PR- SUKUNKA - 71(1) A - 1
NATIONAL TRUST CO. LTD. (AS TRUSTEE)

COALITION MINING LIMITED
SUKUNKA COAL PROJECT

GEOLOGY
VOLUME 1 00645

SUKUNKA COAL PROJECT

GEOLOGICAL REPORT

PREPARED FOR: COALITION MINING LIMITED

BY: CLIFFORD MCELROY & ASSOCIATES PTY. LIMITED

SYDNEY
MARCH 10, 1972

PREFACE

This geological report on the Sukunka Coal Project, British Columbia, Canada, has been prepared for Coalition Mining Limited by Clifford McElroy & Associates Pty. Limited.

The report, in 12 volumes, contains the results of the geological programme carried out during the 1971 field season, also incorporating earlier work.

The text, with supporting tables and figures is included in Volume 1. Volumes 2 and 3 contain all the relevant maps; Volume 4 contains the geological cross sections.

In Volumes 5 to 11 are the various appendices; the complete record of all drill holes sunk during 1971 are contained in Volumes 6 to 10. For completeness, a summary of the 50 drill holes sunk on behalf of Brameda Resources Limited in 1969 and 1970 are included in Volume 11. Volume 12 contains half scale reductions of the electric well logs.

CLIFFORD McELROY & ASSOCIATES PTY. LTD.

G.R. Wallis
B.E. M.Aus.I.M.M.

C.T. McElroy
M.Sc.,Ph.D.
M.Aus.I.M.M.

SECTION 1.

TABLE OF CONTENTS

VOLUME 1.

VOLUME 1 (CONT'D.)

VOLUME 1 (CONT'D.)

VOLUME 1 (CONT'D.)

SECTION 8 : EXTENDED SUMMARY AND CONCLUSIONS

VOLUME 1 (CONT'D.)

PAGE NO.

TABLES

VOLUME 1.

TEXT FIGURES

VOLUME 1.

VOLUME 1 (CONT'D.)

VOLUME 1 (CONT'D.)

VOLUME 1 (CONT'D)

MAPS

VOLUME 2.

VOLUME 3.

VOLUME 3 (CONT'D)

VOLUME 3 (CONT'D)

GEOLOGICAL CROSS SECTIONS

VOLUME 4.

SECTIONS:

A', A, B', B, C', C, D,
E', E, F, G, H, I, J,
K.

APPENDICES

VOLUME 5. ° REFER TO CONFIDENTIAL ANALYSIS FILE
PR-SUKUNKA 71(4)D

APPENDIX A : Coal Quality Data

VOLUME 5 (CONT'D.)

VOLUME 5 (CONT'D.)

VOLUME 6.

VOLUME 7.

VOLUME 8.

APPENDIX F : (cont'd.)

Drill Hole Data

Diamond Drill Holes	C-23 to C-35

VOLUME 9.

APPENDIX F : (cont'd.)

Drill Hole Data

Diamond Drill Holes	C-36 to C-41
Diamond Drill Holes	CS-1 to CS-7

VOLUME 10.

APPENDIX F : (cont'd.)

Drill Hole Data

Diamond Drill Holes	CM-1 to CM-9
Reverse Circulation Drill Holes	R-1 to R-15

VOLUME 11.

APPENDIX F : (cont'd.)

Drill Hole Data

Diamond Drill Holes	S-1 to S-50

VOLUME 12.

Well Logs.

SECTION 2

SUMMARY

The Sukunka Coal Project is located in east-central British Columbia, Canada. An area of more than 10 square miles has been intensively explored and assessed by Coalition Mining Limited since July, 1970.

This report contains details of the geological programme, the associated diamond drilling and other exploration activities carried out by Coalition Mining Limited in the 1971 field season together with the interpretations, conclusions and recommendations arising from this work.

Within the two principal coal seams, the Chamberlain and Skeeter Seams, are 74 million long tons of medium to high rank bituminous, low volatile coal. From these reserves, can be produced 41 million long tons of washed coal, with an ash content in the range 4 to 5%, which will produce a strong, hard metallurgical coke.

/2-2

The seams occur within gently folded sediments which have been dislocated by a series of thrust faults. These faults, which act as controls in the design of the mining plan, divide the area into three major blocks, in each of which the coal is independently mineable. The competence of the roof and floor strata of both seams contribute to the generally favourable mining conditions.

Additional geological investigations are recommended in order to clarify a number of less well-defined elements of the structural picture and to confirm the existence of additional coal reserves generally south-east of the current project area. It is also recommended that other potentially economic coal deposits within the Peace River District be assessed.

An extended summary of the most important points covered in this report is given in Section 8.

SECTION 3

INTRODUCTION: GEOGRAPHIC SETTING, HISTORICAL REVIEW AND GEOLOGICAL APPROACH

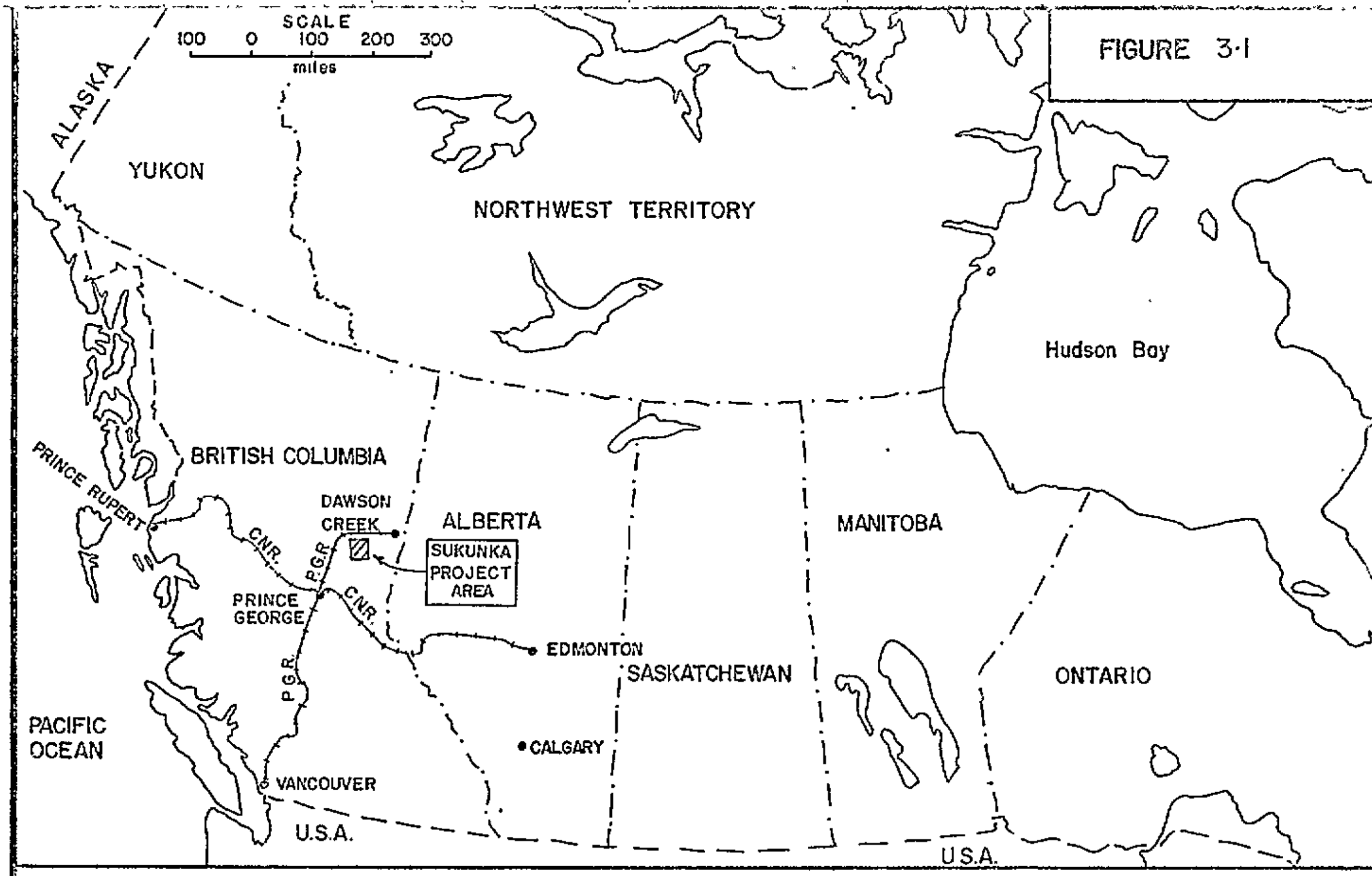
3.1 GEOGRAPHIC SETTING

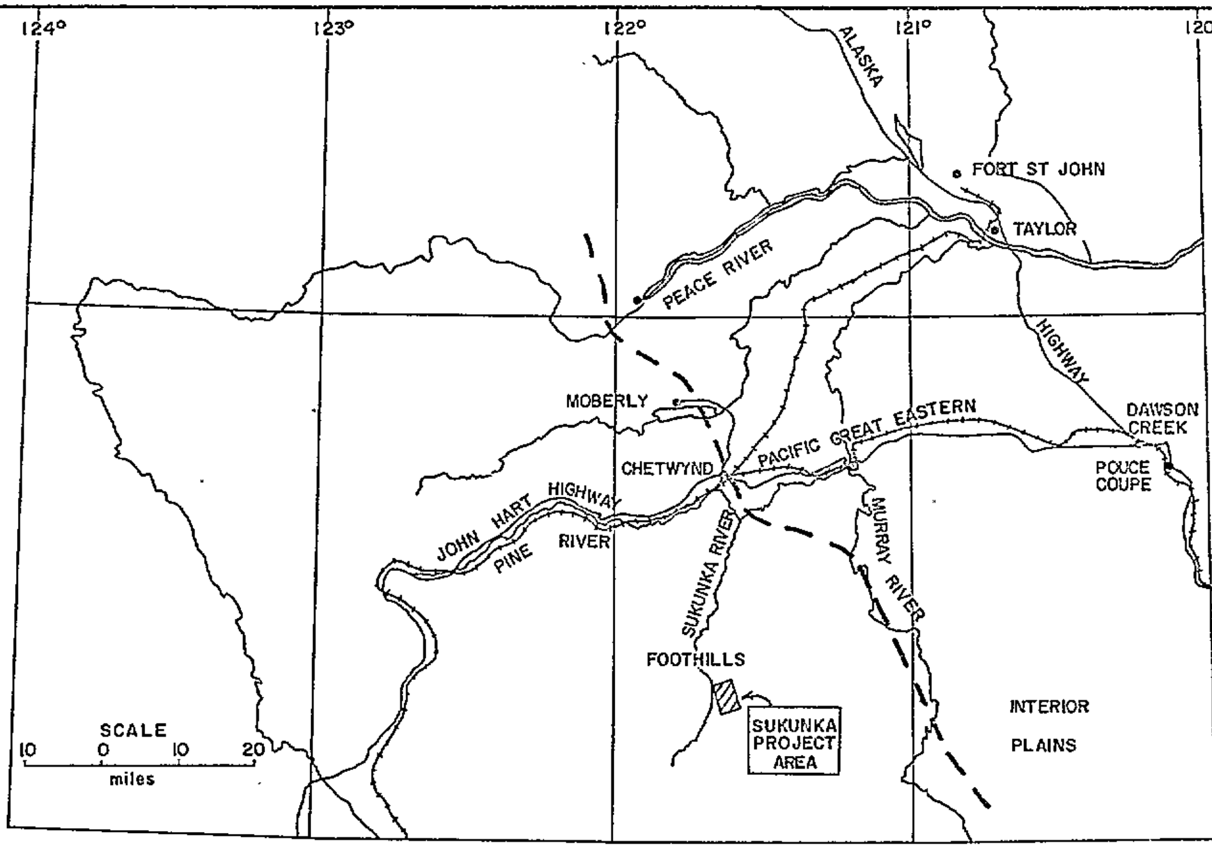
The Sukunka Coal Project, covering an area of 41 square miles, is located some 37 miles south of Chetwynd in British Columbia, Canada. Chetwynd lies some 500 miles north of Vancouver. It is distant about 400 miles east of the west Canadian coast and is connected to the coast at Vancouver by the Pacific Great Eastern Railway. The Canadian National Railway joins the Pacific Great Eastern Railway at Prince George, connecting to Prince Rupert on the west coast. These general locality relationships are shown in Figures 3.1, 3.2 and 3.3

The project area covers part of the Sukunka River Valley in the eastern foothills of the Rocky Mountains. The area is generally mountainous, with a maximum relief of approximately 4,100 feet, from an altitude of 2,600 feet a.s.l. in the Sukunka Valley floor to 6,692 feet a.s.l. on the summit of Bullmoose Mountain. Essentially, this comprises a block, defined by the Sukunka Valley on the west, Skeeter Creek and southern tributaries of Chamberlain Creek, to the north and south respectively. Both creeks are west-flowing tributaries of the Sukunka.

Although there are many minor creeks, the drainage pattern is dominated by Skeeter and Chamberlain Creeks. Apart from Bullmoose Mountain, there are no other named prominent peaks within the project area. Mount Chamberlain, altitude 6,283 feet, lies one mile to the south of the area. The base survey map, Map 5, shows details of the triangulation survey and also shows the local names set up for a large number of minor trig. points.

FIGURE 3·1





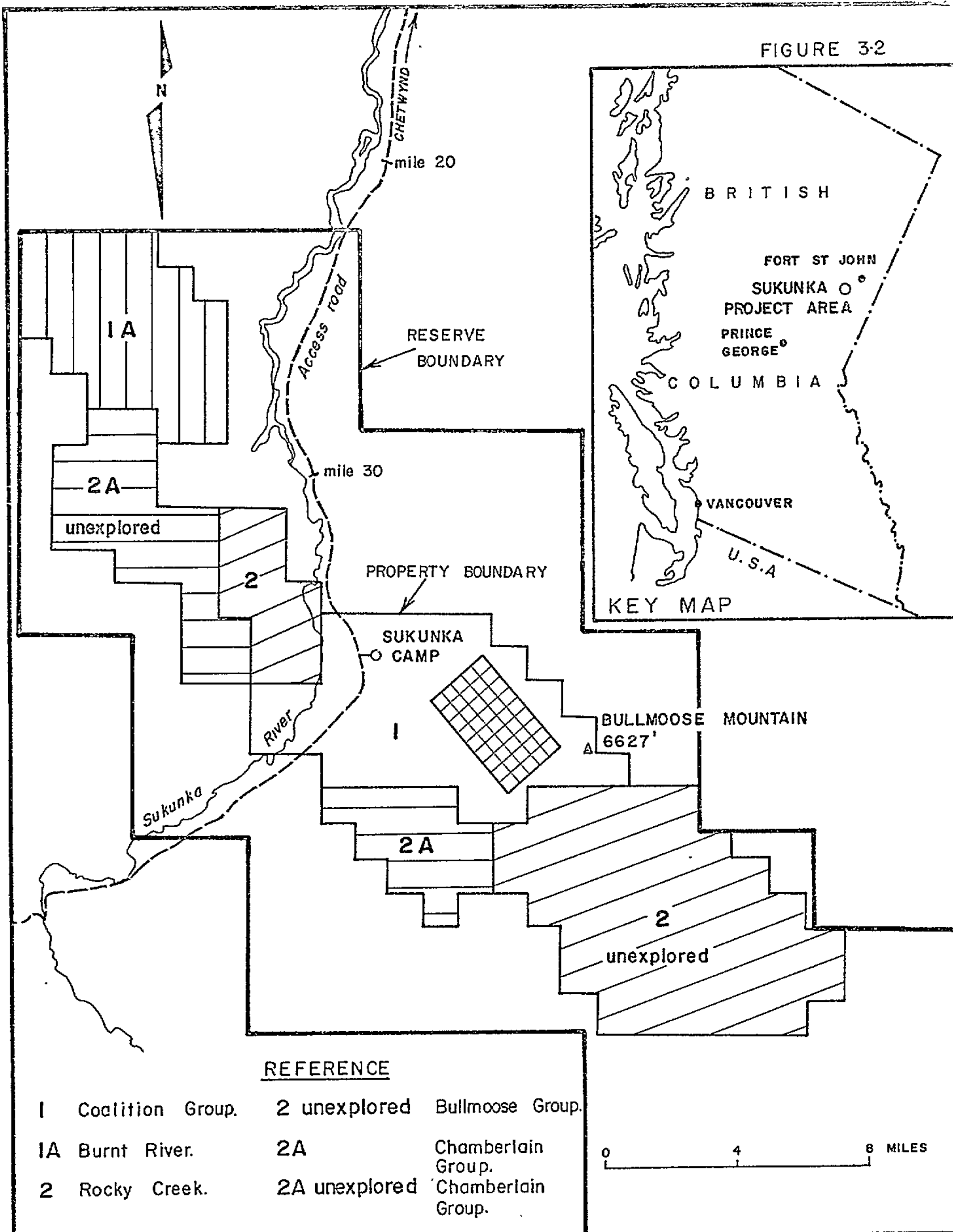
LOCALITY MAP

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY. LIMITED.



COAL LICENCE AREAS

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February, 1972

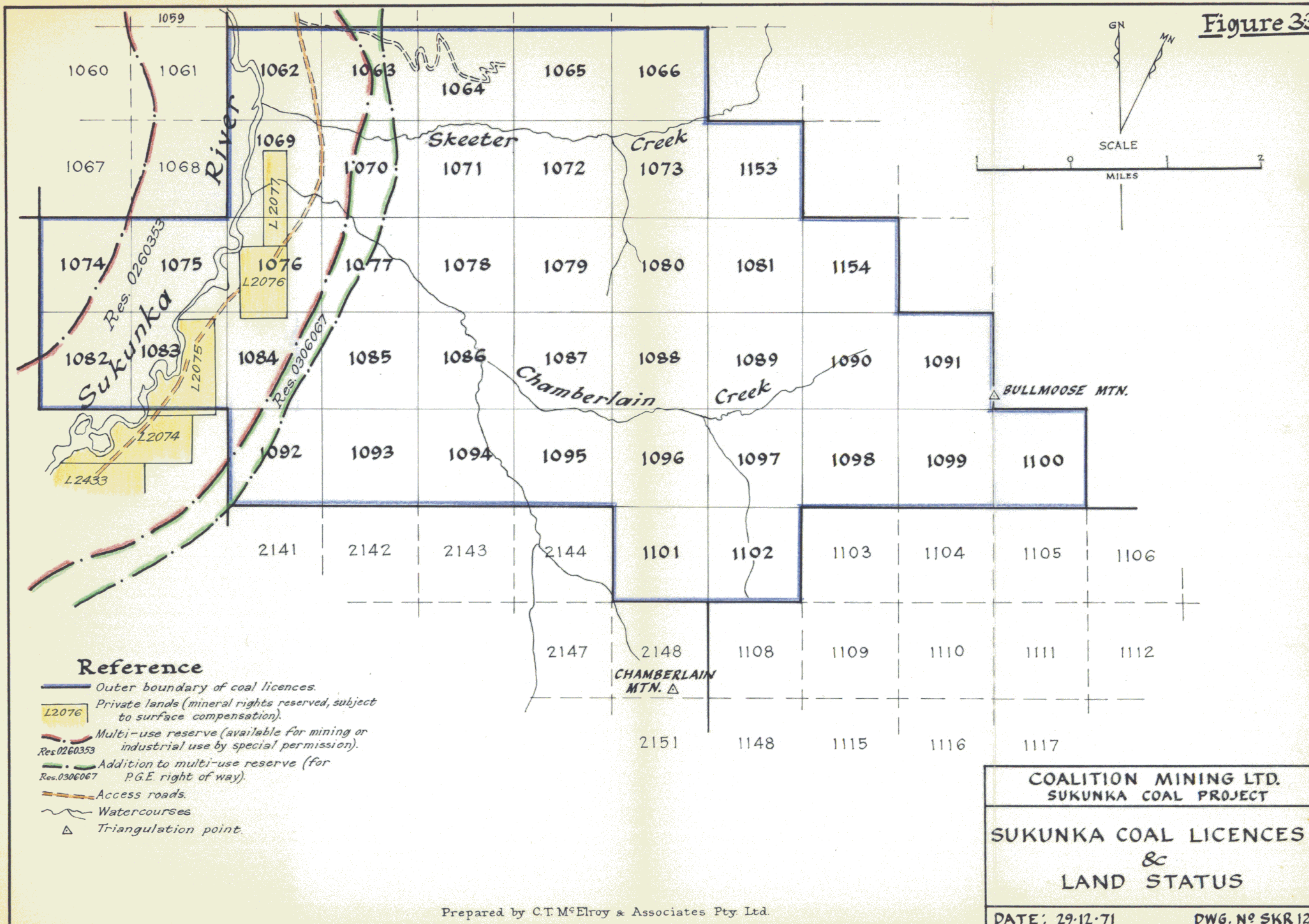
PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED

Current geological activities have been centred in an area covered by an exploration grid on 2,000 feet centres extending in a north-west/south-east direction for 20,000 feet and north-east/south-west direction for 10,000 feet. The area contained within this grid is 7.17 square miles. Appropriate extensions of exploration activity beyond the grid have been made from time to time, as warranted.

3.2 HISTORY OF INVESTIGATIONS

In mid-1969, Brameda Resources Limited took up 128 Coal Licences of one square mile each in the Sukunka River Area. This followed upon reports received from M.E. Hopkins and H.J. Gluskoter of the Illinois Geological Survey and J.E. Hughes of Vancouver who had, at different times, reported to Brameda upon the occurrence of coal seams in the area and the likelihood of the occurrence of other commercial coal deposits in the area between the Peace River and the Sukunka Valley.

Early in 1970, Mr. Richard Austen of Austen & Butta Limited, Sydney, Australia and Mr. David Waring of Inter-Continental Fuels Limited of London, had, after discussions with Brameda Resources Limited, set in train arrangements for a preliminary geological assessment to be made on their behalf with a view to obtaining an interest in Brameda's project. Accordingly, in November, 1970, Dr. C.T. McElroy of Clifford McElroy & Associates Pty. Limited, Consulting Geologists of Sydney, visited the Sukunka Coal Project to establish the relative merits of the several parts of the area, offered under option to Messrs. Austen and Waring. Brameda had, by this time, virtually completed a programme of 50 diamond drill holes (including two inclined holes and one extended hole) with a total footage of 44,380 feet.


1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1153
1074
1075
1076
1077
1078
1079
1080
1081
1154
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
2141
2142
2143
2144
1101
1102
1103
1104
1105
1106
2147
2148
1108
1109
1110
1111
1112
2151
1148
1115
1116
1117
Sukunka River
Skeeter Creek
Chamberlain Creek
Res. 0260353
Res. 0306067
L2077
L2076
L2075
L2074
L2433
BULLMOOSE MTN.
CHAMBERLAIN MTN.
GN
MN
SCALE
1 0 1 2
MILES
Reference
Outer boundary of coal licences.
L2076 Private lands (mineral rights reserved, subject to surface compensation).
Res.0260353 Multi-use reserve (available for mining or industrial use by special permission).
Res.0306067 Addition to multi-use reserve (for P.G.E. right of way).
Access roads.
Watercourses
Triangulation point
Prepared by C.T. McElroy & Associates Pty. Ltd.
COALITION MINING LTD.
SUKUNKA COAL PROJECT
SUKUNKA COAL LICENCES & LAND STATUS
DATE: 29·12·71
DWG. No SKR 126
Figure 33

A large number of coal analyses of both Skeeter and Chamberlain Seams had been completed and some coking tests and other physical tests on the coal had been carried out. A reconnaissance geological map on a scale of 1,000 feet to the inch had been prepared, largely based on aerial photographs, but modified by field observations and drilling results. Geological cross sections had been drawn along the Brameda exploration grid. Number 1 and Number 2 adits in the Chamberlain Seam and Number 3 adit in the Skeeter Seam had been driven to lengths of approximately 100 feet to 150 feet in the vicinity of Chamberlain Creek. Most of the results of this work by Brameda were incorporated into a summary report by W.R. Bergey (1970). A Progress Report by C.T. McElroy (1970) prepared for Austen and Butta Limited, updated that report to November 1970 in the light of field observations and further information supplied by Brameda Resources Limited.

