.04
I	0.795	.500	4.98	1.70	3.37
H					
G	1.650	.500	4.02	1.70	5.64
				TOTAL	11.42

Section 4000 N

L					
K					
J					
I	0.220	.500	4.98	1.70	.93
H					
G	0.475	.500	4.02	1.70	1.62
				TOTAL	2.55

Calculation of Inferred Resources in the Summit Resource Area

Seam	Thickness (m)	Surface Area (km^2)	Specific Gravity (g/cc)	Tonnes (million)
G	3.91	1.920	1.70	12.76
F	2.71	2.996	1.70	13.80
D	1.29	3.142	1.70	6.89
			TOTAL	33.45

Speculative Resource

Calculations

Summary

Speculative Resource Calculation

for Mt. Klappan Coal Property

Section	Resulting Total Seam Tonnage (million tonnes)
5500 S	44.02
5000 S	36.15
4500 S	38.05
4000 S	26.16
3500 S	26.73
3000 S	27.55
2500 S	25.78
2000 S	27.21
1500 S	28.14
1000 S	19.02
500 S	11.07
000	69.53
1000 N	260.70
3000 N	238.33
5000 N	197.97
7000 N	107.87
9000 N	47.98
TOTAL	1232.26

Section	Jkkm Contact Length (km)	Theoretical Jkkm total Present (km^2)	Planimetered Actual JKkm Present (km^2)	Jkkm Proportion Present (km^2)	Regional Aggregate Coal Thickness (m)	Proportioned Coal Thickness Present (m)	Specific Gravity (g/cc)	Width (km)	Tonnes (million)
500 S	1.36	0.476	0.210	.44	21.78	9.58	1.70	0.5	11.07
1000 S	1.30	0.455	0.360	.79	21.78	17.21	1.70	0.5	19.02
1500 S	1.52	-	-	1.00	21.78	21.78	1.70	0.5	28.14
2000 S	1.47	-	-	1.00	21.78	21.78	1.70	0.5	27.21
2500 S	1.53	0.623*	0.568	.91	21.78	19.82	1.70	0.5	25.78
3000 S	1.60	0.620*	0.577	.93	21.78	20.26	1.70	0.5	27.55
3500 S	1.90	0.728*	0.555	.76	21.78	16.55	1.70	0.5	26.73
4000 S	1.57	0.533*	0.480	.90	21.78	19.60	1.70	0.5	26.16
4500 S	2.57	0.788*	0.632	.80	21.78	17.42	1.70	0.5	38.05
5000 S	3.20	1.120	0.679	.61	21.78	13.29	1.70	0.5	36.15
5500 S	3.36	1.173	0.836	.71	21.78	15.46	1.70	0.5	44.02

*value obtained using a planimeter

Section	Jkkm Contact Length (km)	Theoretical Jkkm total Present (km^2)	Planimetered Actual JKkm Present (km^2)	Jkkm Proportion Present (km^2)	Regional Aggregate Coal Thickness (m)	Proportioned Coal Thickness Present (m)	Specific Gravity (g/cc)	Width (km)	Tonnes (million)
000	5.82	2.037	0.880	.43	21.78	9.37	1.70	0.75	69.53
1000 N	6.52	2.282	1.653	.72	21.78	15.68	1.70	1.50	260.70
3000 N	5.55	1.943	1.124	.58	21.78	12.63	1.70	2.00	238.33
5000 N east	3.59	1.257	0.741	.59	21.78	12.85	1.70	2.00	156.85
west	1.82	0.637	0.388	.61	21.78	13.29	1.70	1.00	41.12
7000 N	2.35	0.823	0.510	.62	21.78	13.50	1.70	2.00	107.87
9000 N	1.92	0.672	0.300	.45	21.78	9.80	1.70	1.50	47.98

Property Resource Calculations

Summary

Resource Calculations Over Remaining Property

(other than inferred or speculative)

Section	Resulting Total Seam Tonnage (million tonnes)
15 000 N	31.98
13 000 N	42.31
11 000 N	41.91
9 000 N	225.22
7 000 N	181.86
5 000 N	51.45
3 000 N	17.91
1 000 N	2.55
000 N	64.31
1 000 S	141.79
3 000 S	178.25
5 000 S	112.85
7 000 S	66.24
9 000 S	86.81
11 000 S	89.37
TOTAL	1334.81

C C C

Resource Calculations Over Remaining Property
(other than inferred or speculative)

		JKkm Contact Length (km)	Theoretical Total JKkm Present (km^2)	Planimetered Actual JKkm Present (km^2)	JKkm Proportion Present	Regional Aggregate Coal Thickness (m)	Proportioned Coal Thickness Present (m)	Specific Gravity (g/cc)	Width (km)	Tonnes (million)
15,000 N	E	2.62	0.917	0.298	.33	10.89	3.59	1.70	2.00	31.98
	W									
13,000 N	E	4.08	1.428	0.399	.28	10.89	3.05	1.70	2.00	42.31
	W									
11,000 N	E	3.77	1.320	0.392	.30	10.89	3.27	1.70	2.00	41.91
	W									
9,000 N	E	2.22	0.777	0.389	.50	10.89	5.45	1.70	2.00	41.14
	W	7.53	2.636	1.747	.66	10.89	7.19	1.70	2.00	184.08
7,000 N	W	9.27	3.245	1.708	.53	10.89	5.77	1.70	2.00	181.86
5,000 N	E									
	W	4.09	1.432	0.483	.34	10.89	3.70	1.70	2.00	51.45
3,000 N	E									
	W	2.30	0.805	0.168	.21	10.89	2.29	1.70	2.00	17.91
1,000 N	E									
	W	0.54	0.189	0.330	.17	10.89	1.85	1.70	1.50	2.55
0,000	E	0.92	0.322	0.248	.77	10.89	8.39	1.70	0.75	9.84
	E	1.37	0.480*	0.450	.94	10.89	10.24	1.70	0.75	17.89
	W	2.20	0.770	0.380	.49	10.89	5.34	1.70	0.75	14.98
	W	2.78	0.973	0.407	.42	10.89	4.57	1.70	1.00	21.60
1,000 S	E	3.41	1.194	0.822	.69	10.89	7.51	1.70	1.50	65.30
	W	5.30	1.855	0.960	.52	10.89	5.66	1.70	1.50	76.49
3,000 S	E	3.61	1.264	1.055	.83	10.89	9.04	1.70	2.00	110.96
	W	3.43	1.201	0.637	.53	10.89	5.77	1.70	2.00	67.29
5,000 S	E	3.10	1.085	0.613	.56	10.89	6.10	1.70	1.75	56.26
	W	3.49	1.222	0.605	.50	10.89	5.45	1.70	1.75	56.59
7,000 S	E	5.89	2.062	0.559	.27	10.89	2.94	1.70	2.25	66.24
	W									
9,000 S	E	4.04	1.414	0.824	.58	10.89	6.32	1.70	2.00	86.81
	W									
11,000 S	E	3.50	1.225*	0.845	.69	10.89	7.51	1.70	2.00	89.37
	W									
									TOTAL	1334.81

*value obtained using planimeter

Low Ash Resource

Calculations

5% Ash
Coal Tonnage Calculations

Hobbit-Broatch Area

Seam	Drill Hole	Resulting Tonnage (millions)	Seam Thickness (m)	Composite Seam Thickness	Proportionated Tonnage (millions)	Area of Influence (%)	Actual Low Ash Tonnage (millions)
J	82001	32.81	1.41	0.93	21.64	66	14.28
I lower	82001	162.26	6.07 total	3.21	85.81	66	56.63
A	82006	59.55	1.67	1.67	59.55	100	59.55
						TOTAL	130.46

5% Ash
Coal Tonnage Calculations

Lost Fox Area

Seam	Drill Hole	Resulting Tonnage (millions)	Seam Thickness (m)	Composite Seam Thickness	Proportionated Tonnage (millions)	Area of Influence (%)	Actual Low Ash Tonnage (millions)
I	82005	82.56	4.98	2.99	49.57	100	49.57
						TOTAL	49.57

10% Ash
Coal Tonnage Calculations

Hobbit-Broatch Area

Seam	Drill Hole	Resulting Tonnage (millions)	Seam Thickness (m)	Composite Seam Thickness	Proportionated Tonnage (millions)	Area of Influence (%)	Actual Low Ash Tonnage (millions)
K	82001	67.94	3.13	3.45	74.89	66	49.42
I upper	82001	162.26	6.07	1.84	49.19	66	32.46
G	82001	106.21	3.32	1.68	53.74	15	8.06
E lower	82002	57.02	1.66 total	0.82	28.17	19	5.35
C*	82002			0.67			
J	82003	32.81	1.41	2.33	54.22	34	18.43
I	82003	162.26	6.07	3.92	104.79	34	35.63
G	82003	106.21	3.32	1.05	33.59	27	9.07
F	82003	18.18	0.87	2.17	45.35	35	15.87
E upper	82003	57.02	1.66 total	0.86	29.54	35	10.34
E lower	82003	57.02	1.66 total	1.28	43.97	35	15.39
G	82006	106.21	3.32	2.45	78.38	25	19.59
E	82006	57.02	1.66	0.63	21.64	25	5.41
						TOTAL	225.02

*weight averaged at less than 0.50 metres and not used in calculations

10% Ash
Coal Tonnage Calculations

Lost-Fox Area

Seam	Drill Hole	Resulting Tonnage (millions)	Seam Thickness (m)	Composite Seam Thickness	Proportionated Tonnage (millions)	Area of Influence (%)	Actual Low Ash Tonnage (millions)
L	82005	20.20	2.24	0.90	8.12	100	8.12
J	82005	63.02	5.16	3.81	46.53	100	46.53
I	82005	82.56	4.98	1.99	32.99	100	32.99
						TOTAL	87.64

10% Ash
Coal Tonnage Calculations

Summit Area

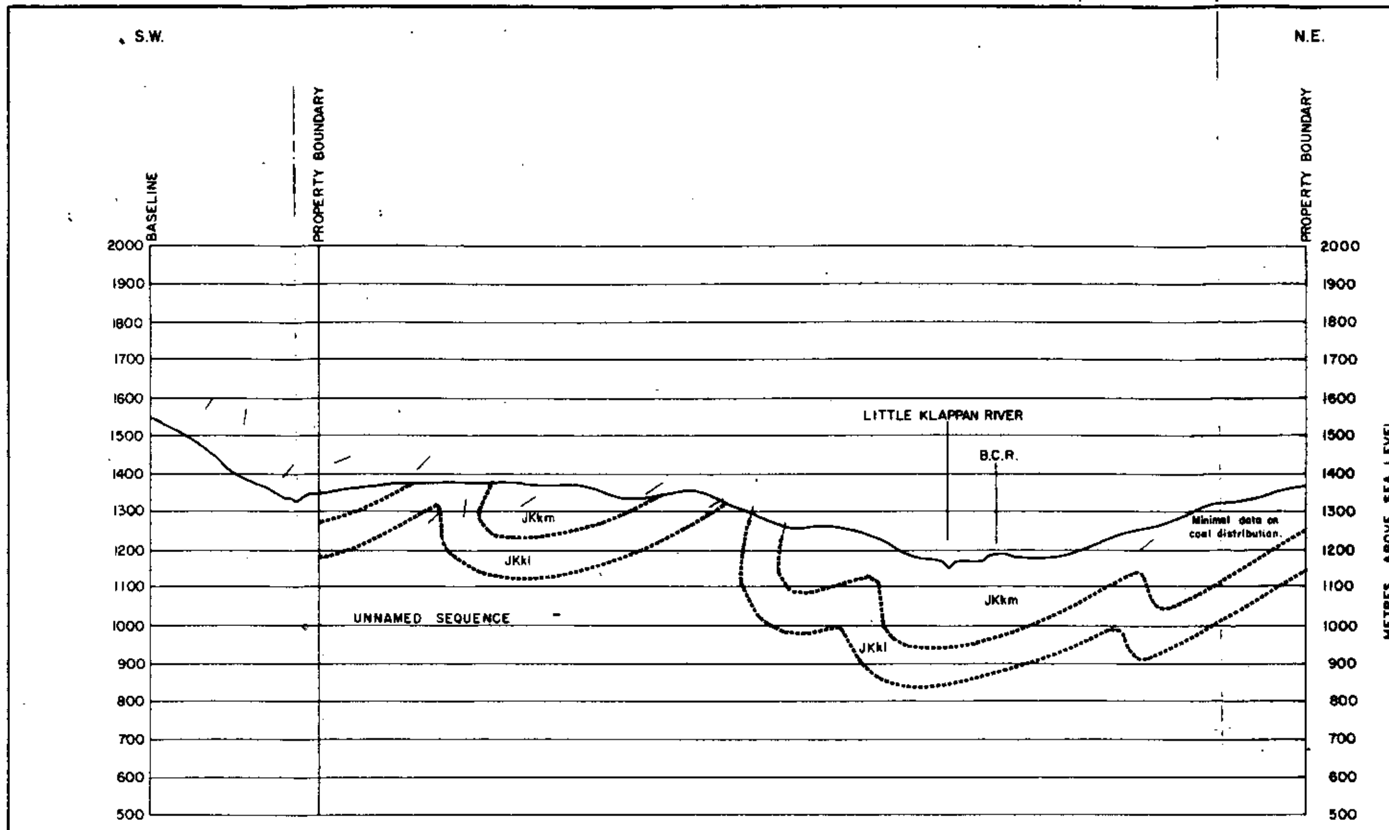
Seam	Drill Hole	Resulting Tonnage (millions)	Seam Thickness (m)	Composite Seam Thickness	Proportionated Tonnage (millions)	Area of Influence (%)	Actual Low Ash Tonnage (millions)
G	82007	12.76	3.91	3.91	12.76	100	12.76
						TOTAL	12.76

APPENDIX C

GEOLOGY MAPS

APPENDIX D

GEOLOGICAL CROSS-SECTIONS



MALLOCH SEQUENCE

JKm	Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal.

KLAPPAN SEQUENCE

JKku	Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal.
JKkm	Repeated coarsening upward sequences of fine to medium-grained sandstone, occasionally conglomeratic, siltstone, claystone and coal; sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base.
JKkl	Interbedded massive, fine grained sandstone and siltstones, containing bivalve fossils, with minor coal.

0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS

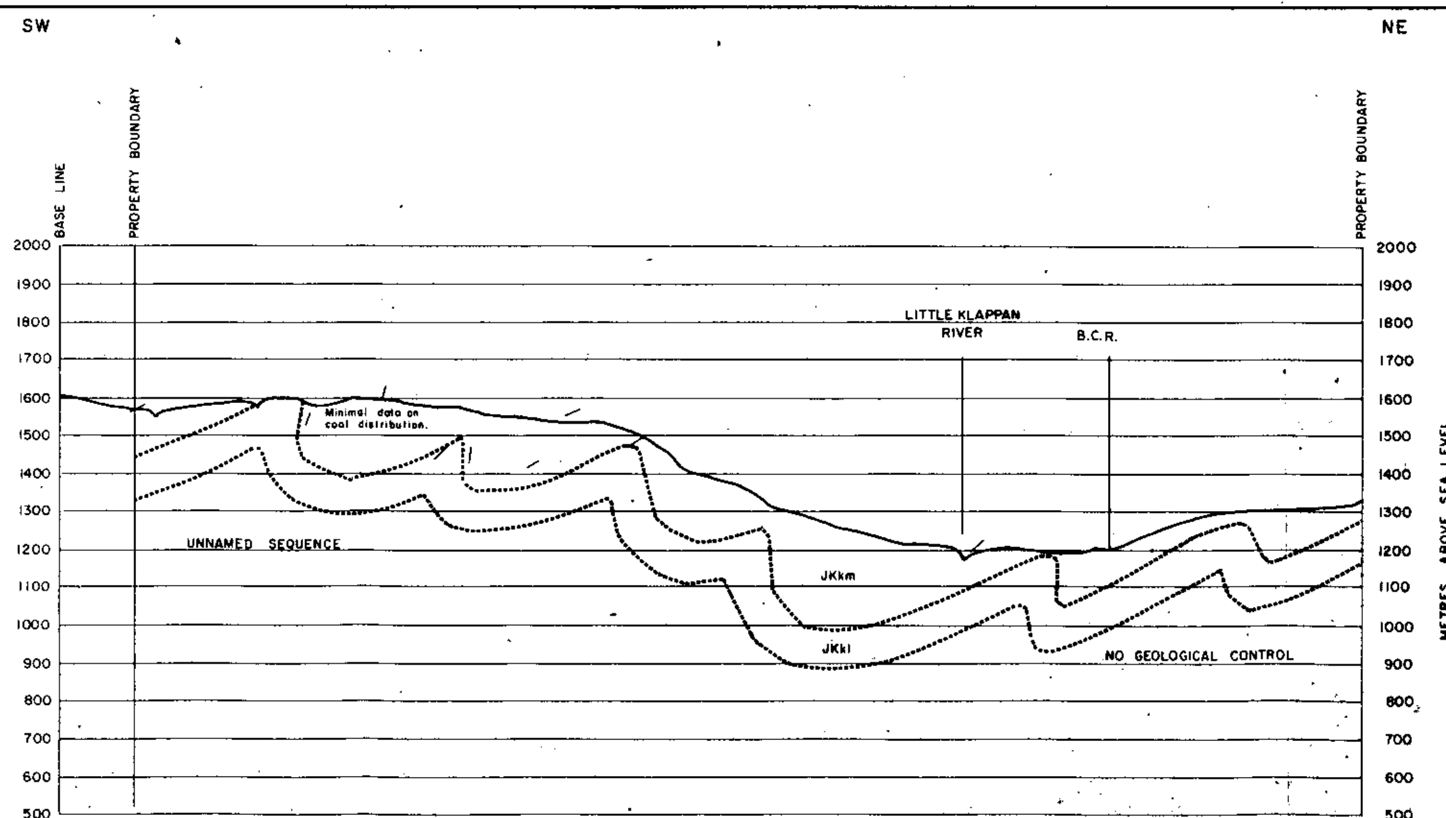
Legend

- GEOLOGICAL CONTACT (INFERRED)
- COAL SEAM TRACE (DEFINED, APPROX.)
- FAULT TRACE (DEFINED, APPROX., INFERRED)
- CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
- ATTITUDE CONTROL POINT
- DDH 82001 — DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA
Gulf

Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
15000N (EAST-WEST)

PREPARED BY: E. SWANBERGSON	SCALE 1:20,000
APPROVED BY: B.P.F. DATE: SEPT. '82	DRAWING No.



MALLOCH SEQUENCE

JKm	Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal.

KLAPPAN SEQUENCE

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0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS

Legend

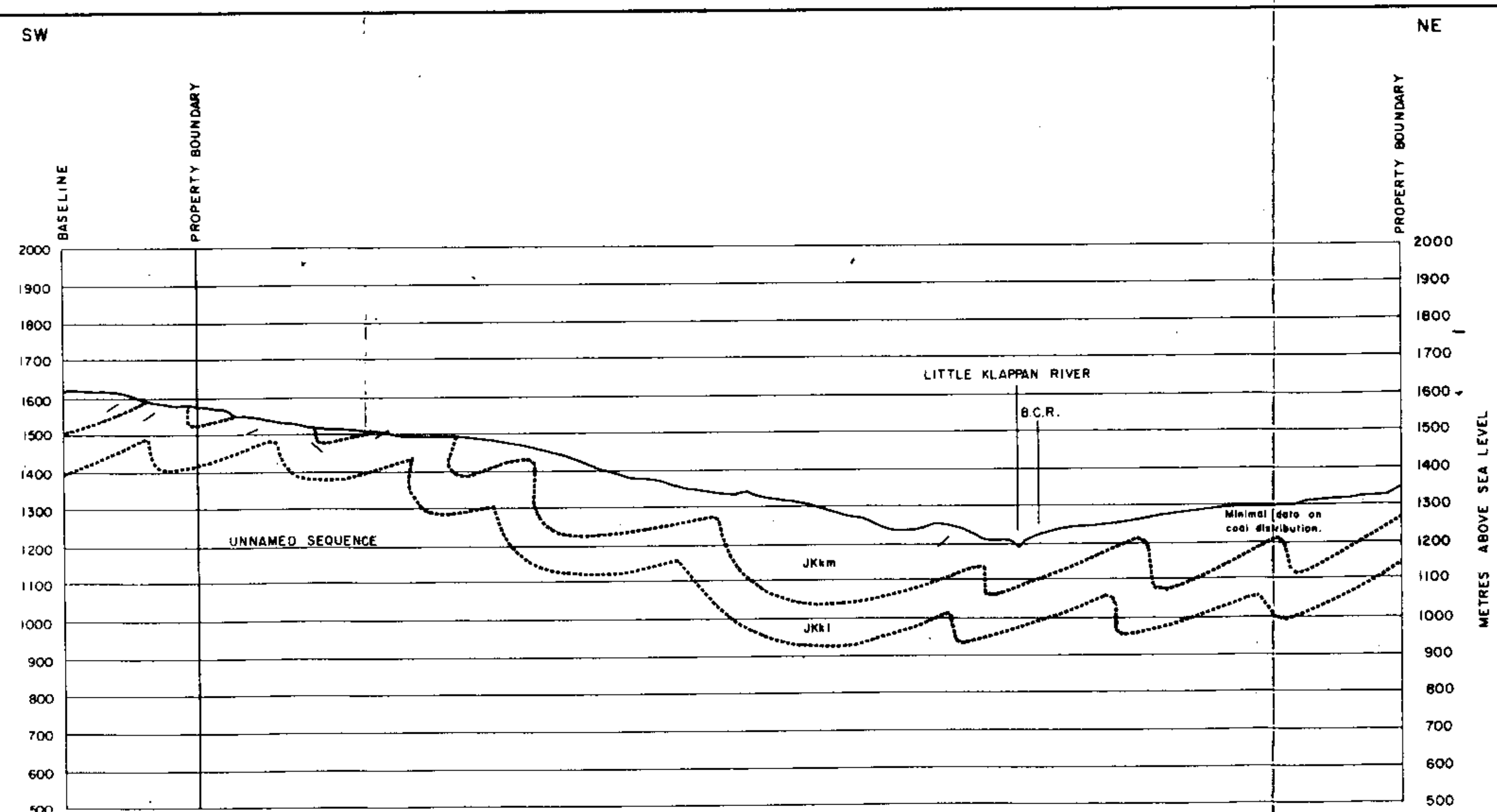
- GEOLOGICAL CONTACT (INFERRED)
- COAL SEAM TRACE (DEFINED, APPROX.)
- FAULT TRACE (DEFINED, APPROX., INFERRED)
- CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
- ATTITUDE CONTROL POINT
- DDH 82001 — DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA
Gulf

Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
13,000N (EAST-WEST)

PREPARED BY: E. SWANBERGSON	SCALE 1:20,000
APPROVED BY: B.P.F. DATE: NOV., 82	DRAWING No.

KPN-82-074



MALLOCH SEQUENCE

JKm — Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal.

KLAPPAN SEQUENCE

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JKkl — Interbedded massive, fine grained sandstone and siltstones, containing bivalve fossils, with minor coal.

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION
11000N (EAST - WEST)

KPN-82-075

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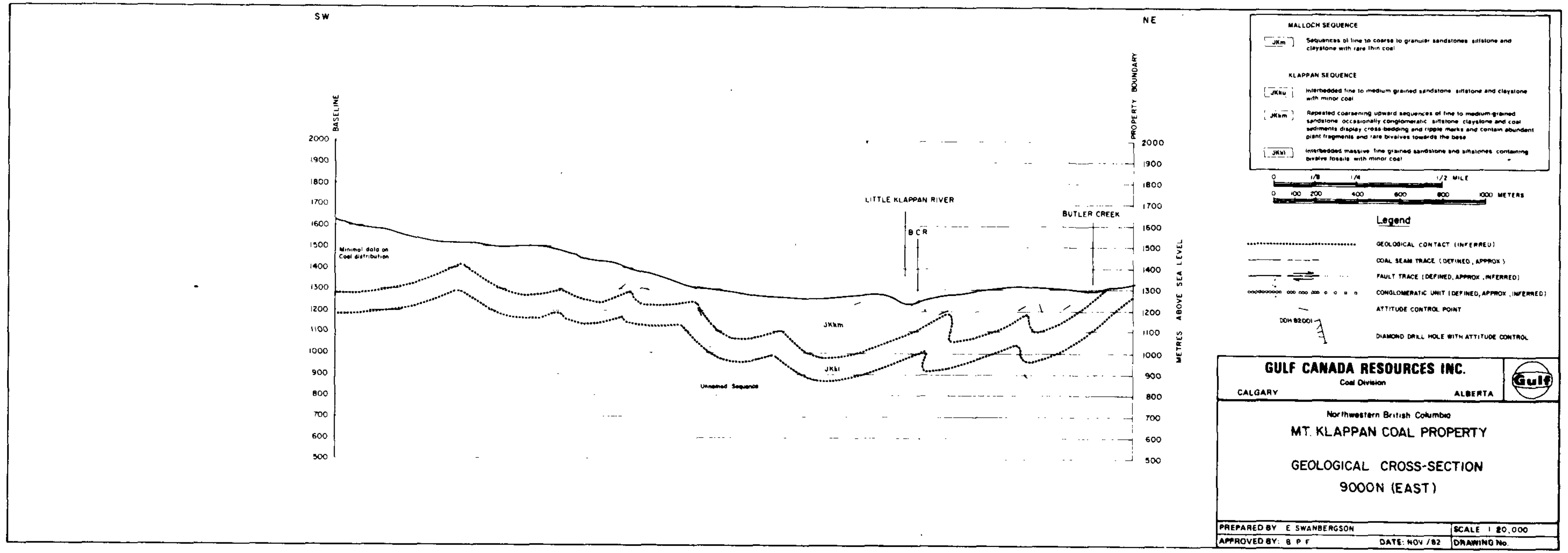
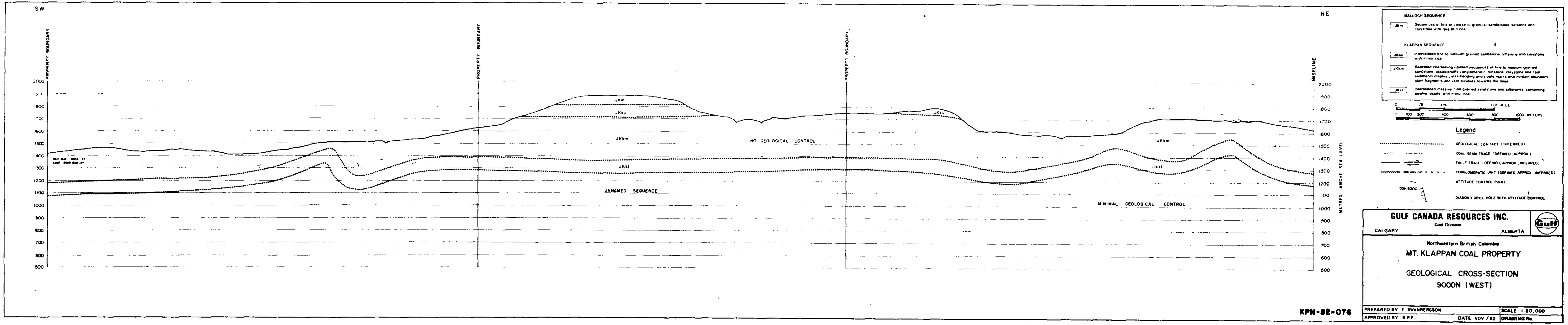
APPROVED BY: B.P.F.	DATE: NOV. / 82	DRAWING No.


SW
NE
BASELINE
PROPERTY BOUNDARY
METRES ABOVE SEA LEVEL
Minimal data on Coal distribution
LITTLE KLAPPAN RIVER
BUTLER CREEK
BCR
JKkm
JKkl
Unnamed Sequence
MALLOCH SEQUENCE
JKm Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal
KLAPPAN SEQUENCE
JKku Interbedded fine to medium grained sandstone siltstone and claystone with minor coal
JKkm Repeated coarsening upward sequences of fine to medium-grained sandstone occasionally conglomeratic siltstone claystone and coal sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base
JKkl Interbedded massive fine grained sandstone and siltstones containing bivalve fossils with minor coal
0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS
Legend
GEOLOGICAL CONTACT (INFERRED)
COAL SEAM TRACE (DEFINED, APPROX.)
FAULT TRACE (DEFINED, APPROX., INFERRED)
CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
ATTITUDE CONTROL POINT
DDH 82001
DIAMOND DRILL HOLE WITH ATTITUDE CONTROL
GULF CANADA RESOURCES INC.
Coal Division
CALGARY
ALBERTA
Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
9000N (EAST)
PREPARED BY E. SWANBERGSON
SCALE 1:20,000
APPROVED BY: B.P.F.
DATE: NOV/82
DRAWING No.