It should perhaps here be stated that the initial work by Brameda formed a valuable basis for future work. Changing requirements and variations in approach meant that a re-appraisal of much of this work was necessary. The existing geological reconnaissance map was developed by detailed field mapping and all the other geological techniques referred to in this section into an accurate representation of the surface geology. All of the existing core, some 44,000 feet, was re-logged in terms of stratigraphic units and the Gething Formation of these cores was re-logged in detail.

At this stage, the area held by Brameda was considered as five blocks. These were merely physiographic entities having no relation to licence boundaries, except, of course, that they were contained within the overall area of licences held by Brameda.

They were imprecisely defined as follows -

<u>Block A</u> - The high ground delimited by Skeeter Creek in the north and Chamberlain Creek in the south, which, in effect, comprised somewhat more than the northernmost 75% of the present exploration grid area.

<u>Block B</u> - The high ground between Chamberlain Creek in the north and West Bullmoose Creek in the south. This block lies immediately to the south of Block A. A small northern part (say 10% or 15%) of Block B corresponded to somewhat less than the southern 25% of the present exploration grid area.

<u>Block C</u> - An area rising from the Sukunka Valley floor westerly to the high ground south of Rocky Creek, which forms its northern boundary.

<u>Block D</u> - The area adjoining Block C to the north, extending from Rocky Creek to Burnt River on the western side of the Sukunka.

<u>Block E</u> - The southernmost entity extending easterly from West Bullmoose Creek towards the Wolverine River.

At the time of the November 1970 visit, the whole of Blocks A and B were under offer to Messrs. Austen and Waring for participation in development, with the option for an additional interest in Blocks C, D and E.

After a brief aerial reconnaissance of the geological structure of all the blocks, it was apparent that Blocks A and B held the greatest promise of a successful outcome of detailed exploration. All other blocks

(a) obviously contained strata that were steeply dipping and/or strongly folded, or

(b) due to lack of outcrop as viewed from the air, remained very questionable.

Additionally, the results of the substantial drilling programme, completed by Brameda in Blocks A and B, were available for study. In other areas there was virtually no sub-surface information except for the record of one diamond drill hole in Block D which gave unpromising results.

At this time, a major change in the composition of the parties concerned occurred following upon negotiations between Messrs. Austen and Waring and Mr. J.H. Moore, President, Brascan Limited of Canada and subsequently Mr. Cliff Sawyer, Vice President, Brascan Limited. Negotiations were continued as a joint venture between Coalition Mining Limited (comprising Brascan Limited, the major participant, Austen & Butta Limited and Inter-Continental Fuels Limited) and Brameda Resources Limited and Teck Corporation. Arising from these negotiations and further visits to the site by technical staff of Austen & Butta Limited and Dr. McElroy, a substantial programme of exploration was formulated in July 1971, to be implemented by Coalition Mining Limited. The area of 41 square miles finally settled upon in the negotiations included

(a) the original Block A plus a strip one mile wide north of Skeeter Creek;

(b) only a small adjoining part of Block B;

(c) the southern part of Block C, and;

(d) the Sukunka Valley floor between these blocks. Figure 3.3 shows the details of the 41 Coal Licences now under option to Coalition. Figure 3.2 demonstrates the relation of the Coalition Group of Licences to other titles in the area. The exploration grid is also shown in this figure.

Mr. G. Wallis, Senior Associate of Clifford McElroy & Associates Pty. Limited, was appointed as Project Manager and in mid-July 1971, took over responsibility for all local administration and technical operations at the Sukunka site, continuing in this capacity until December 1971. Mr. Wallis received continued advice and assistance in all his budgeting activities from Mr. Walter Jennings, Financial Affairs Manager of Brascan Limited.

3.3 GEOLOGICAL PROGRAMME

Inherent in the philosophy of the geological approach, was a built-in limitation of time and budget. Although reasonable budget limitations are normal to most geological programmes, extra problems were here generated by the necessity to complete the programme within the field season, which was already advanced by the time work could be commenced. Thus, there was an effective period of a little over four months from mid-July to late November before the onset of winter prevented further effective field operations.

In the formulation of the general principles of the exploration strategy, excessively costly items, which might include such procedures as the driving of long adits, would need careful evaluation, no matter how desirable such activities might be. The main emphasis was to be placed on an intensive diamond drilling campaign, supported by non-coring methods where appropriate. Detailed geological mapping was to proceed concurrently, both drilling and mapping programmes being subject to the progressive modifications mutually produced.

Surface exposure of the seam by linear bulldozer stripping was to contribute major data on seam thickness and quality, and major and minor structures. A small number of adits of strictly limited length was to be driven in the seams to provide unweathered face and bulk samples and, to some degree, information on the lithologic attributes of roof and floor and associated stress conditions and gas emission. Seam gas was also to be tested in drill cores. Analyses of coal cores were to be carried out in Australia and bulk samples analyses in Canada. A close liaison with the mining engineers of Austen & Butta Limited was to be maintained.

Geophysical techniques proposed were to include well-logging methods and seismic reflection profiling to assist in the elucidation of geological structure.

3.3.1 GEOLOGICAL PERSONNEL

Since the commencement of Coalition's drilling programme, the geological personnel engaged on the project have comprised the following on a full-time or continuing part-time basis.

Site Personnel

G.R. Wallis : Project Manager and Supervising Geologist; overall responsibility for detail design and satisfactory completion of the geological project on time; all site logistics, including arranging drilling contracts; budgeting control; implementation of all aspects of report preparation; time scheduling generally; a major contributor to the writing of the report, notably Section 5, Economic Appraisal of the Coal Seams and Section 6, Mining Conditions.

G.R. Jordan : Geologist; 4½ months continuous engagement on field mapping, selection of bore sites and drilling supervision; responsible for most aspects of structural interpretation; stratigraphic logging of earlier Brameda bores and other detailed logging; general participation in all activities and assistance to the Project Manager as required.

R.S. Verzosa : Geologist; 5 months principally engaged in field mapping and structural interpretations in association with G.R. Jordan.

R.E. Shields : Geological Assistant; continuous engagement extending to the present time; drilling supervision and physical location and preparation of drill sites; other practical aspects of camp logistics; surveying of adits and some drill holes; responsible for earlier logging of most of Brameda's cores and coal sample preparation; currently engaged in site maintenance and maintenance of weather station.

F.H. Tebbutt : Geologist; 2½ months; drilling supervision, core logging including detailed logs of coal seams, coal sample preparation and despatch to laboratories, stratigraphic interpretations in association with G.R. Jordan.

D.M. Devey : Geologist; 5 weeks at end of field programme assisting in stratigraphic and structural interpretations; underground mapping of adits.

N. Nanbu : Geologist; 3 weeks at end of field programme assisting in general compilations and checking of bore hole data; measurement of coal seam sections exposed by bulldozer; geological mapping of adits in association with D.M. Devey.

T. Ravenhill : Geological Draftsman; 3 months drafting of certain preliminary geological, stratigraphic and structural maps; final drafting of certain seam sections; assisted in the supervision of outcrop stripping by bulldozer.

Note : Of the above, Messrs. Verzosa, Shields and Ravenhill were seconded to the team from Brameda-Teck staff; Mr. Nanbu's assistance was provided by courtesy of Nissho-Iwai Company Limited; Messrs. Wallis, Tebbutt, Jordan and Devey are on the geological staff of Clifford McElroy & Associates Pty. Limited and have continued to the present time in the office compilation, interpretation and assessment of the geological data.

Sydney Office Personnel

J.H. Bryan : Supervising Geologist; continued activity in communications and certain compilations throughout the project; co-ordinator of preliminary writings and data prepared by site geologists; substantial original writings and specialised interpretations in the largest section of the report, Section 4 - Geology; supervisory checking; re-interpretation and independent interpretation of certain geological, structural and stratigraphic maps.

A.B. Crouch : Senior Geologist; primarily responsible for sample reception in Sydney and checking prior to delivery to laboratory; receiving and checking of laboratory analyses; preparation of isopach maps, quality evaluation and reserve calculations.

K. Whitby, Geologist and Phillipa Myers, Student Geologist, were involved with a considerable amount of geological drafting in both seam sections and the smaller maps; they also carried out a major part of the checking of geological tabulations and other data.

Four geological cartographers were continuously employed for nearly three months and a large team of casual assistants were engaged in colouring various maps and sections.

C.T. McElroy visited the site on several occasions, including the initial selection of the project area and maintained liaison throughout with Coalition management compiling progress reports as required. He communicated geological progress to the

Japanese Co-ordinating Steel Mills; discussions with senior Japanese geologists in these groups were indeed stimulating and it was more than of interest to note the generally parallel approach to the philosophies of exploration strategy followed by geologists of such diverse backgrounds. He was responsible for enumerating the general principles of the exploration programme, maintaining support as required and establishing the approach to the preparation of the report, especially the report content. He wrote selected sections of the report, notably Section 3 and edited the report generally.

3.3.2 GEOLOGICAL MAPPING

Detailed geological mapping, reproduced as Map 1, was carried out at a scale of 1 inch equals 400 feet and plotted on a base map at a scale of 1 inch equals 1,000 feet. This base map was constructed, at contour intervals of 50 feet from controlled airphoto lay-down. The aerial photography was specially flown for Brameda Resources Limited for whom the base map was also specially prepared. This base map was used for the plotting of drill hole location surveys by Surveyors Underhill & Underhill in 1969-70, and, in 1971, for further drill hole location and outcrop stripping surveys by Watson and Stables initially. Underhill & Underhill resumed this work using tellurometer and theodolite traverses in inaccessible areas.

The geological map is factual where based on observed outcrops and interpretative where projected from drill hole data.

Special emphasis was given to structural aspects and the integration of the data obtained with sub-surface information.

Geological cross sections were constructed along grid lines, either 1,000 or 2,000 feet apart, approximately normal to the regional structural trend. Further notes relevant to the compilation of these sections are contained in the cover sheet of Volume 4.

Early in the investigation it became apparent that the single most pressing geological problem would be the elucidation of the geological structure. The development of the "Plate Concept" was perhaps the most meaningful step forward in this elucidation. The concept is elaborated in Section 4.3, and in the geological cross sections and maps referred to in that section. A trend surface analysis by computer of the depth of cover and the structure of the Chamberlain Seam was carried out by Dr. A.C. Cook of Wollongong University College, as reproduced in Appendix C.

An experimental seismic reflection profiling programme was carried out to evaluate the method as a tool in the structural studies. It was required that faults of displacement of, say, less than 25 feet be delineated. It was not possible to achieve this degree of definition due to the lack of a continuous suitable unit for energy transmission and due to an associated high noise level. Full details of this geophysical work are given in Appendix B.

3.3.3 DRILLING PROGRAMME

It is always difficult, unless geological conditions are especially uniform, to reach a decision on the distribution and density of drill holes which will be necessary to provide the control to adequately prove the reserves in a given area within a coal field. A standard spacing of data points, employed in Australia to establish Measured Reserves within a given area of a coal field, is at half mile centres. Provision for adjustment to this spacing according to geological complexity, is given in this standard, as reproduced in Appendix A. After careful consideration, it was decided that, as a matter of policy, a spacing of 2,000 feet, i.e. less than half a mile, would be maintained in the Sukunka Coal Project area, especially as more than 50 drill holes were already established in this pattern.

Drill holes at closer spacing would be employed as necessary in areas where a greater density of stratigraphic or structural data points was required. In hindsight, it is felt that the philosophy of drill hole spacing employed seems to have been the most reasonable use of the drilling capacity available, with due regard to available time, budget and personnel. In the Coalition drilling programme, 7 drill rigs were commissioned and a total of 58 fully cored diamond drill holes and 14 reverse circulation drill holes were sunk, the total footage being 56,905 feet. Together with the earlier Brameda programme of diamond drilling, comprising 50 holes plus 2 inclined holes and 3 extended holes, total footage 44,380 feet, the overall total was 101,286 feet. The grid locations of all the holes are shown in Table 3.1. For convenience, as shown on this Table, different prefixes to the drill hole numbers were used. Explanations of the nomenclature of these series, together with footage distribution, are as follows -

S Series : Original series of "Sukunka" holes sunk by Brameda Resources Limited. 55 holes as above, total 44,380 feet.

C Series : The main drilling series of "Coalition" holes sunk by Coalition Mining Limited, generally spaced at approximately 2,000 feet centres. 42 holes, total 45,318 feet.

CS Series : A restricted series of "Coalition Structure" holes sunk by Coalition Mining Limited, at appropriate spacings to test specific structural features. 7 holes, total 2,862 feet.

TABLE 3.1

GRID REFERENCES TO SUKUNKA BORE HOLES

S - Series				C - Series				CS & CM Series		R - Series	
Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.
S- 1	A1	S-28	G1	C- 1	H3	C-26	I5	CS- 1	A1	R- 1	H2
- 2	G0	-29	G5	- 2	C1	-27	K3	- 2	A1	- 2	H2
- 4	H2	-30	F5	- 3	F1	-28	J4	- 3	A2	- 3	I2
- 5	D3	-31	E4	- 4	B2	-29	K5	- 4	B2	- 4	H2
- 6	C5	-32	K6	- 4a	B2	-30	A1	- 5	B2	- 5	I2
- 7	D0	-34	E1	- 5	F2	-31	A0	- 6	B2	- 6	I2
- 8	A1	-35	F5	- 6	B2	-32	C2	- 7	B2	- 7	I2
- 9	A1	-36	H5	- 7	C1	-33	G1	CM- 1	A2	- 8	I2
-10	I1	-37	E2	- 8	D3	-34	C4	- 2	A2	- 9	I3
-11	I3	-38	F1	- 9	E1	-35	F1	- 3	A2	-10	I2
-12	J2	-39	J5	-10	C1	-36	E3	- 4	D1	-11	H1
-13	I2	-40	E4	-11	B1	-37	G2	- 5	E1	-12	I3
-14	B0	-41	D3	-12	F1	-38	C4	- 6	B3	-13	I4
-15	H1	-42	J3	-13	F4	-39	C4	- 7	B3	-14	I4
-16	K1	-43	D0	-14	H4	-40	J2	- 8	C2	-15	A1
-17	C1	-43a	D0	-15	G6	-41	H0	- 9	D2		
-18	D2	-43b	"	-16	J1						
-19	C2	-44	H4	-17	E6						
-20	E2	-45	D1	-18	K2						
-21	E3	-46	I1	-19	K6						
-22	B2	-47	A2	-20	J6						
-23	E2	-48	E0	-21	J4						
-24	C2	-49	A1	-22	I3						
-25	F3	-50	B2	-23	K4						
-26	F2			-24	K1						
-27	G3			-25	K2						

CM Series : A restricted series of "Coalition Mine Heading" holes sunk by Coalition Mining Limited, specifically to establish conditions along the line of proposed development for the information of the mining engineers of Austen & Butta Limited. 9 holes, total 3,750 feet.

R Series : A series of "Reverse Circulation" holes sunk at approximately 500 feet centres along the upper course of Chamberlain Creek, specifically to establish the continuity and structure of the Chamberlain across the structural trend. 14 holes, total 4,976 feet.

Detailed and/or stratigraphic logs of all Coalition drill holes, stratigraphic logs of S Series holes, graphic logs and seam sections are all included in Appendix F, Volume 6-11. Volume 12 contains the geophysical well-logging records. The logging method employed a combined gamma ray-neutron tool producing a single log which provided stratigraphic correlation of the various rock units. A total of 46 holes, including 5 of the S Series, were run using this tool. In addition, density logs were run in 7 holes where problems of coal seam recovery were encountered.

3.3.4 SURFACE AND SUB-SURFACE EXPOSURE

(i) EXPOSURE OF OUTCROPS OF COAL SEAMS

Because of the scarcity of natural outcrops of the coal seams, a target was set to expose all accessible locations either by continuous side cuts or cross trenching by bulldozer. The extent of this exposure is indicated on Map 1 where some 14,800 feet of exposure was completed at an average cost of $3.50 per linear foot along the northern and western outcrops of the seams and along

Chamberlain Creek. Some 10,000 feet was completed in the Chamberlain Seam and 2,000 feet in the Skeeter Seam. Additionally, some 3,000 feet was intermittently exposed in both seams. Details of this programme are included in Appendix E. The return of information from this relatively low expenditure has amply demonstrated the value of this part of the programme. Not only were details of the continuity of seam plies and stone bands obtained, not being otherwise available, but the floor and roof conditions were clearly displayed for study by mining engineers and geologists. Of at least equal importance were the minor roof structures displayed, or more specifically, the limited occurrence of such structures, thus aiding the overall predictability of likely conditions to be met in later sub-surface workings. Additionally, height control on the continuous sections so displayed, has given valuable information on the overall geological structure.

(ii) EXPOSURES OF COAL SEAMS IN ADITS

A total of 5 adits was driven in the coal seams as follows, with lengths and locations as shown :

Adit # 1	Chamberlain Seam	-	187 feet, Chamberlain Creek.
Adit # 2	Chamberlain Seam	-	104 feet, Chamberlain Creek.
Adit # 3	Skeeter Seam	-	52 feet, Chamberlain Creek.
Adit # 4	Chamberlain Seam	-	72 feet, north salient.
Adit # 5	Skeeter Seam	-	65 feet, north salient.

Adits #1, 2 and 3 were driven by Brameda Resources Limited in 1970 and #4 and 5 by Coalition Mining Limited in 1971. Full details of these adits are included in Appendix E.

The principal purpose of these adits was to obtain face and bulk samples for analysis and physical tests. In addition, some information, even though of limited application, was gained towards a knowledge of roof and floor conditions, gassiness and geological structure.

From time to time, various groups had put forward proposals for the driving of one or more twin adits, of the order of 6,000 to 10,000 feet in length, across the structural trend in the vicinity of Chamberlain Creek. Early in the programme, it was decided that other activities would give a greater return of information for expenditure.

This decision was made having regard to many factors, including the following :

(a) Information from an adit with respect to geology and mining, would, in the main, apply along a single line only, and would be of limited use over any significant area.

(b) The cost of a long adit would be in the range $500,000 to $1,000,000, which was more than excessive in the total budget picture.

(c) Mining conditions, including rate and method of extraction and surrounding stress environments generally, could not be accurately simulated.

(d) Judiciously sited outcrop stripping and closely spaced reverse circulation drill holes could supply most of the structural information over a much wider geographic area at a fraction of the cost of driving a long adit. Short adits could also be driven to provide samples and a limited amount of geological and mining data.

In the light of results, the decision not to proceed with a long adit has been vindicated, even beyond the most hopeful expectations.

3.3.5 COAL QUALITY EVALUATION AND RESERVES

Proximate analysis and determination of physical properties, including washability tests of the coal cores, face samples and bulk samples, in part were carried out in the laboratories of Cargo Superintendents (A/sia) Pty. Ltd., Sydney, Australia. Bulk and face samples were dealt with in the laboratories of Coal Science and Minerals Testing, Calgary, Alberta.

Check samples, including some of the earlier cores, were also run. Full data on all analytical work is included in Appendices A and F.

Petrographic analyses of drill core samples were carried out by Dr. A.C. Cook of Wollongong University College and Messrs. Birmingham and Cameron of the Geological Survey of Canada. Dr. Cook also carried out carbonization tests on the samples submitted. Details of these studies are contained in Appendices C and D.

Reserves in appropriate categories were calculated in accordance with the standards of the New South Wales Standing Committee on Coalfield Geology on the basis of detailed isopach maps. Isoash maps graphically highlight the distribution of ash in these high quality seams. All aspects of the reserves and coal quality are discussed in Section 5.

3.3.6 MINING CONDITIONS

A close liaison was maintained throughout the field work and the writing of this report with the mining engineering staff of Austen & Butta Limited, with Henry E. Collins, Chartered Engineer of London and Dr. A. Hargraves, Broken Hill Proprietary Co. Ltd., Australia, working on gassiness and strata control. Section 6 of this report is an epitome of this prolonged communication, bringing together, with certain necessary repetition from other sections, the salient features of structure, lithology, hydrology and other physical aspects affecting mining.

3.3.7 REPORT PREPARATION

Severe limitations were imposed upon the preparation of an adequate report due to the deadline of March 10, 1972, that had been set. Additionally, it was required that all geological interpretations and reserve calculations be complete by February 21, 1972, for study by the validators, Robinson and Robinson, Inc., Consulting Mining Engineers of Charleston, West Virginia.

The drilling programme ceased on November 12, 1971 and the geologists left the site on December 2, 1971. There was thus an effective period of some 10 weeks for the final preparation of the great bulk of the geological data of this report. The necessary lag between submission of samples and availability of results meant that analytical data on the coal seams were still coming to hand from the laboratories of Cargo Superintendents (A/sia) Pty. Ltd., up to January 24, 1972. Thus, tables, reserve calculations in quality categories and coal quality maps could not be finalized until after that date. With all the appended data, the geological report comprises some 2,000 pages together with 40 supporting geological maps and sections and more than 40 text figures. It was necessary to hand-colour some 25 sheets of this illustrative material. Thirty complete copies and thirty partial copies of the report were required. Thus, in all, more than 60,000 pages were printed, with some 1,900 illustrations of which 750 were hand-coloured. Each report was bound in 12 volumes,for which a total of some 400 covers were required to be appropriately gold blocked and the contents assembled.

In these circumstances, the timing proved to be somewhat tight. To meet the stage by stage deadlines for printing, the report was written in sections as appropriate sections of data were, hopefully, finally interpreted. Of necessity, certain cross-references and observations, arising from the writing of other sections, were added later. Foot-notes and insertions were introduced to cover these situations. Other editorial deficiencies of like nature were inevitable, e.g. certain minor repetitions and minor inconsistencies in terminology. Furthermore, it was also necessary to number the pages in groups, section by section.

The many text figures, most of which are scaled-down versions of selected large-scale maps, have been designed to make the geological text section of this report a virtual entity, readable independent of the great bulk of appended data. Thus, by adding the geological map and a typical section to Volume 1, it is felt that the major substance of the report will be provided.

Not only will this be convenient for any reviewer of the report, but has practical advantages in situations when either all 12 volumes of data were not required or when transportation difficulties were involved.

All in all, it is felt that a reasonable integration of separate writings of all the members of the geological team was achieved. A process of successive editing was employed which tended to iron out the differences in literary style and presentation. As many independent checks as possible in the time available were carried out on the more critical data.

It would also be fair to say that much more remains to be gained from further interpretation of the numerous structural and stratigraphic maps that have been produced. The critical reviewer will be able to extend the work that has been done on the basis of the data presented.