SW
NE
PROPERTY BOUNDARY
BASELINE
METRES ABOVE SEA LEVEL
Minimal data on coal distribution
JKm
JKku
JKkm
JKkl
NO GEOLOGICAL CONTROL
UNNAMED SEQUENCE
MINIMAL GEOLOGICAL CONTROL
MALLOCH SEQUENCE
JKm Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal
KLAPPAN SEQUENCE
JKku Interbedded fine to medium grained sandstone siltstone and claystone with minor coal
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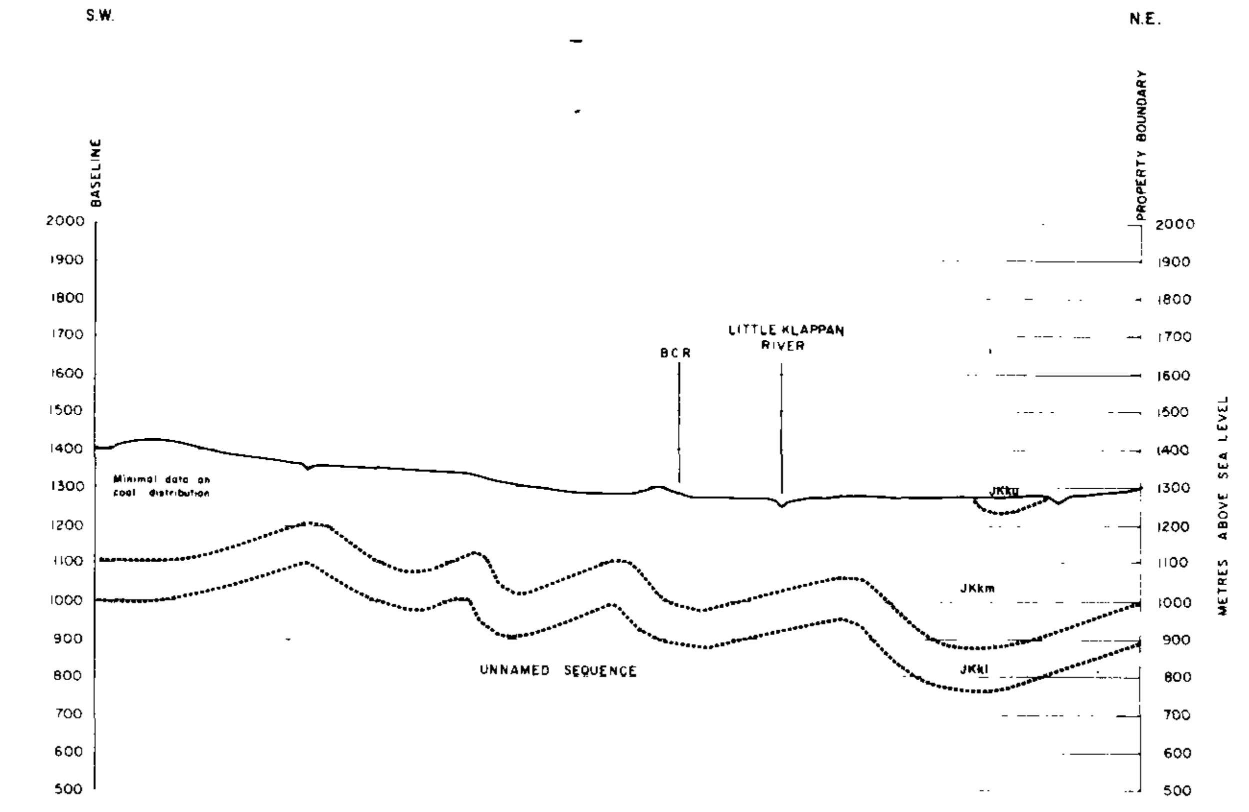
0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS
Legend
GEOLOGICAL CONTACT (INFERRED)
COAL SEAM TRACE (DEFINED, APPROX.)
FAULT TRACE (DEFINED, APPROX., INFERRED)
CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
ATTITUDE CONTROL POINT
DDH 82001
DIAMOND DRILL HOLE WITH ATTITUDE CONTROL
GULF CANADA RESOURCES INC.
Coal Division
CALGARY
ALBERTA
Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
9000N (WEST)
PREPARED BY E. SWANBERGSON
SCALE 1:20,000
APPROVED BY: B.P.F.
DATE: NOV/82
DRAWING No.
KPN-82-076



MALLOCH SEQUENCE

JKm — Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal

KLAPPAN SEQUENCE

JKku — Interbedded fine to medium grained sandstone siltstone and claystone with minor coal

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JKkl — Interbedded massive fine grained sandstone and siltstones containing bivalve fossils with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

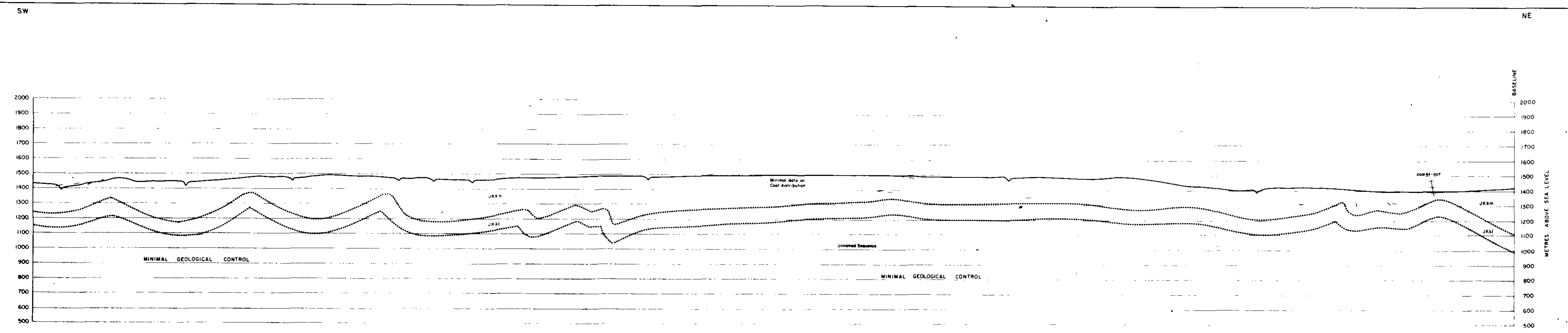
Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

7000N (EAST)

PREPARED BY: E. SWANBERGSON		SCALE 1:20,000
APPROVED BY: B.P.F.	DATE:	DRAWING No.



MALLOCH SEQUENCE

JKm — Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal

KLAPPAN SEQUENCE

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JKkl — Interbedded massive fine grained sandstone and siltstones containing bivalve fossils with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Northwestern British Columbia

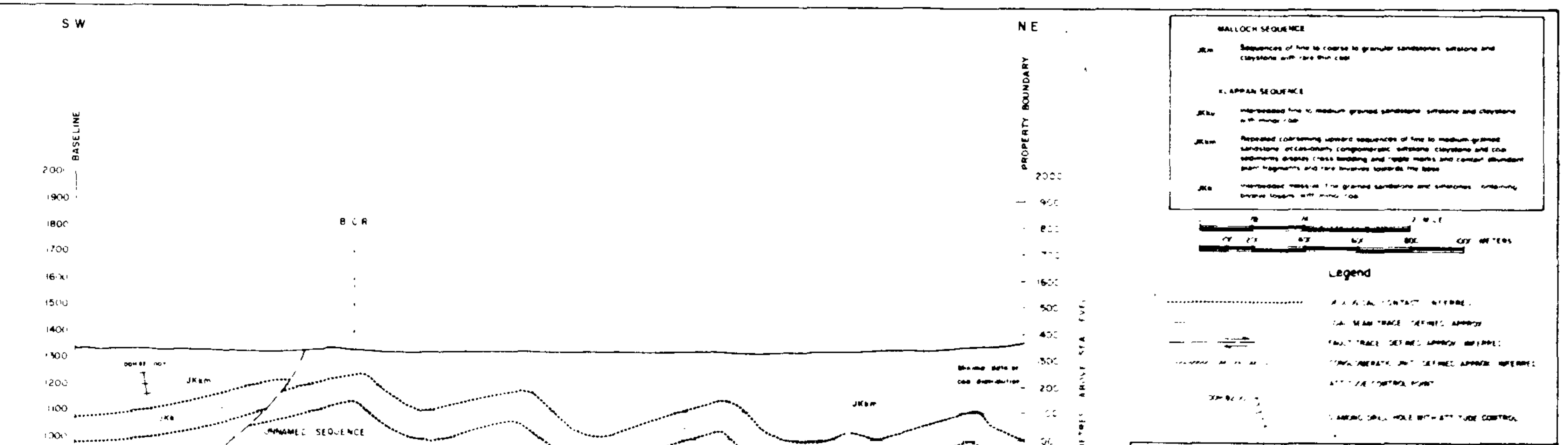
MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

7000N (WEST)

RPN-82-077

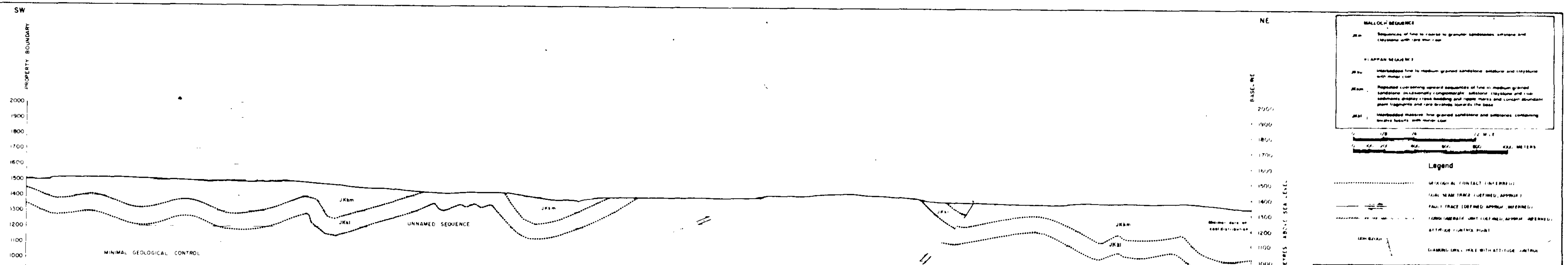
PREPARED BY: E. SWANBERGSON		SCALE 1:20,000
APPROVED BY: B.P.F.	DATE: NOV. 82	DRAWING No.



GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia
MT KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
5000 N (EAST)

PREPARED BY F. SWANBERG/SN		SCALE 1:20,000
APPROVED BY B.P.F.	DATE SEPT./82	DRAWING No

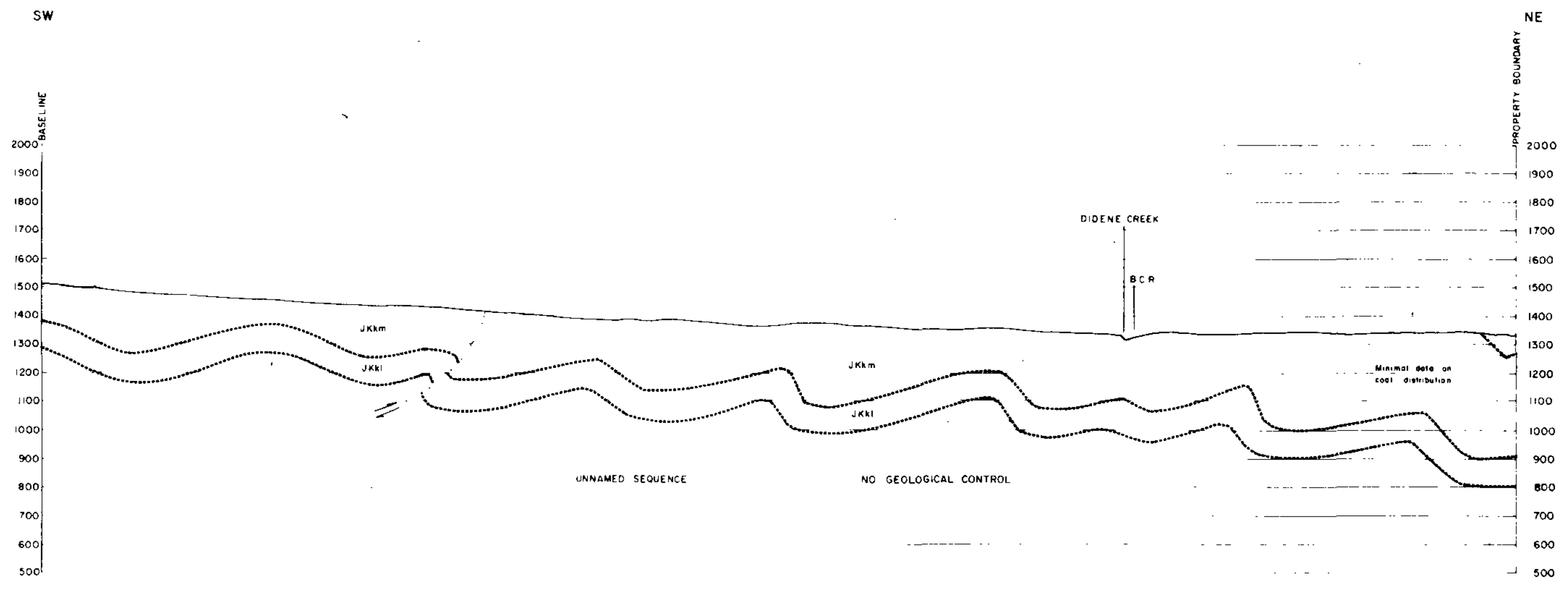


GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia
MT KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
5000 N (WEST)

PREPARED BY J. INNIS		SCALE 1:20,000
APPROVED BY B.P.F.	DATE NOV./82	DRAWING No

KPN-82-078



MALLOCH SEQUENCE

JKm — Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal

KLAPPAN SEQUENCE

JKku — Interbedded fine to medium grained sandstone siltstone and claystone with minor coal

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JKkl — Interbedded massive fine grained sandstone and siltstones containing bivalve fossils with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

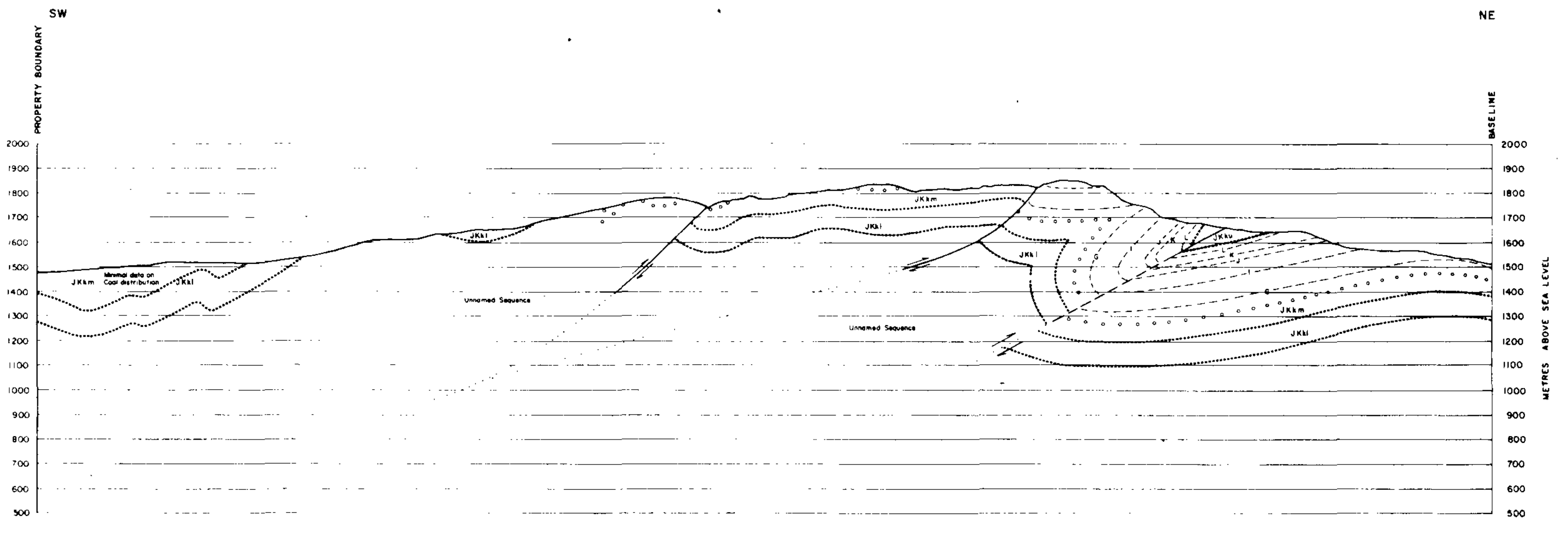
Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

3000N (EAST)

PREPARED BY: J. INNIS	SCALE 1: 0,000
APPROVED BY: B.P.F. DATE: NOV. 82	DRAWING No.



KPN-82-079

MALLOCH SEQUENCE

JKm — Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal

KLAPPAN SEQUENCE

JKku — Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal

JKkm — Repeated coarsening upward sequences of fine to medium-grained sandstone occasionally conglomeratic siltstone, claystone and coal; sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base

JKkl — Interbedded massive fine grained sandstone and siltstones, containing bivalve fossils with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

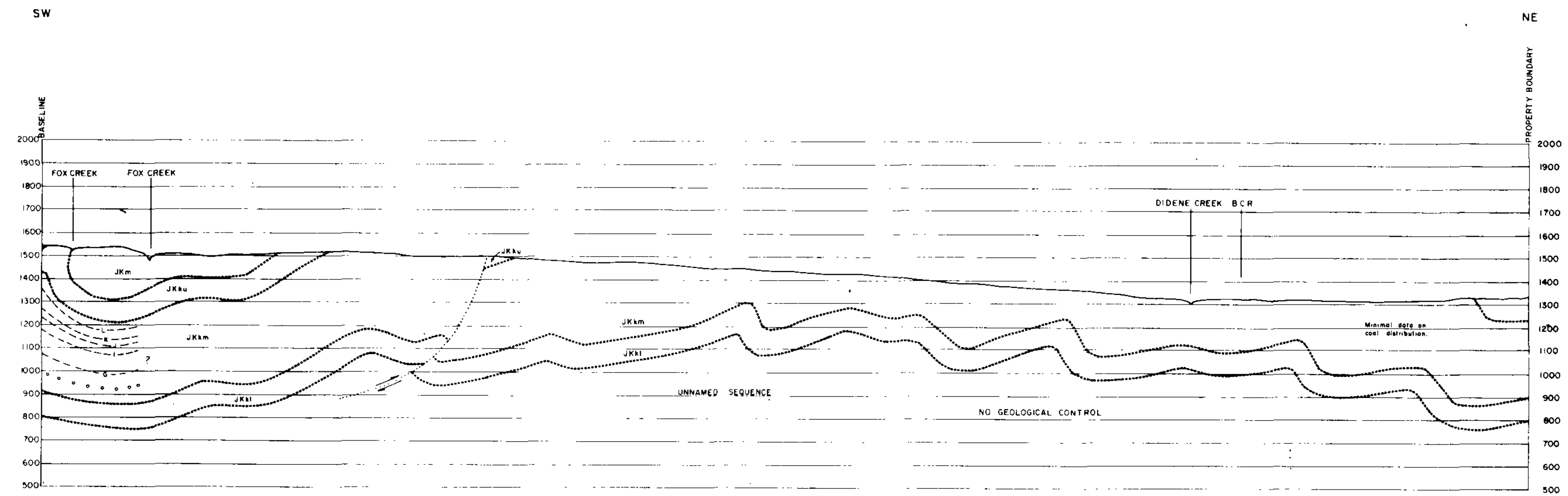
Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

3000N (WEST)

PREPARED BY: J. INNIS	SCALE 1: 0,000
APPROVED BY: B.P.F. DATE: NOV. 82	DRAWING No.



MALLOCH SEQUENCE

JKm	Sequences of fine to coarse to granular sandstones, siltstone and claystone with rare thin coal

KLAPPAN SEQUENCE

JKku	Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal
JKkm	Repeated coarsening-upward sequences of fine to medium-grained sandstone occasionally conglomeratic, siltstone, claystone and coal. sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base
JKkl	Interbedded massive fine grained sandstone and siltstones containing bivalve fossils with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

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FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION 1000N (EAST)

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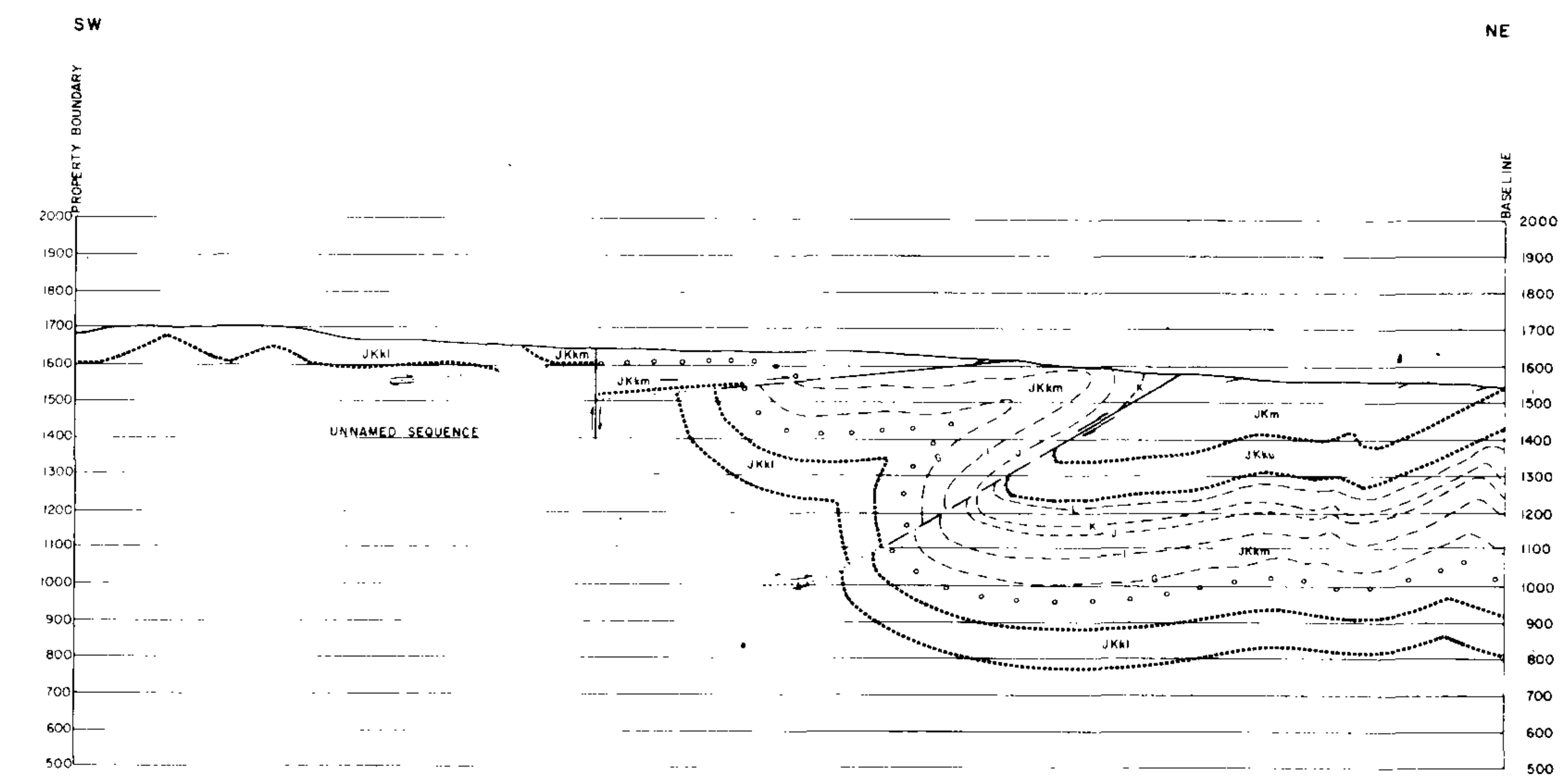

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0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

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FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION 1000 N (WEST)

KPN-82-080

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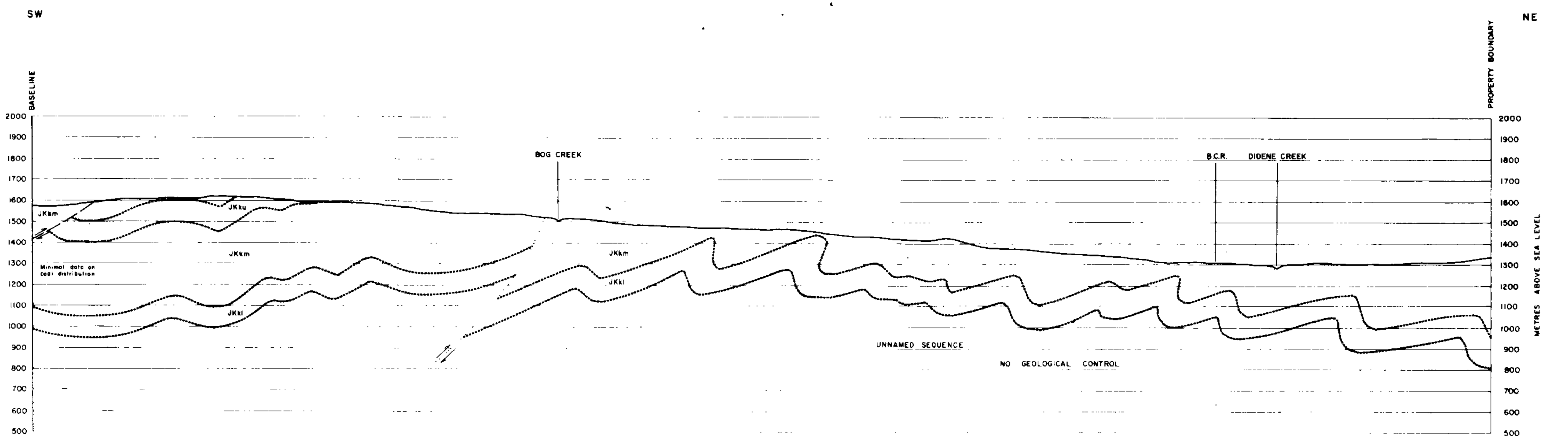

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KLAPPAN SEQUENCE

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JKkl — Interbedded massive, fine grained sandstone and siltstones, containing bivalve fossils, with minor coal

0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION
0000 (EAST)

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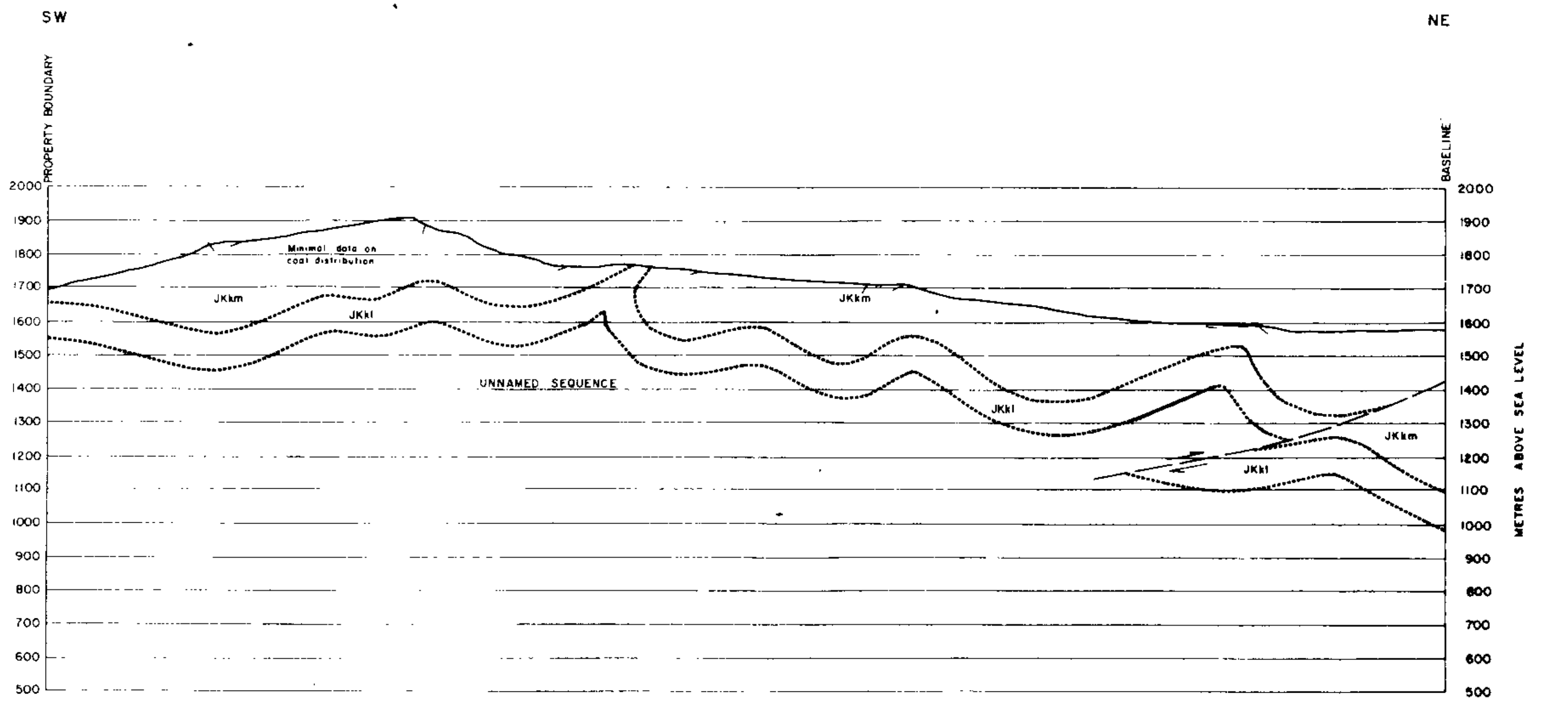
APPROVED BY B.P.F. DATE NOV.,82	DRAWING No.



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0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

Northwestern British Columbia

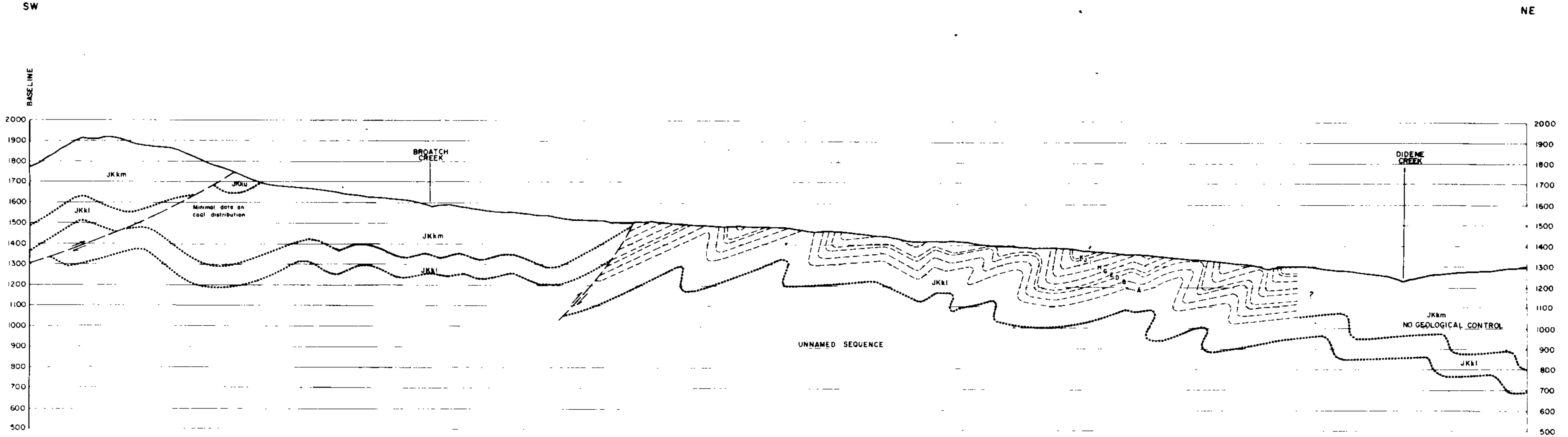
MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

0000 (WEST)

KPN-82-081

PREPARED BY: J. INNIS	SCALE 1:20,000
APPROVED BY: B.P.F. DATE: NOV.,82	DRAWING No.



MALLOCH SEQUENCE

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KLAPPAN SEQUENCE

JKku	Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal.
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0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

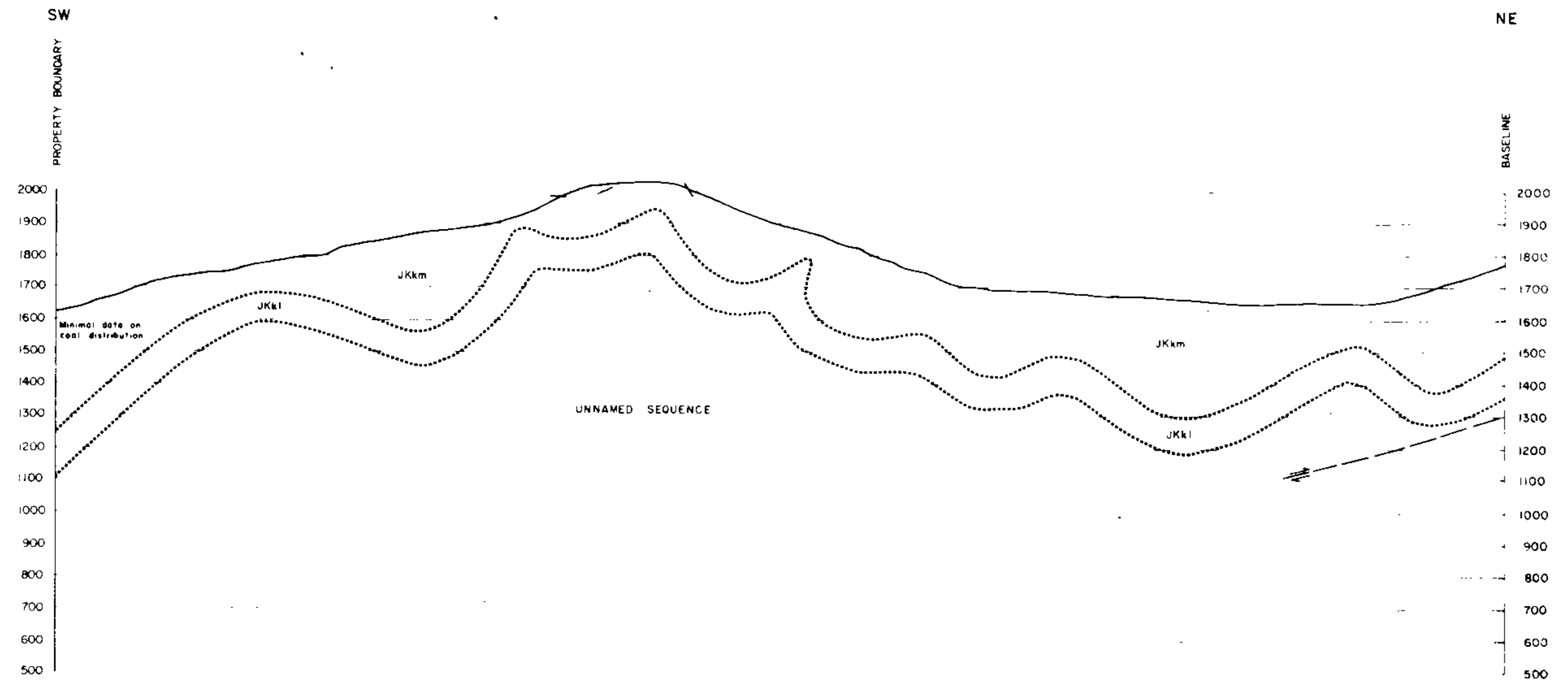
Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

1000S (EAST)

PREPARED BY G. SEVE		SCALE 1:20,000
APPROVED BY B.P.F	DATE: NOV. 82	DRAWING No.



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0 1/8 1/4 1/2 MILE

0 100 200 400 600 800 1000 METERS

Legend

GEOLOGICAL CONTACT (INFERRED)

COAL SEAM TRACE (DEFINED, APPROX.)

FAULT TRACE (DEFINED, APPROX., INFERRED)

CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)

ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Gulf

Northwestern British Columbia

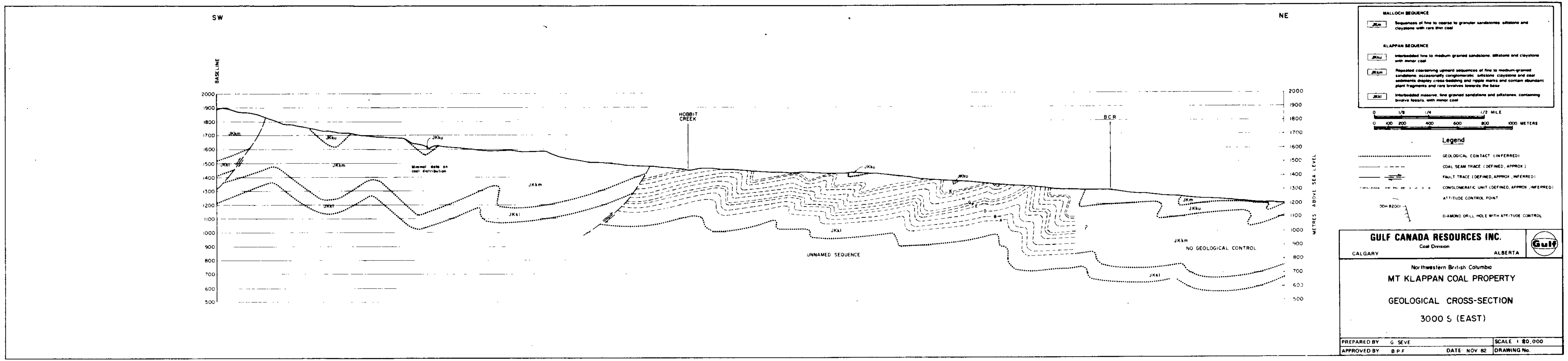
MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

1000S (WEST)

PREPARED BY J. INNIS		SCALE 1:20,000
APPROVED BY B.P.F	DATE NOV 1982	DRAWING No.

KPN-82-082


SW
NE
BASELINE
HOBBIT CREEK
BCR
JKm
JKu
JKku
JKkm
JKkl
Minimal data on coal distribution
UNNAMED SEQUENCE
NO GEOLOGICAL CONTROL
METRES ABOVE SEA LEVEL
MALLOCH SEQUENCE
JKm Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal
KLAPPAN SEQUENCE
JKku Interbedded fine to medium grained sandstone, siltstone and claystone with minor coal
JKkm Repeated coarsening upward sequences of fine to medium-grained sandstone, occasionally conglomeratic siltstone claystone and coal sediments display cross-bedding and ripple marks and contain abundant plant fragments and rare bivalves towards the base
JKkl Interbedded massive, fine grained sandstone and siltstones, containing bivalve fossils, with minor coal
0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS
Legend
GEOLOGICAL CONTACT (INFERRED)
COAL SEAM TRACE (DEFINED, APPROX.)
FAULT TRACE (DEFINED, APPROX., INFERRED)
CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
ATTITUDE CONTROL POINT
DDH 82001
DIAMOND DRILL HOLE WITH ATTITUDE CONTROL
GULF CANADA RESOURCES INC.
Coal Division
CALGARY
ALBERTA
Gulf
Northwestern British Columbia
MT KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
3000 S (EAST)
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APPROVED BY B.P.F.
DATE NOV 82
SCALE 1:20,000
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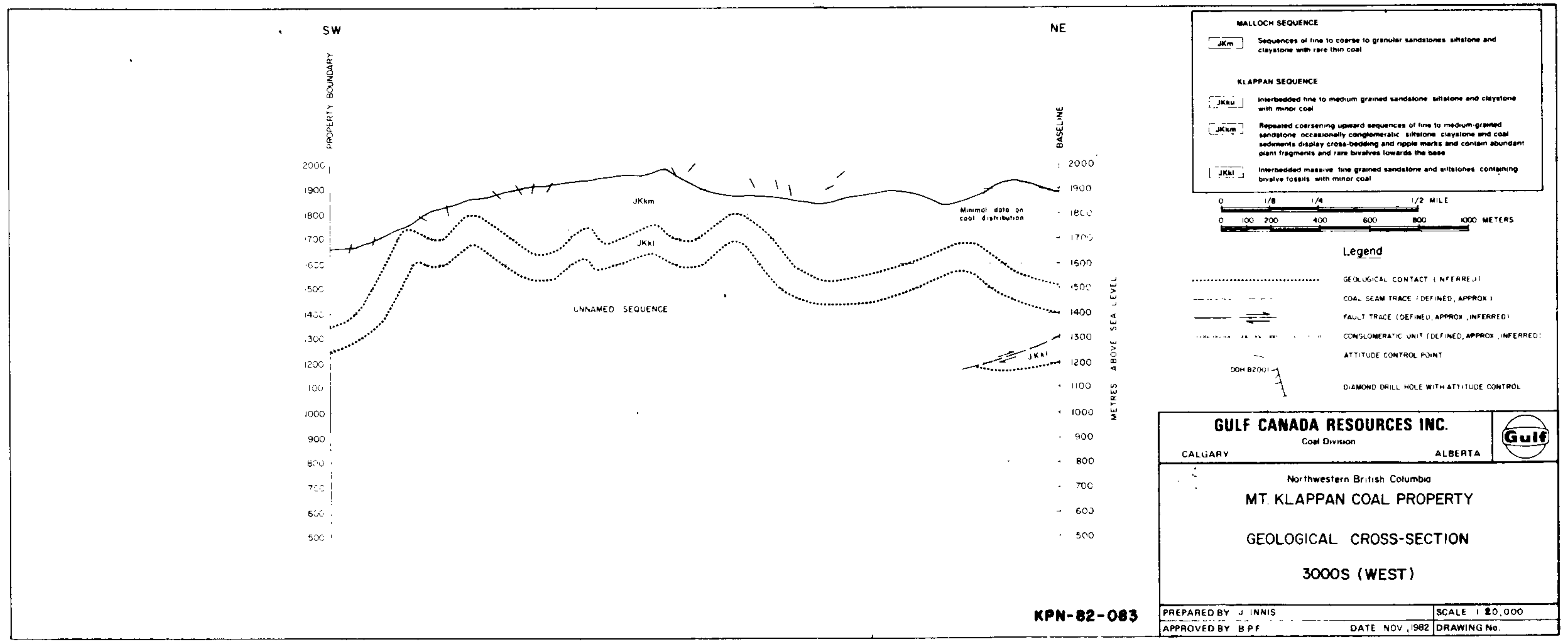
SW
NE
PROPERTY BOUNDARY
BASELINE
JKkm
JKkl
Minimal data on coal distribution
UNNAMED SEQUENCE
METRES ABOVE SEA LEVEL
MALLOCH SEQUENCE
JKm Sequences of fine to coarse to granular sandstones siltstone and claystone with rare thin coal
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0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS
Legend
GEOLOGICAL CONTACT (INFERRED)
COAL SEAM TRACE (DEFINED, APPROX.)
FAULT TRACE (DEFINED, APPROX., INFERRED)
CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
ATTITUDE CONTROL POINT
DDH 82001
DIAMOND DRILL HOLE WITH ATTITUDE CONTROL
GULF CANADA RESOURCES INC.
Coal Division
CALGARY
ALBERTA
Gulf
Northwestern British Columbia
MT KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
3000S (WEST)
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APPROVED BY B.P.F.
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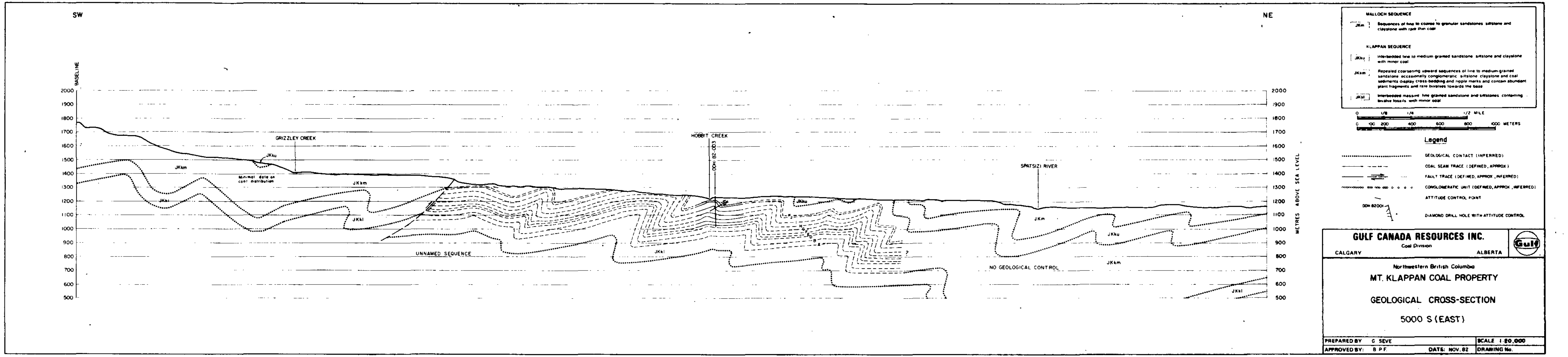
SW
NE
BASELINE
GRIZZLEY CREEK
HOBBIT CREEK
DDH 82-003
SPATSIZI RIVER
JKku
JKkm
JKkl
JKm
Minimal data on coal distribution
UNNAMED SEQUENCE
NO GEOLOGICAL CONTROL
METRES ABOVE SEA LEVEL
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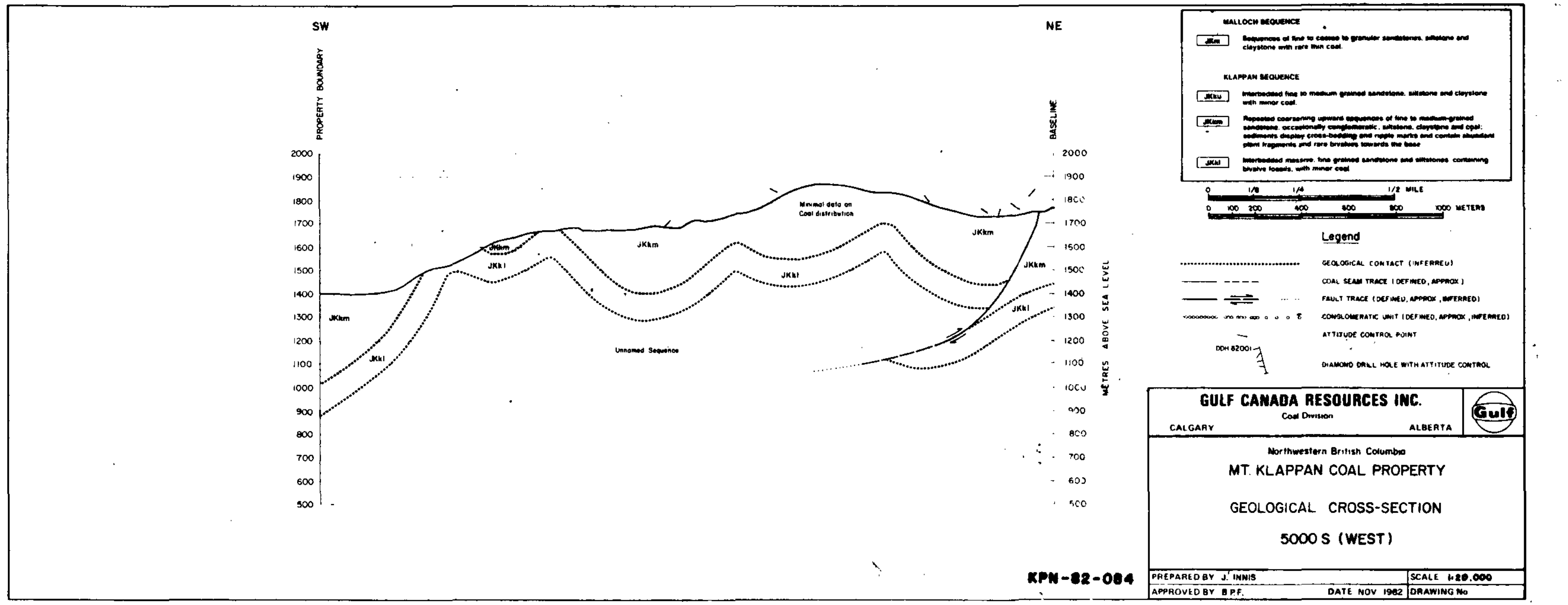
0 1/8 1/4 1/2 MILE
0 100 200 400 600 800 1000 METERS
Legend
GEOLOGICAL CONTACT (INFERRED)
COAL SEAM TRACE (DEFINED, APPROX.)
FAULT TRACE (DEFINED, APPROX., INFERRED)
CONGLOMERATIC UNIT (DEFINED, APPROX., INFERRED)
ATTITUDE CONTROL POINT
DDH 82001
DIAMOND DRILL HOLE WITH ATTITUDE CONTROL
GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA
Gulf
Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
5000 S (EAST)
PREPARED BY G SEVE
APPROVED BY: B P F.
DATE: NOV. 82
SCALE 1:20,000
DRAWING No.


SW
NE
PROPERTY BOUNDARY
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Minimal data on coal distribution
JKm
JKkm
JKkl
Unnamed Sequence
METRES ABOVE SEA LEVEL
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GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA
Gulf
Northwestern British Columbia
MT. KLAPPAN COAL PROPERTY
GEOLOGICAL CROSS-SECTION
5000 S (WEST)
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APPROVED BY B.P.F.
DATE NOV 1982
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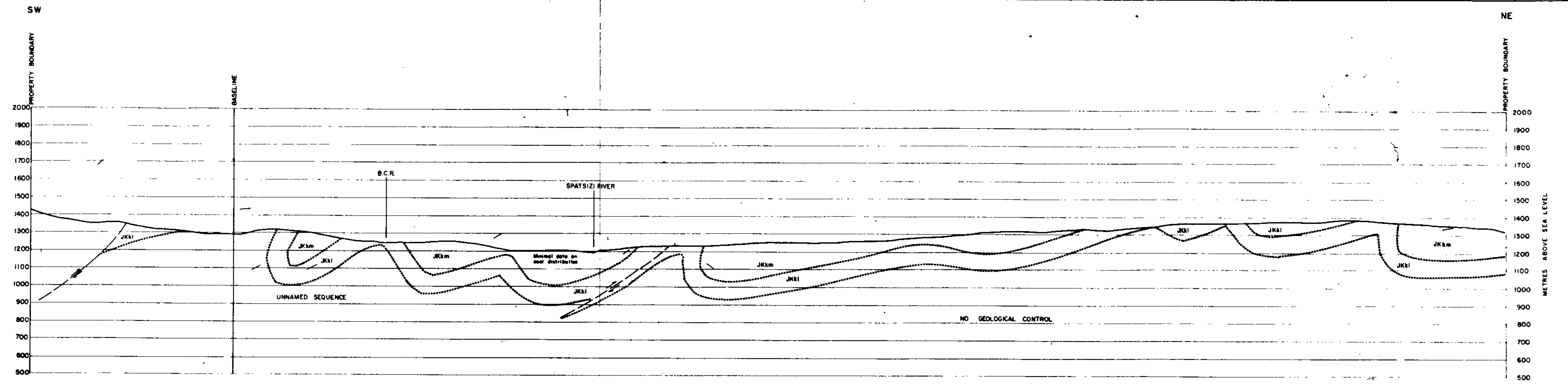
KPN-82-084



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Legend

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DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

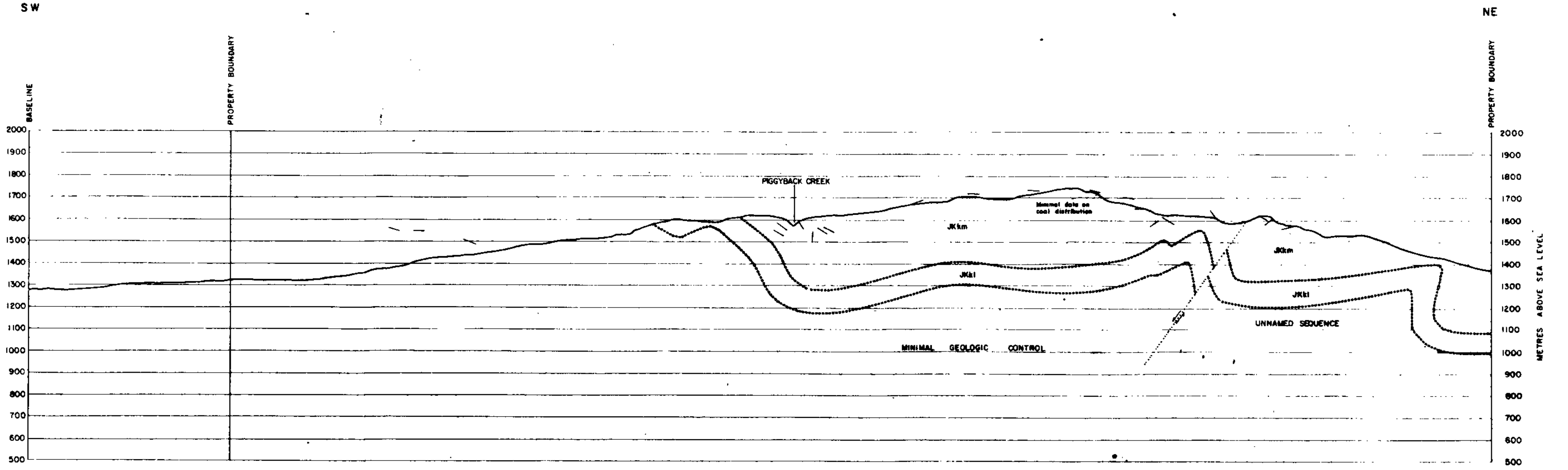
Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

7000S (EAST)-(WEST)

PREPARED BY: J.M. DUFORD | SCALE 1:20,000
APPROVED BY: B.P.F. DATE: NOV. '82 | DRAWING No.



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Legend

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ATTITUDE CONTROL POINT

DDH 82001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

9000S (EAST)

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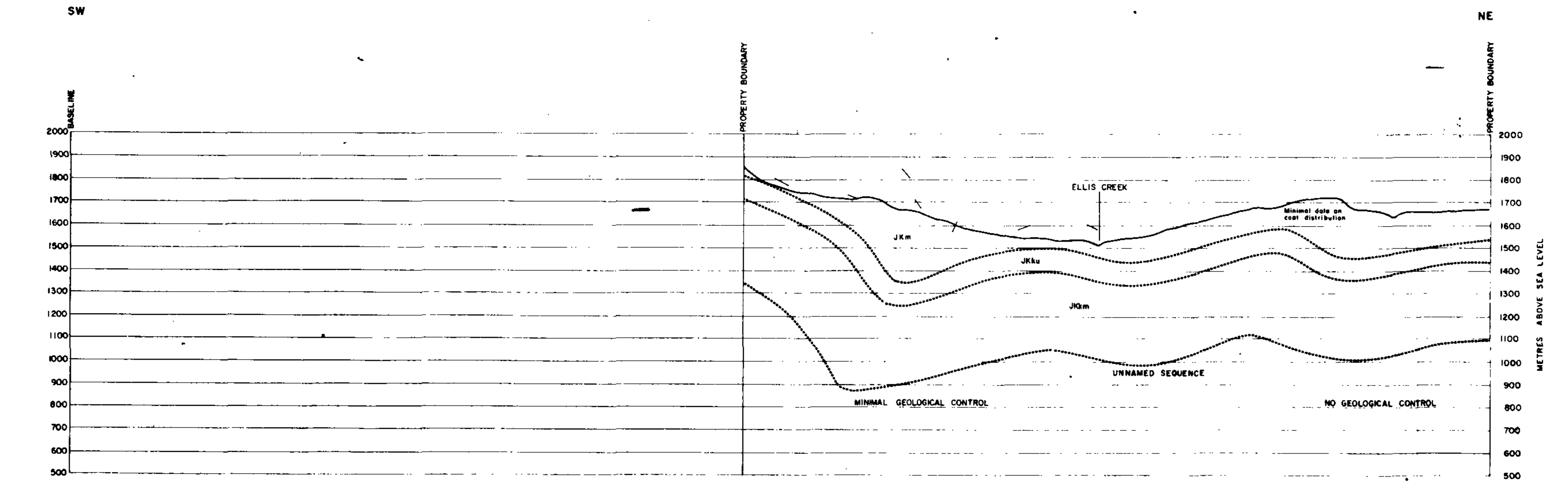

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0 100 200 400 600 800 1000 METERS

Legend

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DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

GULF CANADA RESOURCES INC.