SECTION 4

GEOLOGY

This section of the report deals with relevant aspects of the regional geology and discusses the stratigraphy and strucutral geology of the Sukunka Coal Project area. Particular emphasis is placed on the coal-bearing Gething Formation; each sedimentation unit of the Upper Gething sequence is described in detail.

Twenty text figures are included in this section to assist the reader and to lessen the necessity to refer to the various maps in Volumes 2 and 3. However, reference must be made to the Geological Map and the Fence Diagrams in Volume 2 and the Geological Cross·Sections in Volume 4 to obtain a full appreciation of geological relationships.

The term "Sukunka Coal Project area" or "project area" here refers to the area covered by the Geological Map, (or more generally, the relevant part of the Coal Licence area marked on that map), while "exploration grid" or "grid area" refers to the 20,000 feet by 10,000 feet area in which a 2,000 feet grid was set up as a basis for the drilling programme. References to grid lines are as on this grid; grid squares are referred to by the grid reference of their south-western corner.

Section 4 incorporates a considerable amount of the basic data which is included in Volumes 5 to 12 inclusive. The data in Appendix C-2, Appendix B, Appendix E, Appendix F and the well logs in Volume 12 have been incorporated in the Geological Map, Geological Cross Sections, Isopach Maps, Structure Contour Maps and the Fence Diagrams.

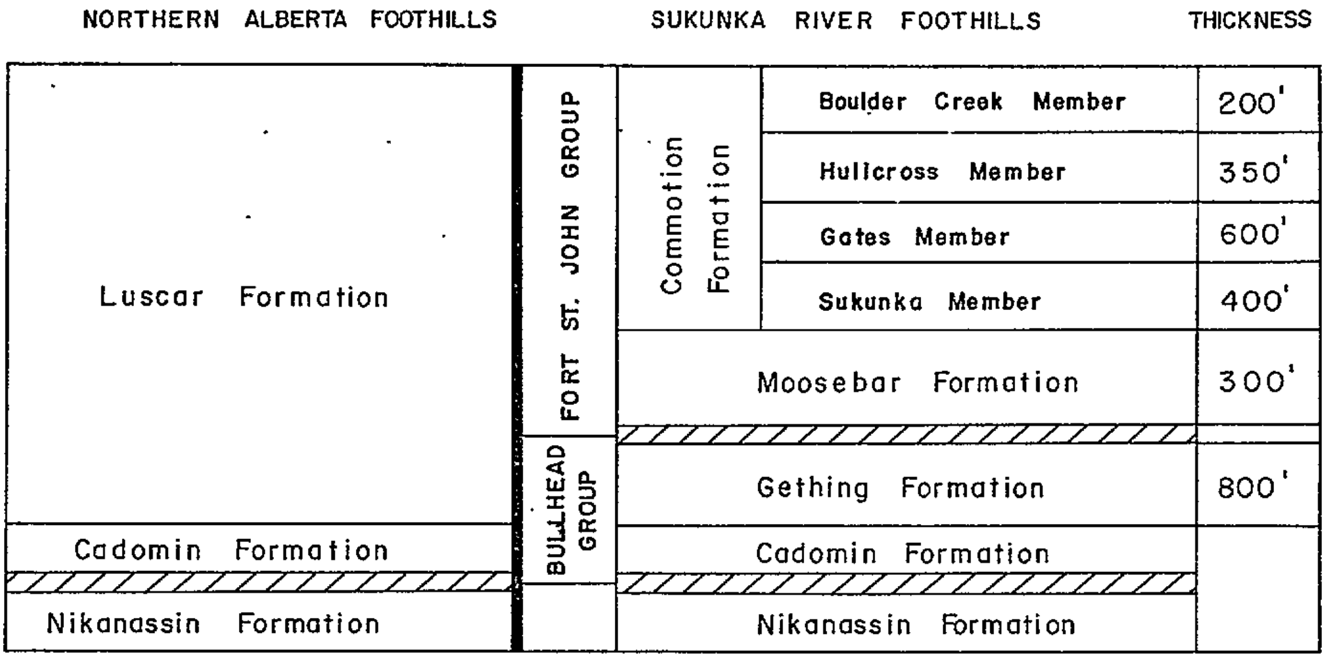
In the Sukunka Coal Project area, there are eight coal seams in the Gething Formation. Four of the seams are in the lower 150 feet of this formation. Two thin bands of coal occur in the lowermost 50 feet; towards the top of this 150 feet interval, there are two seams with numerous claystone bands, which are referred to as the "middle coals". A thin band of coal is locally developed about 570 feet above the base of this formation. The two potentially economical seams in the project area, the Chamberlain and Skeeter Seams are approximately 600 feet and 625 feet, respectively, above the base of the Gething Formation (that is, some 200 and 175 feet respectively, below the top of the formation). The Bird Seam is in the uppermost 10 feet of the formation.

The stratigraphic positions of the foregoing units are shown in Figures 4.3 and 4.4.

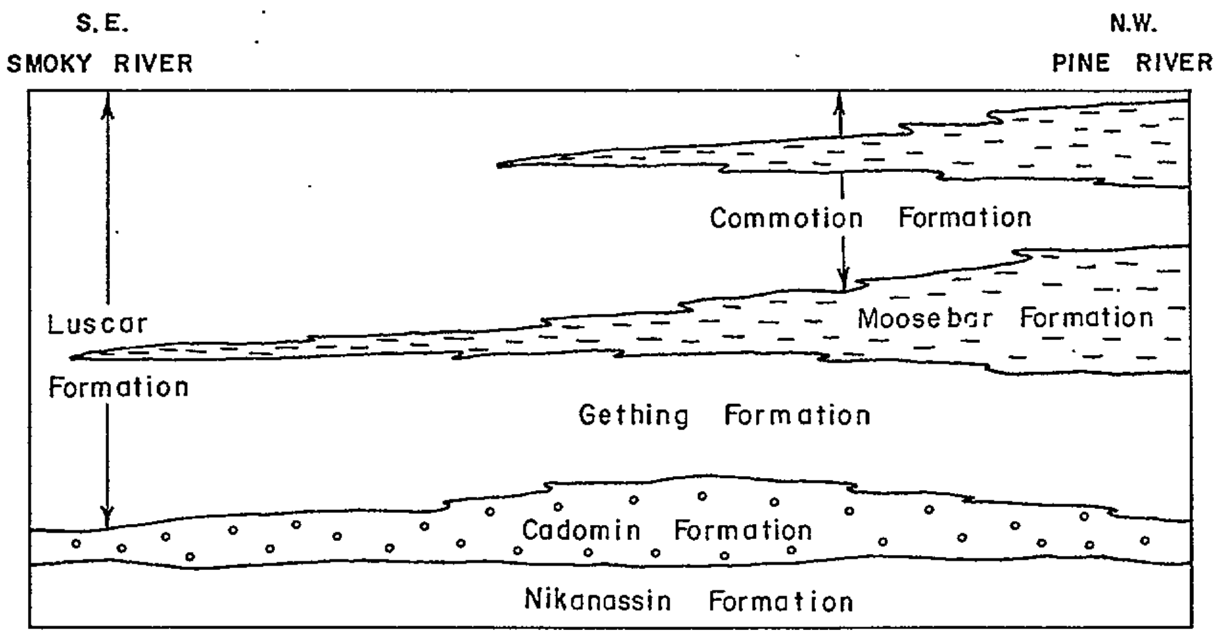
Investigations in the project area were directed towards the upper 200 feet or so of the Gething Formation, including the Chamberlain and Skeeter Seams. With this in view, it has been convenient to refer to that part of the Gething Formation above the floor at the Chamberlain Seam as the Upper Gething sequence. The underlying strata are correspondingly referred to as the Lower Gething sequence.

A detailed knowledge of the Upper Gething sequence has been acquired from drill hole data and from outcrop, particularly where the coal seams have been exposed by stripping. The succession of stratigraphic units within the Upper Gething sequence is for the most part remarkably consistent throughout the project area, and the twelve recognisable sedimentation units are discussed individually in the second part of Section 4.2.3. Variations in thickness and lateral facies changes occur in many of the units within the Upper Gething sequence. These are well documented and

FIGURE 4·1



CORRELATION OF LOWER CRETACEOUS SEQUENCES (Modified after Stott, 1960)



SCHEMATIC DIAGRAM ILLUSTRATING THE RELATIONSHIP BETWEEN LOWER CRETACEOUS SEQUENCES FROM PINE RIVER TO SMOKY RIVER. (Modified after Stott, 1960)

REFERENCE

/////////// Erosional unconformity.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Evidence of Pleistocene glaciation is widespread in the Foothills.

(ii) CRETACEOUS

The Cretaceous rocks of the Foothills of British Columbia have been the subject of recent investigations, particularly by Stott (1960, 1961, 1963 and 1968) and Hughes (1964, 1967).

The Lower Cretaceous sediments of the Fort St. John Group and Bullhead Group, deposited in marine, terrestrial and transitional environments, attain a maximum thickness of about 6500 feet in the Foothills. The terrestrial sequences are characterised by sandstones and conglomerates with interbedded carbonaceous shales, claystones and coal seams. In general, the marine sediments are pelitic and contain the remains of marine organisms.

Stott (1960) proposed a correlation of the Lower Cretaceous sequences in the Foothills at Alberta with that further north-west in British Columbia. This correlation together with the regional facies changes proposed by the same author are included in modified form in Figure 4.1 .

The several periods of marine sedimentation which were a significant part of the early Cretaceous sedimentational history in the Pine River area are represented by only thin intervals of strata or are absent in the vicinity of Smoky River.

The subdivision of the Commotion Formation into three members was introduced by Stott (1968). However, Bergey et. al. (1971) introduced an additional unit, the Sukunka Member, at the base of the Commotion Formation in the Sukunka River area. Figure 4.1 shows the subdivision of the Commotion Formation adopted in this report. The Boulder Creek Member, at the top of the Commotion Formation is the youngest Cretaceous stratigraphic unit cropping out in the Sukunka Coal Project area.

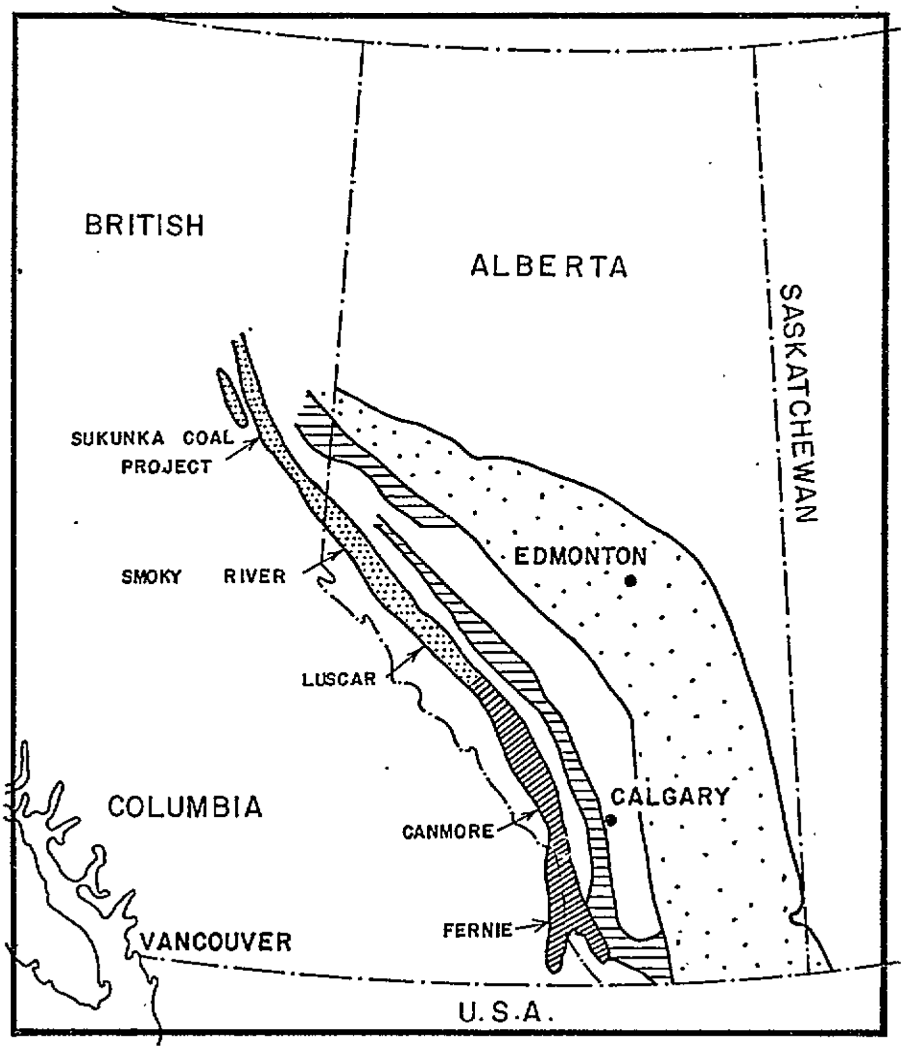
The Fort St. John Group of Stott (1968) includes the Commotion Formation and the underlying Moosebar Formation. The marine mudstones of the Moosebar Formation thin to the south-east towards Smoky River.

The Bullhead Group, as defined by Stott (1968), in the region between the Peace River and the Smoky River includes the coal-bearing Gething Formation and the conglomeratic strata of the basal Cadomin Formation. Within the Sukunka Coal Project area, the Gething Formation has, for convenience, been divided into two units. The Upper Gething sequence, some 200 feet thick, includes the Chamberlain Seam at the base and, at higher stratigraphic levels, the Skeeter Seam and the Bird Seam. The Lower Gething sequence, about 600 feet thick, overlies the Cadomin Formation. Although the Lower Gething sequence includes several coal seams, these are of inferior quality. Thus this part of the Gething Formation was not the subject of detailed investigations in the present project.

The areal distribution of coal-bearing strata in Western Canada has been discussed by Latour (1970). Three prominent north-west trending belts of coal-bearing strata exist in Alberta and British Columbia, as is indicated in Figure 4.2 . In general, the rank of the coal is highest in the west and decreases to the east, corresponding more or less to a decrease in the age of the coal-bearing strata.

The westernmost, Inner Foothills Belt, includes the Sukunka Coal Project and continues further north, at least as far as the Peace River. Low to medium volatile coals of excellent coking quality have been found, or are being won, at a number of localities within this belt. From near Canmore, south to Fernie, the economic coal seams are within the Kootenay Formation of late Jurassic to early Cretaceous age. Further north, to the west of Edmonton, coal is won from the overlying Luscar Formation of Lower Cretaceous age, in strata, probably equivalent to the Commotion Formation. To the north-west, in the Sukunka River

FIGURE 4·2



SCALE

0 100 200 300 MILES

REFERENCE

- Low and medium Volatile Bituminous (in Luscar Formation and Gething Formation)
- Low and medium Volatile Bituminous (in Kootenay Formation)
- High Volatile Bituminous
- Subbituminous

SKETCH MAP

AREAL DISTRIBUTION BY RANK OF COAL DEPOSITS OF WESTERN CANADA

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED (After Latour, 1970) area, the greatest development of coal is in the Gething Formation, a partial equivalent of the Luscar Formation. Further details of coal deposits in the Peace River District are discussed in Section 5.

4.2 JURASSIC/CRETACEOUS STRATIGRAPHY OF THE SUKUNKA RIVER AREA

4.2.1 NIKANASSIN FORMATION

This Jurassic to Lower Cretaceous formation is the oldest rock unit cropping out in the Sukunka Coal Project area. The term Nikanassin Formation was proposed by Mackay (1929) for this sequence of fine-grained sandstones and carbonaceous shales overlying the Fernie Formation of Jurassic age.

The moderately deformed strata of the Nikanassin Formation are exposed in a north-westerly trending belt in the western Foothills, where they attain a thickness of about 4,000 feet.

A widespread erosional unconformity separates the Nikanassin strata from the overlying, distinctive and remarkably continuous conglomerates of the early Cretaceous Cadomin Formation.

The Geological Map, Map 1, shows two small areas where the Nikanassin sediments crop out in the vicinity of the project area. These are along Chamberlain Creek, some 2 miles south of the Sukunka Camp and in an unnamed creek about 2 miles south of Bullmoose Mountain. Here the Nikanassin and overlying Cadomin Formation underlie, or are faulted against, the Gething Formation.

The Nikanassin Formation was not studied in detail and was not intersected in any drill holes.

4.2.2 CADOMIN FORMATION

This unit was originally defined by Mackay (1929) from its type locality at Cadomin Railway Station, south of the Athabasca River, Alberta. The Cadomin Formation represents the commencement of deposition over a considerable area to the north-east of the Rocky Mountains in early Cretaceous time.

Coalescing alluvial fans deposited the conglomeratic sediments in an extensive sheet which flanks its source to the west and thins rapidly eastward from the Foothills. Essentially continuous and conformable, marine and non-marine sedimentation followed the initial conglomeratic phase and continued throughout the Lower Cretaceous.

The Cadomin Formation is composed of massive conglomerates containing well rounded chert, quartz and quartzite pebbles, cobbles and boulders. Stott (1968) records that up to 600 feet of these conglomerates is exposed at localities in the Foothills between the Smoky and Peace Rivers. These overlie older rock units with erosional unconformity, though locally the relationship may be one of apparent conformity.

In the Sukunka River area, the Gething Formation conformably overlies the Cadomin Formation. This relationship exists in an unnamed creek two miles south of Bullmoose Mountain. The Cadomin Formation is faulted against the Gething Formation, just north of Chamberlain Creek.

4.2.3 GETHING FORMATION

Siltstone, sandstone, claystone and coal of the Gething Formation conformably overlie the Cadomin Formation. These two formations together constitute the Bullhead Group (Stott, 1968). The Gething Formation is overlain conformably by the marine mudstones of the Moosebar Formation.

The Gething Formation, about ~~1000~~ 1800 feet thick in the type area on the Peace River, thins to the east and to the south-east; at upper Smoky River, beds equivalent to the Gething Formation, are included in the basal part of the Luscar Formation. In the Sukunka River area, the Gething Formation is about 800 feet thick.

In the Sukunka Coal Project area, there are eight coal seams in the Gething Formation. Four of the seams are in the lower 150 feet of this formation. Two thin bands of coal occur in the lowermost 50 feet; towards the top of this 150 feet interval, there are two seams with numerous claystone bands, which are referred to as the "middle coals". A thin band of coal is locally developed about 570 feet above the base of this formation. The two potentially economical seams in the project area, the Chamberlain and Skeeter Seams are approximately 600 feet and 625 feet, respectively, above the base of the Gething Formation (that is, some 200 and 175 feet respectively, below the top of the formation). The Bird Seam is in the uppermost 10 feet of the formation.

The stratigraphic positions of the foregoing units are shown in Figures 4.3 and 4.4.

Investigations in the project area were directed towards the upper 200 feet or so of the Gething Formation, including the Chamberlain and Skeeter Seams. With this in view, it has been convenient to refer to that part of the Gething Formation above the floor at the Chamberlain Seam as the Upper Gething sequence. The underlying strata are correspondingly referred to as the Lower Gething sequence.

A detailed knowledge of the Upper Gething sequence has been acquired from drill hole data and from outcrop, particularly where the coal seams have been exposed by stripping. The succession of stratigraphic units within the Upper Gething sequence is for the most part remarkably consistent throughout the project area, and the twelve recognisable sedimentation units are discussed individually in the second part of Section 4.2.3. Variations in thickness and lateral facies changes occur in many of the units within the Upper Gething sequence. These are well documented and are best seen on the isopach maps and fence diagrams or on the sketch isopach maps included in the text. Similar lateral variations undoubtedly occur in the Lower Gething sequence, but recognition of them has not been possible from the limited available sub-surface information. Facies changes which occur in the lower 50 feet to 60 feet of the Upper Gething sequence have a significant effect on the interval from the floor of the Chamberlain Seam to the roof of the Skeeter Seam. These lateral facies changes occur in the south-eastern part of the project area and take place across a north-east trending zone between grid line G and grid line I. To the south of this zone, a sandstone/siltstone unit, Unit 1b, separates the Chamberlain Seam into an Upper Split and a Lower Split. Unit 2, a siltstone/claystone laminite sequence however, overlies the Chamberlain Seam throughout the project area. The Skeeter Seam, Unit 5, thins from the north-west towards this area of splitting and, in the south-eastern part of the project area, Unit 5 is dominantly or entirely a carbonaceous claystone. The sandstones of Unit 6 overlie Unit 5 throughout the project area.

The lower part of the Upper Gething sequence reflects a somewhat different depositional history on either side at this north-east trending zone. The differences were greatest during the coal-forming periods and the resultant facies changes are of considerable significance. Thickness variations and facies changes of each unit are discussed in part (ii) of Section 4.2.3.

Secondary mineralization in the Gething Formation is almost entirely confined to the presence of calcite in fault breccias, along some joint planes and, in places, as a thin film on the cleat in the coal. Some of the worm casts in the laminites of this formation have been replaced by pyrite. Pyrite of syngenetic origin is sometimes present in the Skeeter Seam, but more particularly in the upper part of the Bird Seam.

Structural aspects of the Gething Formation are discussed in Section 4.3. Structure contours, isopachs and fence diagrams, relating to units of the Gething Formation, are based on the drill hole data in Appendix F. For the details of any drill hole reference should be made to this appendix, where, in particular, detailed information of the Upper Gething sequence is included. Appendix E includes detailed maps of the outcrop of the Chamberlain and Skeeter Seams where they were exposed by stripping and includes a summary of observations at a number of localities along the outcrop.

The Lower Cretaceous coal-bearing strata of the Sukunka area, which includes the Commotion Formation as well as the Gething Formation, contain comparatively few plant fossils. Whereas disseminated plant debris has been observed at several localities, well preserved flora are very uncommon. A distinctive zone of shelly fossils occurs in the claystone immediately above the Skeeter Seam. The Gething Formation is relatively lacking in coarse detritus.

The foregoing, together with the argillaceous units with shelly fossils conveys an overall aspect suggestive of a low energy alluvial plain environment influenced by and with affinities to a marginal marine environment rather than to the periodic influence of higher energy terrestrial environments depositing coarse detritus.