Coal Division

CALGARY ALBERTA

Northwestern British Columbia

MT. KLAPPAN COAL PROPERTY

GEOLOGICAL CROSS-SECTION

11000 S (EAST)

PREPARED BY: J.M. DUFORD	SCALE 1:20,000
APPROVED BY: G.P.F. DATE: SEPT. '82	DRAWING No.

KPM-82-0[illegible]

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GULF CANADA RESOURCES INC.

MOUNT KLAPPAN COAL PROJECT

1982

MINE ASSESSMENT

VOLUME 5

INFRASTRUCTURE

Coal Licence Number 7118 to 7177

7381 to 7392

and

7416 to 7432 inclusive

Cassiar Land District

NTS Map Number 104 H

Latitude Between 57°11' and 57°22'N
Longitude Between 128°39' and 129°05'W

BY

PHILLIPS BARRATT KAISER
Engineering Ltd.
Vancouver, B.C. Canada

DECEMBER 1982

00110 (6)

PBK Project No. 82054

MOUNT KLAPPAN COAL PROJECT

Phillips Barratt Kaiser Engineering Ltd.

GULF CANADA RESOURCES INC.

Phillips Barratt Kaiser

MOUNT KLAPPAN COAL PROJECT LOCATION MAP

Phillips Barratt Kaiser

PBK

MOUNT KLAPPAN COAL PROJECT

MINE ASSESSMENT

VOLUME 1	SUMMARY
VOLUME 2	GEOLOGY
VOLUME 3	MINING
VOLUME 4	PREPARATION FACILITIES
▷ VOLUME 5	INFRASTRUCTURE

VOLUME 5

INFRASTRUCTURE

Phillips Barratt Kaiser

PBK

MOUNT KLAPPAN COAL PROJECT

VOLUME 5

INFRASTRUCTURE

TABLE OF CONTENTS

PART

PART 1

INTRODUCTION

PART 1 - INTRODUCTION

CONTENTS

1.1 SYNOPSIS

This volume of the report covers the regional infrastructure necessary to support the mine operation. The components of this infrastructure are railroad, pipeline, road, port, electrical power, water and townsite requirements.

In addition, the socio-economic and environmental implications for the Mount Klappan coal mining project are discussed.


YUKON
N.W.TERRITORIES
BRITISH COLUMBIA
BRITISH COLUMBIA
ALASKA
BRITISH COLUMBIA
ALBERTA
CASSIAR
DEASE LAKE
FORT NELSON
Stikine River
Preliminary Access Road
SPATSIZI PLATEAU PROVINCIAL PARK
37
Mount Klappan Project Site
Route 1
Route 2
Route 2
Route 1
STEWART
HAZELTON
BCR
SMITHERS
TERRACE
PRINCE RUPERT
RIDLEY ISLAND
KITIMAT
FORT ST JAMES
CNR
16
PRINCE GEORGE
97
FORT ST JOHN
DAWSON CREEK
NE COAL AREA
LEGEND
Existing Railways
Proposed Railways
BCR British Columbia Railway
CNR Canadian National Railway
Existing Highways
Proposed Roads
Air Strips
Existing Mines
SCALE 0 10 50 100 KM
MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.
REGIONAL ACCESS MAP
M1
Phillips Barratt Kaiser
PLATE 1.1
December 1982 / 82054

PART 2

COAL TRANSPORTATION

PART 2 - COAL TRANSPORTATION

CONTENTS

2.1 INTRODUCTION

The basic system considered for transportation of the coal from the minesite to the port is by rail. The shipping port for the purpose of this evaluation is the terminal which is now being constructed at Ridley Island to handle the coal that will be produced in northeastern British Columbia.

Consideration was given to using a coal slurry pipeline from the minesite to the port of Stewart (the closest seaport to Mount Klappan).

2.2 RAIL HAULAGE

221 OVERVIEW

It would be necessary to complete and upgrade the existing British Columbia Railway (BCR) line to reach the Mount Klappan project site. The distance was calculated and an estimate was made of the cost of restoring and completing this line.

The southern end of this BCR line joins the Canadian National Railway (CNR) system near Prince George. This gives a total haulage distance of approximately 1 400 kilometres to the coal terminal at Ridley Island. It was determined that this distance could be reduced by approximately 50% by constructing a cutoff from the BCR line to intersect the CNR line near Hazleton. Several possible routes for this cutoff were studied and the capital cost of each was estimated. Plans showing each of these routes are included in this report. See Plate 2.1.

Based on total haul distance and cost of construction the Northern Route #2 is the preferred route. This would reduce the total haul distance from Mount Klappan to Ridley Island to approximately 600 km.

222 MAIN LINE COMPLETION

The BCR line is laid to Chipmunk, 85 kilometres south of the Mount Klappan property. The right-of-way is in various stages of development over this 85 kilometre stretch, with approximately 25 kilometers requiring new grade and the balance requiring track only. The route is shown on Plate 2.2.

223 NEW RAILWAY CUTOFF - SOUTHERN ROUTE 1

This route commences approximately 2 km south of Bulkley Canyon along the existing CNR and covers a distance of 196 km to intersect the BCR near its milepost 79. See Plate 2.3.

This route climbs to a maximum elevation of 3 400 feet, crosses some very difficult terrain, and requires the construction of 5 bridges, the longest of which is 180 metres.

224 NEW RAILWAY CUTOFF - ALTERNATIVE SOUTHERN ROUTE 1A

This route, total length 180 km, follows the same path as Route 1 for the first 24 km from the CNR, and for the last 50 km to the BCR. Between these points the line covers a distance of 106 km over terrain which is somewhat less difficult than for Route 1. See Plate 2.3.

Route 1A has the following advantages over Route 1:

- shorter by 16 km;
- crosses less rugged terrain;
- requires fewer and smaller river crossings;
- the highest elevation for the alternate section is 500 feet lower;
- it is more accessible;
- gradients are less severe; and,

225 NEW RAILWAY CUTOFF - NORTHERN ROUTE 2

This route commences approximately 6 km south of Hazleton at the CNR and covers a distance of 176 km, intersecting the BCR near its milepost 125. See Plate 2.4

Six major bridges, the longest being 450 metres, and four major culverts are required for this route. For the last 80 km of the route only maps at a scale of 1: 250 000 were available and, therefore, the data obtained and the estimated costs do not have the same level of accuracy as for Routes 1 and 1A, for which maps at a scale of 1: 50 000 were used.

An alternative to Route 2, Route 2A, was plotted but cost estimates were not prepared because the terrain was less favourable, and the overall distance was 14 km more.

The following criteria were obtained from the British Columbia Railway engineers and were used as a basis for the route selection and for the cost estimates for the railway evaluation.

Grades:

- recommended maximum of 1% in the loaded direction.

- recommended maximum of 1.3% in the unloaded direction.

Horizontal Curves:

- recommended maximum of 6 degrees.

Siding Tracks:

- recommended distance between siding tracks for "pullout" of trains.
  Minimum - 20 km
  Maximum - 30 km.

- length of siding - 2240 metres for holding 95 cars and diesel drive units.

Clearing and Grubbing Width Along R/W:

- 30 metres minimum.

- Additional allowance for cut and fill areas.

Track Subgrade Widths:

In accordance with standards shown on drawing "Typical Sections & Details" by B. C. Railway - for North East Coal Development.

Design Loads:

Coopers E-80 based on the American Railway Engineering Association Code.

2.3 PORT

The shipping port chosen for this evaluation was the terminal which is now being constructed at Ridley Island to handle the coal which will be produced in northeastern British Columbia.

No evaluation was made as to the availability of this facility to handle the tonnage being considered for the Mount Klappan project. However, when completed in 1983, the planned capacity of this terminal will be 12 million tonnes per year, approximately 4 million tonnes per year more than the tonnage proposed from the Quintette and Bullmoose Coal Projects now under construction in the northeast. The Ridley Island Coal Terminal can be expanded to handle 15 to 16 million tonnes per year as the demand increases.

2.4 SLURRY PIPELINE

The possibility of pumping coal in slurry form from Mount Klappan to the port of Stewart was considered as an alternate to railway transportation. It was estimated that this pipeline would be of the order of 225 km long.

An investigation into this option was not made because the final coal products have not been identified and, therefore, the size consistency of the shipped products is not known. The technical problems in pumping coarse coal (100 mm x 0) a distance of 225 km have been identified and are:

- Pipe friction loss. The velocities (4-5 m/sec) required to sustain flow of the large coal particles would result in pressure losses on the order of 400 kilopascals/km, approximately five times more than for conventional coal slurry pipeline systems.

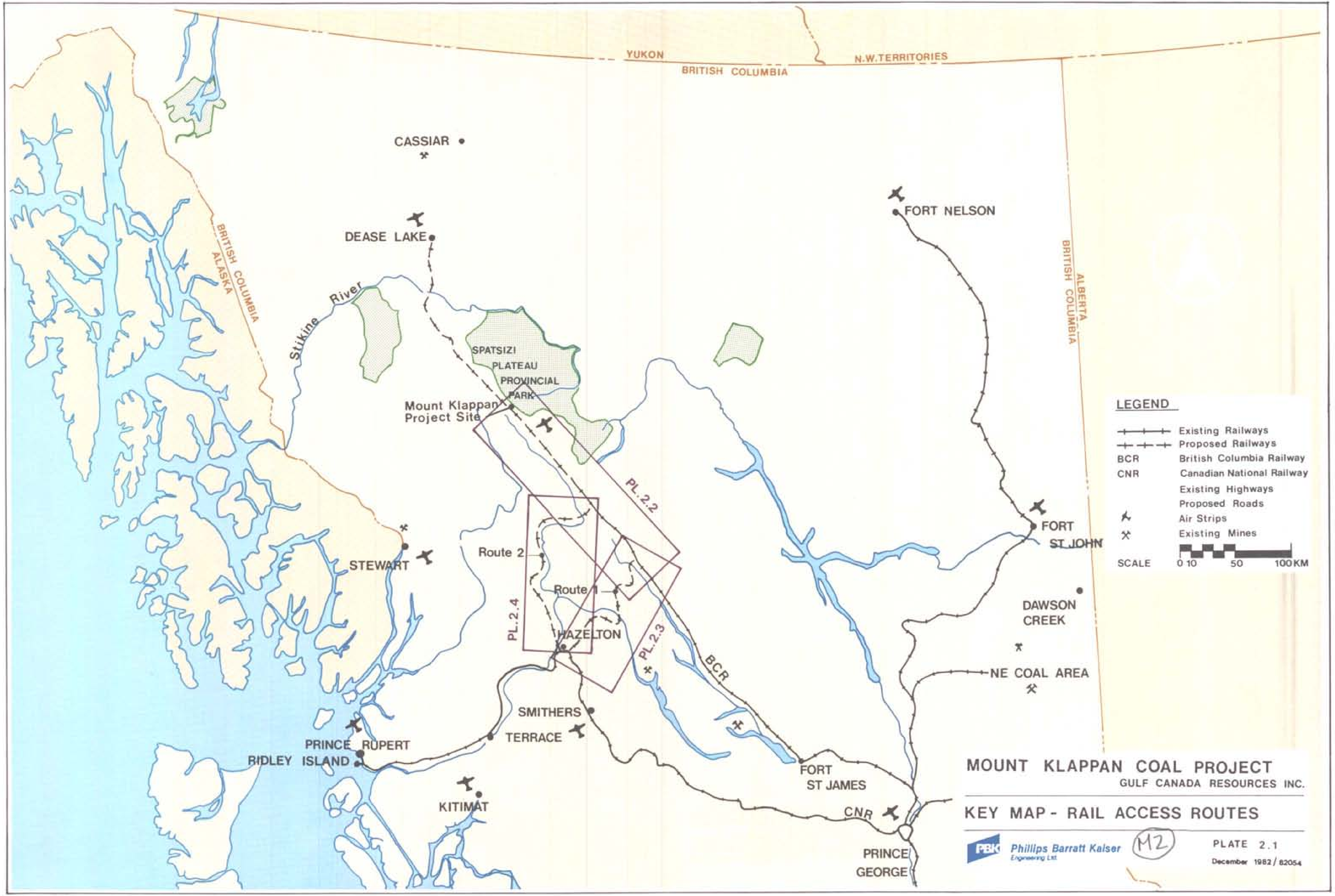
- Pump requirements. The large coal size would require single stage centrifugal pumps which are limited to case pressures lower than desirable for efficient pump station sizing and location. When combined with the high head losses noted above, the result is an inordinate number of intermediate pump stations, each of high horsepower. (A consequence of this aspect is the severe attrition of coal size as a result of multiple passes through these pumps.)

- Abrasion. Wear resulting from the high flow velocities in "brute force" systems can be accommodated by installation of abrasion-resistant pipe and/or lining, or by thick-wall standard steel pipe in which the steel is sacrificed over the project life. In shorter systems, particularly those applications where the pipe can be installed above ground, the pipe may be more easily replaced. In the above ground case, it may be rotated four to six times, prolonging replacement. For the Mount Klappan-Stewart project, environmental and weather conditions would dictate a buried pipeline system, probably even extra depth in order to get below the frost line. It is doubtful that either thick wall pipe, specially treated pipe, or abrasion resistant liners would perform over a project life of twenty years without replacement.

- Restart capability. Any slurry pipeline system must be capable of restart following shutdown, planned or otherwise, while charged with slurry. This is one of the primary reasons for the relatively fine particle size requirement for long distance, large volume slurry pipeline systems. For short "brute force" systems, restart may be accomplished by temporary pumping at higher than normal velocities (provided the system is so designed), and any blockage which may occur can quite easily be located and overcome. For a relatively long pipeline system, in a remote area, this is not the case.

There are a number of coal slurry pipelines handling fine coal in operation at the present time and the technology has been developed. Construction and operation of a pipeline handling fine coal in this area should not present a problem.

The pipeline option should be investigated when the coal specifications are known and the specific size requirements can be determined.



YUKON
N.W.TERRITORIES
BRITISH COLUMBIA
BRITISH COLUMBIA
ALASKA
BRITISH COLUMBIA
ALBERTA
CASSIAR
DEASE LAKE
FORT NELSON
Stikine River
SPATSIZI PLATEAU PROVINCIAL PARK
Mount Klappan Project Site
PL. 2.2
PL. 2.3
PL. 2.4
Route 2
Route 1
STEWART
HAZELTON
BCR
FORT ST JOHN
DAWSON CREEK
NE COAL AREA
SMITHERS
TERRACE
PRINCE RUPERT
RIDLEY ISLAND
KITIMAT
FORT ST JAMES
CNR
PRINCE GEORGE
LEGEND
Existing Railways
Proposed Railways
BCR British Columbia Railway
CNR Canadian National Railway
Existing Highways
Proposed Roads
Air Strips
Existing Mines
SCALE 0 10 50 100KM
MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.
KEY MAP - RAIL ACCESS ROUTES
PBK Phillips Barratt Kaiser Engineering Ltd.
M2
PLATE 2.1
December 1982 / 82054

Point	Distance in km
D - H	80
H - J	52
J - K	85
Total	217

MOUNT KLAPPAN COAL PROJECT

GULF CANADA RESOURCES INC.

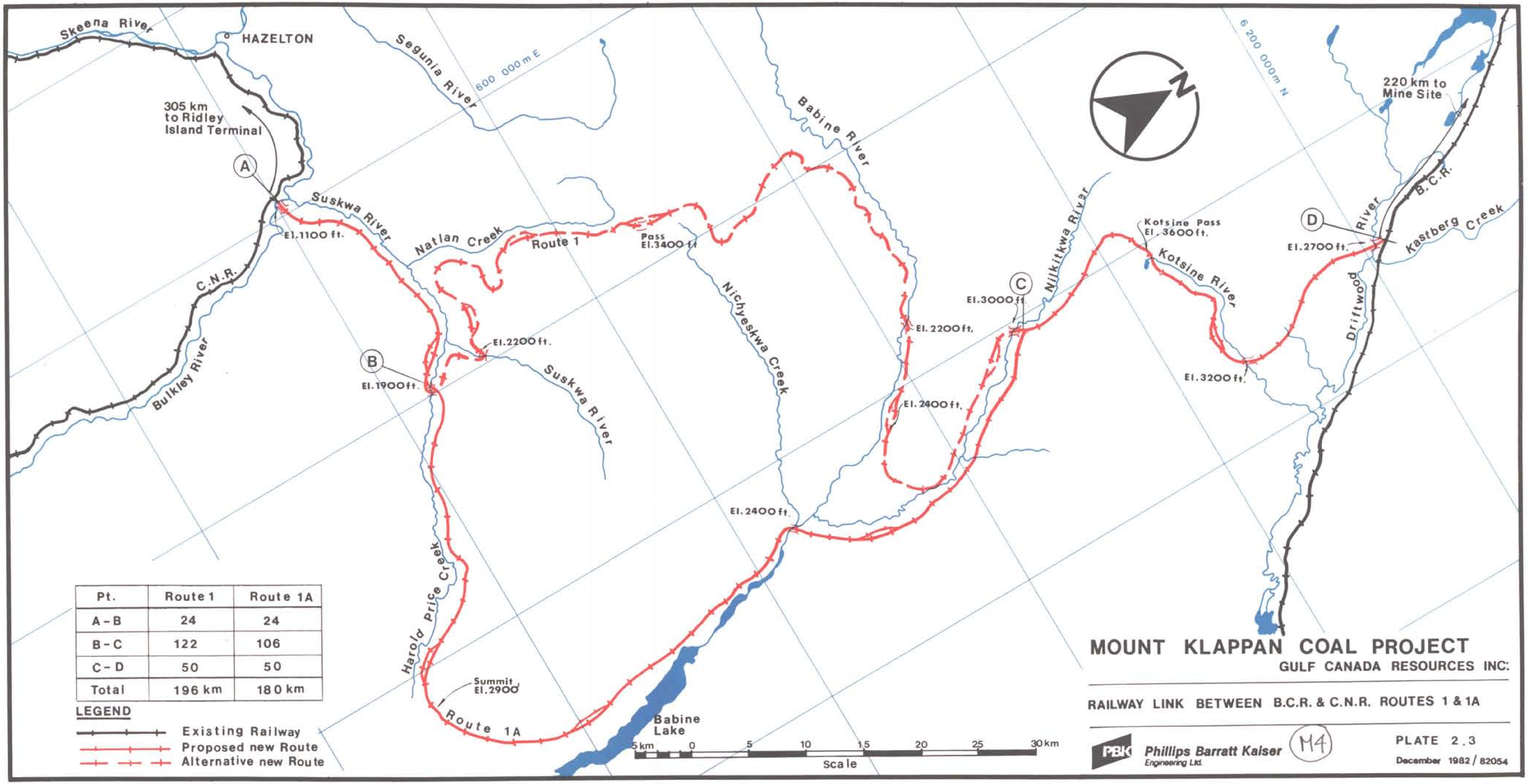
PROPOSED CONTINUATION OF B.C. RAILWAY

PBK Phillips Barratt Kaiser Engineering Ltd.

M3

PLATE 2.2

December 1982 / 82054



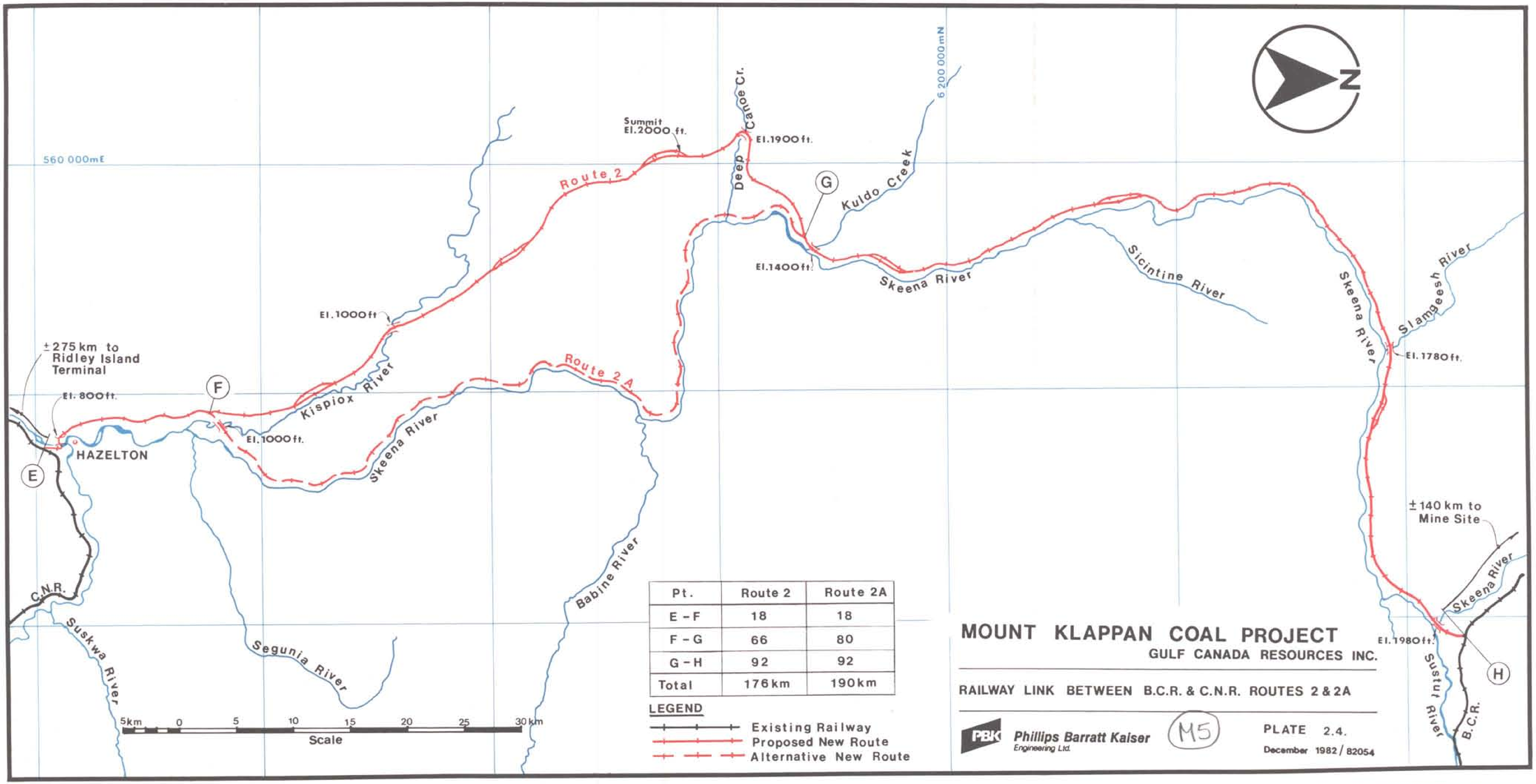
Pt.	Route 1	Route 1A
A - B	24	24
B - C	122	106
C - D	50	50
Total	196 km	180 km

MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.

RAILWAY LINK BETWEEN B.C.R. & C.N.R. ROUTES 1 & 1A

Phillips Barratt Kaiser Engineering Ltd. (M4)

PLATE 2.3
December 1982 / 82054



Pt.	Route 2	Route 2A
E - F	18	18
F - G	66	80
G - H	92	92
Total	176 km	190 km

LEGEND

- Existing Railway
- Proposed New Route
- Alternative New Route

MOUNT KLAPPAN COAL PROJECT

GULF CANADA RESOURCES INC.

RAILWAY LINK BETWEEN B.C.R. & C.N.R. ROUTES 2 & 2A

PBK Phillips Barratt Kaiser Engineering Ltd.

M5

PLATE 2.4.

December 1982 / 82054

PART 3

ROAD ACCESS

PART 3 - ROAD ACCESS

CONTENTS

3.1 INTRODUCTION

An investigation was made to determine the feasibility of building a road link between the existing Stewart-Cassiar Highway and the Mount Klappan property. Two routes were studied, plans and profiles were prepared, and capital costs were estimated. Plate 3.1

Due to the shorter construction length (146 km) and the more direct routing to access the property, Route #1 is the preferred long term road access.

In addition, the cost of up-grading the British Columbia Rilway roadbed as a temporary access road north from the property for project construction purposes was estimated. Plate 3.2.

3.2 PERMANENT ROAD ACCESS

321 ROUTE 1

This road starts at the Stewart-Cassiar Highway # 37 near the confluence of Taft Creek and the Bell Irving River and covers a distance of 146 km to the property. Three bridges will be required, two are 70 metres long and one is somewhat shorter. See Plate 3.3.

322 ROUTE 2

This road leaves the existing Stewart-Cassiar Highway at the junction of Tintina Creek and Meziadin Lake and covers a distance of 226 km to the property. Six bridges are required, most of which are approximately 100 metres long. See Plate 3.4.

323 PERMANENT ROAD DESIGN CRITERIA

The roadway is designed as a Rural Arterial Road for an average running speed of 60 to 90 km/h in accordance with the requirements of the Roads and Transportation Association of Canada.

The typical section requirements based on the provisions of the B.C. Ministry of Transportation & Highways are as follows:

- pavement width 7.3 m (24 ft.);
- pavement thickness 76 mm (3") placed in two lifts;
- shoulder width 3.0 m (10 ft.);
- top crushed granular base thickness 150 mm (6").

- bottom granular base thickness 300 mm (12");

- profile grade width 14.6 m (48 ft.);

- side slopes - in accordance with the provisions of the B.C. Ministry of Transportation & Highways;

- clearing and grubbing width along the right of way - 30 metres minimum. Additional allowance for cut and fill areas.

3.3 TEMPORARY ACCESS ROAD

331 ROUTE AND REQUIREMENTS

Preliminary road access to the site will be via the existing Stewart-Cassiar Highway to the Ealue Lake area. See Plate 3.2. At this point, a secondary existing road branches off the highway and heads in the northeast direction until it reaches the west bank of the Klappan River, about 15 km south of where it flows into the Stikine River. Part of the existing timber pile and log deck bridge across the Klappan River still remains, but a significant portion will have to be rebuilt to allow road access to the existing subgrade of the BCR line on the east bank of the Klappan River (BCR mileage marker 276 approximately).

On the east bank of the Klappan River, the road turns southward and uses the existing subgrade of the BCR line for the connection to the Mount Klappan site (BCR mileage marker 210).

Along this 90 km long railway subgrade, the following work would have to be carried out to provide the preliminary road access to the Mount Klappan site.

- remove sidehill slide material from the subgrade between Eaglenest and McEwan Creeks.

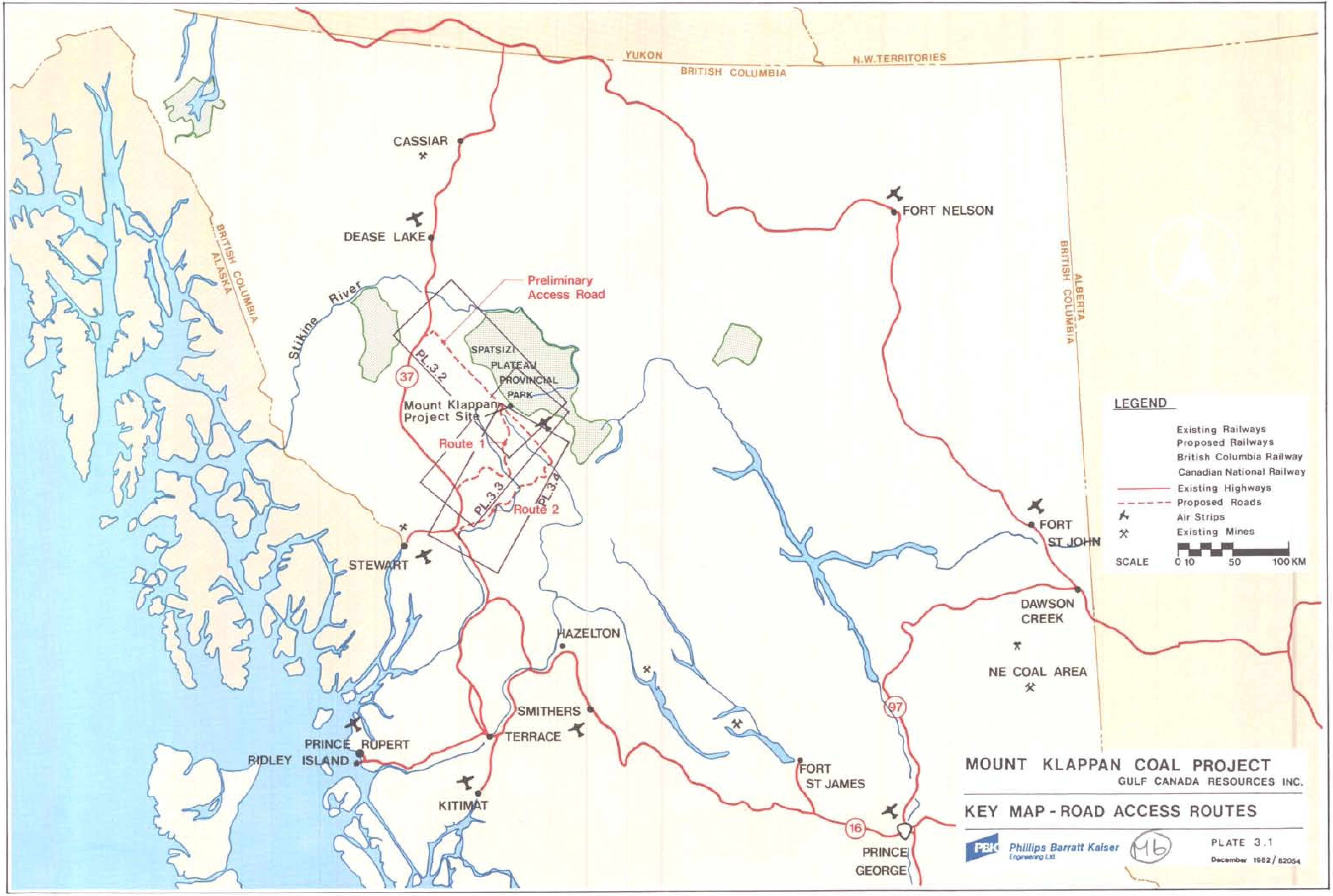
- place temporary superstructure and deck over the existing piers and abutments of the bridges over Eaglenest and McEwan Creeks.

- place granular surfacing over the subgrade.

Insert

Maps 6→9

Here



MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.

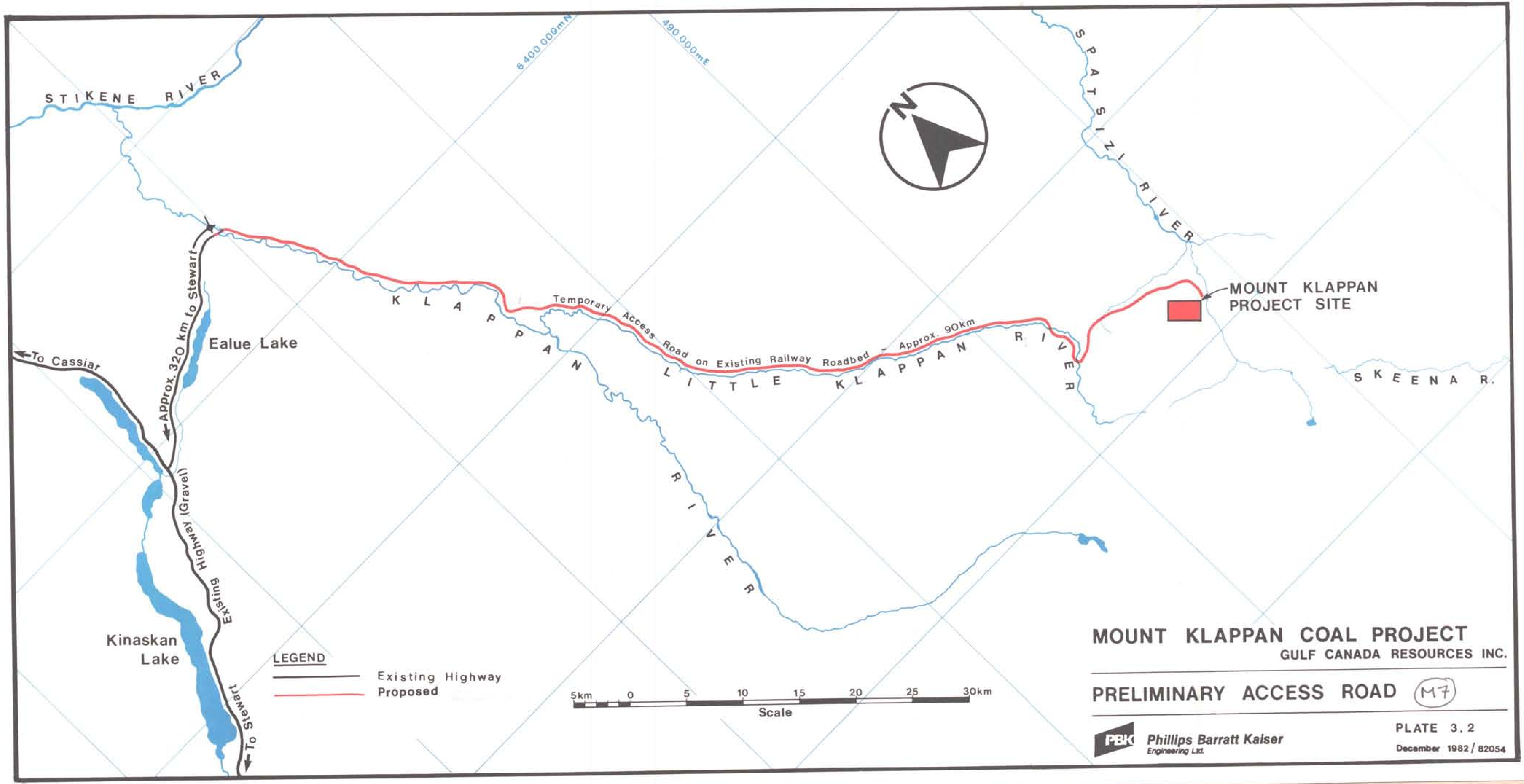
KEY MAP - ROAD ACCESS ROUTES

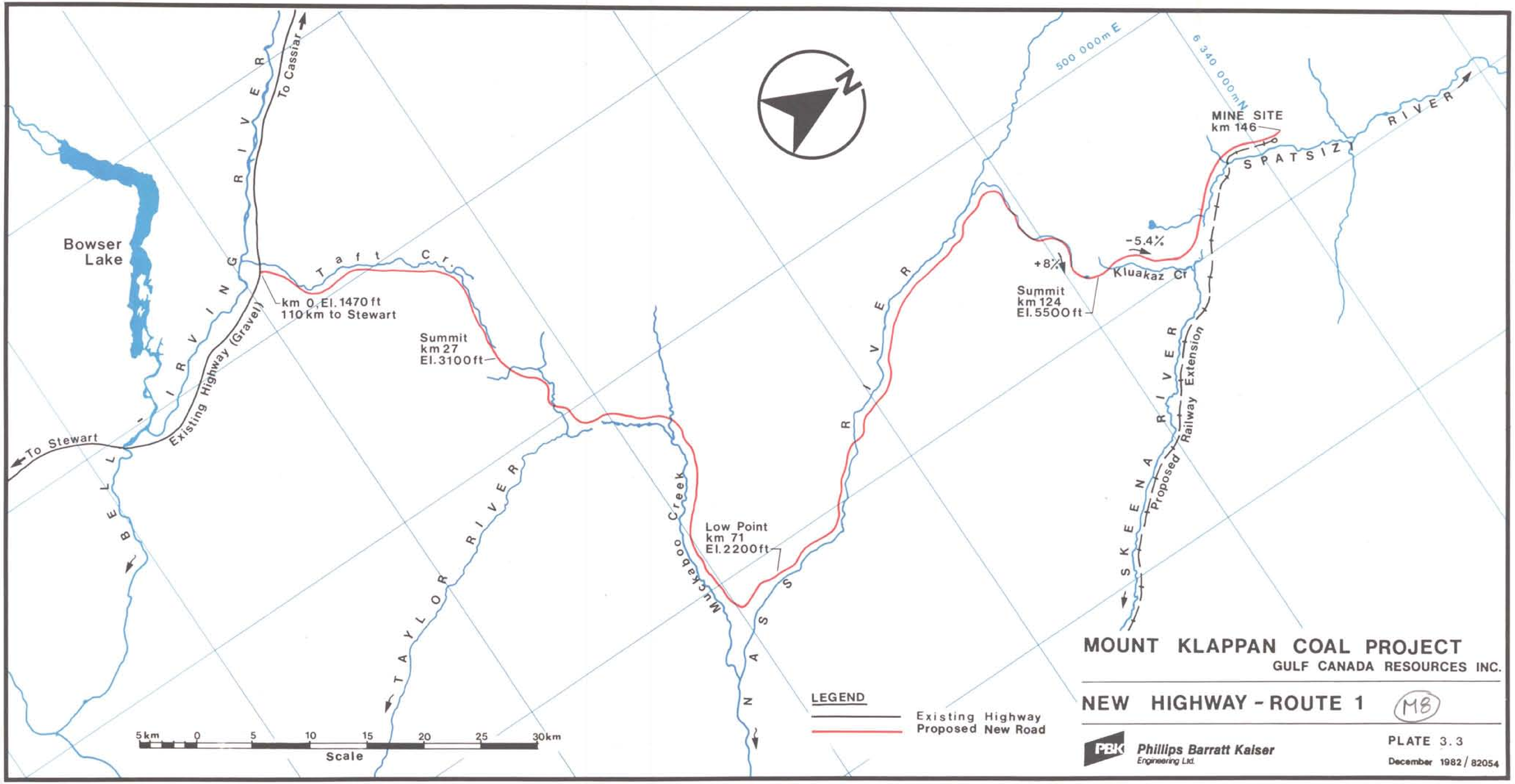
PBK Phillips Barratt Kaiser Engineering Ltd.

M6

PLATE 3.1

December 1982 / 82054


STIKENE RIVER
6 400 000mN
490 000mE
SPATSIZI RIVER
KLAPPAN RIVER
Temporary Access Road on Existing Railway Roadbed - Approx. 90km
LITTLE KLAPPAN RIVER
MOUNT KLAPPAN PROJECT SITE
SKEENA R.
To Cassiar
Approx. 320 km to Stewart
Ealue Lake
Existing Highway (Gravel)
Kinaskan Lake
To Stewart
LEGEND
Existing Highway
Proposed
5km 0 5 10 15 20 25 30km
Scale
MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.
PRELIMINARY ACCESS ROAD
M7
PBK Phillips Barratt Kaiser Engineering Ltd.
PLATE 3.2
December 1982 / 82054



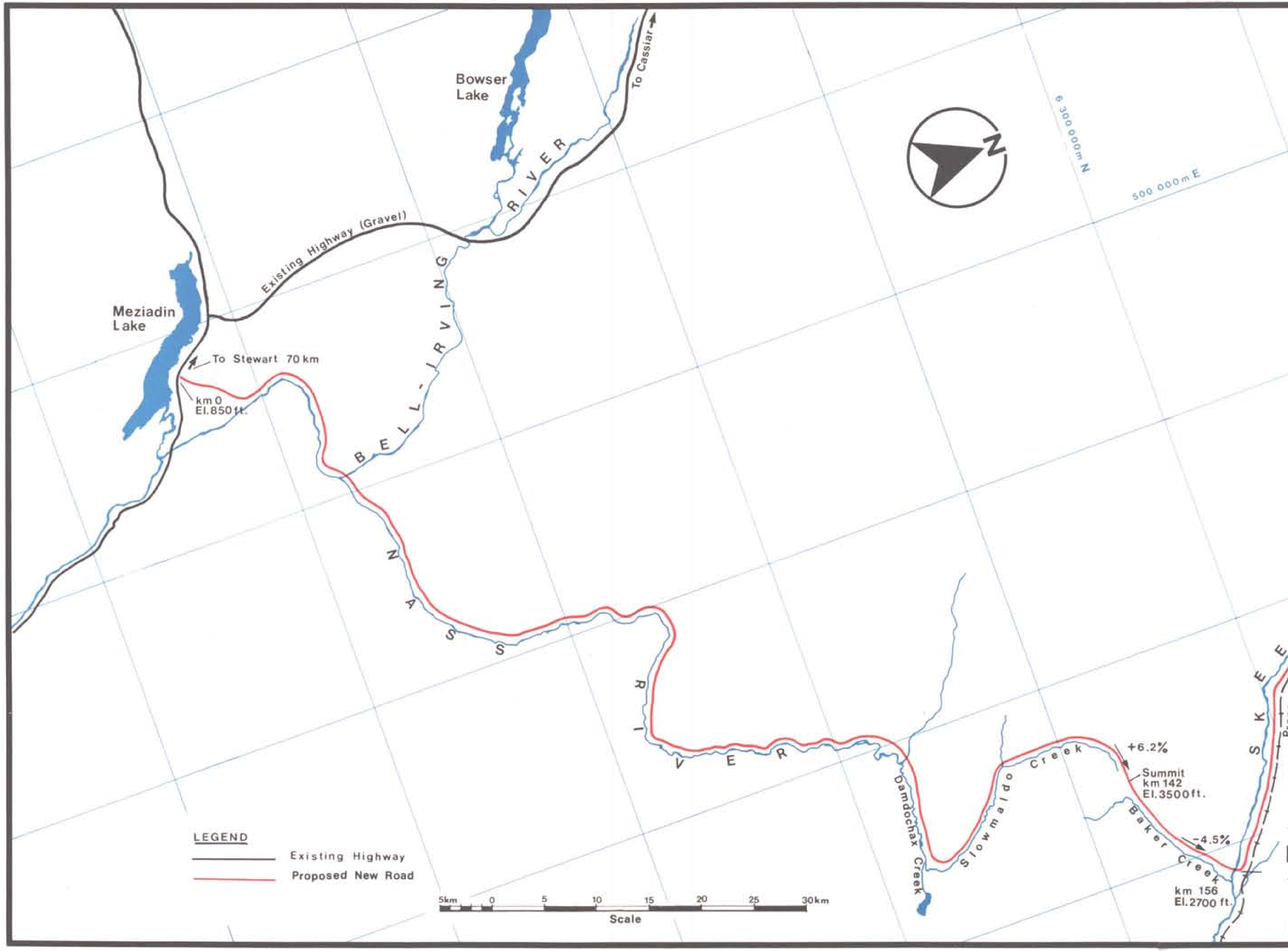
MOUNT KLAPPAN COAL PROJECT
GULF CANADA RESOURCES INC.

NEW HIGHWAY - ROUTE 1 (M8)

Phillips Barratt Kaiser Engineering Ltd.

PLATE 3.3

December 1982 / 82054



MOUNT KLAPPAN COAL PROJECT

GULF CANADA RESOURCES INC.

NEW HIGHWAY - ROUTE 2

M9

PBK Phillips Barratt Kaiser Engineering Ltd.

PLATE 3.4

December 1982 / 82054

PART 4

SERVICES

PART 4 - SERVICES

CONTENTS

4.1 INTRODUCTION

Different basic provisions were made for the living accommodations for the mine employees. The one million tonne per year case is a fly-in operation whereas the five million tonne case requires a new townsite to be built close to the minesite. These are discussed in this part, as are the water and electrical power considerations.

4.2 ACCOMMODATIONS - 1 Mtpy CASE

For this fly-in operation the total number of on-site personnel (at any one time) estimated for the 1 million tonne operation in a typical year is 155. These employees will be air-lifted to the site from Smithers, B. C. on a routine scheduled basis for a seven day stay and will live in camp accommodations while at the mine. This camp will be built as a permanent installation and will include sleeping quarters, kitchen and dining facilities, and recreational areas for off-duty hours.

In addition, there will be a support staff of 24 people in Smithers performing functions which do not require full-time coverage at the mine.

Total personnel, in a typical year, will be 335.

4.3 ACCOMMODATIONS - 5 Mtpy CASE

The total number of personnel estimated for the 5 million tonne operation in a typical year is 1 100. It is assumed that these employees will reside in a public townsite to be constructed near the mine property.

A cost allowance per employee has been included in the capital cost estimate to be used to assist in the townsite development. An allowance has been made for a mine-site camp for the first 1½ years of mine operation to allow time for the townsite to be constructed.

4.4 - ELECTRICAL POWER

The supply of electrical power for this assessment is based on the premise of tying into a 138 kV supply near the property at current B.C. Hydro charges for power consumed.

4.5 - WATER

An investigation into the availability of a source of fresh water has not been made, and the assumption has been made that sufficient water can be obtained from the numerous fresh water sources available in the area.

PART 5

SOCIO-ECONOMIC IMPACT

PART 5 - SOCIO-ECONOMIC IMPACT

CONTENTS

5.1 INTRODUCTION

511 PURPOSE

The Mount Klappan coal licences are located in the Bowser Basin coal bearing area in northwestern British Columbia. The owner of the licences, Gulf Canada Resources Inc., is desirous of conducting a long-term exploration and development programme with the objective of achieving coal production from the property in the late 1980's.

Preliminary indications are that the property has the potential to produce up to 5.0 million tonnes per year (Mtpy) of product coal for a minimum of twenty years. Further exploration is expected to develop substantial additional reserves.

The proponent recognizes that a development of this magnitude will result in significant socio-economic impacts in the northwest region of British Columbia and in adjoining areas. Accordingly, Gulf Canada Resources Inc., in conjunction with its consultants, Price Waterhouse Associates, has prepared this preliminary socio-economic assessment of the proposed mine.

This assessment exceeds the formal preliminary prospectus requirements of the "Guidelines for Coal Development" of the Province of British Columbia. Its purpose is to address the major socio-economic issues related to the proponent's intentions and to provide an indication of future planning needs at provincial and local levels at the earliest possible time.

512 IMPACT AREA

The study area in relation to the location of the Mount Klappan project is shown on Plate 5.1. The impact area is comprised of the following areas of British Columbia:

Skeena-Stikine Region:

- Stewart Area
- Hazelton Area
- Prince Rupert Area
- District of Terrace (part of the Kitimat - Terrace Area)

Cariboo - Fort George Region:

- Smithers - Houston Area

The impacts of the mine development are likely to be most evident in the central and southern parts of the Skeena-Stikine Region of northwestern British Columbia. However, because of the transportation routes discussed in this report and the likelihood that the town of Smithers may serve as a base for significant development activity, the impact area will include the Smithers - Houston area of the Cariboo - Fort George Region.

513 STUDY APPROACH

The major components of this assessment are as follows:

- a description of the Mount Klappan project covering two possible production profiles, each of which will create certain unique impacts;

- a discussion of the socio-economic conditions presently existing in the study area and their probable direction in the absence of the Mount Klappan project;

- an assessment of the socio-economic impacts expected to arise as a result of each of the production profiles; and,

- areas where further studies are required.

While many assumptions are made with regard to the mine and infrastructure components for the purpose of this study, it is emphasized that almost all these components, except for the actual location of the mine, are subject to change or confirmation as planning is undertaken. Accordingly, this preliminary assessment can provide only general indications of the probable impacts of the development.

514 GENERAL ASSUMPTIONS

The following general assumptions are made throughout the analysis:

- product coal will be produced at either a rate of 1.0 Mtpy or 5.0 Mtpy;

- in the 1.0 Mtpy scenario employees will be flown in and out of the property. No new townsite will be required. Smithers has been selected as the base of operation for this case;

- for the 5.0 Mtpy production level, employees will live near the mine in a new townsite;

- all product coal will be exported;
- product coal will be transported to tidewater by rail in both cases for ship loading at the new coal port at Ridley Island, near Prince Rupert;
- rail access will be provided by the British Columbia Railway from a northward extension of the existing Dease Lake line, which presently extends to within 85 km of the property;
- in the 5.0 Mtpy case, the existing rail route east to Prince George (BCR) and west again to Prince Rupert (CNR) will be shortened by the construction of 176 km of new railway linking existing BCR trackage with the CNR at Hazelton. (This link will reduce the total rail hauling distance from the mine to tidewater by 800 km.);
- power requirements will be met by B.C. Hydro. It is assumed that a new power transmission line would be constructed to serve developments in the region before the mine commences production, or a thermal power plant will be developed on site; and
- Permanent road access will not be required for the 1.0 Mtpy production scenario. For the new townsite alternative, road access will be provided to the Stewart-Dease Lake Highway at Meziadin Lake.

5.2 THE MOUNT KLAPPAN PROJECT

521 LOCATION AND ACCESS

The Mount Klappan coal licences are located in the Bowser Basin coal area in the Skeena-Stikine region of northwestern British Columbia. The coalfield is approximately 960 km north of the city of Vancouver and 530 km northwest of Prince George.

The Canadian National Railway links Prince George and Prince Rupert while a British Columbia Railway line has been constructed from Prince George to just south of the coalfield. Beyond this point, the railbed has been prepared to the Mount Klappan property and beyond. At present, the southern portion of the railway is in use but further construction work on the northern portion of the line has been deferred indefinitely.

Access to the coalfield is currently by fixed wing aircraft or helicopter. Road access to the Mount Klappan property, from the Hazelton - Dease Lake all-weather highway via the unfinished northern portion of the British Columbia Railway railbed would be possible with the construction of a bridge over the Klappan River and the laying of two bridge decks across streams crossing the railbed portion.

522 RESOURCE POTENTIAL, QUALITY AND MARKETING

Although much further exploration work remains to be done, preliminary indications suggest that 620 million tonnes of inferred coal are available in an area of less than ten percent of the total property area. These preliminary geological assessments indicate that the property will support an annual production level of 5.0 Mtpy over a period of twenty years.

The results of coal quality studies indicate that product coal is of anthracite rank and will therefore command a relatively higher price than most other British Columbia coal types. Of particular significance, anthracite coal has the potential to satisfy different product markets from those presently served by the major coal producers in the northeast and the southeast. The Mount Klappan product thus provides an opportunity for British Columbia to develop new markets different from those served by the province's established coal producers.

The nature of the market for Mount Klappan coal has yet to be fully determined. The proponent continues to undertake market studies designed to assess product demand and identify potential markets for a variety of coal products. Some of these products may require an on-site beneficiation process and, thus, not only will they command a relatively higher price than raw coal, but they will also result in a higher level of value added in British Columbia.

523 PRODUCTION ALTERNATIVES

The annual production level for the property has not been determined. However, the two alternatives are as follows:

- a large scale, 5 Mtpy production level. This volume of production, with the relatively isolated location of the mine-site, will require the development of a new townsite adjacent to the property because the number of employees required and the distance from established communities will prohibit the option of commuting by road, rail or air to the mine site. The socio-economic impacts of this level of development would be significant.

- a smaller mine producing 1.0 Mtpy. This level of operation is considered small enough that employees can live in nearby established communities, fly to and from the mine site and be accommodated in a hostel in the immediate locality of the mine.

Both production alternatives will require rail access for shipping product coal to tidewater. However, engineering studies conducted on behalf of the proponent have assumed that no coal preparation plant will be required for the 1.0 Mtpy alternative and that surface plant operations will be limited to load-out and silo facilities.

524 TIMING OF DEVELOPMENT

Initial studies indicate that a four-year exploration and development programme will be required in the case of the smaller production alternative and a five-year programme for the larger option. Thus, a decision to proceed with construction cannot be made until 1986 at the earliest. Project timing is also subject to the identification and development of markets for the product, contract negotiations for sales, financing, technical and economic considerations and the availability of suitable infrastructure. The construction period is expected to be about two years for the 1.0 Mtpy alternative and up to three years for the larger option. Accordingly, the project would not be capable of shipping product coal until the late 1980's. The production period assumed for both cases is twenty years.

525 INFRASTRUCTURE REQUIREMENTS

The size and nature of the proposed operations indicate that significant investments in infrastructure will be required before the mine enters production.

For the 1 Mtpy case, the following will be required:

- rail access to the site from the northern limit of the existing BCR line from Prince George;

- power supply (alternative sources include the proposed Stikine hydro dam site, a purpose-built hydro generator, a diesel power plant or a thermal generator plant);

- extension of port facilities at Ridley Island; and,

- some development of residential and service facilities in nearby communities.

For the 5.0 Mtpy case, a townsite would be required near the mine to accommodate employees and their families. If the model established by the new town of Tumbler Ridge is followed, the townsite would be provided with a range of service facilities. These facilities would include housing, schools, health care services, community facilities and retail consumer services.

Due to the close location of Spatsizi Wilderness Provincial Park, the development of a townsite with relatively good access from the south and east would also offer the potential for a tourism centre immediately outside the park boundaries. The possibility exists for the development of local industries to serve tourism needs, in addition to those required by the mine and its employees.

In addition, the construction of a rail link connecting the BCR line to the CNR line near Hazelton would have the effect of cutting out Prince George and reducing the distance from the mine to tidewater at Prince Rupert very significantly. This could also have a positive effect on the viability of other resource developments in the Skeena-Stikine region.

526 SOCIO-ECONOMIC IMPACT POTENTIAL

Although certain provincial impacts will arise from the development, the areas most affected will be those close to the mine. However, the nearest settlement is Eddontenajon, some 100 km northwest of the mine site. The impact area extends southwards to the more heavily populated east-west corridor between Smithers and Prince Rupert. This area includes the communities of Stewart, Telegraph Creek, Hazelton and Terrace, as well as Smithers and Prince Rupert. All of these communities will be affected by the development, construction and operations of the mine and are included in the impact area defined in section 512.

Both levels of development considered in this assessment have the potential to affect the current socio-economic status of northwestern British Columbia to a significant degree. The 1.0 Mtpy production alternative would result in impacts spread over several existing communities but concentrated on Smithers, while the larger townsite option would produce significant additional impacts on the mine area with smaller impacts on the communities.

The following provides a general indication of the socio-economic impact potential for each production alternative.

	1.0 Mtpy	5.0 Mtpy
Direct Regional employment	Small positive effect	Large positive effect
Indirect Regional employment	Limited, spread over existing communities	Large, but focused mainly on new town area. Some effect on existing communities used as supply/service centres.
Regional income	Medium positive effect, caused by higher than average income levels.	Large positive effect.
Regional population	Limited, some dispersion over existing communities but concentrated in Smithers.	Large, restricted mainly to new town area. Some indirect effect on existing communities, particularly during construction.
Housing and services	Concentrated on Smithers where existing services might be strained to capacity.	Large impact created by new town development.
Community land & infrastructure	Limited.	New town required; substantial requirements for housing, services, community infrastructure, recreation, cultural, commercial.

	1.0 Mtpy	5.0 Mtpy
Regional infrastructure	Limited, some dispersion over existing communities but concentrated in Smithers.	Large, restricted mainly to new town area, Some indirect effect on existing communities, particularly during construction.

5.3 THE NORTHWEST REGION OF BRITISH COLUMBIA

531 OVERVIEW

The northwest region of British Columbia is the subject of a recent report published by the Province of British Columbia.[1] The specific region examined encompasses the Stikine and Kitimat-Stikine Census Divisions together with Sub-division A of the Skeena-Queen Charlotte Division. This region approximates the impact area of this assessment.

The Northwest Report notes that the northwest "remains one of the few regions of the province where significant opportunities for further development exist but the necessary infrastructure is largely absent". A thinly populated area lacking in developed industries, transportation facilities and services, the northwest (Skeena-Stikine) region as a whole contains 28% of the land area of the province but less than 3% of the population.

About two-thirds of the population is located in three settlements, Prince Rupert, Kitimat and Terrace, all of which are located toward the south. The northern portion of the region is characterized by expanses of undeveloped wilderness with small settlements occupied largely by native peoples. With the exception of the mining communities of Stewart and Cassiar, there are no existing settlements in the northern sector of the region whose population exceeds 1 000 persons.

The physical characteristics of the region have not been conducive to the development of modern transportation systems. Bordered on the west by the Coast Mountains and on the east by the Omineca Range and the Rocky Mountains, the area is generally mountainous

1 The Northwest Region - A British Columbia Regional Economic Study. Ministry of Industry and Small Business Development, May, 1982.

and relieved by prominent river valleys. The Stikine Plateau, an extensive tableland located in the north central part of the region, contains many peaks above 2 000 metres and is the site of the province's largest wilderness park, the Spatsizi Plateau Wilderness Provincial Park.