(i) THE LOWER GETHING SEQUENCE

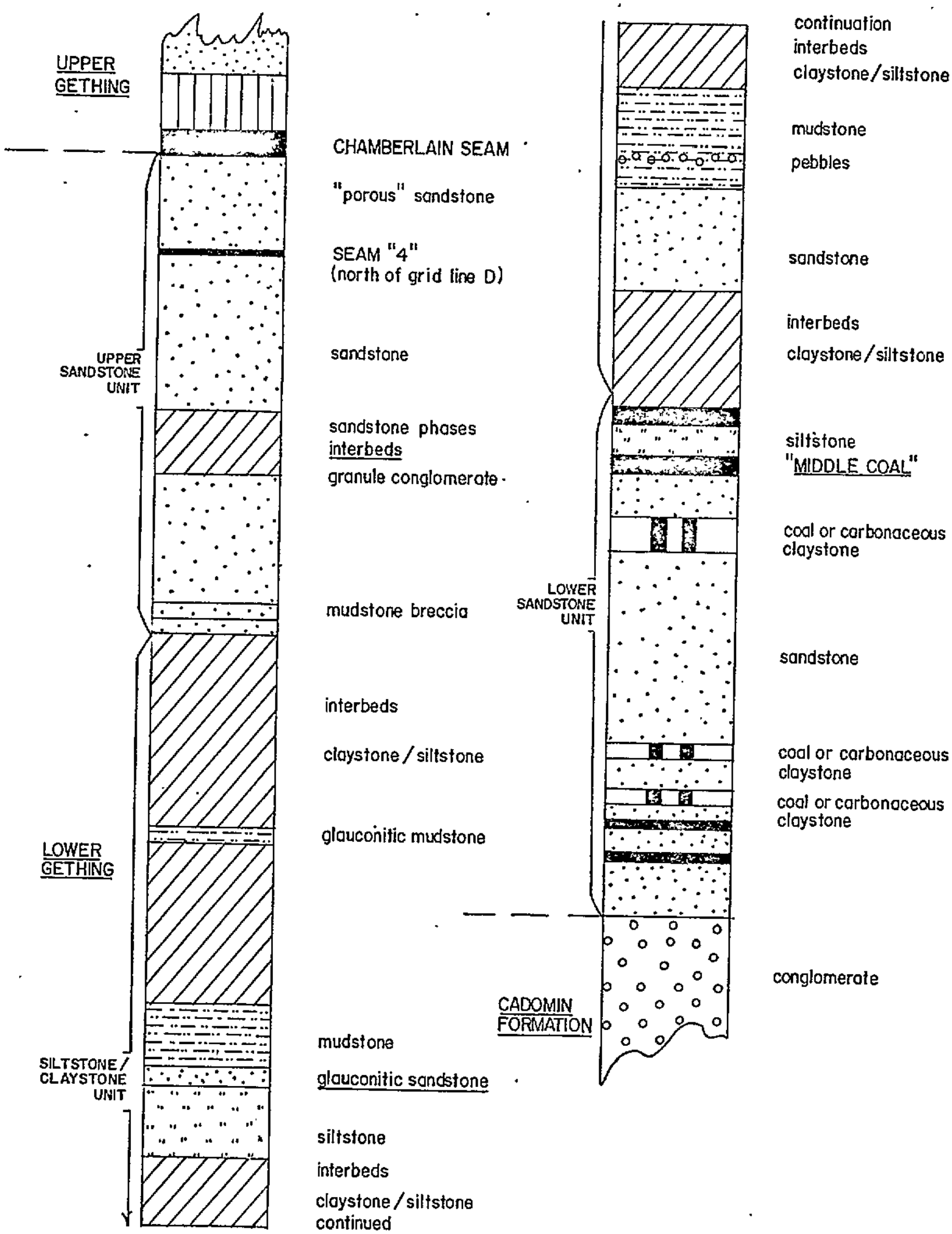
The Lower Gething sequence within the project area is defined as that interval of strata which lies between the top of the Cadomin Formation and the base of the Chamberlain Seam in the Gething Formation. Only one drill hole, D.D.H. S-7, penetrated the Cadomin Formation while 12 other drill holes have intersected more than 100 feet of Lower Gething strata. The stratigraphy of the Lower Gething sequence in the project area has been established in some detail from this drill hole data. Figure 4.3 is a Composite Graphic Section of the Lower Gething sequence. Unlike the Upper Gething, there is insufficient data on the Lower Gething strata to establish the presence of gradual lateral facies changes. The logs of D.D.H. S-8 and D.D.H. S-7 show that the Lower Gething sequence is approximately 600 feet thick and consists of 3 principal units: an upper and a lower sandstone unit separated by a sequence of claystone and siltstone.

The lowermost 150 feet is composed dominantly of fine and medium-grained quartz-lithic sandstone. Two coal seams, referred to as the "middle coals" by Hughes (1969/70), occur towards the top of this interval of strata. The upper seam, from information in five drill holes, is up to 7 feet thick, while the lower seam is 23 feet thick in D.D.H. S-7. Both of these seams contain numerous claystone bands of variable thickness. The seams are separated by about 15 feet of siltstone. Several thin bands of coal are present in the lowermost 50 feet of the Gething Formation.

The "middle coals" are overlain by a siltstone/claystone unit, about 300 feet thick. Carbonaceous claystone, siltstone and mudstone are the dominant lithologies. Several thin beds of glauconitic sandstone or mudstone were intersected in a number for 4.11

FIGURE 4·3

COMPOSITE GRAPHIC SECTION
LOWER GETHING SEQUENCE



SCALE
1" = 50 Feet

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY. LIMITED.

of the drill holes that penetrated the Lower Gething strata.

The uppermost 150 feet of the Lower Gething sequence is similar to the basal interval of similar thickness. This upper sandstone unit includes 20 feet of interbedded siltstone and claystone which occurs about 70 feet below the top of the Lower Gething. These interbeds exhibit graded bedding and are similar to those of Unit 9 in the Upper Gething sequence. The quartz-lithic sandstones of the upper sandstone unit are characterized by the presence of several thin beds of mudstone breccia, a sedimentary feature not recorded in the sandstones of the Upper Gething succession. A thin coal seam occurs about 30 feet below the Chamberlain Seam in the north-western part of the exploration grid, particularly between grid line A' and grid line C. In D.D.H. C-8 this coal seam attains a maximum thickness of 3.82 feet and is separated from the Chamberlain Seam by a massive, porous, quartz-lithic sandstone unit which increases in thickness to the north-west, but is generally in excess of 20 feet thick.

(ii) UPPER GETHING SEQUENCE

The Upper Gething sequence is defined by the Chamberlain Seam at the base, and a distinctive glauconitic sandstone at the top. These strata have been mapped in some detail throughout the Sukunka Coal Project area, and are considered separately from the underlying less economically important, Lower Gething sequence which is of less economic importance. The distribution of the Upper Gething is shown on the Geological Map, Map 1.

The essentially flat-lying sandstones, interbedded siltstones and claystones, siltstone/claystone laminites, siltstones and three coal seams are considered to be of non-marine origin. The marine mudstones of the Moosebar Formation rest with apparent conformity on the Gething Formation in the project area. However, on a regional scale Stott (1968), suggests that the relationship is one of disconformity. The strata within the Gething Formation are conformable.

Drilling in the project area has shown that the Upper Gething varies in thickness from a maximum of about 198 feet in D.D.H. C-24, in the south, to about 150 feet in D.D.H. CS-4 in the north-west of the exploration grid. The average thickness is of the order of 170 feet, and in general, the sequence thins towards the north. As a result of repetition due to faulting, some of the drill holes have intersected a thickness in excess of 300 feet of Upper Gething strata, and as much as 524 feet in D.D.H. C-17 (E/6).

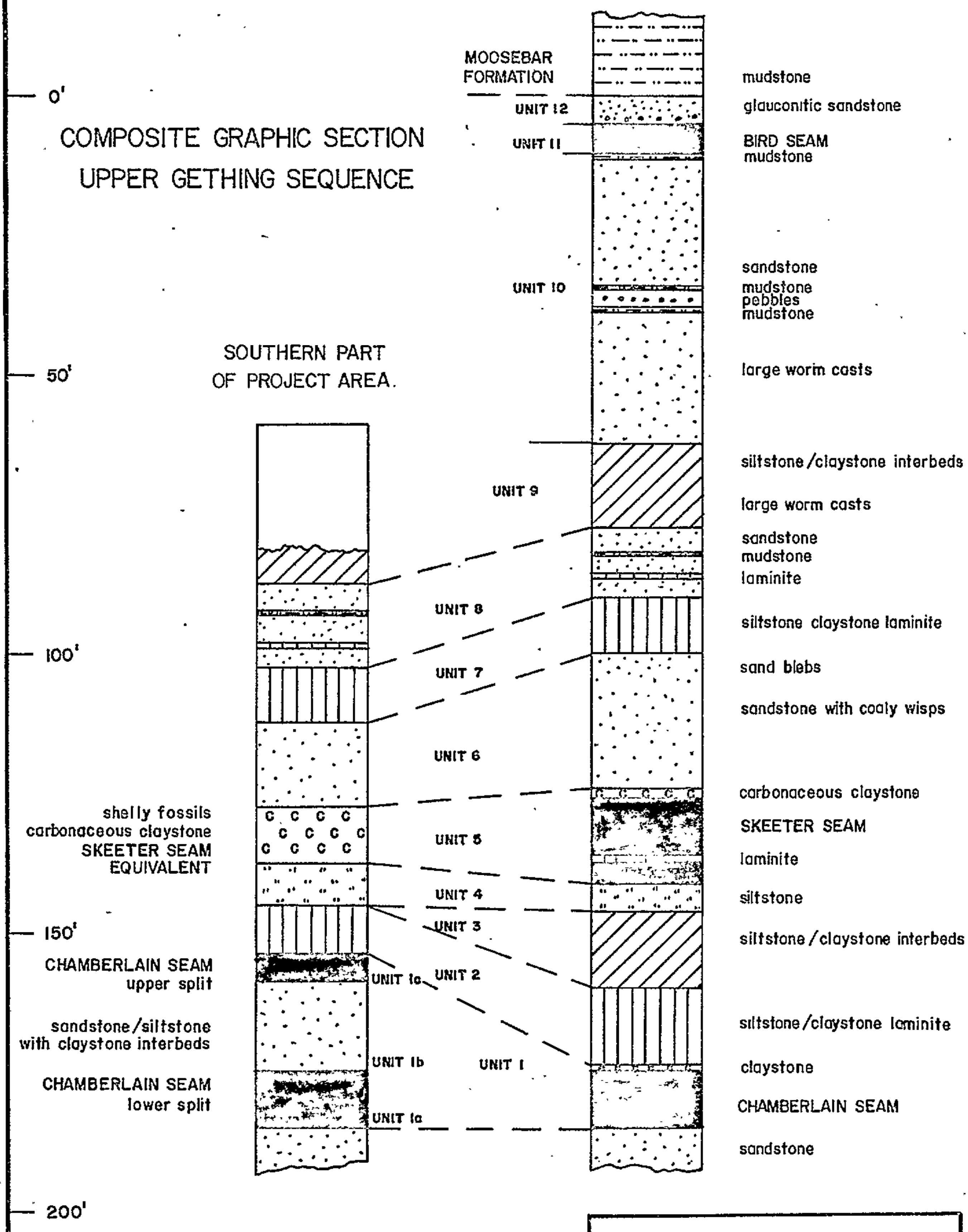
The Upper Gething sequence in the project area crops out below the tree line and is usually masked by densely wooded areas with thick undergrowth and windfall, scree from the overlying Moosebar Formation and glacial debris. The most continuous natural exposures of Upper Gething strata are located along the larger creeks. Outcrops along Skeeter and Chamberlain Creeks and their tributaries contributed substantially to the surface mapping. In areas which are largely covered by scree, surface data has been obtained from many road traverses.

Parts of the Upper Gething sequence have been exposed by the bull-dozing programme. The Chamberlain Seam has been exposed continuously along the north salient of the project area between the Chamberlain and Rim Faults (see Geological Map, Map 1). Much of the Skeeter Seam has also been exposed in this same area. In addition, the Chamberlain Seam has been exposed in Chamberlain Creek, in the vicinity of Adit #1, to the north-east of the Skeeter Fault, and to the south-east of the exploration grid. Although weathering of the units within the Upper Gething sequence produces some changes in the surface appearance of the rocks, most of the units which are distinctive in drill cores can also be recognised as distinctive in the field. Some of these distinguishing features are accentuated by the weathering process. The glauconitic sandstone unit overlying the Bird Seam is rarely seen in outcrop due to the masking effect of scree from the overlying Moosebar Formation. Where this sandstone does crop out however, the bright green colour readily distinguishes it from the sandstones lower in the sequence.

The sandstone unit which immediately underlies the Bird Seam crops out more continuously than other units in the Upper Gething sequence. Along Chamberlain Creek this unit forms part of the cliff immediately above Adits #1, #2 and #3. This sandstone unit develops a flaggy appearance in outcrop and is similar to the sandstones of the Gates Member in the overlying Commotion Formation.

All of the argillaceous units develop a very similar appearance as they weather and are described in the field as mudstones. In outcrop, the graded bedding in these argillaceous units can only be seen on freshly broken surfaces. Thin layers typically

FIGURE 4·4



COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

separate on the weathered surface of these sediments. The thickness of any one layer is directly related to the thickness of the graded bedded unit. Apart from the glauconitic sandstone there are no marked colour changes in the sediments of the Upper Gething sequence as weathering takes place.

As a general rule, a feature of this sequence is the remarkable consistency of individual units over the entire project area; only very minor variations occur in the character of these units. This has allowed precise correlation of the information obtained both in the field and from bore holes, and has assisted greatly in the determination of the sub-surface structure.

As a result of this stratigraphic continuity, it has been possible to draw up a typical graphic section relevant to the greater part of the project area, see Figure 4.4 . Each recognisable significant lithological unit within the Upper Gething sequence is discussed below. For convenience each unit, commencing with the Chamberlain Seam at the base, has been numbered as is shown in Figure 4.4 . Deviating from the general situation, there are, to the south of Chamberlain Creek, some significant variations involving the strata between the floor of the Chamberlain Seam and the roof of the Skeeter Seam. A supplementary graphic section of this interval is included in Figure 4.4 .

Unit 1 - Chamberlain Seam

The Chamberlain Seam is continuous at depth throughout the area covered by the exploration grid, and crops out on the flanks of the high ground bounded by Skeeter and Chamberlain Creeks, and to the south of Bullmoose Mountain. The floor of the seam ranges in elevation from 2881 feet in D.D.H. C-17 at E/6 on the grid, to 4496 feet in D.D.H. S-32, some 2000 feet east of grid point J/6.

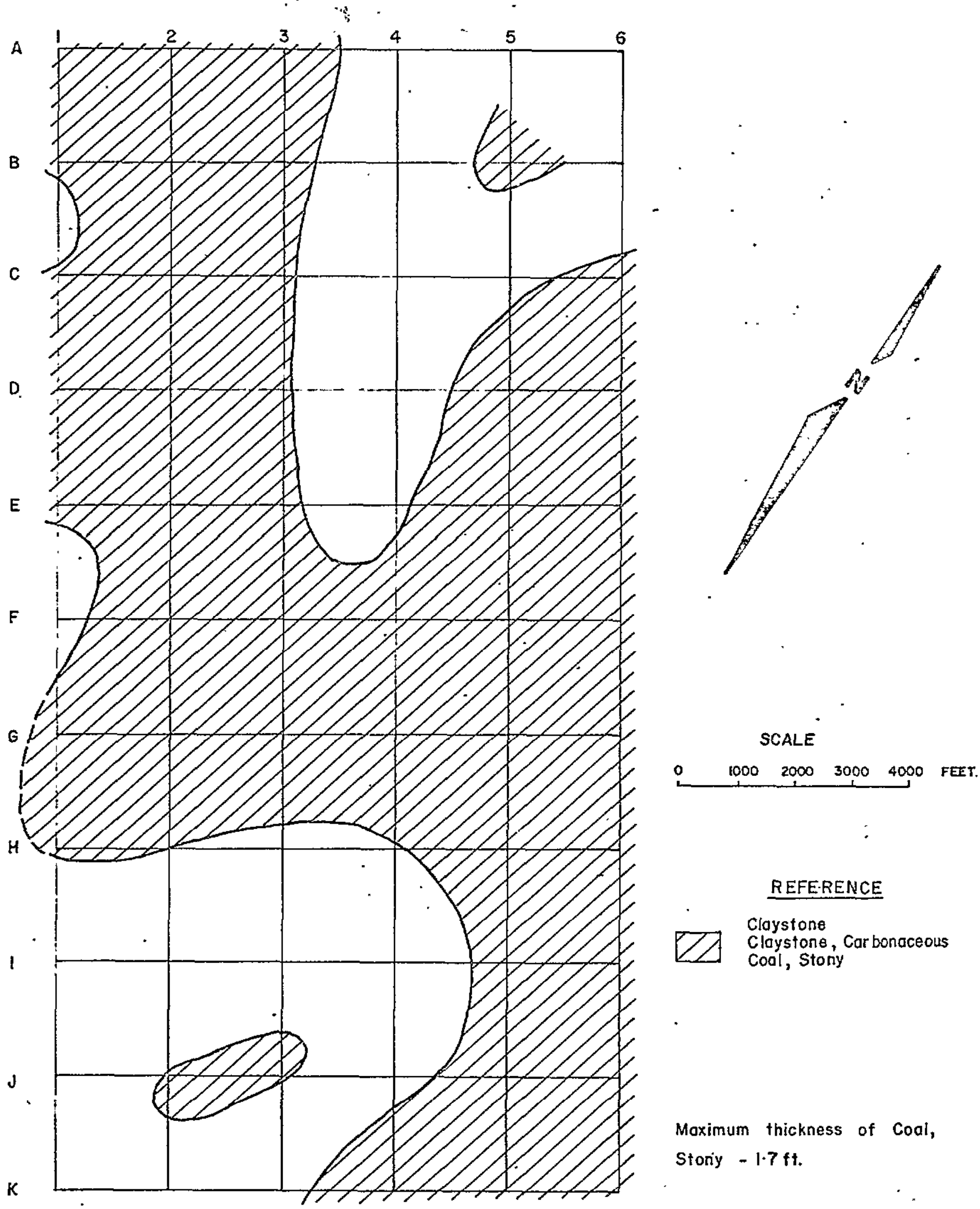
The changes of level of the seam are due mainly to low angle thrust faulting and gentle undulatory structures rather than to steeply dipping strata. Thus, with the exception of disturbed zones immediately adjacent to faults and small localised areas with dips of up to 25°, the seam has a horizontal to sub-horizontal attitude in each of the thrust plates with dips seldom being in excess of 10°. (Refer to Maps 1, 6, 7 and 8).

The seam is in general remarkably free of stone bands. However, in the area south of Chamberlain Creek, the seam is split by a sandstone band which, in the project area, increases in thickness further to the south and west to a maximum of 42 feet in D.D.H. S-46 (I/1). For convenience of reference, the seam has been divided into three sub-units, in ascending order, 1a, 1b and 1c. As shown in Figure 4.4 , 1a and 1c refer to the upper and lower splits of the seam respectively and 1b to the intermediate stone band. Details of the variation in thickness of Unit 1b are shown in Map 12. The band varies from grey, medium-grained, quartz-lithic sandstone to grey siltstone and locally includes minor dark grey claystone interbeds. Coaly partings are not uncommon within this unit.

The upper split of this seam, Unit 1c, is the thinner of the two, increasing from less than 1 foot in D.D.H. S-46 in the north near the upper reaches of Chamberlain Creek, to a maximum further south approximately along line J of the grid. In this vicinity a thickness of 5.59 feet was recorded in D.D.H. C-18 (K/2). As can be seen on the Isopach Map of the Upper Chamberlain Split, Map 11, this unit is in excess of 3 feet thick for most of this area.

Immediately above the Chamberlain Seam at the base of the interseam sediments is a bed of stony coal/carbonaceous claystone, or dark grey to brown claystone. This bed, locally referred to as "bone",

FIGURE 4·5



SKETCH MAP

UPPER GETHING SEQUENCE
DISTRIBUTION OF CLAYSTONE
AND COAL STONY - ROOF OF
CHAMBERLAIN SEAM.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

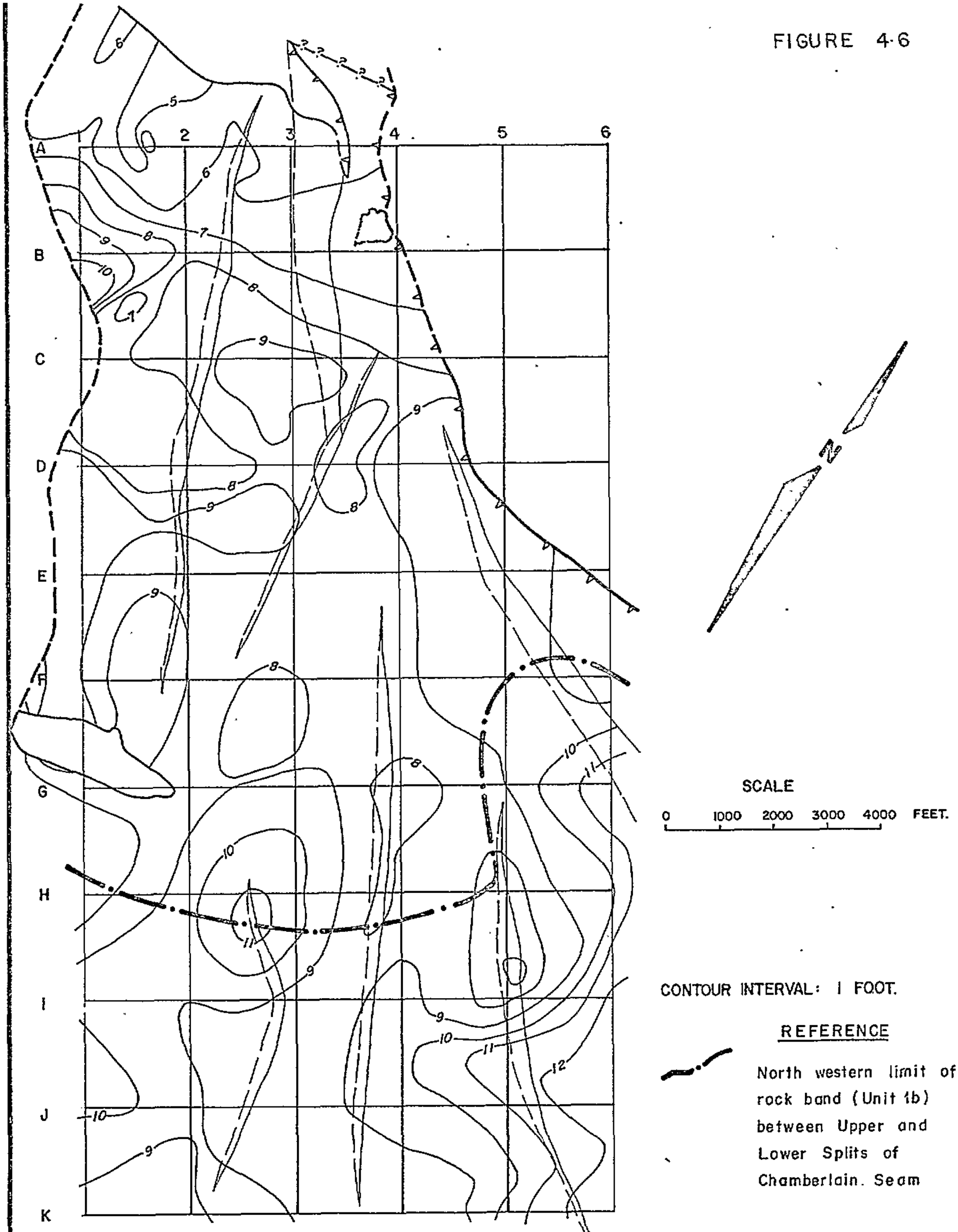
may include more than one of these closely related rock types, though the more carbonaceous lithology usually directly overlies the coal. The distribution of this claystone/stony coal unit is shown on the accompanying Sketch Map, Figure 4.5 , and is included because of the likelihood that some of this material will inevitably be mined with the coal. This "bone" horizon varies in thickness from as little as 0.17 feet in D.D.H. CM-7 to 0.93 feet (0.58 of stony coal overlain by 0.35 of carbonaceous claystone) in D.D.H. C-32.

The Isopach Map of the Chamberlain Seam, Map 10, shows that over the greater part of the grid area the Chamberlain Seam and its extension as the lower split, exceeds 8 feet in thickness. However, one positive trend in thickening commences at about grid line B, where Unit 1 thins to the north from about 7 feet to as little as 4.58 feet in D.D.H. S-8. See Figure 4.6.