532 PRESENT SOCIO-ECONOMIC CONDITIONS

.1 Population and Workforce

The population of the northwest region as a whole in 1981 was some 63 000 individuals[1], of whom approximately 50 200[2] reside in the study area, as follows:

	1981 Population
Skeena - Stikine Region	
Stewart Area:	
Stewart	1 456
Sub-division A	952
Hazelton Area:	
Hazelton	393
New Hazelton	712
Sub-division B	1 967
District of Terrace	10 914
Prince Rupert Area:	
Prince Rupert	16 197
Port Edward	989
Sub-division A	263
Indian Reserves	7 041
	40 884
Cariboo - Fort George Region	
Smithers	4 570
Houston	3 921
Telkwa	840
	9 331
	50 215

1 The Northwest Region, op.cit.

2 Statistics Canada, 1981

As shown above, some 40 000 persons, or 80% of the total impact area population, are concentrated in the southern sector of the area, south of Hazelton.

Native peoples comprise a significant proportion of the regional population. While 1981 census data indicates there are slightly over 7 000 individuals living on reserves in the area, the Northwest Report suggests the total native population (status and non-status Indians) is probably double this number.

The Canada Employment and Immigration Commission estimates that some 69.6% of the study area's population is of working age, while 70.7% of the working age population participates in the labour force. This would indicate a working age population of 35 000 in the study area and a labour force of some 25 000 persons. As with the total population, the labour force is heavily concentrated towards the south of the study area.

.2 Present Industrial Activity

The current economy of the area is highly dependent on the forest industry. Coastal communities in the area also derive considerable economic benefits from the commercial fishing industry. Mining and mineral exploration provide much of the economic base for the local Stewart, Smithers, and Stikine areas.

Much of the present economic activity of the area is concentrated in the southern portion of the region. In the Prince Rupert area, fishing and fish processing provided approximately 1 600 jobs in 1976, while forestry operations employed an additional 755. A major coal and grain terminal currently under construction is expected to employ 300 to 400 individuals over the construction period, 1982 through 1984, and permanent employment of over 100 people.

The Terrace - Hazelton economy is highly forestry-oriented, serving as the northern division headquarters for B.C. Timber and its related sawmill operations in Terrace and Kitwanga.

Mining, mineral exploration and forestry provide the base for the Smithers economy. The Smithers area, with its history of mining and mineral exploration, has become an important regional supply centre for exploration activities in the region.

There are six mines in the southern area; Bell Copper and Granisle at Granisle, Granduc at Stewart; Equity Silver near Houston; Amax molybdenum mine on Alice Arm; and the relatively small Dupont Baker mine northeast of Smithers. At normal operating levels, these mines together employ over 1 800 people, as follows:

Producing Mines	Employees
Bell	350
Equity Silver	275
Granduc	420
Granisle	350
Amax	450
Baker	45
	1 890

However, three of these mines have an indicated life span of less than ten years.[1] As of December 1982, all of these mines had either reduced or suspended operations pending improved market conditions. At present, no major additional mine projects are in an advanced state of development.

A recent report by the Ministry of Energy, Mines and Petroleum Resources[2] indicates that "exploration activity remains brisk in the Toodoggone area north of Smithers with approximately 3 500 mineral claim units to date. Many high grade gold and silver deposits are indicated and there is good potential for more operating mines in addition to the Dupont Baker mine, which opened in 1981."

.3 Income Levels

Individual Tax Return data for 1979, the most recent year for which data is available, indicates that the average income of individuals in the northwest region is as follows:

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1 Northwest Region, op cit., p. 48.

2 Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, B.C. Mineral Quarterly, Second Quarter 1981, p.2.

	$
Northwestern Region average	13 880
Community components:	
Terrace	14 025
Hazelton	9 523
Stewart	13 189
Sub-division A	9 098
Sub-divison B	9 454
Sub-division C	10 904
Prince Rupert	13 980
Port Edward	13 049
Sub-division A	9 106

By comparison, average British Columbia income in 1979 was $13 277.

The current recession has severely affected both the forestry and mining industries in the area, with the result that a number of forestry and mining operations have closed down pending a recovery. Average income in 1982, after adjusting for inflation and closures, is probably less than the levels indicated above.

533 EXISTING INFRASTRUCTURE

As indicated in the preceding section, except for the southern portion, the study area is geographically disperse, with few and relatively isolated communities. The Northwest Report cites the lack of economic diversity as a major constraint to the development of infrastructure elements in the region. This situation is even more acute in the northern portion of the study area where virtually no infrastructure development has taken place over recent years.

.1 Roads

There are two principal highways in the area:

- Highway 16 is a two-lane paved roadway extending from Prince Rupert to Hazelton and southeast through Smithers and Houston to Prince George. Between Prince Rupert and Terrace (approximately 150 km) this route has recently been upgraded at a reported cost of $40 million; and,

- Highway 37 extends north from Kitwanga/Hazelton approximately 450 km to Dease Lake, Cassiar and further north, with branches to Stewart and Telegraph Creek. It is a two-lane, variable-width roadway with numerous one-lane bridges. Twenty-five percent is paved or sealed, with the balance gravelled. The Northwest Report suggests an investment of approximately $350 million would be required to improve all of Highway 37 and 37A to a full standard two-lane route.

In addition, various roads have been built and are operated by private companies in the area, with some sections available for public use.

No roads access the Mount Klappan property at the present time, with the exception of the BCR constructed right-of-way south from Dease Lake and north from Fort St. James.

.2 Railway

The study area is currently served by the Canadian Natioal Railway line running east-west through Prince George, Burns Lake, Smithers and Terrace to Prince Rupert. This line is currently being upgraded to carry grain and coal shipments from the northeast to the new Prince Rupert terminal facilities, with coal shipments scheduled to commence in 1984. Additional improvements are projected to handle increased traffic loads to 1990.

The Dease Lake Extension of the BCR currently operates as far as Driftwood (approximately 100 km northeast of Hazelton). An additional 150 km of track have been completed to Chipmunk (approximately 85 km southeast of the proposed mine at Mount Klappan), but has not been put into service. The right-of-way extends to Dease Lake and sub-grade construction has been completed over much of this distance. This sub-grade passes through the Mount Klappan property.

The Northwest Report indicates that a connection has been proposed from the BCR line at Chipmunk to the CNR line at Terrace or Hazelton.

BCR is deferring additional capital expenditures on non-operating portions of this line pending a decision on future operations. The extent to which construction proceeds will ultimately depend on the nature and extent of future development of the region, as well as the future of existing logging and sawmilling activities currently served by the Dease Lake Extension. The McKenzie Royal Commission has estimated that the cost of completion of this line from Chipmunk to Dease Lake is in the order of $160 million (1977 dollars).

.3 Air

There are major airports at Prince Rupert, Terrace and Smithers. These are maintained by Transport Canada and offer a full range of navigational aids capable of handling aircraft up to the Boeing 737 and 727 sizes.

While the runway systems at these airports are described as generally adequate, the Northwest Report indicates that some improvements in terminal buildings, surface access routes to the airports and additional navigational aids may be required to service future development.

There are additional smaller public airstrips at Stewart and Iskut, and unlicensed airstrips include Cassiar, Dease Lake and the junction of Highways 37 and 37A to Stewart.

CP Air and Pacific Western provide scheduled service to the major aiports, while Trans-Provincial provides limited scheduled service to Stewart and Dease Lake. Numerous chartered aircraft and helicopter services are also available in the area.

.4 Port Facilities

There are three major ports servicing the area.

- Prince Rupert is a National Harbours Board port facility. Major development of this port to handle shipments of 12 million tonnes of product coal annually is currently underway at a cost of some $230 million. Development of a 1.5 million tonne $300 million grain terminal is also in process and a proposed petrochemical port is also projected.

- Stewart serves as an export port for asbestos fibre from Cassiar, and Esso Resources has an ore concentrate wharf for exports from the Granduc Mine. A request by Stewart for ferry facilities to link it with Prince Rupert is under consideration.

- Kitimat, while outside the study area, provides deepwater port facilities to Alcan, Eurocan and other industries in the region and has the potential to accommodate future development, if necessary.

.5 Electricity

Electric power is provided to the impact area as follows:

- the B.C. Hydro Grid provides power to Terrace, Prince Rupert and Kitimat from the Skeena Substation near Terrace. Additional power is purchased from Alcan's Kemano Generating Station.

- remote diesel generation plants, operated by B.C. Hydro, provide power to Stewart, Atlin, Dease Lake, Eddontenajon (Iskut) and Telegraph Creek. Generally, only residential and small commercial requirements are met by these plants. Presently, the cost of diesel power generation, while relatively high, is less than the cost of transmission lines to connect these remote communities to the main grid system.

- additional diesel generation plants are operated by private individuals and companies throughout the region.

The Northwest Report suggests that there are a number of options currently under consideration for future power supply in the region. These include a possible extension of the existing B.C. Hydro grid, the development of up to four hydro generating stations in the Stikine-Iskut area, the purchase of additional power from a possible expansion of Alcan's Kemano generating station, or the development of additional diesel and gas turbine generating stations.

The Stikine-Iskut development, consisting of four sites on the Stikine and Iskut Rivers (for a total capacity of 2 800 MW and about 13 billion kWh/year) and two 500 kV transmission lines running south through Hazelton east of Highway 37, could be put forward for government approval in 1984, with possible completion in 1993. A portion of this development, at More Creek, could theoretically be put in service as early as 1989.

.6 Industry

The current industrial base in the region is quite limited. As discussed previously, most industry in the region is concentrated in the southern portion with only one large development, Cassiar, to the north. As a result, supply routes and related infrastructure are not well developed.

534 GENERAL DEVELOPMENT POTENTIAL

A major portion of the Northwest Report deals with the economic growth potential of the region over the next ten years. By sector, the results of this analysis are as follows:

Forests

The industry is anticipated to remain relatively stable (ignoring market factors) over the next ten years, due to a lack of additional readily-accessible merchantable timber or high quality wood fibre.

Minerals

The area is believed to contain "immense untapped mineral potential", but is "relatively inaccessible and lacks virtually all the infrastructure that is necessary for sustained development". Assuming market improvement by the late 1980's, the development of support facilities and the resolution of various environmental constraints, the Northwest Report states that the 1990's could be a decade of dramatic mineral development in the northwest.

Petroleum/Petrochemicals

With no known indigenous oil and gas reserves in the northwest, the only potentially exploitable reserves are offshore deposits. A moratorium has been placed on exploration of these reserves. However, should this be lifted, it is believed that significant development could occur by the late 1980's.

Several other petroleum-related developments are projected over the next ten years. These include a possible gas liquification plant at Port Simpson, Kitimat or Prince Rupert. This development may also involve substantial pipeline construction and additional hydro/power transmission development.

An ammonia-urea plant has also been proposed at Kitimat by Ocelot Industries. While outside the direct study area, this project could draw on resources within the study area. Approximately 937 man years of employment are projected during the construction phase of this project, and 125 workers during the operating phase.

A major petrochemical facility has also been proposed for British Columbia. While the location of this plant has not been determined, if it were located in or adjacent to the northwest region (at Prince George), some impact on the port at Prince Rupert and the northwest as a whole may be anticipated.

535 DEVELOPMENT CONSTRAINTS

The Northwest Region Report highlights a number of constraints on regional development. Some of these are viewed as "domestic" in that they may be alleviated through changes or adjustments in domestic governmental policy, while others are the result of external factors. On a broad geographic basis, they include:

.1 Southern Sector of the Impact Area (south of Hazelton)

Municipal Infrastructure:

The capacity of Prince Rupert and Terrace to absorb any significant additional growth in terms of land availability, suitability, service requirements and cost has been questioned. As well, competition between local governments for tax revenues and the high development-related costs incurred by individual municipalities have been cited as constraints.

Transportation:

Due to improvements currently under development, transportation in the southern part of the study area is not believed to be a constraining factor in future development through the late 1990's.

Power:

There appear to be no shortages of power within the southern portion of the region and lack of power is unlikely to be a constraint to growth. Should shortages occur, there appears to be a number of alternatives available to service this region.

Social and Labour Issues:

Few, if any, significant restraints to development of the southern sector are anticipated from these issues. It is possible that some labour shortages may develop in the mid to late 1980's in this area, but these will be a function of general economic conditions at that time.

.2 Northern Sector of the Impact Area (north of Hazelton)

Power Supply:

A lack of large volume low-cost electric power is cited as a major constraint on development of this area. Given the capital requirements involved in providing power to the area, a joint industry-government commitment to long-term development would apear to be required. The long lead-time required for provision of low cost power places a high priority on planning for this aspect of any future development.

Transportation:

The lack of either adequate rail or road transportation is another key constraint on the development of the northern area. Highway 37 would require substantial upgrading for it to be used for additional heavy truck traffic and there is no road access from Highway 37 to the proposed development area. Access via Ealue Lake can be developed by the installation of one bridge over the Klappan River and two bridge decks across streams crossing the B.C. Railway road bed.

The Dease Lake extension of the B.C. Railway was never completed and, for the Mount Klappan project, 85 km of additional track and some upgrading of existing track are required to service the property. As well, the current BCR/CNR route would involve a circuitous routing to Prince Rupert via Prince George, while a shorter route would require the construction of a 176 km rail line from a point approximately 52 km south of the property (Chipmunk) to Hazelton or Terrace.

Workforce Residency:

Any requirement for a large resident workforce in the northern area will necessitate a comprehensive review of the available alternatives. The lack of any existing municipal infrastructure in this area dictates either the incorporation and expansion of the small existing settlements or the development of significant new communities. Either option will be constrained by a number of factors, including the timing, size and relative location of future developments, anticipated lifespan of proposed projects, land availability, municipal finances, and social and environmental considerations.

536 PROVINCIAL GOVERNMENT ATTITUDE TO DEVELOPMENT

The current attitude of the provincial government toward development in the northwestern region is summarized in the Cabinet Committee on Economic Development publication of September 1982 entitled "The New Frontier". The Committee is stated as having "the responsibility to foster development by monitoring government activities and expenditures that support private sector projects".

This report indicates that the government is generally supportive of private sector development in the region and recognizes a requirement for major investment by both the public and private sector. While the southern zone is regarded as having more immediate development potential, significant potential for development in the northern zone, especially in the mining sector, is noted. The constraints to development described previously, and the potential costs of their being overcome, are major considerations. The government is cognizant of the need for long-term planning to commence immediately. Specific commitments to review resource transportation needs, a streamlining of government regulations and the development of secure and reasonably-priced energy sources are evidence of the government's attitudes in this regard.

5.4 SOCIO-ECONOMIC IMPACTS - 1.0 Mtpy PRODUCT COAL

This subsection presents a preliminary assessment of the regional socio-economic impacts which will result from the development of the mine to produce 1.0 Mtpy of coal. The assessment assumes that no new town will be required and that no coal preparation plant will be installed at the mine site.

541 EMPLOYMENT

.1 Direct Regional Employment

Details of employment by year, together with the calculations required to determine population, family structure and housing requirements, are set out in Table 5.1. Direct employment resulting from the mine, throughout the life of the project, is recorded in Table 5.1. The following illustrates the manpower requirement for years 16-20.

Mine:	
Supervision and engineering	22
Operating labour	110
Maintenance supervision	13
Maintenance labour	55
	200
Loadout and Silos	29
Administration and Management	59
Total	288

.2 Indirect Regional Employment

In addition to the direct regional employment, further employment opportunity will be created in the region largely by the expenditures of the mine, its direct employees and the operation of the infrastructure. To the extent that some of these services are already available, these opportunities will not only be represented by the establishment of new jobs, but also by increases in the activity of the existing labour force. The employment multiplier assumed is 0.3 indirect employees for each direct employee, to give 86 indirect employees.

542 REGIONAL PERSONAL INCOME AND SALARY LEVELS

The total direct labour cost of the mine operation averaged over the mine life, including overtime but excluding benefits, is estimated at $9.1 million per year, or approximately $31 000 per employee. The income of direct employees is likely to be less than that of mine employees. A conservative estimate is the $13 880 regional average earnings for 1979 or approximately $18 500 in 1982 dollars. The total regional income of the 86 indirect employees is therefore estimated at $1.6 million per year. In total, regional income would be increased by $10.7 million per year for the duration of the project.

543 PROVINCIAL EMPLOYMENT AND INCOME

A full discussion of duration and estimation of provincial employment multipliers is beyond the scope of this preliminary assessment. The estimate of indirect provincial employment instead assumes a multiplier of 2.0, which is at the lower end of the range of multipliers used in estimates for the indirect employment created by the larger Northeast Coal Development and is well within the accepted range of multipliers used for new mining developments in Canada, generally.

This multiplier suggests that the total direct and indirect jobs created by the Mount Klappan project in the Province of British Columbia would be 576. Assuming an average provincial income level of $18 000 for the 202 indirect employees outside the region, gross provincial income would be increased by some $14.3 million per year by the development of the mine.

544 REGIONAL POPULATION

Incremental changes in regional population will depend upon not only the percentage of female employment and family characteristics, but, more particularly, upon the extent to which the local under-utilized labour force may be attracted by jobs at the new mine. Although the percentage of unemployed in the region is currently high, the proponent has not yet conducted studies to indicate the proportion of the under-utilized local work force which may be available to work at the mine. Furthermore, since the earliest date for the commencement of operations is several years away, the availability of labour will depend entirely upon the then current conditions and not those evident at the present time.

At an annual production of 1.0 Mtpy of coal, it is possible that, if the mine were developed immediately, the majority of the skilled and non-skilled labour requirements for the project could be met by the existing under-utilized regional work force. If this condition persists up to the time of operations, the impact on the regional population would be minimal, although some movement between communities could be anticipated.

On the other hand, should the mine commence operations at a time of relatively full employment, there will be a considerable population impact because the work force would have to move to the area from other parts of the province or Canada. In order to demonstrate the maximum potential of this impact, population calculations were carried out under the assumption that the new labour demand would all be incremental to the region. Housing demand was estimated on the same assumption.

Population multipliers for resource-based towns in British Columbia (Canadian Employment and Immigration Commission data) range from 1.9 to 2.3, with Smithers being at the high end of the range at 2.2. The multipliers have tended to decline over recent years, in part due to the higher incidence of two-income families. However, mine employees will have a substantially higher income level than the average for the region and there will, thus, be somewhat less incentive for a second family member to work. Accordingly, the population multiplier for the new employment is assumed to be the same as Smithers, at 2.2. If the direct and indirect work force of 374 was entirely recruited from outside the region, this would result in an additional population of some 823 persons.

The company's intention will be to fly in employees to the mine site from the most convenient established centre, assumed for the purpose of this assessment to be Smithers. Additional population moving to the region would, therefore, be likely to locate there and the population impact would, thus, be mainly limited to that one area.

545 MAXIMUM IMPACTS ON FAMILY STRUCTURE, HOUSING REQUIREMENTS AND COMMUNITY SERVICES

This section reviews the maximum impact of the development on family structure, population, housing requirements and community services on the assumption that the work force is all recruited from outside the region.

.1 Family Structure and Population Demographics

Estimates generated for the new northeast community of Tumbler Ridge were used to provide an indication of the family structure and demographics of the new population. The estimates, shown overleaf, include both direct and indirect work forces and represent a typical year after full production is achieved. Further details, by year, appear in Table 5.1.

STRUCTURE OF INCREASE IN POPULATION

	Number	Per Cent
Work Force		
Families with children:		
Two adults working	94	25
One adult working	101	27
Families without children:		
Two adults working	82	22
One adult working	22	6
Single and Separated	75	20
	374	100
Other Adults		
Non-working adults	123	
Unemployed and other adults	50	
	173	
Children		
0 - 4 years	82	30
5 - 12 years	99	36
13 - 18 years	95	34
	276	100
Total Population Increase	823	

The total population increase projected above results in the following number of family units:

Families with children	148
Families without children	63
Singles	75
Unemployed	25
Total	311

.2 Housing Requirements

Page 4 of Table 5.1 estimates the annual and cumulative housing requirements of the additional population. The housing calculation assumes that 50% of single, separated, and unemployed individuals share accommodation and that no existing stock of housing is available. Thus, the number of housing units required is 75% of the population increase in this category. Other than this, each family unit occupies one housing unit. The mix of new housing units actually required will be a function of the existing stock of accommodation available in the area at the time.

The table below indicates that the majority of housing construction will take place in the first four years of the project, as follows:

	Year 1	Year 2	Year 3	Year 4
Detached	54	15	2	3
Duplex	11	2	1	1
Townhouses	11	5	1	1
Apartments	55	15	4	4
Mobile Homes	88	12	2	1
	219	49	10	10

Although some further construction is shown as warranted in the middle years of the project, the number of additional houses is small.

.3 Services

The imposition of a population increase of over 800 persons on the town of Smithers, whose present population is currently estimated at 4 500, will create additional demand for local, regional, and provincial services. However, in view of the timing of the development schedule and the possibility that unused resources may exist in the area at the time the services are needed, this impact will not necessarily require commensurate investment in new services.

Detailed studies of available and planned services in the Smithers locality have not been undertaken and, accordingly, it is premature to suggest what the overall impact would be. Moreover, the impact will be strongly influenced by the extent to which the mine employs existing residents of the community or new residents. This, in turn, will be determined by the local economic conditions prevailing at the time.

The maximum impact in terms of requirements for additional services will be realized if full employment already exists in the area and the community is expanded to accommodate the 800 people who would be drawn to the area by the mine's development.

Under these conditions, demand for services would be created in the following major sectors:

Education

- up to 99 elementary school places; and
- up to 95 high school places.

Serviced Land
- sufficient for up to 313 additional housing units.

Health Care
- Additional facilties in accord with provincial standards.

Commercial Facilities
- Some additional investment in hotel, retail, and distribution services.

Security
- Additional police and fire services in accord with provincial standards.

The public costs of these services should be offset by increases in school and municipal property taxes.

546 CONSTRUCTION EMPLOYMENT

Engineering data is not yet available on the level of construction employment required to build the mine. However, initial indications were calculated by estimating the labour content of certain construction expenditures.

Total expenditures for development, initial installations and other pre-production costs are estimated at $51 000 000 in the two years prior to the installation of equipment. Installed equipment costs in the next two years total $83 000 000. Assuming that 35% of the pre-production cost and 15% of the installed-equipment cost represent direct labour, the total man years of construction labour are estimated to be as follows:

	Capital Costs Incurred ($ million)	% Labour	Labour Cost ($ million)	Man Years Employed at $35,000 per Employee
Year-2	2.0	35	0.70	20
Year-1	49.0	35	17.15	490
Year 1	73.0	15	10.95	313
Year 2	10.0	15	1.50	43
Total	134.0		30.30	866

The majority of the construction work force would be accommodated in temporary facilities at the mine site. However, the financial impact of a construction payroll exceeding $30 million over the four-year period would have a positive effect upon the surrounding communities from which the work force would be drawn.

547 INFRASTRUCTURE

.1 Rail

The Dease Lake line of the British Columbia Railway from Prince George currently extends to within 85 km of the proposed mine site. The rail bed is completed up to the mine site and it is estimated that rail could be installed on the existing sub-grade at a cost of $52 million. Coal would thus be hauled 668 km on BCR trackage from the mine to Prince George and a further 752 km on the CNR line to Prince Rupert.

The feasibility of shortening the rail distance to tidewater by constructing a new route from the BCR line to the existing CNR line at Hazelton is presently under consideration. It is unlikely that this alternative could be justified at a production level of 1.0 Mtpy.

.2 Road Access

Because employees will be moved in or out of the mine site by air, and will only remain on site while working, road access will not be required during the operations phase. However, an access road will be required during the construction period and the most practical approach is from Ealue Lake south, along the existing rail sub-grade. It is estimated that this route could be made good at a cost of $1 million.

.3 Port

The new coal loading facility at Ridley Island, Prince Rupert is planned for 12 Mtpy capacity, with a proposed expanded capacity of 15 to 16 Mtpy. Space exists at Ridley Island to increase capacity to 40 Mtpy. Coal shipments from northeastern British Columbia are expected to account for 8 Mtpy. There is, thus, available capacity for shipping Mount Klappan coal with relatively little change in the port operator's plans. The socio-economic effects of the expansion to handle Mount Klappan coal will not be significant in terms of the regional economy of Prince Rupert, but the throughout will contribute to the financial viability of the new port operation.

548 EXPENDITURES

.1 Expenditures

Total capital expenditures for mine development, equipment and construction are estimated at $158.3 million over the twenty-year production period. Of this amount, $134 million will be incurred in the pre-production period and in the first two years of construction.

In addition to direct mine site costs, a further sum estimated at $52 million will be required to complete the construction of the railway to the mine site. Further, the site access road required during the construction period is estimated to cost $1 million.

Other capital expenditures likely to be incurred but which have not been estimated are;

- the cost of any special port facilities needed to handle coal at Ridley Island;
- costs of railway rolling stock;
- the costs of services required in the Smithers area; and,
- costs of housing construction.

.2 Operating Expenditures

Mine operating costs can be projected at $31 million per year, as follows:

	$ million
Labour and benefits	12
Operating supplies & services	15
Contract expenditures	4
	31

Most of the labour expenditures and a substantial portion of other operating and contract expenditures will find their way into the local economy.

549 SUMMARY

This preliminary assessment indicates that the socio-economic impacts arising from the development of the Mount Klappan mine at 1.0 Mtpy will include:

- 288 direct and 86 indirect new jobs created in the southern sector of the northwest region of British Columbia;
- regional income increased by some $10.7 million per year for the duration of the project;
- total provincial employment increased by 576 and provincial income by $14.3 million per year;
- a maximum population increase of some 800 people. However, regional population increases will be determined by the extent to which employment resources are under-utilized at the time the mine is developed;
- 313 housing units to house this population increase, primarily in the Smithers area. The majority of these units will be required in the first two years of operations;
- over 800 man years of labour over four years to construct the mine. Much of the $30 million payroll for these employees will find its way into the local economy;
- a new rail extension to move coal from the mine site. The capital cost of this construction is estimated at $52 million; and,

- mine capital expenditures estimated at $158 million, of which $134 million will be expended in the first four years of development. Operating expenditures are estimated at $31 million per year.

5.5 SOCIO-ECONOMIC IMPACTS - 5.0 Mtpy PRODUCT COAL

The development of the Mount Klappan mine to produce 5.0 Mtpy of product coal for an initial operating period of twenty years will result in significant social and economic impacts on the northwest region of British Columbia because of the high level of employment, infrastructure and expenditures required.

A new town will have to be constructed in the vicinity of the mine because there are not established communities within reasonable commuting distance and it would be impractical to fly in a work force of the size needed at a 5.0 Mtpy level. The new town will absorb much of the economic activity related to mine development and, thus, the potential for impacts on the established communities in the southern sector of the study area will be somewhat lessened.

The detailed calculations related to employment, population, demographics, and housing appear at the end of the section in Table 5.2. The paragraphs which follow provide descriptions of the socio-economic indicators for a typical year at full production.

551 EMPLOYMENT

.1 Direct Regional Employment

Direct employment at the mine site is expected to peak at 979 in the sixth year of production and remain at or close to that level for the duration of the project. This employment is made up as follows:

Mine		
Supervision and engineering	54	
Operating labour	418	
		472
Plant		
Supervision	36	
Operating labour	88	
		124
Maintenance		
Supervision	38	
Labour	243	
		281
Administration and Management		102
Total		979

.2 Indirect Regional Employment

Indirect regional employment was estimated by applying a multiplier of 0.5 to the direct employment. This multiplier is higher than used for the 1.0 Mtpy case as it reflects the need for a high level of support and service facilities in the new town. Indirect employment is thus estimated at 490 people. The total number of regional jobs generated by the 5.0 Mtpy project is estimate 1 469.

552 REGIONAL PERSONAL INCOME AND SALARY LEVELS

Average income levels are estimated at approximately $31 000 for direct employees and $18 500 for indirect employees, as in paragraph 542. Total regional income of direct employees is therefore estimated at $30.3 million per year and for indirect employees, $9.1 million, for a total of $39.4 million per year for the duration of the project.

553 PROVINCIAL EMPLOYMENT AND INCOME

The estimation of indirect provincial employment assumes a multiplier of 2.5, which is higher than the 2.2 as described in paragraph 543, but consistent with the multipliers used to estimate the employment impacts of the Northeast Coal Development. This suggests that the total direct and indirect jobs created in the province of British Columbia would be about 2 450, with a gross provincial income of $57.1 million.

554 REGIONAL POPULATION

Incremental changes in the regional population in this larger production case are only slightly more clearly defined than in the previous example. With the development of the new townsite, there will certainly be significant population increase in the northern part of the study area. To the extent that this population may be drawn from existing settlements in the southern part, this increase may represent only a shift in population rather than new residents attracted to the area. However, this shift will depend very largely upon the economic conditions prevailing in the existing settlements at the time the townsite is developed.

On the assumption that relatively full employment in the existing communities will prevail and the townsite will be populated by people from outside the region, the maximum potential population increase has been calculated.

A population multiplier of 2.3 applied to the estimated 1 469 direct and indirect work force generated by the mine development indicates a maximum potential regional population increase of 3 400 persons. Not all of these people will be resident in the new townsite as, for example, some of the indirect employees will be involved in providing services to the mine from surrounding communities such as Smithers and Stewart. It is estimated that 95% of the direct employees and 85% of indirect employees will live in the new townsite, giving an estimated townsite population of 3 100 persons.

555 FAMILY STRUCTURE AND POPULATION DEMOGRAPHICS

The following table is indicative of the family structure and demographics of the townsite population, and is based on Tumbler Ridge projections.

STRUCTURE OF INCREASE IN POPULATION

	Number	Per Cent
Work Force		
Families with children:		
Two adults working	336	25
One adult working	363	27
Families without children:		
Two adults working	296	22
One adult working	81	6
Single and separated	270	20
	1 346	100
Other Adults		
Non-working adults	444	
Unemployed and other adults	150	
	594	
Children		
0 - 4 years	341	29
5 - 12 years	402	35
13 - 18 years	413	36
	1 156	100
Total Population Increase	3 096	

556 HOUSING REQUIREMENTS

The population of 3 100 persons is estimated to require 1 039 housing units of various kinds. Nine hundred and seventy-three of these units will be required by the sixth year of production as follows:

	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Detached	57	41	41	27	27	19	80
Duplex	15	9	7	4	4	2	9
Townhouses	15	9	14	8	7	5	18
Apartments	58	43	42	27	28	19	63
Mobile Homes	145	68	35	12	4	2	9
	290	170	139	78	70	47	179

Construction of the remaining 66 units would take place over years seven to ten.

557 CONSTRUCTION EMPLOYMENT

Construction employment is based on the estimated labour content of the initial capital expenditures for mine development and construction, as follows:

	Capital Costs Incurred ($ million)	% Labour	Labour Cost ($ million)	Man Years Employed at $35,000 per Employee
Year -3	15.0	35	5.25	150
Year -2	92.0	35	32.20	920
Year -1	215.0	15	32.25	922
Year 1	61.0	15	9.15	261
Year 2	48.0	15	7.20	206
Total	431.0		86.05	2 459

The construction payroll of $86 million would have a positive effect upon the surrounding communities if they were able to supply a significant portion of the labour required. In addition, construction employees from outside the area can be expected to spend a reasonable proportion of their incomes in the local communities.

No estimates are available for construction labour related to the townsite, railways and roads, but it is estimated that their employment and income impacts could be at least as high as those estimated for the mine itself.

558 SERVICES

The establishment of a new townsite will require the provision of a full range of services because its isolated location will prevent substantial reliance on services provided elsewhere on a regional basis. The following paragraphs provide an indication of the major services which would be required for a population of 3 100 persons, assuming normal provincial government standards are considered.

.1 Education

Primary school education facilities would be required to accommodate some 400 children of the ages 5 - 12 years. Although this number exceeds provincial standards for one elementary school (360 children), it would be difficult to justify a second school unless additional industrial or tourism development were to take place in the area.

A secondary school would be required to accommodate a maximum of some 410 students of the ages 13 - 18 years. While this falls short of the standard of 1 000 secondary students per school, there will be no alternatives in the area and a small secondary school will be required.

.2 Medical and Health

The population will not be sufficient to justify a hospital. Medical clinic and ambulance services will be required, as will emergency transportation services for more serious cases to hospitals outside the region.

.3 Government Services

The government services required on site will include the following:

Federal
- manpower services
- post office
- RCMP

Provincial
- Family services
- Highway maintenance

Municipal
- Fire
- Engineering, inspection and public works
- Library
- Recreation

.4 Commercial Facilities

The town will need a number of basic commercial business services to support its population of 3 100 persons. These will include the following:

apartment	laundromat/dry cleaner
banking services	legal and insurance
B.C. Hydro office	liquor store
building contractor	lumber yard
building maintenance	motel/restaurant
clothing and shoe stores	personal care
electrical and hardware supplier	pharmacy
gas and car service	supermarket

559 INFRASTRUCTURE

The requirement for infrastructure to support the 5.0 Mtpy operation will be substantially greater than that required for the smaller mine. In addition to the townsite and the completion of the rail link to the mine-site, the infrastructure components required will include a new rail link to shorten the distance between the minesite and tidewater, and the construction of a new highway west towards the existing Dease Lake highway. A second highway linking the townsite to existing communities such as Hazelton and Smithers would also be desireable, although its costs might be prohibitive in the earlier years of the townsite's development. Additional port facilities will be required at Prince Rupert.

Infrastructure requirements may be summarized as follows:

- a new townsite for 3 500 persons;
- power supply to the townsite and mine;
- extension of the British Columbia Railway line 85 km to the mine;
- cut-off link between the BCR trackage and CNR track at Hazelton;
- new rolling stock to ship coal to tidewater;
- new road west from the townsite to Meziadin Lake on Highway 37, east of Stewart;
- new road south from the townsite to the Hazelton area; and,
- expansion of the deepwater coal port at Ridley Island, near Prince Rupert.

The magnitude of the infrastructure needed for the 5.0 Mtpy case suggests that a very substantial investment will be required. While detailed cost studies have not been carried out, estimates prepared for various aspects of the Northeast Coal Development enable order-of-magnitude figures to be suggested for some components. These are shown below:

	$ million
Townsite housing	90
Townsite development	50
Railway extension (preliminary engineering estimate)	52
Railway cut-off link (preliminary engineering estimate)	176
Rolling stock	72
Road west to Meziadin Lake (preliminary engineering estimate)	55
Port expansion	30
Total	525

No estimates are available for the costs of power supply or the second new road linking the new town to Hazelton.

5510 EXPENDITURES

.1 Capital Expenditures

The total identified capital expenditures required to develop and maintain the mine over its twenty-year life and install the infrastructure amount to $1 113 million as summarized below:

	$ million
Mine	578
Infrastructure	535
Total	1 113

Mine capital expenditures of $432 million will be incurred in the pre-production period and in the first two years of production. Virtually all of the infrastructure costs would be incurred before production commences.

These costs do not include an allowance for power supply or for the new road south from the minesite. A further $147 million of capital expenditures will be made by the mine over the remainder of its twenty-year operating life.

.2 Operating Expenditures

Mine operating expenditures can be projected at $125 million per year, as follows:

	$ million
Labour and benefits	43
Operating supplies & services	69
Contract expenditures	13
	125

Most of the labour expenditures and a substantial portion of the other operating and contract expenditures and a substantial portion of the other operating and contract expenditures will find their way into the local economy.

5511 SUMMARY

This preliminary assessment indicates that the socio-economic impacts arising from the development of the Mount Klappan mine at 5.0 Mtpy will include:

- up to 979 direct and 490 indirect jobs created in the northern sector of the northwest region of British Columbia;

- regional income increased by $39.4 million per year for the duration of the project;

- total provincial employment increased by 2 450 and provincial income by $57.1 million per year.

- a maximum regional population increase of 3 400 people. Regional population increases will be determined by the extent to which local employment resources are under-utilized at the time the project is developed. There could be some shift to the new town from established communities. The maximum townsite population would be 3 100;

- about 1 039 housing units at the townsite, of which some 973 will be required in the first six years of production;

- some 2 500 man years of construction labour to build the mine. Construction labour will also be required in the building of the infrastructure;

- two new schools and a range of other government services at the new townsite. A variety of private sector businesses will also be required.

- capital expenditures on infrastructure development of over $535 million. Significant additional costs will be incurred on infrastructure components for which costs are not yet available;

- mine capital expenditures of $578 million, of which $431 million will be expended in the first five years of development and production; and,

- operating expenditures of $125 million per year.

5.6 AREAS FOR FURTHER STUDY

The preceding text indicates that the development of the Mount Klappan mine has the potential to create significant positive socio-economic impacts in the northwestern region of British Columbia. This potential includes new jobs, increased regional income and a general increase in economic activity. The development may also provide justification for expanded road, rail, and power facilities in a presently undeveloped region.

The location of the mine close to the Spatsizi Wilderness Park may be considered from several points of view. The establishment of a mine close to the park border may be viewed as detracting from the amenity value of a scarce wilderness resource. On the other hand, the area directly affected by the mine workings will be very small by comparison with the park area and, if the townsite is developed, access to the park will be made much easier for those who wish to enjoy it.

The development of the mine to produce 1.0 Mtpy will result in a limited socio-economic impact in the immediate mine area. Since virtually all of the employees would be flown in and out, most of the identified impact would fall on Smithers, the muster point. The additional population would create substantial impact on Smithers, which would be mitigated if it were found possible to also draw the labour force from the surrounding communities such as Hazelton, Houston, and Terrace. Indeed, this situation would probably occur automatically if the mine were prepared for production at a time of high unemployment, so that both the positive and negative impact would be dissipated throughout the southern portion of the impact area.

The development of the mine at 5.0 Mtpy raises a different set of issues because of the necessity to construct a townsite. In this case, the impact upon the the regional economy would be much greater, but those affecting existing communities in the southern portion of the study area would be rather less, because of the natural focus on the new townsite.

Indeed, negative economic effects could be created in some towns in the region if residents were drawn from there to the new town, leaving existing facilities under-utilized.

To a considerable degree, the movement of population to the new town from existing communities would be subject to the state of the regional economy at the time construction and operation of the mine commence. If economic activity is low, the establishment of new jobs would be a positive factor, offset by the reduction in utilization of existing facilities. In this case, the most significant positive impact in the region may well be an increase in the income levels of existing residents and a greater degree of income security. Few, if any, overall population effects would be apparent as there would be little need to encourage immigration from outside the area.

The proponents recognizes that, as planning for the project proceeds, a detailed assessment of socio-economic issues will be required.

In particular, careful study of the following factors will be undertaken.

Employment
- direct employment related to construction
- education and training requirements for operating labour
- refinement of potential for creation of indirect employment
- source of labour force

Population
- further consideration of the sensitivity to population issues under prevailing economic conditions.

Housing Development
- affordability issues
- existing housing stock in local communities
- housing finance and assistance

Services
- detailed study of existing educational, medical and health, and other facilities available in the region.

Community Land and Infrastructure
- study of local availability and comparison with development requirements

Regional Infrastructure
- in-depth studies of potential infrastructure facilities, notably rail, roads and power.

Social and Economic Adjustment Consideration
- cultural design issues
- urban design factors.

During the study programme, particular attention will be paid to the resolution and mitigation of the issues related to the socio-economic impacts on existing communities in the northwestern area of British Columbia.

TABLE 5.1 - Page 1

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

1 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
SKEENA-STIKINE AREA																							
DIRECT EMPLOY. -OPERATIONS	0	0	265	318	289	290	287	288	288	288	288	288	285	285	285	285	285	288	288	288	288	288	180
REGIONAL MULT.	1	1	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
INDIRECT EMPLOY -REGIONAL	0	0	53	64	87	87	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	54
TOTAL REGIONAL EMPLOYMENT	0	0	318	382	376	377	373	374	374	374	374	374	371	371	371	371	371	374	374	374	374	374	234
WORK FORCE BY SEX																							
FEMALES: (% OF DIRECT)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
(% OF INDIRECT)	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
- DIRECT	0	0	53	64	58	58	57	58	58	58	58	58	57	57	57	57	57	58	58	58	58	58	36
- INDIRECT	0	0	29	35	48	48	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	30
TOTAL FEMALES	0	0	82	99	106	106	104	105	105	105	105	105	104	104	104	104	104	105	105	105	105	105	66
MALES	0	0	236	283	270	271	269	269	269	269	269	269	267	267	267	267	267	269	269	269	269	269	168
TOT. WORK FORCE	0	0	318	382	376	377	373	374	374	374	374	374	371	371	371	371	371	374	374	374	374	374	234
REGIONAL WORK FORCE AND POPULATION																							
ADD. DIRECT POP	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ADD. INDIR POP	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
% IN REGION	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
FEMALES	0	0	82	99	106	106	104	105	105	105	105	105	104	104	104	104	104	105	105	105	105	105	66
MALES	0	0	236	283	270	271	269	269	269	269	269	269	267	267	267	267	267	269	269	269	269	269	168
TOTAL RESIDENT WORK FORCE	0	0	318	382	376	377	373	374	374	374	374	374	371	371	371	371	371	374	374	374	374	374	234
POPULATION MULT	1.65	1.65	1.75	1.85	1.95	2.1	2.15	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
ADDITIONAL POPULATION RESIDENT IN REGION	0	0	557	707	733	792	802	823	823	823	823	823	816	816	816	816	816	823	823	823	823	823	515

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

1 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
INCREMENTAL FAMILY AND EMPLOYMENT STRUCTURE																							
FAMILIES																							
(%)	16	16	18	20	23	23	23	24	24	24	24	25	25	25	25	25	25	25	25	25	25	25	25
2ADULTS WORKING	0	0	58	76	86	86	86	90	90	90	90	94	92	92	92	92	92	94	94	94	94	94	58
(%)	12	12	14	18	19	22	23	24	25	25	26	26	27	27	27	27	27	27	27	27	27	27	27
1ADULT WORKING	0	0	45	69	71	83	86	90	94	94	97	97	100	100	100	100	100	101	101	101	101	101	63
COUPLES																							
(%)	23	23	23	25	27	24	24	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22
2ADULTS WORKING	0	0	74	96	102	90	90	86	86	86	86	82	82	82	82	82	82	82	82	82	82	82	52
(%)	2	2	2	3	3	4	4	4	4	5	5	6	6	6	6	6	6	6	6	6	6	6	6
1ADULT WORKING	0	0	6	11	11	15	15	15	15	19	19	22	22	22	22	22	22	22	22	22	22	22	14
(%)	47	47	43	34	28	27	26	25	24	23	22	21	20	20	20	20	20	20	20	20	20	20	20
SINGLE OR SEP'D	0	0	135	130	106	103	96	93	89	85	82	79	75	75	75	75	75	75	75	75	75	75	47
INCREMENTAL WORK FORCE	0	0	318	382	376	377	373	374	374	374	374	374	371	371	371	371	371	374	374	374	374	374	234
NON-WORKING ADULTS	0	0	51	80	82	98	101	105	109	113	116	119	122	122	122	122	122	123	123	123	123	123	77
OTHER ADULTS AND UNEMPLOYED	0	0	2	3	7	10	18	25	33	40	50	50	50	50	50	50	50	50	50	50	50	50	50
CHILDREN (< 19)	0	0	186	242	268	307	310	319	307	296	283	280	273	273	273	273	273	276	276	276	276	276	154
ADDITIONAL REGIONAL POPULATION	0	0	557	707	733	792	802	823	823	823	823	823	816	816	816	816	816	823	823	823	823	823	515

NUMBER OF FAMILY UNITS

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
FAMILIES	0	0	74	107	114	126	129	135	139	139	142	144	146	146	146	146	146	148	148	148	148	148	92
COUPLES	0	0	43	59	62	60	60	58	58	62	62	63	63	63	63	63	63	63	63	63	63	63	40
SINGLES	0	0	135	130	106	103	96	93	89	85	82	79	75	75	75	75	75	75	75	75	75	75	47
UNEMPLOYED	0	0	1	2	4	5	9	13	17	20	25	25	25	25	25	25	25	25	25	25	25	25	25
TOTAL	0	0	253	298	286	294	294	299	303	306	311	311	309	309	309	309	309	311	311	311	311	311	204

TABLE 5.1

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

1 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
AGE DISTRIBUTION																							
(%)	10	10	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	9	9	9	9	9
0 - 4	0	0	61	78	81	87	88	91	91	91	91	91	90	82	82	82	82	82	74	74	74	74	46
(%)	12	12	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	12	12	12	11	11	11
5 - 12	0	0	72	92	95	103	104	107	107	107	107	107	106	106	106	98	98	99	99	99	91	91	57
(%)	10	0	10	10	13	14	15	15	15	12	10	10	9	10	10	11	11	12	13	13	13	13	10
13 - 18	0	0	53	72	92	111	118	123	123	98	85	82	77	85	85	93	93	95	103	103	111	111	51
(%)	24	23	20	19	18	17	16	16	15	15	15	15	16	16	16	16	16	16	16	16	16	15	15
19 - 24	0	0	111	134	132	135	128	132	123	123	123	123	131	131	131	131	131	132	132	132	132	123	77
(%)	30	28	27	25	25	25	24	24	24	23	23	23	23	23	23	23	23	22	22	22	22	22	22
25 - 34	0	0	150	177	183	198	192	198	198	189	189	189	188	188	188	188	188	181	181	181	181	181	113
(%)	11	11	12	12	12	12	12	12	12	12	13	13	13	13	13	13	13	14	14	14	14	14	14
35 - 44	0	0	67	85	88	95	96	99	99	99	107	107	106	106	106	106	106	115	115	115	115	115	72
(%)	2	3	4	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
45 - 54	0	0	22	42	44	48	48	49	58	58	58	58	57	57	57	57	57	58	58	58	58	58	36
(%)	0	2	3	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
55 - 64	0	0	17	14	15	16	16	16	16	16	16	25	16	16	16	16	16	16	16	16	16	16	10
(%)	1	0	1	2	0	0	1	1	1	5	6	5	6	6	6	6	6	5	5	5	5	7	10
65 +	0	0	4	13	3	0	12	8	8	42	47	41	45	45	45	45	45	45	45	45	45	54	53
ADD. REGIONAL POPULATION	0	0	557	707	733	793	802	823	823	823	823	823	816	816	816	816	816	823	823	823	823	823	515

CUMULATIVE ANNUAL HOUSING REQUIREMENTS:

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
FAMILIES AND COUPLES	0	0	117	166	176	186	189	193	197	201	204	207	209	209	209	209	209	211	211	211	211	211	132
SINGLES, SEP'D UNEMPLOYED	0	0	102	99	82	81	79	79	79	79	80	78	75	75	75	75	75	75	75	75	75	75	54
TOTAL	0	0	219	265	258	267	268	272	276	280	284	285	284	284	284	284	284	286	286	286	286	286	186
MAX. FAMILIES AND COUPLES	0	0	117	166	176	186	189	193	197	201	204	207	209	209	209	209	209	211	211	211	211	211	211
MAX. SINGLES AND UNEMPLOYED	0	0	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
TOTAL	0	0	219	268	278	288	291	295	299	303	306	309	311	311	311	311	311	313	313	313	313	313	313

TABLE 5.1

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

1 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ANNUAL HOUSING REQUIREMENTS:																							
FAMILIES AND COUPLES	0	0	117	49	10	10	3	4	4	4	3	3	2	0	0	0	0	2	0	0	0	0	0
SINGLES, SEP'D, AND UNEMPLOYED	0	0	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL UNITS REQUIRED	0	0	219	49	10	10	3	4	4	4	3	3	2	0	0	0	0	2	0	0	0	0	0
ASSUMED HOUSING MIX (%)																							
DETACHED UNITS		20	25	30	35	40	40	45	50	55	55	55	55	60	60	60	60	60	65	65	65	65	65
DUPLEX UNITS		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
TOWNHOUSES		5	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
APARTMENTS		20	25	30	35	40	40	35	35	30	30	30	30	25	25	25	25	25	20	20	20	20	20
MOBILE HOMES	100	50	40	25	15	5	5	5	0														
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ANNUAL HOUSING TYPE REQUIREMENTS:																							
DETACHED UNITS	0	0	54	15	2	3	2	3	3	3	2	2	1	0	0	0	0	1	0	0	0	0	0
DUPLEX UNITS	0	0	11	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWNHOUSES	0	0	11	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
APARTMENTS	0	0	55	15	4	4	1	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0
MOBILE HOMES	0	0	88	12	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL UNITS REQUIRED	0	0	219	49	10	10	3	4	4	4	3	3	2	0	0	0	0	2	0	0	0	0	0
CUMULATIVE																							
DETACHED UNITS	0	0	54	69	71	74	76	79	82	85	87	89	90	90	90	90	90	91	91	91	91	91	91
DUPLEX UNITS	0	0	11	13	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
TOWNHOUSES	0	0	11	16	17	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
APARTMENTS	0	0	55	70	74	78	79	80	81	82	83	84	85	85	85	85	85	86	86	86	86	86	86
MOBILE HOMES	0	0	88	100	102	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103
CUMULATIVE REQUIREMENT	0	0	219	268	278	288	291	295	299	303	306	309	311	311	311	311	311	313	313	313	313	313	313

TABLE 5.2

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

5 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
SKEENA-STIKINE AREA																							
DIRECT EMPLOY. -OPERATIONS	0	443	595	770	745	766	805	979	979	979	979	979	979	979	979	979	979	935	935	935	935	935	981
REGIONAL MULT.	1	1	1.2	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
INDIRECT EMPLOY -REGIONAL	0	0	119	154	298	383	403	490	490	490	490	490	490	490	490	490	490	468	468	468	468	468	491
TOTAL REGIONAL EMPLOYMENT	0	443	714	924	1043	1149	1208	1469	1469	1469	1469	1469	1469	1469	1469	1469	1469	1403	1403	1403	1403	1403	1472
WORK FORCE BY SEX																							
FEMALES:																							
(% OF DIRECT)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
(% OF INDIRECT)	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
- DIRECT	0	89	119	154	149	153	161	196	196	196	196	196	196	196	196	196	196	187	187	187	187	187	196
- INDIRECT	0	0	65	85	164	211	222	270	270	270	270	270	270	270	270	270	270	257	257	257	257	257	270
TOTAL FEMALES	0	89	184	239	313	364	383	466	466	466	466	466	466	466	466	466	466	444	444	444	444	444	466
MALES	0	354	530	685	730	785	825	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	959	959	959	959	959	1006
TOT. WORK FORCE	0	443	714	924	1043	1149	1208	1469	1469	1469	1469	1469	1469	1469	1469	1469	1469	1403	1403	1403	1403	1403	1472
RESIDENT WORK FORCE AND POPULATION																							
RES - % OF DIR.	0	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
- % OF IND.	0	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
% ON SITE (AVG)	0	95	93	93	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92
FEMALES	0	85	172	223	288	334	351	427	427	427	427	427	427	427	427	427	427	407	407	407	407	407	427
MALES	0	336	495	639	673	720	756	919	919	919	919	919	919	919	919	919	919	879	879	879	879	879	922
TOTAL RESIDENT WORK FORCE	0	421	667	862	961	1054	1107	1346	1346	1346	1346	1346	1346	1346	1346	1346	1346	1286	1286	1286	1286	1286	1349
POPULATION MULT	1.65	1.65	1.75	1.85	1.95	2.1	2.15	2.2	2.25	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
POPULATION RESIDENT AT TOWN SITE	0	695	1167	1595	1874	2213	2380	2961	3029	3096	3096	3096	3096	3096	3096	3096	3096	2958	2958	2958	2958	2958	3103

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

5 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
RESIDENT FAMILY AND EMPLOYMENT STRUCTURE																							
FAMILIES																							
(%)	16	16	18	20	23	23	23	24	24	24	24	25	25	25	25	25	25	25	25	25	25	25	25
2ADULTS WORKING	0	68	120	172	222	242	254	324	324	324	324	336	336	336	336	336	336	322	322	322	322	322	338
(%)	12	12	14	18	19	22	23	24	25	25	26	26	27	27	27	27	27	27	27	27	27	27	27
1ADULT WORKING	0	51	93	155	183	232	255	323	337	337	350	350	363	363	363	363	363	347	347	347	347	347	364
COUPLES																							
(%)	23	23	23	25	27	24	24	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22
2ADULTS WORKING	0	96	154	216	260	252	266	310	310	310	310	296	296	296	296	296	296	282	282	282	282	282	296
(%)	2	2	2	3	3	4	4	4	4	5	5	6	6	6	6	6	6	6	6	6	6	6	6
1ADULT WORKING	0	8	13	26	29	42	44	54	54	67	67	81	81	81	81	81	81	77	77	77	77	77	81
(%)	47	47	43	34	28	27	26	25	24	23	22	21	20	20	20	20	20	20	20	20	20	20	20
SINGLE OR SEP'D	0	198	287	293	267	286	288	335	321	308	295	283	270	270	270	270	270	258	258	258	258	258	270
RESIDENT WORK FORCE	0	421	667	862	961	1054	1107	1346	1346	1346	1346	1346	1346	1346	1346	1346	1346	1286	1286	1286	1286	1286	1349
NON-WORKING ADULTS	0	59	106	181	212	274	299	377	391	404	417	431	444	444	444	444	444	424	424	424	424	424	445
OTHER ADULTS AND UNEMPLOYED	0	0	5	10	20	30	50	75	100	125	150	150	150	150	150	150	150	150	150	150	150	150	150
CHILDREN (< 19)	0	215	389	542	681	855	924	1163	1192	1221	1183	1169	1156	1156	1156	1156	1156	1098	1098	1098	1098	1098	1159
TOWN SITE POPULATION	0	695	1167	1595	1874	2213	2380	2961	3029	3096	3096	3096	3096	3096	3096	3096	3096	2958	2958	2958	2958	2958	3103
NUMBER OF FAMILY UNITS																							
FAMILIES	0	85	153	241	294	353	382	485	499	499	512	518	531	531	531	531	531	506	508	508	506	508	533
COUPLES	0	56	90	134	159	168	177	209	209	222	222	229	229	229	229	229	229	218	218	218	218	216	229
SINGLES	0	198	287	293	267	286	288	335	321	308	295	283	270	270	270	270	270	258	258	258	258	258	270
UNEMPLOYED	0	0	3	5	10	15	25	38	50	63	75	75	75	75	75	75	75	75	75	75	75	75	75
TOTAL	0	339	533	673	730	822	872	1067	1079	1092	1104	1105	1105	1105	1105	1105	1105	1059	1059	1059	1059	1059	1107

TABLE 5.2

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

5 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
AGE DISTRIBUTION																							
(%)	10	10	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	9	9	9	9	9
0 - 4	0	70	128	175	206	243	262	326	333	341	341	341	341	310	310	310	310	296	266	266	266	266	279
(%)	12	12	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	12	12	12	11	11	11
5 - 12	0	83	152	207	244	288	309	385	394	402	402	402	402	402	402	372	372	355	355	355	325	325	341
(%)	10	9	9	10	12	14	15	15	15	15	14	14	13	14	14	15	15	15	16	16	17	17	17
13 - 18	0	62	109	160	231	310	353	444	454	478	440	426	413	444	444	474	474	447	477	477	507	507	539
(%)	24	23	20	19	18	17	16	16	15	15	15	15	16	16	16	16	16	16	16	16	16	15	15
19 - 24	0	160	233	303	337	376	381	474	454	464	464	464	495	495	495	495	495	473	473	473	473	444	465
(%)	30	28	27	26	25	25	25	25	25	24	24	24	24	24	24	24	24	23	23	23	22	22	22
25 - 34	0	195	315	415	469	553	595	740	757	743	743	728	743	728	728	728	728	680	680	680	651	651	683
(%)	11	11	12	12	12	12	12	12	12	12	13	13	13	13	13	13	13	14	14	14	14	14	14
35 - 44	0	76	140	191	225	266	286	355	363	372	402	402	402	402	402	402	402	414	414	414	414	414	434
(%)	2	3	4	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
45 - 54	0	21	47	96	112	133	143	178	212	217	217	217	217	217	217	217	217	207	207	207	207	207	217
(%)	0	2	3	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
55 - 64	0	14	35	32	37	44	48	59	61	62	62	93	62	62	62	62	62	59	59	59	59	59	62
(%)	1	2	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	3	3
65 +	0	14	8	16	13	0	3	0	1	17	25	23	21	36	36	36	36	27	27	27	56	85	83
TOWN SITE POPULATION	0	695	1167	1595	1874	2213	2380	2961	3029	3096	3096	3096	3096	3096	3096	3096	3096	2958	2958	2958	2958	2958	3103