Drill hole records for D.D.H. S-39 indicate that 2 feet of coal was recovered in the core. The hole was drilled during the 1970 field season on behalf of Brameda Resources; an attempt to electrically log the hole in the 1971 field season was unsuccessful due to collapse of the hole. The only log available is in summary form and does not record the lithologic units accurately enough to indicate the accuracy of the coal recovery. Additionally, the isopach maps of adjacent rock units provide no evidence for a sudden thinning of the coal seam in this area. Consequently, the data from D.D.H. S-39 has been disregarded.

It is evident from bore logs such as those of C-14, S-2, C-9, and S-16 that thicknesses in excess of 20 feet of Chamberlain Seam have been encountered. However, these intersections are in fault zones and the increased thickness is best explained as being due to compression of tectonic origin. Accordingly, as these values are not meaningful, they have not been included on the isopach maps or used in calculations of coal reserves. The Isopach Map,

FIGURE 4·6



SKETCH ISOPACH MAP

CHAMBERLAIN SEAM

PLATE 2

SHOWING LOWER SPLIT ONLY IN SOUTH

See also Map 10 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

Map 10 indicates that the areas where the Chamberlain Seam exceeds 9 feet are considerable. Thicknesses of up to 12.98 feet of the lower split have been recorded in the south-eastern part of the grid and, in general, the seam thickness decreases to the north-west.

Greater detail of the coal and its physical properties and other attributes are given in Section 5, dealing with coal quality. The coal has an overall bright appearance, but close examination reveals that the coal is mainly dull with frequent bright bands or dull with minor bright bands. The dull coal is, however, highly lustrous, and its description and identification as such is possibly only by comparison with the brighter coal. In undisturbed areas the coal has a moderately well developed vertical to sub-vertical cleat, sometimes with minor calcite infillings. In many areas joint and/or shear planes disposed at angles of between 0^{o} to 90^{o} to the core axis occur and a variety of attitudes of this planar feature can be found at different levels in any one seam section. Where cleats and joints in the Chamberlain Seam are observed, the coal and the roof material exhibit variations in the joint density. In the brighter vitrain bands cleats are often as closely spaced as 0.01 feet, while in the dull bands the cleats are normally spaced more than 0.03 feet apart. In contrast, within the more competent roof of the seam, joints are approximately 0.10 feet apart, and in the overlying claystone are commonly 0.05 feet apart.(1)

In the fault zones shearing becomes a prominent feature with numerous slickensided planes along which the coal fractures into finely divided flakes. The bright slickensided surfaces, being at an angle to the bedding, completely mask the banding in the coal thus making the recognition of the amount of dull and bright bands virtually impossible in such zones.

(1) See Appendix E for description of outcrop observations and underground data from Adit #1 to #5.

Units 2, 3 and 4 - Chamberlain/Skeeter Interseam Sediments

Between the Chamberlain Seam and the Skeeter Seam, or its carbonaceous claystone equivalent, is an argillaceous sequence which varies in thickness from 10 feet to nearly 60 feet. Over much of the project area three distinct units are recognised, as is indicated on the Composite Graphic Section of the Upper Gething Sequence, Figure 4.4 . Units 2, 3 and 4 are recognised in those areas north of Chamberlain Creek where the Skeeter Seam is potentially of economic significance. To the south and south-east of the project area Units 2 and 4 are usually present in the interval between the Chamberlain Seam and the carbonaceous claystone equivalent of the Skeeter Seam (see Figure 4.4). Map 21[1] shows the variations in thickness of these interseam sediments throughout the exploration grid area.

In general, the thickness of this interval of strata is between 15 feet and 25 feet. To the south-east, where the Skeeter Seam is absent or is represented only by thin coaly bands and carbonaceous claystone, these strata are somewhat thicker, generally being between 20 feet and 40 feet in all.

Overlying the "bone" at the top of the Chamberlain Seam is a siltstone/claystone laminite, Unit 2, which is extremely widespread, as is the siltstone below the Skeeter Seam, Unit 4. The interbedded siltstone and claystone, Unit 3, is distinguished by the less frequent alternation of lithologies. Unit 3 is not recognised in the south-eastern part of the project area.

The siltstones in the three units are similar, being brownish grey to grey in colour with minor fine-grained quartz-lithic sandstone phases. Discrete, lenticular carbonaceous blebs or wisps are often present in the arenaceous phases. The claystones are dark grey in colour and provide a contrast with the lighter coloured, coarser-grained sediments. The laminites and siltstone/claystone interbeds part readily along bedding planes. The

(1) See also Figure 4.7.

siltstones of Unit 4 are less thinly bedded and are relatively more massive.

Worm casts are sometimes present in these argillaceous sediments, but fossils and plant debris are extremely rare.

Unit 5 - Skeeter Seam

The Skeeter Seam, or its carbonaceous claystone equivalent, is recognised throughout the whole of the exploration area. To the north of Chamberlain Creek, the Skeeter Seam is generally between 15 feet and 40 feet above the Chamberlain Seam as is shown on Map 21; in plate 3, at the outcrop, and in D.D.H. C-34, the inter-seam distance is approximately 10 feet. In the southern part of the project area, a significant lateral facies change has resulted in Unit 5 being dominantly a carbonaceous claystone with some coaly bands.

The Composite Graphic Section of the Upper Gething sequence, Figure 4.4 , includes an additional graphic section of the sequence recognised south of Chamberlain Creek. The areal distribution of the carbonaceous claystone, the Skeeter Seam equivalent, is coincident with that of Upper Split of the Chamberlain Seam over large areas in the southern part of the project area. In the earlier stages of investigation, the coal, which is now established as the Upper Split of the Chamberlain Seam, was considered to be the Skeeter Seam. With the acquisition of additional drill hole data and an increasing knowledge of the detailed stratigraphy of the Upper Gething sequence, it was possible to establish the composite sections presented in Figure 4.4 . These demonstrate the facies changes and enabled correlation of the lower part of the Upper Gething sequence throughout the project area.

In the southern part of the project area, the correlations presented in Map 3 are based more particularly on the recognition of the inter-seam sediments, Units 2, 3 and 4 or Units 2 and 4 where Unit 3 is absent and on the recognition of Unit 6 which overlies the Skeeter Seam or its carbonaceous claystone equivalent. It is, on this basis, that the Upper Split of the Chamberlain Seam has been recognised.

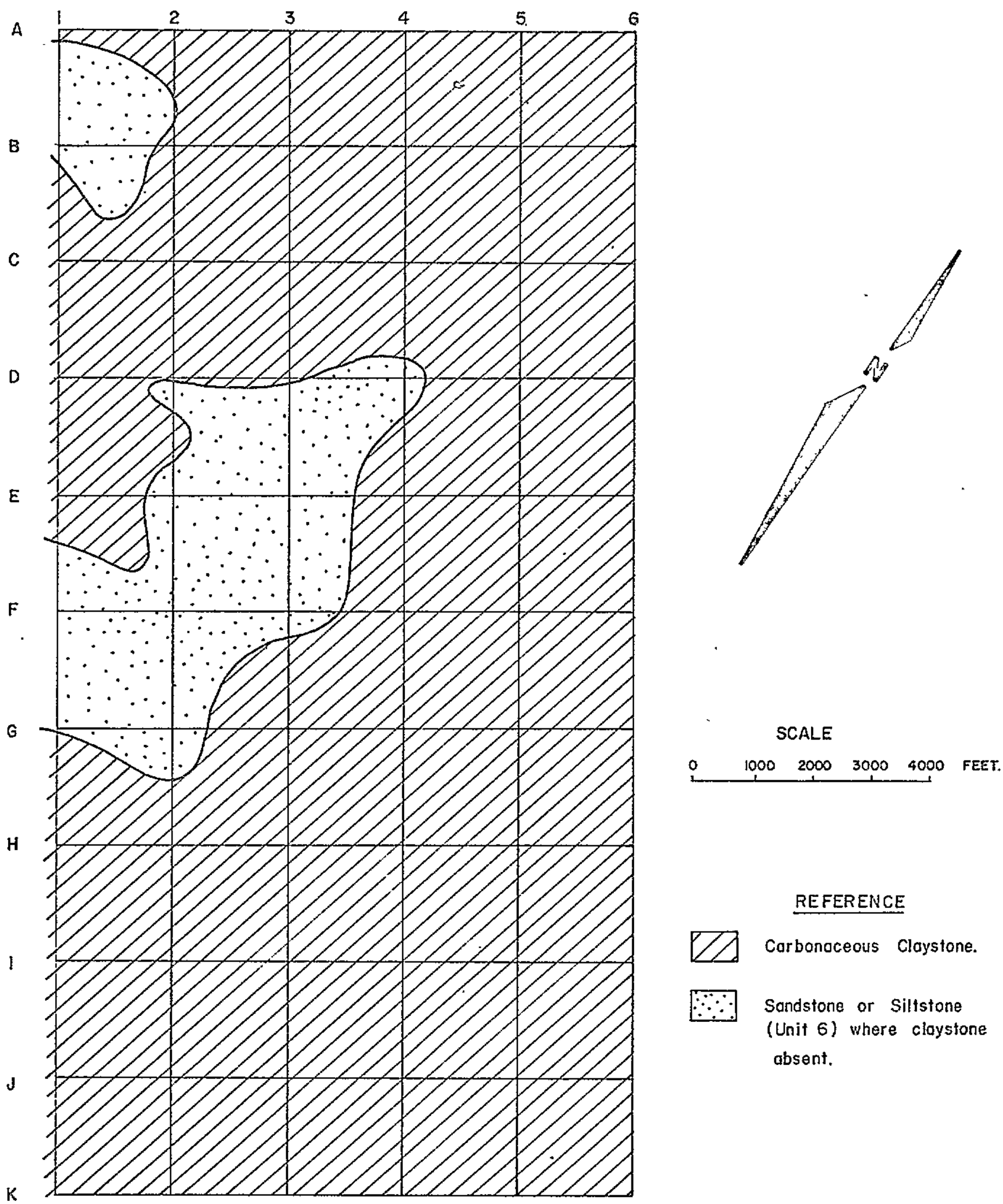
The Skeeter Seam is gently dipping to flat lying as is the Chamberlain Seam. The two seams are so close together in the succession that the structure contours constructed for the Chamberlain Seam accurately reflect the sub-surface structure of the Skeeter Seam.

Generally south of grid line H, the carbonaceous claystone equivalent of the Skeeter Seam includes thin bands of coal, but no isopachs have been included on Map 14 in this area. Elsewhere this seam is from 3 feet to 14.5 feet thick, although this maximum thickness is recorded in only one drill hole, D.D.H. C-37. In general, the Skeeter Seam is about 8 feet thick in the north-western part of the project area, and thins to the south-east.

The fence diagram, Map 4, shows the distribution of the bands in the Skeeter Seam in the north-west where workable sections of this seam exist. *The working section of the Skeeter Seam, Maps 15 and 16, usually includes the Upper Split of the Skeeter Seam, may include the Upper Band of stone and the coal below the roof of the seam and less frequently includes the Lower Band of stone and the coal above the floor of the seam.*

The Lower Band varies considerably in thickness, as shown in Map 20, attaining a maximum of 7.6 feet in D.D.H. C-8. The thickness of this carbonaceous claystone or siltstone band, and of the comparatively thin coal band below it are such that these can rarely be considered in the working section.

FIGURE 4·8



SKETCH MAP

UPPER GETHING SEQUENCE
DISTRIBUTION OF CARBONACEOUS CLAYSTONE.
(SKEETER SEAM ROOF)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

The Upper Split of the Skeeter Seam, Map 19, may include the entire interval above the Lower Band and below the roof of the seam, but an Upper Band, usually less than 1 foot thick, is frequently developed in the uppermost few feet of the Skeeter Seam. The Upper Band, composed of carbonaceous claystone and dark grey mudstone, occurs sporadically in the north-western part of the project area.

The coal of the Skeeter Seam is best described as "mainly dull with minor bright bands." The coal tends to be brighter in the upper part of the seam. Vertical cleats, though well developed, are not as pronounced as those in the Chamberlain Seam.

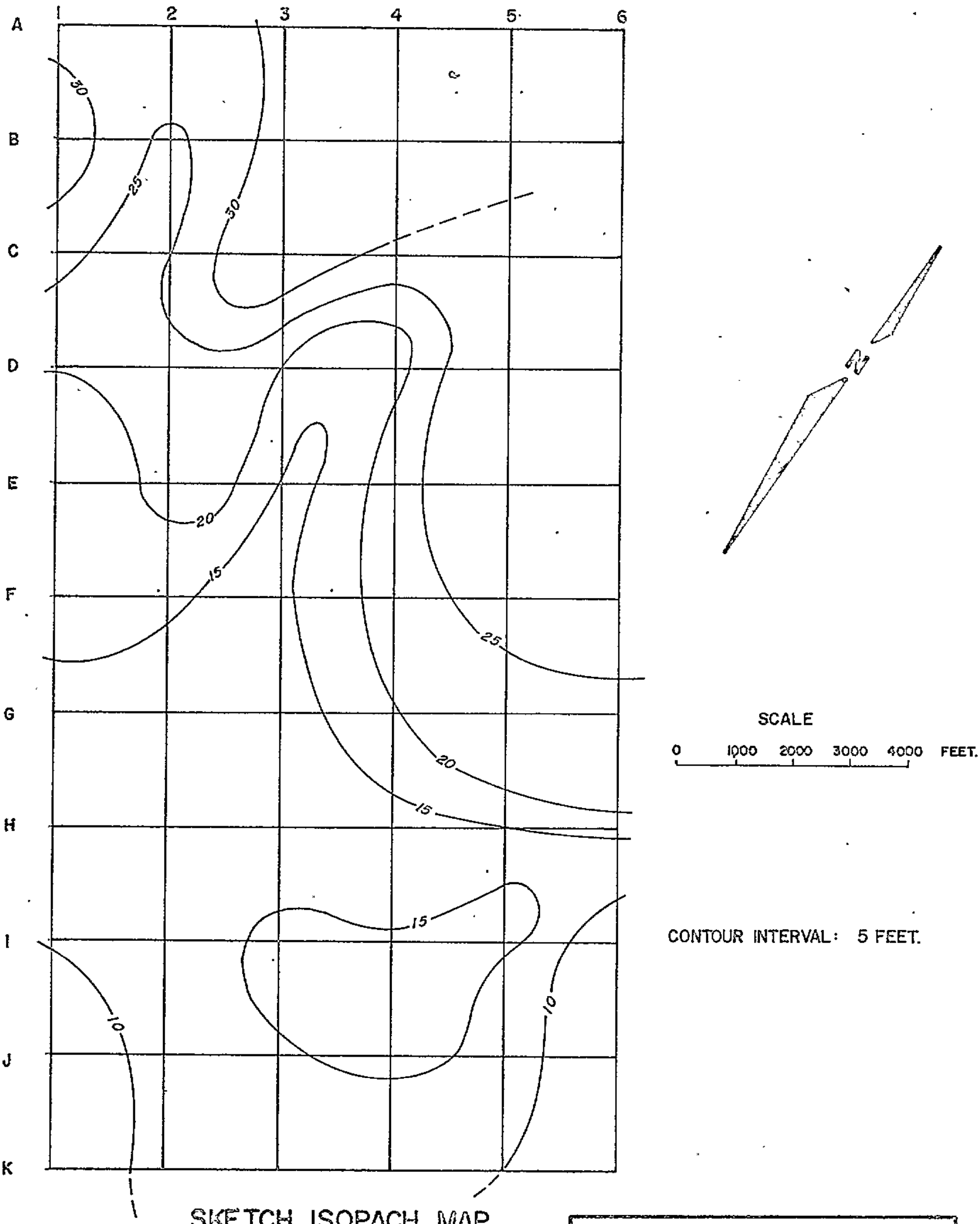
The roof of the Skeeter Seam is dark grey to dark brown carbonaceous claystone in the north-western part of the project area. This claystone, which often contains shelly fossils, is included in Unit 5 in the Composite Graphic Section, Figure 4.4. In the absence of this claystone roof, the roof of the Skeeter Seam is the sandstone of Unit 6. Figure 4.8, a sketch map, shows the areas where Unit 6 forms the roof of the Skeeter Seam.

The carbonaceous claystone roof is generally between 1 foot and 3 feet thick, however, to the south-west where Unit 5 is entirely composed of this lithology, a maximum of 9.14 feet was recorded in D.D.H. C-26. The shelly fossil zone near the top of Unit 5 is a particularly useful marker horizon which is present throughout the greater part of the project area.

Unit 6 - Sandstone with Coaly Wisps

Overlying the claystone roof of the Skeeter Seam is a sandstone unit which is continuous throughout the project area. This light grey, fine-grained, quartz-lithic sandstone unit contains brown carbonaceous claystone and grey siltstone interbeds. The

FIGURE 4·9



CONTOUR INTERVAL: 5 FEET.

SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE

UNIT 6

SANDSTONE (COALY WISPS)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

carbonaceous claystone roof of the Skeeter Seam, where present, passes up into the sandstone unit which contains interbeds of claystone near the base. Approximately 2 to 3 feet above the base, a carbonaceous claystone band from 1 foot to 3 feet thick is usually present. Above this band the claystone interbeds become less abundant.

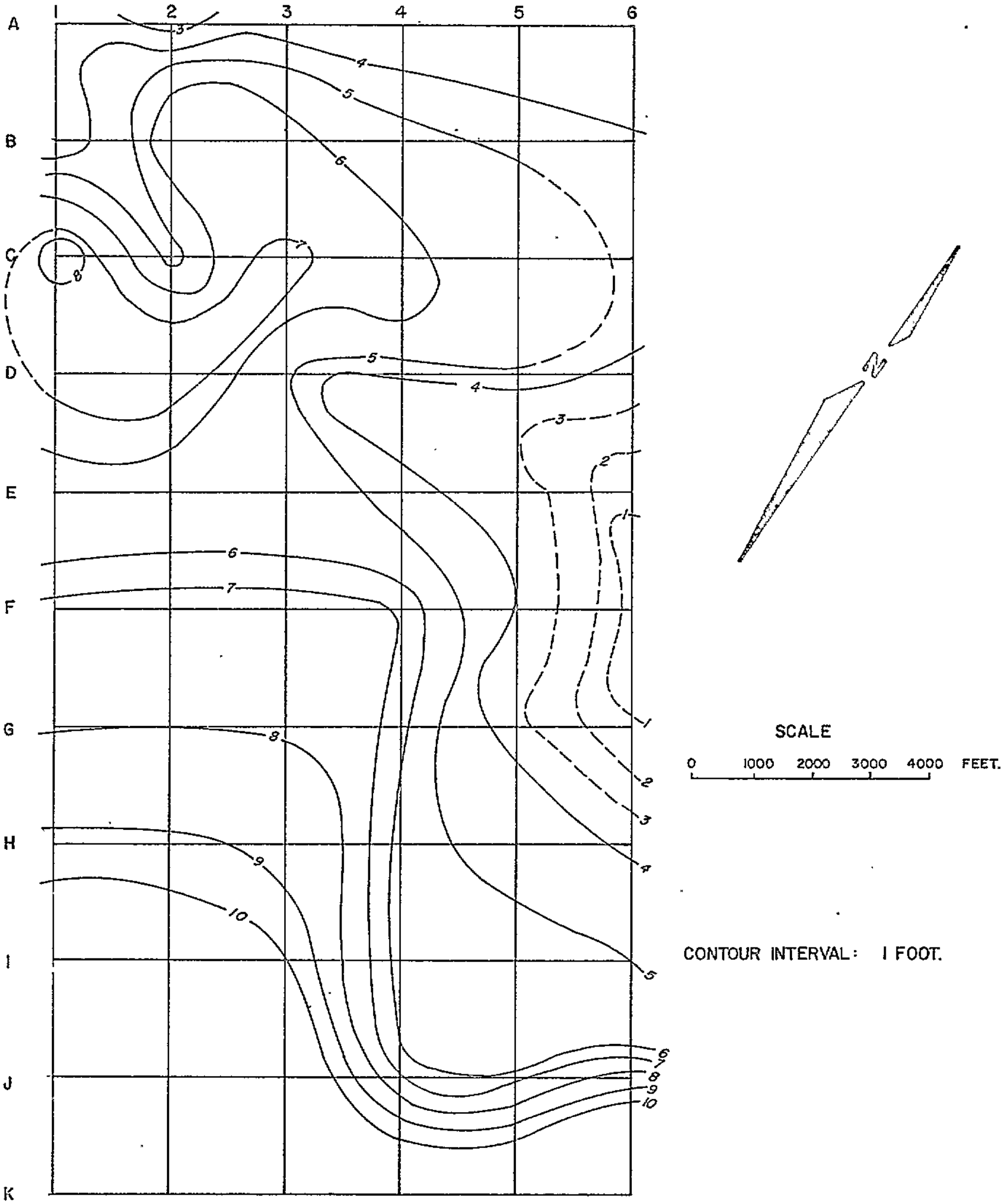
The ubiquitous occurrence of lenticular carbonaceous or coaly wisps and random carbonaceous penny bands in this sandstone is quite distinctive; the unit as a whole is a useful marker bed. Particularly towards the top of this unit, light coloured sandstone bodies are usually present. These small circular bodies, with a diameter of about 0.1 inch, which are clearly seen in the drill cores, are possibly cross sections of worm burrows. Their lighter colour is due to the absence of carbonaceous material.

The Sketch Isopach Map, Figure 4.9 , shows a variation in thickness of this unit from about 15 feet in the south-east, to more than 30 feet in the north-west.

Unit 7 - Siltstone/Claystone Laminite

This rock unit overlies Unit 6 throughout the project area. The alternating laminae of dark grey claystone and lighter grey siltstone are generally less than 0.04 feet thick. Siltstone laminae are sometimes absent towards the top and base of the unit. Pyrite nodules and worm casts occur sporadically throughout the laminite.

The Sketch Isopach Map, Figure 4.10, shows this unit thickening to the south-east where it is generally in excess of 7 feet, whereas in the north-west a thickness of less than 5 feet is more usual.



CONTOUR INTERVAL: 1 FOOT.

SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE
UNIT. 7
SILTSTONE AND CLAYSTONE
LAMINITE

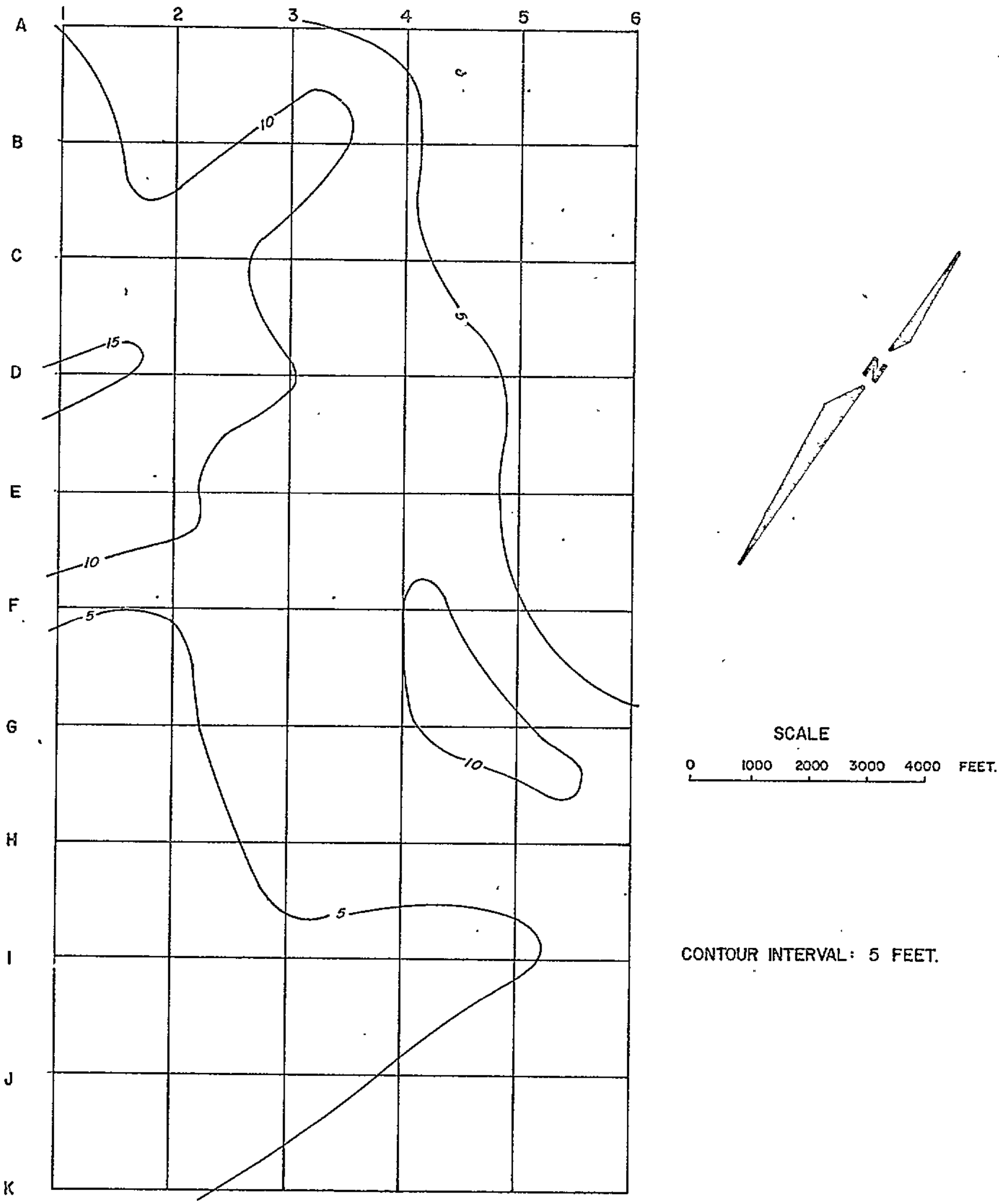
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 4·11



SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE

UNIT 8

SANDSTONE

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

Unit 8 - Middle Sandstone

The term "middle sandstone" has been used to describe the sandstone unit between the siltstone and claystone interbeds and the siltstone/claystone laminite in the Bird/Skeeter interseam sediments. This unit is quartz-lithic sandstone varying in colour from light grey to brownish grey or dark grey. It is generally fine-grained and in places is dominantly silt grade, though becoming medium-grained towards the top. The upper 1 foot is commonly granule conglomerate. Siltstone and claystone wisps and interbeds are found in many of the drill cores.

The Composite Graphic Section of the Upper Gething sequence, Figure 4.4 , shows both a laminite and mudstone layer occurring within this sandstone unit. While these are not everywhere present, their occurrence in many drill holes is useful in distinguishing this sandstone from others in the sequence, where faulting has occurred. Small scale cross bedding and load casts are present in some of the finer-grained sediments.

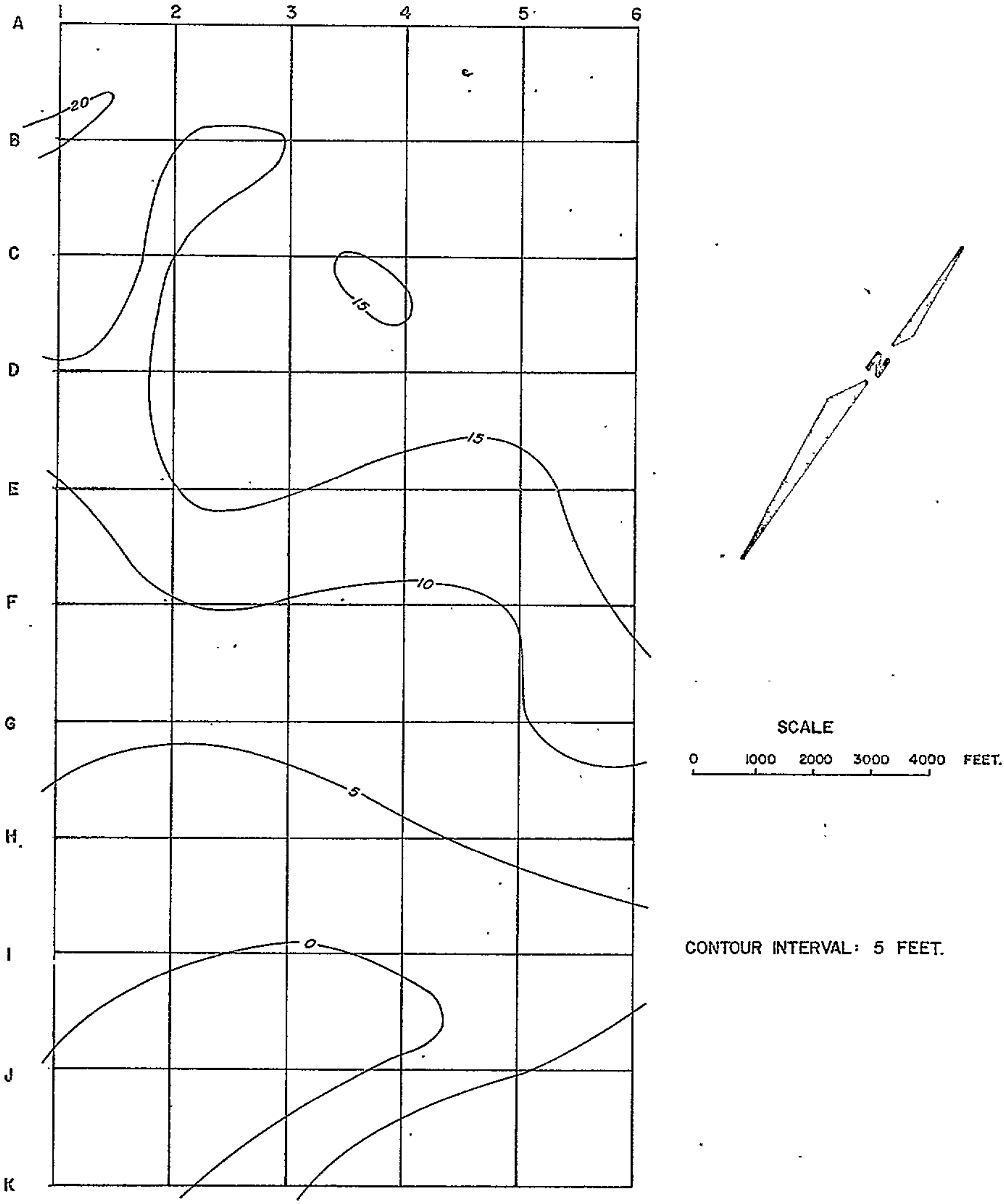
This sandstone unit is found throughout the project area and is usually between 5 feet and 10 feet thick. A maximum thickness of 16 feet is recorded in D.D.H. S-45. A Sketch Isopach Map of this unit is included as Figure 4.11.

The top of this unit and its thickness in the southern corner of the grid, is difficult to determine where unit 9 is absent. In this area the sandstone of Unit 11 directly overlies Unit 8.

Unit 9 - Siltstone and Claystone Interbeds

This unit is composed of pale grey siltstone interbedded with a darker grey claystone or mudstone. The interbeds commonly range from 0.05 to 0.3 foot in thickness and in places include minor sandstone interbeds, up to approximately 1 foot thick as in

FIGURE 4·12



SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE

UNIT 9

SILTSTONE AND CLAYSTONE INTERBEDS

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

D.D.H. C-9. Similar interbeds occur elsewhere in the Cretaceous sequence of the project area. The Sukunka Member overlying the Moosebar Formation contains similar sediments but these are much thicker and are widely separated stratigraphically from the Gething. Some 50 feet below the Chamberlain Seam, there are also similar interbeds, but these are frequently interbedded with sandstone, including substantial beds of sandstone.

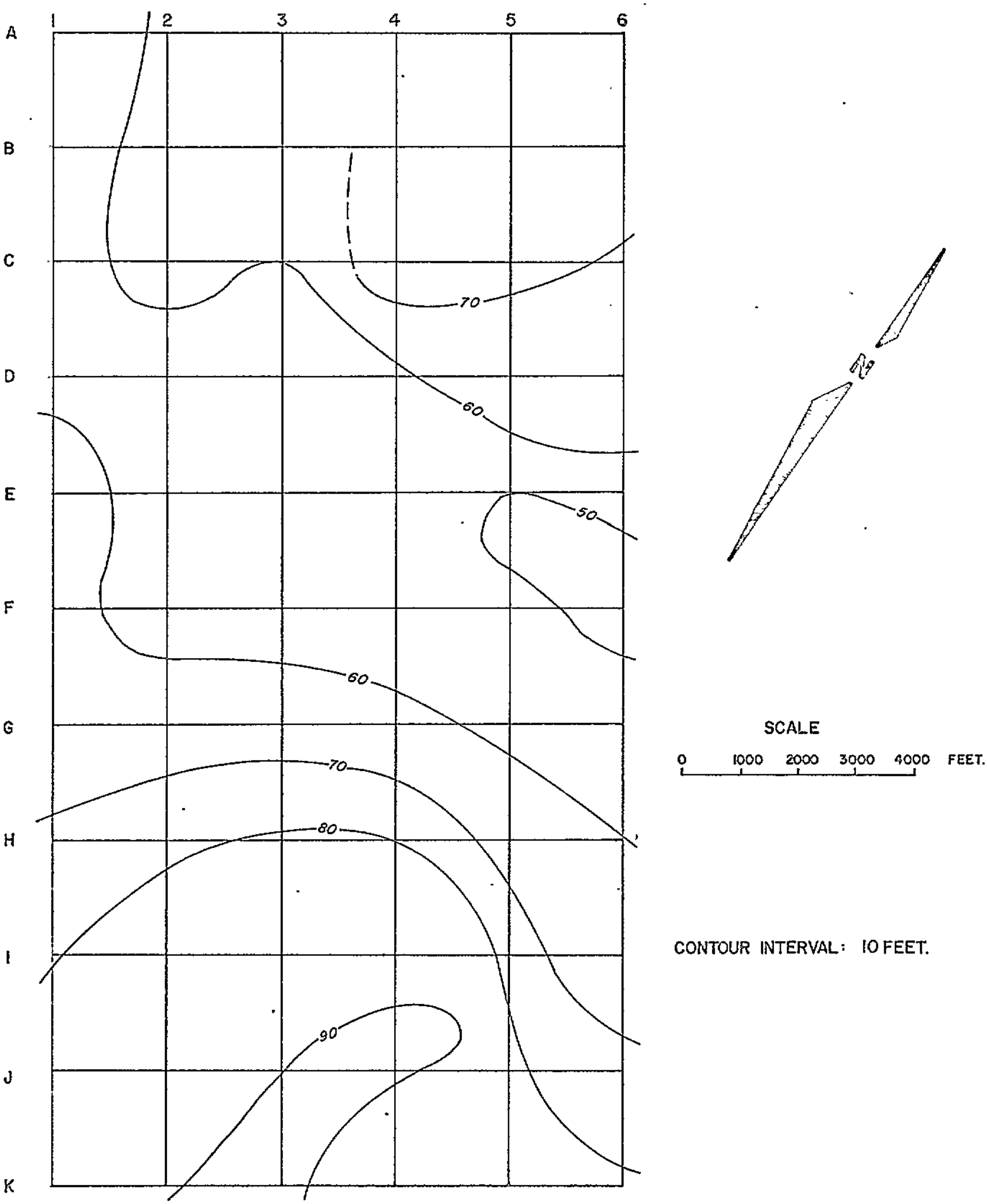
This unit contains thin zones of worm casts approximately 0.1 inch diameter which are similar to those found in the Sukunka Member above the Moosebar Formation. The siltstone interbeds exhibit graded bedding and were used in some drill holes to recognise overturning. The boundaries between adjacent interbeds are somewhat irregular.

As can be seen on the Sketch Isopach Map, Figure 4.12, the siltstone and mudstone interbeds are thickest in the north-west where, in D.D.H. S-14, they are approximately 21 feet thick. Thinning occurs gradually to the south and in the southernmost corner of the grid area, this unit is not present. For most of the area, the interbeds are between 5 feet and 15 feet thick.

Unit 10 - Upper Sandstone

This unit is composed dominantly of fine-grained, light grey quartz-lithic sandstone. The Composite Graphic Section of the Upper Gething sequence, Figure 4.4 , shows the approximate location of several distinctive interbeds which are normally present in this stratigraphic interval.

Some 25 feet above the base, in about the middle of this unit, is a zone in which a pebble band is frequently encountered. The pebble band is usually less than 1 foot thick and one or more thin mudstone or laminite interbeds are commonly present in close



SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE
UNIT 10
SAND STONE

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

association over a total interval of about 5 feet. The presence of these interbeds is sufficiently diagnostic of Unit 11 to enable recognition of this sandstone, particularly where the Upper Gething sequence has been disrupted by faulting.

Another feature of the unit which is sufficiently widespread to warrant mention is the occurrence of abundant small worm casts, 0.1 inch diameter, in a zone between 5 and 10 feet from the top of the sandstone. A zone in which larger, 0.4 inch diameter worm casts are usually present occurs in an interval between 10 and 20 feet from the base of the sandstone.

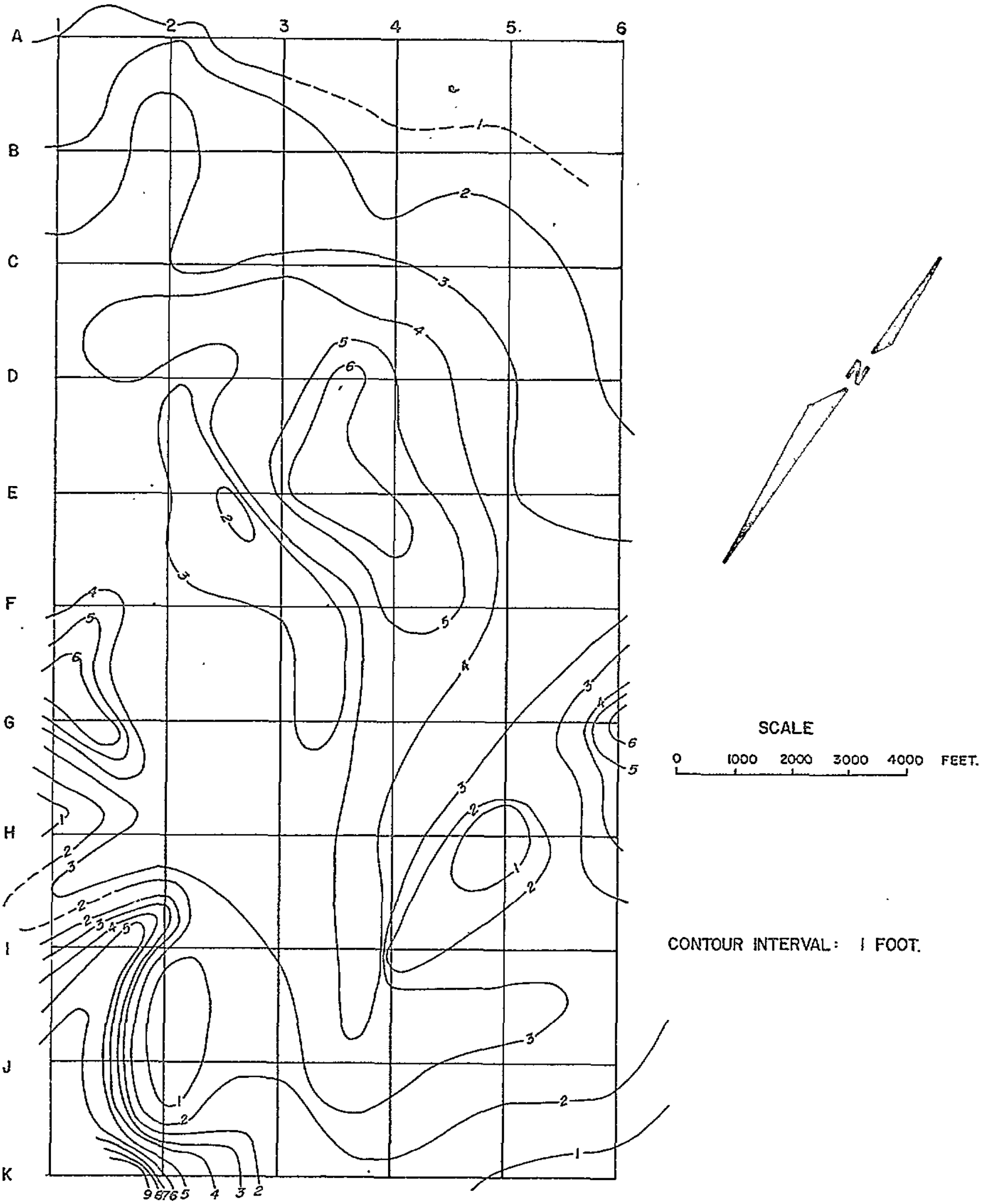
Immediately below the Bird Seam, the top few feet of sandstone is carbonaceous, with abundant coaly wisps and partings. The basal few feet of the unit may include siltstone or mudstone interbeds.

The sandstone is the thickest of the recognisable, distinct units of the Upper Gething and occurs throughout the project area underlying the Bird Seam. The Sketch Isopach Map, Figure 4.13, indicates a thickening to the south-east where this unit is about 90 feet thick. Elsewhere a thickness of between 50 feet and 70 feet was usually encountered in the drill holes.

Unit 11 - Bird Seam

This is the uppermost of the three significant coal seams in the Upper Gething which are recognised in the project area. A detailed study of the Bird Seam was not undertaken in this investigation. The seam is generally less than 4 feet thick and its economic potential does not compare with that of the Chamberlain or Skeeter Seams.

The coal is generally dull with minor bright bands and earlier work by Brameda Resources Limited indicated a high sulphur content.



SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE
UNIT II
BIRD SEAM

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Pyrite nodules are present in the upper part of the seam or in the upper split where a siltstone or claystone band is present. The seam is split by a stone band over about half of the project area, particularly in the south-west of the exploration grid; the upper split is the thicker of the two. In D.D.H. C-2 the seam contains two stone bands.

The Sketch Isopach Map, Figure 4.14, shows very clearly the wide variation in seam thickness. Less than 1 foot of the Bird Seam was encountered in a number of drill holes, while in the south-eastern corner of the grid, 9.5 feet was encountered in D.D.H. C-24.

South-east of the project area unpublished data, provided by Teck Corporation Limited, indicates that the Bird Seam is relatively continuous and is between 5 feet and 7 feet thick in their Bullmoose Project Area.

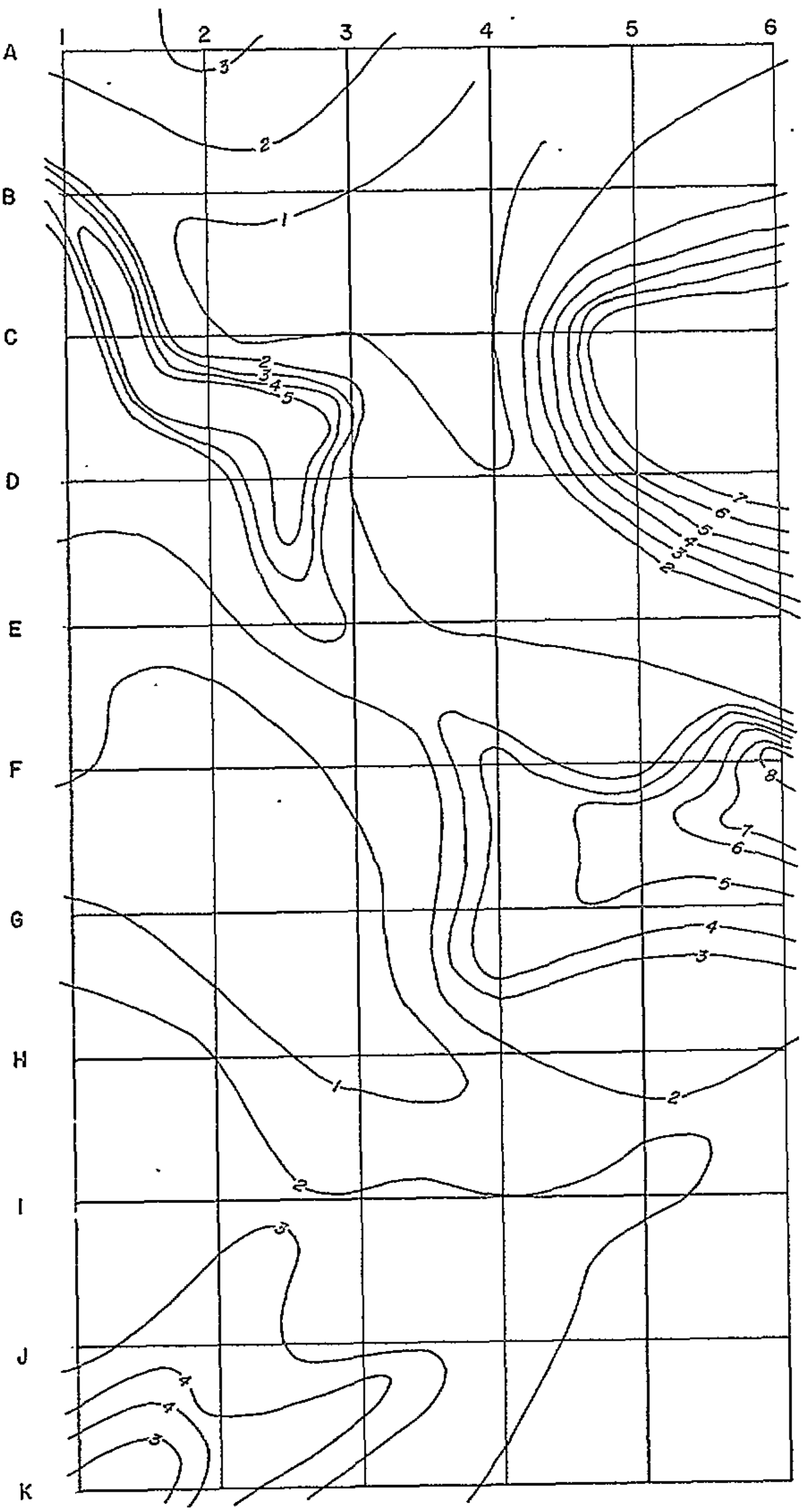
Unit 12 - Glauconitic Sandstone

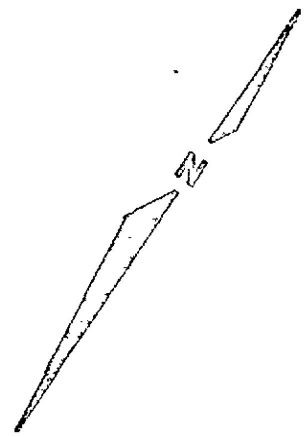
This uppermost unit of the Upper Gething sequence is a particularly useful marker horizon, overlying the Bird Seam throughout the project area. The pebbly sandstone at the base passes up into a green-grey quartz-lithic sandstone with discrete grains of glauconite. The glauconite is most abundant towards the top of the unit which is correspondingly darker green.

Grey mudstones of the Moosebar Formation overlie the glauconitic sandstone. Stott (1968) suggests that this thin unit may be correlated with the thicker, widespread glauconitic sediments of the Bluesky Formation to the east, in the Peace River Plains.

A thickness of between 2 feet and 5 feet is recorded from many of the drill holes as is indicated in Figure 4.15. A maximum thickness of 11.5 feet was encountered in D.D.H. C-10, while less than 1 foot is recorded from several drill holes.

FIGURE 4·15





SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1 FOOT.

SKETCH ISOPACH MAP

UPPER GETHING SEQUENCE
UNIT 12
GLAUCONITIC SANDSTONE

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

4.2.4 MOOSEBAR FORMATION

The Moosebar Formation conformably overlies the Gething Formation throughout the project area. This formation, of marine origin, marks a major change of sedimentary environment, whereby a marine transgression brought to a close the extensive period of sedimentation during which the underlying non-marine coal-bearing strata were deposited.

Stott (1968) records a thickness of approximately 600 feet of the Moosebar Formation, cropping out near Bullmoose Mountain. From the drill core data in the project area, however, the upper half of this 600 feet interval is a different and distinct lithological unit, which proved useful in determining the subsurface structure. The Gething Formation is immediately overlain by a monotonous, extremely uniform claystone sequence about 300 feet thick, apart from a very limited development of silty phases and thin bentonitic bands. The claystones are overlain by a similar thickness of interbedded siltstone, claystone and sandstone.

For these latter sediments, the term Sukunka Member was introduced by J.E. Hughes, who included them in the overlying Commotion Formation.

The terminology of Hughes has been adopted in this report. The term Sukunka Member as here used should not be confused with the same term informally introduced and applied by Spieker (1921) to a sequence which is stratigraphically much higher in the Cretaceous.

Thus the term Moosebar Formation in the project area refers to the lower 300 feet only of the 600 feet sequence.

The boundary between the Moosebar Formation and the overlying Sukunka Member of the Commotion Formation is a gradational one which is not always easily determined in drill core or in outcrop. However, reference to the Neutron and Gamma Ray logs shows that the composition of each of these two units is sufficiently different to enable the boundary to be most accurately defined with the aid of these radioactive logs.(1)

The lower boundary of the Moosebar Formation has been placed at the top of the glauconitic sandstone which overlies the Bird Seam. The glauconitic sandstone is considered to have greater affinity, in terms of its gross lithologic attributes, with the Gething Formation, though it is most likely of marine origin. Glauconitic sandstones also occur in the lower part of the Gething Formation. The Moosebar Formation, composed entirely of dark grey claystones, is considered to be a particularly meaningful and useful stratigraphic unit in the Sukunka River area. Throughout the Moosebar Formation minor discontinuous bentonitic claystone layers are present. In the lower few feet of the Moosebar Formation, two 4 inch thick, light grey bentonitic claystone beds separated by approximately one foot of grey claystone occur throughout the project area. Numerous thin bands of pyritic concretions and, less commonly, of marine shelly fauna are also a feature of this formation.

The behaviour of the Moosebar Formation under tectonic stress imposed during the Rocky Mountain Orogeny is discussed in Section 4.3.1.

(1) Refer to Well Logs included in Volume 12 of this report.

4.2.5 COMMOTION FORMATION

Within the project area the Commotion Formation comprises four Members. The basal Sukunka Member, recognised in this area by Hughes, conformably overlies the Moosebar Formation. The overlying Gates Member, Hullcross Member and Boulder Creek Member are recognised on a regional scale by Stott (1968) between the Peace River and the Kakwa River in the eastern foothills. The distribution of the Commotion Formation is shown on Map 1.

The Sukunka Member is composed of a sequence of interbedded fine-grained, quartz-lithic sandstones and siltstones which are of the order of 400 feet thick. The essentially flat lying sediments of the Sukunka Member were intersected in drill holes collared above about 4,800 feet a.s.l. The sediments of the Sukunka Member are considered to have been deposited in a transitional environment following the widespread deposition of the marine mudstones of the Moosebar Formation and prior to the deposition of the marine sediments of the Gates Member.

The sandstones, conglomerates, siltstones, shales and mudstones of the Gates Member attain a thickness of about 600 feet in the project area.

Several coal seams exist in the Gates Member, but these are generally less than 4 feet thick and include numerous bands of carbonaceous claystone or stony coal. In the project area these seams are not of economic significance, but some 120 miles to the south-east in the Smoky River area, the coal seams of the Commotion Formation are of greater importance than those of the Gething Formation. The Gates Member crops out extensively in the higher parts of the project area, above the tree line.

Argillaceous marine sediments of the Hullcross Member conformably overlie the Gates Member. The dark grey shales and mudstones, which are about 350 feet thick, frequently contain pyritic and ferruginous concretions.

The Boulder Creek Member of the Commotion Formation is the youngest Cretaceous sequence in the project area. The sandstones and interbedded conglomerates, mudstones and minor coal seams crop out near the south-eastern corner of the exploration grid above 6000 feet a.s.l.

Within the grid area the essentially flat lying strata of the Commotion Formation have been disrupted to a minor extent by several of the low angle thrust faults. Only to the east, along the Bullmoose Fault Complex, have these strata been extensively faulted and folded.

4.3 STRUCTURAL GEOLOGY

4.3.1 STRUCTURAL SETTING

(i) REGIONAL

The strata of the Sukunka Coal Project area, lying within the western foothills of the Rocky Mountains, have been subjected to deformation associated with the Rocky Mountains Orogeny. Contemporaneous faulting and folding, related to this orogenic phase, occurred during Eocene time. In the Peace River District this tectonism has produced a series of large scale south-south-easterly trending structures which consist of tightly folded and reverse faulted anticlines, separated by broad relatively undeformed synclines. The Sukunka Coal Project is located within one of the synclinal structures and is bounded on the north-east margin by an extensively faulted major anticlinal structure, referred to here as the Bullmoose Fault Complex.

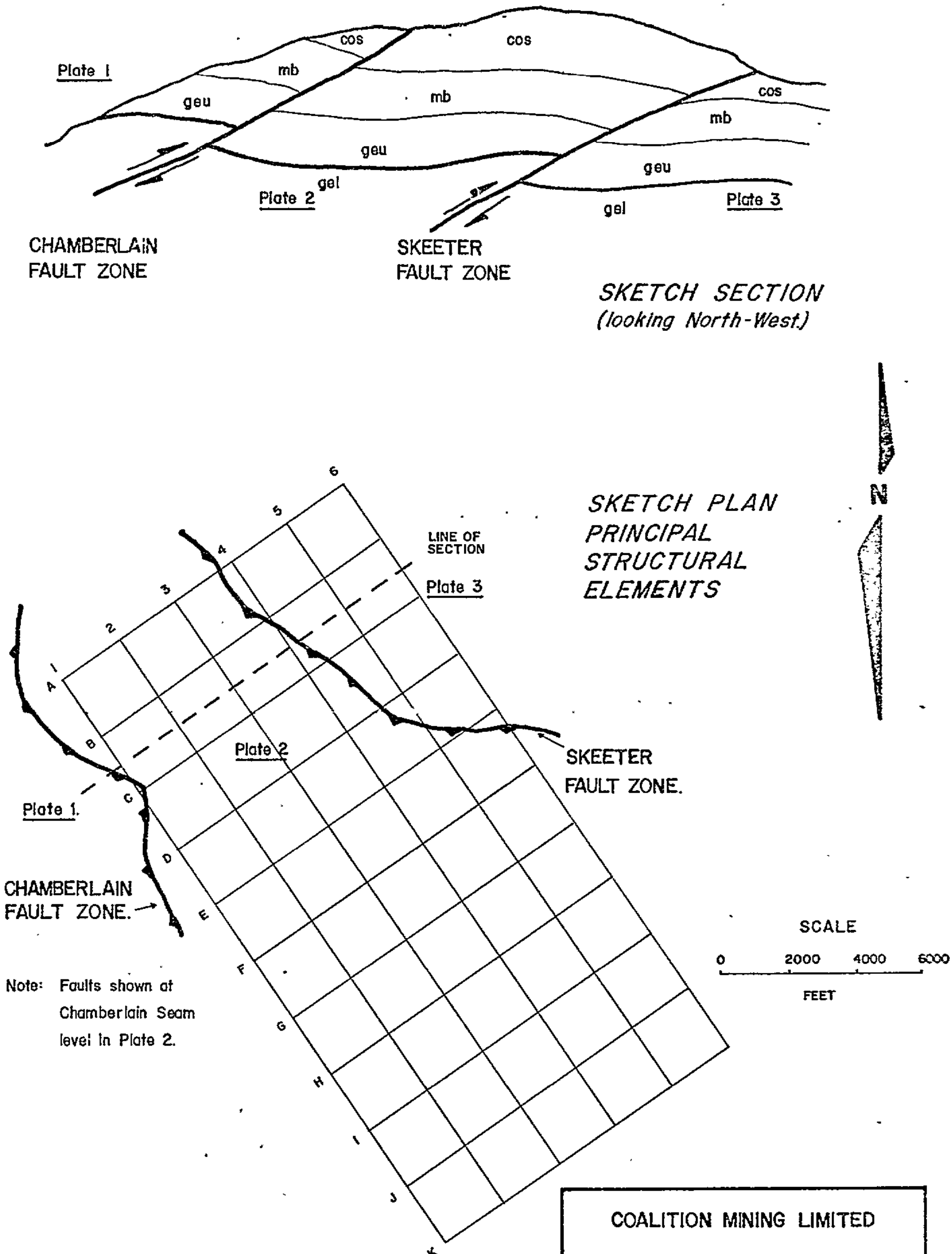
(ii) LOCAL

Gently dipping and essentially unmetamorphosed strata have been dislocated by a series of thrust faults. The faults have separated the strata into three blocks, which are referred to here as plates. The structural elements discussed in the following pages are illustrated in Figure 4.16.

Two major thrust faults, the Chamberlain Fault and the Skeeter Fault, form the western and eastern boundaries respectively of Plate 2. Plate 1 lies to the west and Plate 3 to the east.

For convenience of discussion, Plate 2 has been divided into three sub-plates, 2a, 2b and 2c, separated by the Pond and Rim Faults. This terminology is applicable only north of grid line E. The faults follow the regional south-south-easterly tectonic trend, dipping in a south-westerly direction at low angles.

FIGURE : 4·16



COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

In Section 4.3.2 below is discussed the nature of the major fault systems, the Chamberlain and Skeeter Faults. Sections 4.3.3, 4.3.4 and 4.3.5 deal with the configuration of the three plates. The faults other than the Chamberlain and Skeeter Faults are discussed in Section 4.3.4 as part of the structural elements of Plate 2.

In the discussion which follows, particular reference is made to the displacement of the Chamberlain Seam along the faults, to the position of the faults at the level of the Chamberlain Seam and to the nature of folding and dip of the strata at that stratigraphic level. All such references to the Chamberlain Seam apply equally to the Skeeter Seam, which occurs some 20 feet to 40 feet above the Chamberlain Seam. As the two seams are separated by such a small stratigraphic interval, the preparation of separate structure contour maps of the Skeeter Seam was not justified. At the scale of these maps, 1 inch to 1000 feet, the structure contours of the Skeeter Seam would be essentially identical to those of the Chamberlain Seam.

4.3.2 MAJOR FAULT SYSTEMS

(i) THE CHAMBERLAIN FAULT

One phase of the drilling programme was especially directed towards establishing the attitude and bearing of this fault as well as the amount of displacement. Drilling along grid line A with a spacing of approximately 500 feet shows that this fault forms a zone bounded by two converging planes with the enclosed strata relatively undisturbed. The average dip of this zone is 8^{o}. The dip of the fault may increase at depth, west of D.D.H. C-31. Displacement along the Chamberlain Fault effects the Upper and Lower Gething sequences such that repetitions of the Chamberlain Seam were intersected in D.D.H. C-31, S-49, C-30 and S-1. Upward continuity of this fault within the Moosebar Formation cannot be clearly defined. This fault could exist as a single plane, as might reasonably be expected in a uniform unit such as the Moosebar Formation. If this were the case, it would be impossible to prove, due to the lack of any useful marker horizons. On the other hand, the stress could be accommodated by a large number of small displacements occurring more or less regularly over this thick interval of strata.

Drill intersections along grid line C indicate a dip of 8° between D.D.H. C-2 and D.D.H. C-10, increasing to 12° from D.D.H. C-10 to D.D.H. C-7 giving an average dip of 10° along the zone of the fault over a horizontal distance of 2000 feet. (See Geological Cross Section C'). Along this section line, the throw of the Chamberlain Fault is interpreted as being 140 feet with a heave of 600 feet and the displacement along the plane of the fault is 830 feet. The attitude of this fault was established further north along grid line B by deepening D.D.H. S-14 and further south on grid line C by deepening D.D.H. S-17. The results confirmed the data obtained along grid line C' and established that the plane of the fault zone is particularly constant in attitude in this area. (Refer to Cross Sections B, C' and C). Map No. 7 shows the position of the Chamberlain Fault at the level of the Chamberlain Seam in Plate 2, while Map 6 shows the position at that level in Plate 1. Details of the variation in attitude of the Chamberlain Fault and the range of throw and heave measured at the level of the Chamberlain Seam are presented below.

Dip	maximum	12°
	minimum	4°
	average	8°

The dip tends to flatten with depth.

Throw	maximum	300 feet
	minimum	120 feet
Heave	maximum	1600 feet
	minimum	500 feet

Displacement along the Chamberlain Fault is greatest in the region of D.D.H. C-31, decreasing towards the south-east.

(ii) THE SKEETER - RIM FAULT SYSTEM

The displacement on these two faults varies considerably along strike. The displacement at the level of the Chamberlain Seam is greatest in the north-west along the Rim Fault and greatest in the south-east along the Skeeter Fault. In any one of the north-east bearing cross sections, the overall displacement from the upper plate of the Rim Fault to the lower plate of the Skeeter Fault is relatively constant. (Refer to Cross Sections A, B', C' and C). This fault system is more complex and less well defined by drilling than is the Chamberlain Fault. The Skeeter and Rim Faults are adjacent structures located near the north-east corner of the project area, as shown in Map 1. The Rim Fault lies within Plate 2 and the Skeeter Fault defines the north-east boundary of this plate.

The Skeeter Fault has been intersected in D.D.H. C-39 on grid line B, in D.D.H. S-41 and D.D.H. C-34 on grid line C and in D.D.H. S-31 on grid line D. These intersections and the surface geology to the north of D.D.H. C-39, show that the strata are disrupted in a multiple fault system where a recumbent fold is developed on the overthrust plate, Plate 2. The complexity of structure encountered in D.D.H. C-39 is greater than that occurring at any other locality and is not representative of the structural deformation along the thrust faults in the project area.

The Skeeter Fault parallels the Chamberlain Fault north of grid line C, but diverges in an easterly direction south of this point. Along grid line C, based on intersections in D.D.H.'s S-41 and C-34, the dip at the Skeeter Fault is 22°. This dip is considerably greater than that of the Chamberlain Fault and this may be due to the closer proximity of the major faulted anticlinal structure, the Bullmoose Fault Complex.

As is seen on the Geological Cross Sections, the displacement along the Skeeter Fault increases from a throw of about 20 feet at grid line C to 820 feet at grid line E. The heave is not a simple parameter and cannot be determined because of the complex nature of the thrust faulting.

4.3.3 PLATE 1.

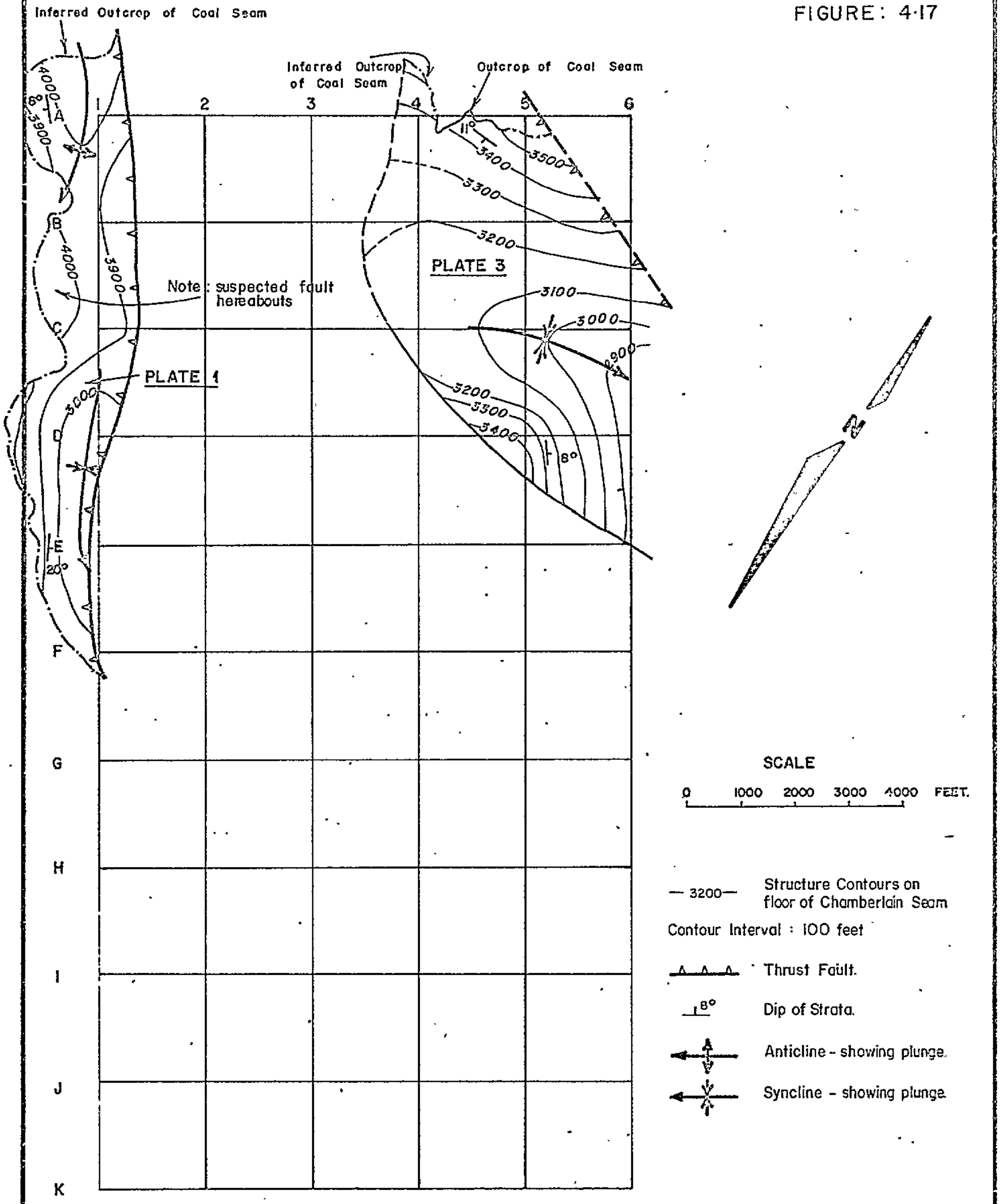
The upthrown block of the Chamberlain Fault constitutes Plate 1. Thus Plate 1 is bounded on the north-east by the Chamberlain Fault and with respect to the Chamberlain Seam, by the outcrop of that seam to the south-west, as is shown on Map 6.

In the northern part of Plate 1, the strata form an anticlinal structure which is considered to be a drag fold along the Chamberlain Fault. Dips of up to 15^{o} are common on the limbs of the anticline, but the limbs of several small parasitic folds dip at angles up to 30^{o}. In the north, the fold axis parallels the Chamberlain Fault but diverges further to the south-east where it has a more southerly trend. In the disturbed zone of the Chamberlain Fault, dips of up to 56^{o} have been recorded.

For all of the thrust faults in the project area, observations based on the drill holes and to a limited extent on the surficial geology, indicate that the steeper dips and, indeed, the degree to which the strata are disrupted is greatest on the upper plate of the thrust faults.

Evidence of faulting within Plate 1 has been recorded in a few drill holes. In D.D.H. C-2 a repetition of the Moosebar Formation indicates a throw of 50 feet, which is expected to persist down to the level of the Chamberlain Seam. This fault is considered to be parallel to the Chamberlain Fault and of limited extent.

FIGURE: 4·17



SKETCH MAP

REGIONAL STRUCTURAL FEATURES
PLATES 1 and 3

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 6 FOR DETAILED STRUCTURE CONTOURS

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Geological Cross Section D shows a back thrust fault within the Upper Gething sequence. This is the only north-east dipping thrust fault detected in the project area. Repetition of strata as a result of this fault was detected in D.D.H. S-43A, while zones of brecciation and a thickening of the sequence in D.D.H. S-43 and D.D.H. S-43B enabled the attitude of the fault to be established. This fault is not considered to extend down to the level of the Chamberlain Seam in Plate 1.

A minor fault indicated to be present by a repetition of Moosebar Formation strata in D.D.H. S-34 is not expected to persist in depth.

4.3.4 PLATE 2.

Plate 2, the largest of the three structural plates, lies between the Chamberlain Fault and the Skeeter Fault and occupies the greater part of the project area as is shown on Map 7. In the north-western part of the project area, north of grid line F, three sub-plates are recognised. The sub-plates, designated Plate 2a, Plate 2b and Plate 2c, are separated by thrust faults which are present at the level of the Chamberlain Seam as is indicated on Map 7. Four other thrust faults exist at the Chamberlain Seam level further south.

Both the intra-plate faults and the plate boundary faults are well documented from drill hole information, but their presence at the surface is extremely difficult to detect and in fact, the displacement on many of the low angle thrust faults decreases significantly in the higher stratigraphic units and some at least terminate before reaching the surface.

The significance, location, displacement and extent of the faults *at the level of the Chamberlain Seam*, (and therefore also, in effect, at the level of the Skeeter Seam), is of the utmost importance in this report. The ensuing discussions, then, relate to the faults at that level and reference to Map 7 and the cross sections is more meaningful than is reference to Map 1.