CUMULATIVE ANNUAL HOUSING REQUIREMENTS:

FAMILIES AND COUPLES	0	141	243	375	453	521	559	694	708	721	734	747	760	760	760	760	760	726	726	726	726	726	762
SINGLES, SEP'D UNEMPLOYED	0	149	217	224	208	226	235	279	278	278	278	269	259	259	259	259	259	250	250	250	250	250	259
TOTAL	0	290	460	599	661	747	794	973	986	999	1012	1016	1019	1019	1019	1019	1019	976	976	976	976	976	1021
MAX. FAMILIES AND COUPLES	0	141	243	375	453	521	559	694	708	721	734	747	760	760	760	760	760	760	760	760	760	760	762
MAX. SINGLES AND UNEMPLOYED	0	149	217	224	224	226	235	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279
TOTAL	0	290	460	599	677	747	794	973	987	1000	1013	1026	1039	1039	1039	1039	1039	1039	1039	1039	1039	1039	1041

TABLE 5.2

POPULATION MODEL FOR MOUNT KLAPPAN COAL PROJECT

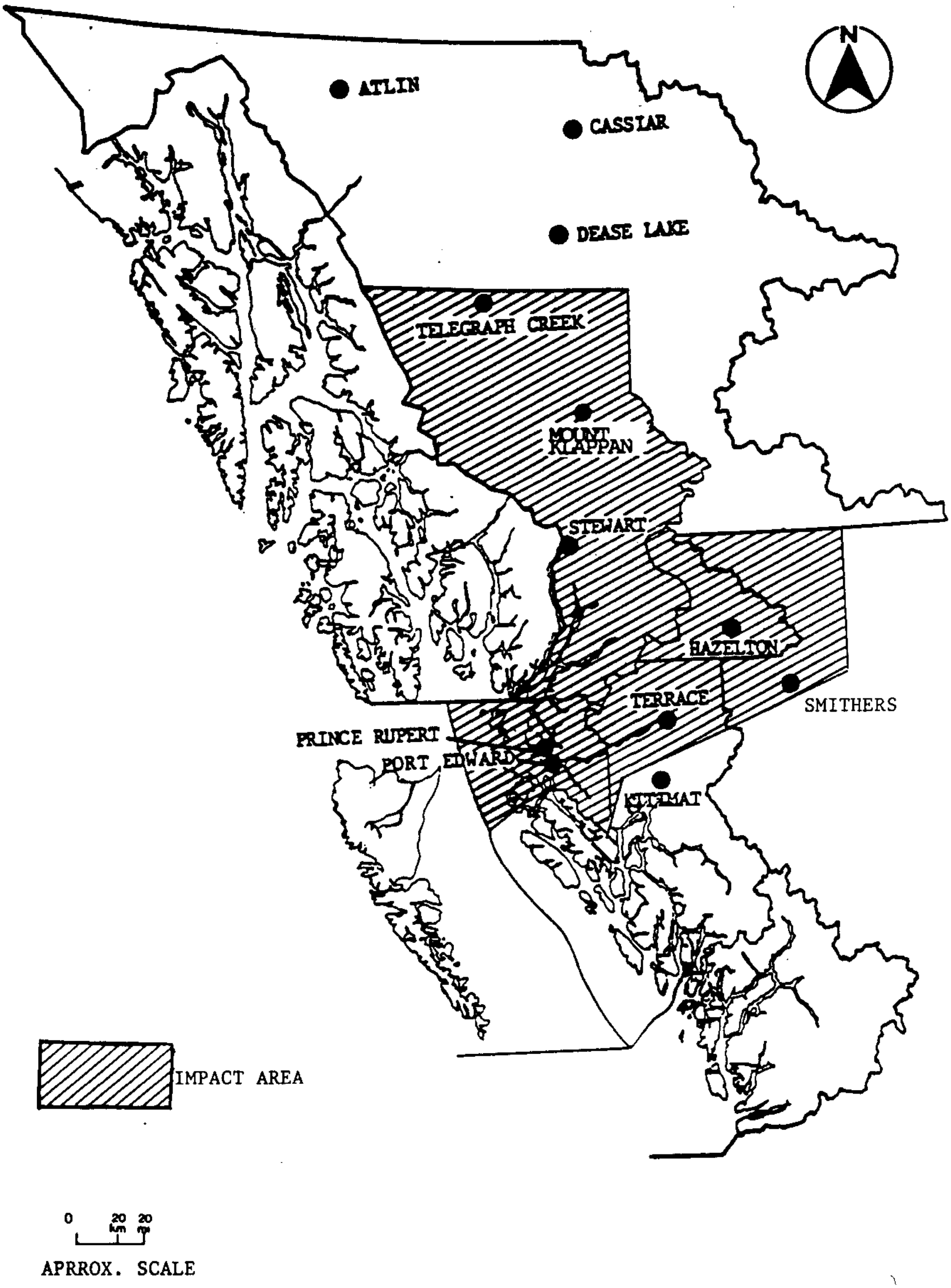
5 Mtpy Case

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ANNUAL HOUSING REQUIREMENTS:																							
FAMILIES AND COUPLES	0	141	102	132	78	68	38	135	14	13	13	13	13	0	0	0	0	0	0	0	0	0	2
SINGLES, SEP'D, AND UNEMPLOYED	0	149	68	7	0	2	9	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL UNITS REQUIRED	0	290	170	139	78	70	47	179	14	13	13	13	13	0	0	0	0	0	0	0	0	0	2
ASSUMED HOUSING MIX (%)																							
DETACHED UNITS		20	25	30	35	40	40	45	50	55	55	55	55	60	60	60	60	60	65	65	65	65	65
DUPLEX UNITS		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
TOWNHOUSES		5	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
APARTMENTS		20	25	30	35	40	40	35	35	30	30	30	30	25	25	25	25	25	20	20	20	20	20
MOBILE HOMES	100	50	40	25	15	5	5	5	0														
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ANNUAL HOUSING TYPE REQUIREMENTS:																							
DETACHED UNITS	0	57	41	41	27	27	19	80	7	7	7	7	7	0	0	0	0	0	0	0	0	0	2
DUPLEX UNITS	0	15	9	7	4	4	2	9	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
TOWNHOUSES	0	15	9	14	8	7	5	18	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
APARTMENTS	0	58	43	42	27	28	19	63	5	4	4	4	4	0	0	0	0	0	0	0	0	0	0
MOBILE HOMES	0	145	68	35	12	4	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL UNITS REQUIRED	0	290	170	139	78	70	47	179	14	13	13	13	13	0	0	0	0	0	0	0	0	0	2
CUMULATIVE																							
DETACHED UNITS	0	57	98	139	166	193	212	292	299	306	313	320	327	327	327	327	327	327	327	327	327	327	329
DUPLEX UNITS	0	15	24	31	35	39	41	50	51	52	53	54	55	55	55	55	55	55	55	55	55	55	55
TOWNHOUSES	0	15	24	38	46	53	58	76	77	78	79	80	81	81	81	81	81	81	81	81	81	81	81
APARTMENTS	0	58	101	143	170	198	217	280	285	289	293	297	301	301	301	301	301	301	301	301	301	301	301
MOBILE HOMES	0	145	213	248	260	264	266	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
CUMULATIVE REQUIREMENT	0	290	460	599	677	747	794	973	987	1000	1013	1026	1039	1039	1039	1039	1039	1039	1039	1039	1039	1039	1041

PLATE 5.1

MOUNT KLAPPAN COAL PROJECT

IMPACT AREA



PART 6

ENVIRONMENT

PART 6 - ENVIRONMENT

CONTENTS

Table

6.1 SUMMARY

No environmental factor which would preclude development of the Mount Klappan coal deposit has been found. Environmental impacts will occur as a result of project development, but proper planning, design, construction, operation and reclamation will reduce the significance of these impacts. The most significant environmental issue relates to the project's proximity to Spatsizi Plateau Wilderness Park.

6.2 DISCIPLINE - SPECIFIC DISCUSSION

621 LAND USE

.1 Introduction

Land use can be divided into the following categories: 1) Resource Use - mining, forestry, agricultural, recreation and 2) Land Status - residential, commercial, lands held in reserve by government departments or agencies, lands used or claimed by native people, and lands with historic value.

.2 Resource Use

.21 Mining

The region contains previously identified mineral deposits and has potential for mineral development. A recently commissioned study to investigate The Northwest Region has indicated that the potential exists for developing mineral deposits along corridors common to these sites and the Mount Klappan project. As mining developments require a substantial infrastructure for power, transportation and municipal affairs, the current lack of such requirements is the major deterrent to future mining developments. The Mount Klappan project possesses the potential to "spearhead" the establishment of such infrastructure.

.22 Forestry

The proposed mine site and associated corridors are located within vast tracts of forest. For the most part, particularly in the case of the mine site itself and the northern portions of the corridors, the timber is of poor quality (mature western hemlock and balsam fir). Current levels of timber harvesting are low in the northern portions of the region and timber processing operations are minimal or non-existent. Further south, particularly in the Hazelton area, harvesting is more extensive and several timber processing operations are in place. This is largely related to the presence of various local markets.

The Mount Klappan project has the potential to improve the regional forest industry. Access in the form of rail lines and roads would permit timber harvesting in previously inaccessible "good quality" areas or areas for which the economics and harvesting had been poor. A community infrastructure and associated lumber requirements would also encourage establishment of some form of timber processing operations. Proper planning of transportation corridor alignments would, however, be essential to avoid stands of better quality timber. In addition, the presence of increased numbers of workers or recreational users would mean increased fire protection requirements for the affected areas.

.23 Agriculture

Within the region in general, only 0.9 percent of the land is deemed arable and only 0.04 percent is cultivated. Agricultural activities are constrained by the paucity of suitable soil and the short growing season. Principal agricultural activities involve cattle ranching, with limited scale forage and vegetable crop production. With the exception of river valleys in the immediate vicinity of the town of Hazelton, no agricultural areas exist either at the proposed Mount Klappan site or along its associated corridors. Principal agricultural activities involve cattle ranching, with limited-scale forage and vegetable crop production. Construction of corridors associated with the Mount Klappan project would provide additional access to other fertile valley bottoms where agricultural activities could be pursued. As arable land is at a premium, corridor alignments should be designed to provide minimal disruption of potential agricultural areas.

.24 Recreation

With the exception of Spatsizi Plateau Wilderness Park, no park facilities exist or are currently planned for the areas in close proximity to the proposed Mount Klappan project or its associated corridors. The tremendous diversity of landform types, wildlife and vegetation, provides many potential recreational opportunities. Current recreational activities include hunting, fishing, back-packing, horse riding, canoeing, rafting and naturalist pursuits. These activities generally receive logistical support from a local, viable guiding/outfitting industry.

Construction of the Mount Klappan project would have numerous implications for the region in general. Increased access would allow more opportunities for the public to experience activities such as alpine hiking, white-water canoeing, hunting and fishing. If not properly managed, however, this would increase demands on the region's natural resources, particularly in the case of Spatsizi Plateau Wilderness Park. Established in 1975, this park currently possesses a management strategy which stresses maintenance of wilderness conditions through 1) controlled access, 2) dispersed recreational activites, and 3) limited facility development. The presence of a transportation corridor and/or a permanent townsite on the border of the park would result in increased recreational use of the park, and potential conflict with the existing management philosophy for Spatsizi Park.

.3 Land Status

.31 Government/Residential/Commercial

The proposed Mount Klappan mine site and the vast majority of the corridor right-of-way are located on provincial crown land. Only small tracts of land have been designated for commercial or residential use and these are located at the terminus of the two proposed railway alternatives, in the Kispiox/Hazelton and New Hazelton areas.

Implications of construction of the Mount Klappan project and associated corridors are several. Firstly, new corridors would encourage settlement and commercial interests either government-sanctioned or not (e.g., squatters). A townsite would certainly involve both residential and commercial interests, with certain lands being removed from a provincial status and perhaps being assigned as deeded land. This is viewed as a positive aspect.

.32 Native

A number of areas within the region have also been set aside by the Department of Indian Affairs and Northern Development for Indian use. Reasons for this action are various but include protection of areas of cultural importance, traditional resource-harvesting activities and native residential areas. The closest Indian Reserve to the proposed mine site is at the village of Iskut, approximately 100 km to the northwest. Along the proposed railway corridors, Indian Reserves occur near the confluence of the Babine and Skeena rivers, and along the Kispiox River, leading into the Skeena River near Hazelton.

In addition, much of the land in the region is included in a variety of land claims based on aboriginal title. Preliminary assessment of these claims suggests that the proposed mine site and the various corridors occur in areas associated with one or more of these claims. No conflicts with Indian reserves are anticipated.

.33 Historical

From an historical perspective, the region is of interest because of the occurrence of both coastal (Tsimshian) and interior (Athapaskan) linguistic subfamilies. Historically, Athapaskans ranged widely throughout the interior region (possibly including the proposed mine site) while engaged in seasonal hunting, trapping and fishing. Their semi-nomadic lifestyle led to the development of a less elaborate culture than their coastal counterparts. Caucasians rarely frequented the area until the 1920's, when the Hyland brothers established a trading post on the Spatsizi River. Limited surveying was conducted in the area during 1935 but most of the activity in the area took place from 1948-1968 when Tommy Walker employed native Indians in a highly successful guiding/outfitting operation. Guiding and outfitting is still an important pursuit of several people in the area.

Much of the railway alignments and the slurry pipeline corridor transect what was both Athapaskan and Tsimshian Indian Lands. The Tsimshain (coastal) culture developed within a relatively bountiful environment where wide ranging pursuit of a food source was of less importance. As a result, these people became semi sedentary and developed elaborate cultures which included totem pole construction. The Kispiox/Hazelton area near the terminus of railway alternative #2 is of interest because of the occurrence of both Tsimshian and Athapaskan cultures. The only known historical area of archaeological significance for either the mine site or associated corridors occurs in the Kispiox River valley.

The project is deemed to be largely positive in terms of adding to the knowledge of British Columbia's cultural history through the stimulus of development.

622 PHYSICAL ENVIRONMENT

.1 Introduction

The physical environment is divided into the following categories: atmospheric, terrestrial and aquatic environments.

.2 Atmospheric Environment

.21 Climate

The Klappan Licence Area is located on the east side of the Skeena Mountains in a climatic regime identified as the Northern and Central Plateau and Mountains. The winters in this area are generally colder and drier than southern areas of British Columbia due to the frequent influxes of continental Arctic air and the less frequent occurrence of moist Pacific air. Summers are short and quite cool, although the long days partially compensate for these conditions. The wide range in temperature values at the proposed mine site is characteristic of most interior reporting centres in western Canada, with mean daily temperatures similar to or warmer than those for other coal-producing areas such as Cranbrook in southeastern British Columbia and Fort Nelson in northeastern British Columbia (Table 6.1). Precipitation values (approximately 300 mm per year) are similar to those reported for Calgary but generally less than for Cranbrook and Fort Nelson (Table 6.1). Winds are extremely variable, being strongly influenced by the various drainages converging at the mine site. Generally speaking, prevailing winds are from the southwest.

.22 Air Quality and Noise

No data is available for present air quality or noise on or near the property. The remoteness of the site suggests that air quality will be pristine in nature and noise will exist only at a background level.

The proposed mine could influence air quality in the immediate area. A coal-fired thermal plant will produce emissions not currently present in the area. Studies to determine the impact of the proposed coal facilities will be required and the plant would be operated to conform with government standards.

.3 Terrestrial Environment

.31 Geology/Vegetation

The Mount Klappan coal property is located within the Skeena Mountains. Glaciation has strongly influenced the physical environment and periglacial processes (e.g., snow accumulation, freeze-thaw action) continues to do so. In addition, steep valley walls, often in excess of 30^{o}, contribute to downslope movement of materials.

Two major surficial materials are present on the property weathered bedrock at higher elevations, and glacial moraine or outwash deposits at lower elevations. Weathered bedrock materials occur predominantly above tree line (1500 m) and are either completely free of overlying vegetation or support sparse, low-lying vegetation such as mountain heather. This area is typically referred to as alpine tundra and comprises approximately 60 percent of the lease. A transition zone (Krummholtz - Subalpine Fir Zone) occurs between the alpine tundra and forested area. This area supports low-lying vegetation and stunted trees and comprises approximately 5 to 10 percent of the lease. A variety of forest types occur between approximately 1200 m and treeline, depending on exposure and drainage, and comprise 20 to 25 percent of the study area. More exposed and well-drained sites support trees such as subalpine fir, lodgepole pine and engelmann spruce. Less exposed and more poorly-drained sites support white spruce and/or black spruce. Below 1200 m, surficial materials are dominated by impermeable silts and clays. These poor drainage conditions have given rise to peat bogs and muskeg which comprise approximately 10 percent of the property.

The various railway and slurry pipeline alignments pass through a variety of vegetation zones, with exposure, elevation and drainage influencing their occurrence. Major vegetation zones occurring along the slurry pipeline include Interior Western Hemlock, Subalpine Spruce-Fir, and Sub-Boreal and Boreal Spruce. Railway Alternative #1 traverses two major vegetation zones, the Sub-Boreal Spruce and Subalpine Spruce-Fir. Railway Alternative #2 encompasses a Sub-Boreal Spruce zone, an Interior Western Hemlock zone and small portions of a Subalpine Spruce-Fir zone.

Influences of the Mount Klappan project on vegetation have been largely described in the discussion of Forestry. High elevation vegetation zones are more fragile than those at lower elevations and are thus less easy to revegetate should they be disturbed. Unvegetated surficial materials are less stable than vegetated soils. Such areas occur either at high elevations or on slopes with steep angles of repose. Mining activities or new transportation corridor construction must consider these issues to avoid erosional problems.

.32 Wildlife

The region under consideration contains a broad diversity of habitat which in turn supports a wide variety of wildlife. The status of wildlife in the region is not yet well understood, largely because detailed studies have not been conducted.

Woodland caribou, mountain goat, stone sheep, moose, mule deer and Columbian Blacktail deer occur in close proximity to either the proposed mine site or associated development corridors. Predator species in the area include grizzly bear, black bear and wolf. Other mammalian species of interest are the wolverine, beaver, lynx and hoary marmot. Preliminary investigations have indicated that the numbers and distribution of these species are highly variable, being dependent upon local, natural conditions and human-related factors such as hunting or trapping.

Nests of Bald Eagles, Golden Eagles and Gyrfalcons have been reported for the region but little is known of their distribution or abundance. While waterfowl do occur throughout the region, they do so in small numbers, due to the paucity of suitable habitat.

Construction of the Mount Klappan project will afford the general public greater recreational opportunities with respect to the wildlife resource. In a positive sense, this will take the form of increased hunting opportunities for resident hunters and increased wildlife-viewing opportunities for naturalists. These positive aspects must, however, be weighed against potential problems associated with improved access to the region and increased demands on the wildlife resource and the government agencies responsible for managing this utilization.

.4 Aquatics Environment

The project has the potential for affecting fish populations in the Stikine, Skeena, Fraser and Nass drainage basins. In these drainages, both anadromous (sea-run) and freshwater fish stocks occur. Although little specific data is available, salmon, steelhead and rainbow trout, Dolly Varden, arctic greyling and whitefish are expected to be present.

Fish populations within the coal property are anticipated to include only Dolly Varden and rainbow trout, as a downstream blockage in the Stikine River precludes access to anadromous fish stocks. Standing crops of fishes within the property are anticipated to be relatively low, but this region has been identified for consideration in habitat enhancement programmes. Fish populations within the influence of the proposed development would be susceptible to impact from alterations in habitat quality, quantity and from facilitated harvest due to increased access to the area.

The greatest concern in relation to development of the project would be the construction of a transportation corridor, parallel with river systems. Direct and indirect impacts on aquatic resources may, however, be largely mitigated through proper design and planning, and appropriate surveillance programmes. If the abandoned rail subgrade is used for development, maintenance programmes would prevent erosion along this corridor; this is viewed positively by government resource personnel. The upgrading of access would necessitate development of appropriate management strategies by regulatory agencies to prevent over-exploitation of this fisheries resource.

6.3 PROJECT - SPECIFIC DISCUSSIONS

631 INTRODUCTION

Consultation with various government agencies and review of the limited amount of regional information have resulted in identification of various issues pertaining to the proposed mine site and associated corridors. These issues can be positive or negative in nature, and pertain to all or some of the project components. For the sake of simplification, component-specific issues have been summarized in a matrix form (Table 6.2) and in the following discussions.

632 MINE SITE

For the one million tonne operation, Land-use issues are largely absent in either a positive or negative sense. Increased recreational use of the adjacent Spatsizi Park by mine employees can be viewed as positive or negative depending on the management strategy for the park.

Physical Environmental issues relate to potential conflicts between the operation of the facility and woodland caribou use of the area and camp/bear interactions and potential air or water contamination arising from the mining facilities or an on-site thermal power station. These impacts can be adequately mitigated with proper planning, design and operation.

For the five million tonne operation the above-described issues are still relevant. Additional Land-use issues involve improved resource-use opportunities. In the case of recreation, a permanent townsite would impose heavy demands on Spatsizi Park.

Additional Physical Environment issues concern the additional pressures on wildlife and fisheries populations as a result of a permanent townsite. Mitigation of these additional impacts will require government development of appropriate resource management programmes.

633 EXISTING RAILWAY PLUS ALTERNATIVE #1

Land-use issues are largely positive in terms of greater opportunities for resource extraction and discovery of historic sites. Physical Environment issues relate to potential construction or operation-related disturbance of localized, high-quality fisheries and wildlife habitat, particularly in the case of anadromous fish in the Upper Skeena drainage.

634 EXISTING RAILWAY PLUS ALTERNATIVE #2

Land-use issues are largely the same for this alternative as for #1 except that known historic sites exist along the Kispiox River and efforts will be required to avoid disturbing them. Physical Environment issues are similar to those for alternative #1.

635 SLURRY PIPELINE

Land-use issues are deemed largely positive in terms of enhanced resource extraction potential and discovery of historic sites, particularly along the Nass River valley. Physical Environment issues relate to potential construction or operation-related disturbance of localized high quality fisheries and wildlife habitat such as that found along the Nass River. Should an access road be constructed along the same route as the pipeline, improved access to previously remote areas would impose demands on the fisheries and wildlife resource. Potential soil stability problems exist along the pipeline route, particularly at "Bear Pass" near Stewart where the formation of glacial lakes is common.

636 ACCESS ROAD

Issues related to an access road depend on the road's status as temporary or permanent. From a Land-use issue perspective, a permanent road would encourage residential and commercial development, and would enhance resource extraction possibilities. Recreationally, a permanent road would allow access to previously remote areas. Such a road would also presumably encourage the discovery of historic sites. A temporary road possesses fewer positive benefits. In terms of Physical Environment issues, the principle issues relate to imposition in terms of increased resident resource-use opportunities but this must be weighed against increased demands placed on management to prevent over-exploitation of the resources.

TABLE 6.1

COMPARATIVE METEROLOGICAL INFORMATION FOR THE MT. KLAPPAN COAL PROPERTY (DIDENE) AND OTHER WESTERN CANADIAN REPORTING STATIONS

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
DIDENE (1979-1981) (Mt. Klappan)												
Mean Daily Minimum (°C)	-14.9	-12.9	-11.7	-8.1	-1.9	0.9	3.2	1.3	-0.2	-3.4	-9.9	-18.5
Mean Daily Maximum (°C)	-12.5	-8.2	0.6	1.1	8.7	13.9	16.7	16.0	9.5	3.8	-1.1	-9.9
Total Precipitation (mm)	16.8	10.0	17.5	21.2	32.4	27.8	49.1	31.3	57.5	51.8	19.8	36.2
FORT NELSON (1951-1980)												
Mean Daily Minimum (°C)	-28.2	-22.6	-16.2	-4.7	3.0	8.0	10.4	8.6	2.8	-4.1	-16.2	-24.9
Mean Daily Maximum (°C)	-19.3	-11.2	-3.2	7.9	16.2	20.7	22.8	21.0	14.5	6.2	-7.8	-17.0
Total Precipitation (mm)	24.9	19.5	24.4	16.7	41.7	69.1	84.3	61.2	41.6	24.3	22.7	21.4
CRANBROOK (1951-1980)												
Mean Daily Minimum (°C)	-14.4	-10.1	-6.6	-1.3	2.7	6.8	8.9	8.2	3.5	-1.1	-6.9	-11.1
Mean Daily Maximum (°C)	-3.9	1.6	5.9	12.3	18.2	22.1	26.8	25.8	19.6	12.2	2.8	-1.7
Total Precipitation (mm)	54.0	37.5	27.9	27.8	43.0	45.5	27.5	34.6	28.8	25.0	40.0	59.6
CALGARY (1951-1980)												
Mean Daily Minimum (°C)	-17.6	-12.9	-9.6	-2.9	2.8	7.0	9.4	8.3	3.8	-1.3	-8.6	-13.8
Mean Daily Maximum (°C)	-6.0	-1.5	1.7	9.4	16.0	19.9	23.3	22.1	17.4	12.3	3.3	-1.8
Total Precipitation (mm)	16.2	15.5	16.1	32.6	48.7	89.4	65.4	55.4	38.2	17.6	12.7	16.0

Meteorological Notes

	Extreme Yearly Minimum Temperature (°C)	Extreme Yearly Maximum Temperature (°C)
Didene (1979-1981)	-41.0	26.1
Fort Nelson (1951-1980)	-51.7	36.7
Cranbrook (1951-1980)	-41.1	38.9
Calgary (1951-1980)	-45.0	36.1

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TABLE 6.2

EVALUATION OF ENVIRONMENTAL ISSUES

REGARDING THE MT. KLAPPAN COAL PROJECT

	Mine Site 1 Mtpy	Mine Site 5 Mtpy	Existing Railway + Alternative #1	Existing Railway + Alternative #2	Slurry Pipeline	Access Road
Land Use						
Forestry	-	-	X	X	X	X
Agriculture	-	-	-	-	-	-
Mining	-	-	-	-	-	X
Recreation	X	X	-	-	-	X
Residential	-	X	-	-	-	X
Commerical	-	X	-	-	-	X
Native	X	X	X	X	X	X
Historic	-	-	X	X	X	X
Physical Environment						
Climate	-	-	-	-	-	-
Air Quality	X	X	-	-	-	-
Water Quantity	-	X	-	-	X	-
Water Quality	X	X	X	X	X	X
Soils	X	X	-	-	X	X
Vegetation	X	X	-	-	X	X
Fish	X	X	X	X	X	X
Wildlife	X	X	X	X	X	X

X = Some form of anticipated impact either positive or negative.
\- = Either no or negligible impact anticipated.

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Fish and Wildlife Branch

Edie, A. Ministry of Environment
Fish and Wildlife Branch

Walker, J. Ministry of Environment
Fish and Wildlife Branch

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Personal Communications (cont'd)

Foubister, L.J.	Ministry of Environment Fish and Wildlife Branch
Fraser, T.	Ministry of Environment Fish and Wildlife Branch
Blower, D.	Ministry of Environment Fish and Wildlife Branch
Lewis, C.P.	Ministry of Environment Terrestrial Studies Branch
Smuin, D.E.	Ministry of Environment
Young, D.A.	Environmental Management Associates
Kent, M.J.	Ministry of Transportation and Highways Highway Design and Surveys Branch
Lofthouse, P.	Ministry of Transportation and Highways Transport Policy Analysis Branch
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Roberts, T.	Ministry of Environment Waste Management Branch
Reynolds, D.M.	Ministry of Environment Fish and Wildlife Branch
Edie, A.	Ministry of Environment Fish and Wildlife Branch

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Whatley, M.	Ministry of Environment Fish and Wildlife Branch
Walker, J.	Ministry of Environment Fish and Wildlife Branch
Foubister, L.J.	Ministry of Environment Fish and Wildlife Branch
Reksten, D.E.	Ministry of Environment Inventory and Engineering Branch
Pommen, L.W.	Ministry of Environment Assessment and Planning Branch
Butcher, G.	Ministry of Environment Assessment and Planning Branch
Chamberlain, T.	Ministry of Environment Aquatic Studies Branch
Buchanan, R.J.	Ministry of Environment Aquatic Studies Research
Galbraith, M.	Ministry of Energy, Mines and Petroleum Resources
Knapp, W.D.	Department of Fisheries and Oceans Habitat Management Division

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