(i) FAULTING

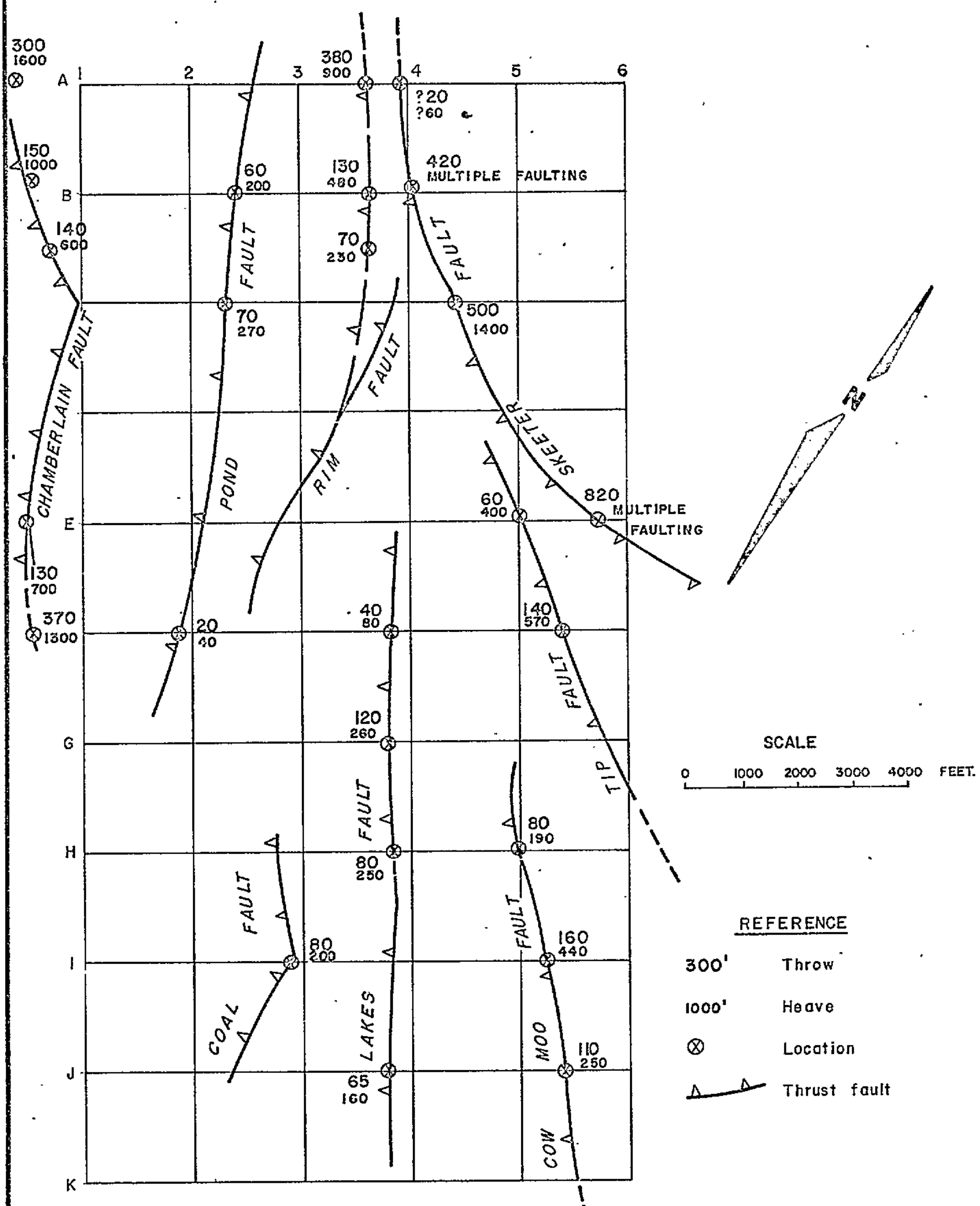
Plate 2a is bounded by the Chamberlain Fault in the south-west and the Pond Fault to the north-east. The Pond Fault extends from the outcrop of the Chamberlain Seam in the north, south to grid line F. This thrust fault closely parallels the Chamberlain Fault, dipping at about 8^{o} to the south-west. The maximum displacement along the Pond Fault was recorded along grid line C, where the throw is 70 feet and the heave is 270 feet.

Plate 2b is bounded in the south-west by the Pond Fault and by the Rim Fault to the north-east. The displacement on the Rim Fault is greatest along grid line A, where in D.D.H. C-6 three fault planes, over a core interval of 150 feet, result in an overall throw of 380 feet and a heave of 900 feet. The displacement decreases towards the south-east end at grid line F, where there is no evidence of this fault.

The Rim Fault is more or less parallel to the Chamberlain Fault and dips at about 12^{o} to the south-west.

Plate 2c lies between the Rim Fault and the Skeeter Fault. The Chamberlain Seam crops out within this sub-plate in the axial region of an anticline, adjacent to the Skeeter Fault. North from grid line D a subsidiary fault of the Rim Fault extends into Plate 2c at least as far as about grid line C, but the northern limit of this thrust fault is not well documented. The possibility that it extends as far as the Skeeter Fault must not be overlooked in the absence of a suitably located drill hole.

FIGURE: 4·18



SKETCH MAP

ILLUSTRATING THRUST FAULT LOCATIONS AT LEVEL OF CHAMBERLAIN SEAM FLOOR

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Within Plate 2, in the south-eastern part of the project area, there are four south-westerly dipping low angle thrust faults at the level of the Chamberlain Seam, as shown on Map 7. These are the Coal, Lakes, Cow Moo and Tip Faults.(1)

The Coal Fault is continuous over a strike length of about 5000 feet south-east and south of grid line H. The greatest displacement on this fault is along grid line I, where the throw is 80 feet and the heave is 220 feet.

The Lakes Fault closely parallels grid line A and lies just to the south-west of this grid line between grid line E and grid line K. The maximum displacement was recorded in D.D.H. C-1 on grid line G, where a throw of 120 feet and a heave of 260 feet was recorded. The displacement decreases both to the north and south of grid line G.

The Cow Moo Fault extends to the south-east from near D.D.H. C-14, grid line H, and passes out of the project area. The throw of this fault on grid line I is 160 feet and the heave is 440 feet. The Cow Moo Fault was encountered in D.D.H. C-14 where a throw of about 100 feet exists, but to the north-west in D.D.H. S-44 there is no indication of the presence of this thrust fault. The fault then may not extend as far as D.D.H. S-44, as is indicated on Map 7. An alternative interpretation, presented on Map 8, shows this fault swinging to the east from D.D.H. C-14 towards D.D.H. C-1. The throw of about 200 feet on the Lakes Fault near D.D.H. C-1 is, in this latter interpretation, suggested to be in part, due to some movement on the Cow Moo Fault. Further drilling will be necessary to clarify the structural interpretation in this area.

The Tip Fault at the level of the Chamberlain Seam lies close to the Skeeter Fault along grid line D and diverges from it to the south-east where the throw increases substantially such that

(1) Available evidence indicates that none of these faults continues to the surface. They are therefore not shown on Map 1.

on grid line F the throw is 140 feet and the heave 570 feet.

(ii) FOLDING

The axes of the gentle undulatory folds in the project area have a south-easterly trend in sympathy with the trend of the thrust faults. These structures in Plate 2, which are present at the level of the Chamberlain Seam, although not normally evident in higher formations, are shown on Map 7. The nature of the folds is clearly seen on the cross sections.

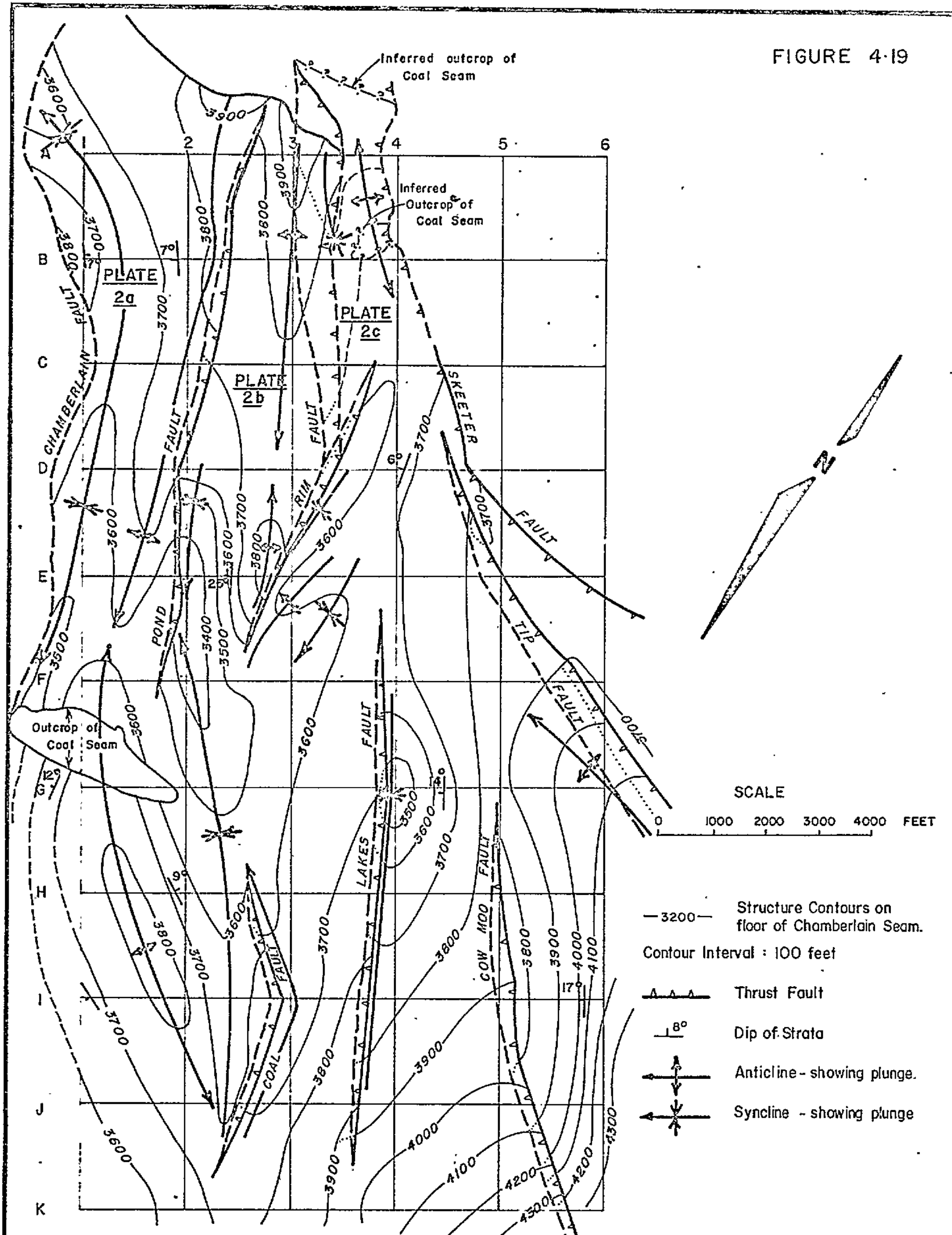
To the north-west of grid line F there is a regional dip to the south-east and the folds plunge gently in this direction. South of grid line F the regional dip is to the north-west and the folds correspondingly plunge to the north-west.

The axial region of many of the folds is adjacent to, and sub-parallel to a thrust fault. The anticlinal structures generally exist on the upper plate of the south-westerly dipping fault plane, with the axes about 1000 feet south-west of the fault, at the level of the Chamberlain Seam. The synclinal structures at the same stratigraphic level generally occur on the lower plate with the axes located some 500 feet to 1000 feet to the north-east of the fault.

Notable exceptions to the above are two structures adjacent and parallel to the Coal Fault. Here the anticline occurs in the lower plate and the syncline, extending to the south-east from the Pond Fault, lies on the upper plate, south-east of the Coal Fault.

Map 1 shows dips measured in the field, in particular those measured where the Chamberlain Seam or Skeeter Seam were exposed by stripping. The Structure Contour Map, Map 7, shows the

FIGURE 4·19



SKETCH MAP

REGIONAL STRUCTURAL FEATURES
PLATE 2

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 7 FOR DETAILED STRUCTURE CONTOURS

PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

overall attitude of the strata at the Chamberlain Seam level, while Map 23 shows the dips of the sandstone floor of the Chamberlain Seam, recorded in vertical drill holes.

The structure contours indicate that at the level of the Chamberlain Seam, the dip of the strata is generally less than 10^{o}. To the north-east of the Cow Moo Fault the strata dip to the south-west at angles of up to 18^{o}. From grid line D to grid line F, between the Pond and Rim Faults, is an area where dips of up to 25^{o} are indicated on Map 7. The steep dips in this latter area probably preclude the economic extraction of coal; due allowance has been made for this in the calculation of reserves.

Local changes in dip, not reflected in the structure contours, have been observed in outcrop at several localities where the Chamberlain or Skeeter Seams have been exposed by stripping. At only three localities along some 12,000 feet of outcrop stripping were steep dips, the maximum being 30^{o}, observed to take place over several hundred feet along strike. South of No. 1 Adit the Chamberlain Seam has a dip of up to 30^{o} on the south-western limb of the anticline close to the Chamberlain Fault.

Where the Chamberlain Seam is exposed along the north salient of the project area, dips of up to 25^{o} to the south-west over a few hundred feet were recorded near D.D.H. S-9, and some 400 feet north-east of No. 4 Adit, close to the Pond Fault. Elsewhere along the north salient, the dip of the Chamberlain or Skeeter Seams does not exceed 12^{o}; at the north-westernmost outcrops, north of grid line A', the dip is essentially horizontal.

4.3.5 PLATE 3

The Skeeter Fault is the south-western boundary of Plate 3, and the Bullmoose Fault Complex forms the north-eastern boundary. The drill hole data outlines the boundaries of this plate, but provides limited data on the intra-plate structure.

Map 6 shows the strata at the Chamberlain Seam level to be in a gentle east-north-easterly trending syncline, with dips on the limbs of this fold being up to 15^{o}, but less than 10^{o} for the greater part of Plate 3. Stripping of the Chamberlain Seam south of Skeeter Creek established that the maximum dip here was 12^{o}.

The drill holes in Plate 3, while not indicating the presence of any major intra-plate faults, included a number of minor fault zones in the Upper Gething strata which may persist to the level of the Chamberlain Seam. Evidence of faulting was observed in D.D.H. C-38, Cross Section B and the thickness of the Moosebar Formation in D.D.H. S-6 suggests repetition of the strata by faulting.

The Bullmoose Fault Complex is a major regional structure consisting of a number of thrust faults and a normal fault, which are shown on Map 1. The magnitude of the displacements on these faults, their close proximity to each other and the steeply dipping nature of the strata in their vicinity clearly makes the Bullmoose Fault Complex a terminating structure with regard to the extraction of coal in the Sukunka Project.

4.3.6 FURTHER ASPECTS OF THE STRUCTURE

(i) STYLE OF FOLDING

On a regional scale, the style of folding in the Peace River district has been described by Hughes (1967). That author recognised three types of parallel folds, which he classified as concentric, lambdate and cuspate folds.

On the local scale, within the project area, these fold types have been recognised, but they are considered to be intimately related. Cuspate and lambdate fold forms are developed in the downward continuation of the concentric folds and are usually confined to the axial regions of the folds. In the project area, the overall style of folding is considered to be best described as concentric to flattened concentric.

Folding of this style, together with cuspate or lambdate folds, has been observed on a small scale adjacent to the major thrust faults where the strata in the Chamberlain Seam/Skeeter Seam interval have been exposed by stripping. Concentric parallel folds are observed along the north salient in Plate 2 where two broad, gently flexed anticlines are separated by a more tightly flexed syncline. As is seen in Map 23, the steeper dips. measured from the core angle in vertical holes, occur almost without exception in the axial regions of the synclines.

(ii) ATTITUDE OF THE FAULTS

The attitude of the Chamberlain Fault has been discussed in Section 4.3.2. This fault, with an average dip of 10°, and a maximum and minimum dip of 12° and 4° respectively, is an overthurst fault. The Pond Fault and the Rim Fault are closely parallel to the Chamberlain Fault and have a similar attitude.

The Skeeter Fault has a somewhat steeper dip of about 22°, doubtless related to the proximity of the Bullmoose Fault Complex. In general, the low angle thrust faults are part of an essentially parallel overthrust system in the project area.

(iii) FAULT CONTINUITY

A feature of the thrust faults, which is of considerable significance, is the lack of continuity of many of the faults from the Gething Formation into the higher stratigraphic units.

Map 1 shows those faults which are considered to exist at the surface where displacements are able to be mapped or inferred with a high degree of confidence. In Map 7, at the level of the Chamberlain Seam, are shown additional faults, the presence of which is based on drill hole data. The cross sections show other faults which neither reach the surface nor continue at depth to the level of the Chamberlain Seam.

The displacement on the major faults is such that they extend from the Lower Gething into the Commotion Formation. These faults constitute the boundaries between Plates 1, 2 and 3, and the Rim Fault the boundary between Plates 2b and 2c. The other lesser faults, present at the level of the Chamberlain Seam and within the Upper Gething sequence, are considered to terminate in the overlying Moosebar Formation. It is considered that the upward continuity of the thrust faults in one or more sub-parallel planes is accommodated in the Moosebar Formation by multiple small displacements in this lithologically and structurally uniform incompetent rock unit. Tectonic thickening of the Moosebar Formation is considered to take place in the vicinity of the termination of these faults.

The downward continuity of the lesser faults in the Gething Formation is sometimes terminated above the sandstone floor of the Chamberlain Seam. This massive sandstone unit, of significant structural competence, is less readily disrupted by faulting and is considered to have exercised a degree of control in containing some of the minor faults within the Chamberlain Seam or the immediate roof.

Field observations have shown that some minor fault or shear zones are sub-parallel to bedding and are confined to a particular thin interval of strata. Observations based on drill hole data indicate more than a coincidental occurrence of fault zones in (a) Unit 10, the sandstone below the Bird Seam or less commonly (b) at about the level of the Skeeter Seam. The intra-plate faults which have a maximum throw of between 70 feet and 160 feet are usually continuous up into the Moosebar Formation and down into the Lower Gething. Thrust faults with smaller displacements, detected in drill holes, are confined to the Upper Gething and may not extend down to the Chamberlain Seam.

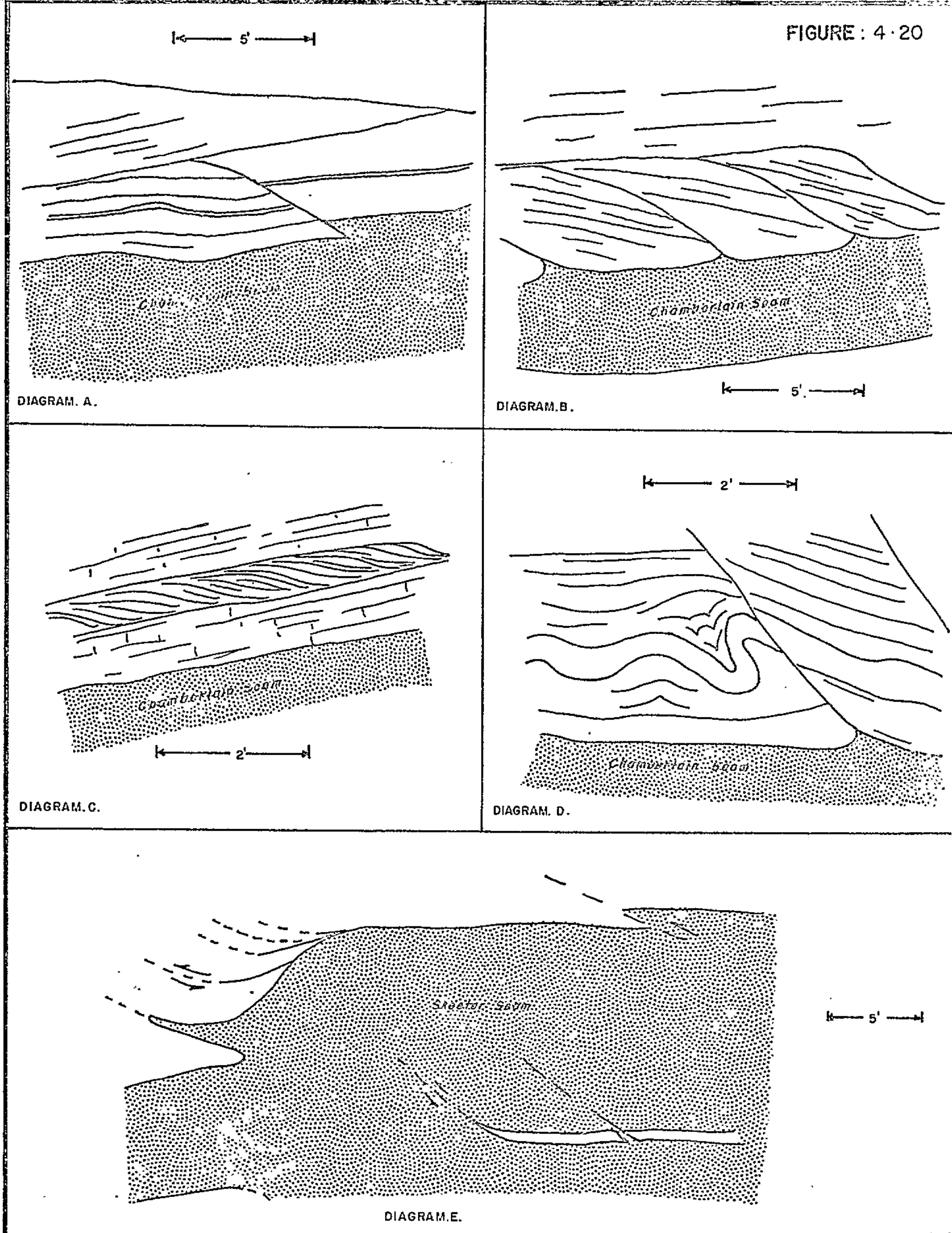
(iv) NATURE OF FAULT ZONES

The faults which form the boundaries between the structural plates, and the intra-plate faults with a throw in excess of 50 feet, exist as one or more zones of shearing or brecciation which vary in width from about 1 foot up to 7 feet. The fault zones consist of well cemented, disoriented fragments of sandstone, siltstone or claystone. These zones and to a lesser extent the joints and fractures in the adjacent rocks, contain numerous calcite veins. Slickensided surfaces are common in both fault zones and adjacent rocks.

Within the Moosebar Formation the faults are expressed as a thicker zone, perhaps 20 or 30 feet thick, with abundant slickensides and calcite-filled fractures.

Some 8 minor faults have been observed above the Chamberlain or Skeeter Seams where the seams have been exposed by stripping. The throw of these faults is usually less than 3 feet and the heave less than 50 feet, a notable exception being a thrust on the southern side of Chamberlain Creek where there is a throw of approximately 20 feet. At a point about 30 feet east of Adit No. 5, another such minor fault consists of a series of closely spaced, in echelon thrust faults in the 10 feet or so of strata immediately overlying the Skeeter Seam. While the dip of the faults may be about 5° to 10° immediately above the seam, the dip decreases so that the fault planes are coincident with bedding about 10 feet above the roof of the seam.

FIGURE : 4·20



INTRAFORMATIONAL TECTONIC STRUCTURES

DIAG A INTRAFORMATIONAL THRUST FAULTING ABOVE THE CHAMBERLAIN SEAM.

DIAG B EN ECHELON STRUCTURE AS IN DIAG. A. NOTE CHAMBERLAIN SEAM FLOOR UNAFFECTED.

DIAG C ZONE OF SHEARING WITHIN THE CHAMBERLAIN SEAM ROOF.

DIAG D INTRAFORMATIONAL FOLD STRUCTURES

DIAG E ROOF AND SEAM STRUCTURES IN OUTCROP ADJACENT TO ADIT #5

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

Shear zones affecting about 1 foot of strata, being parallel to the bedding, occur at many localities where the coal seams are exposed. Up to 1 foot of the lowermost and/or uppermost part of the Chamberlain Seam has been sheared over a horizontal distance of about 100 feet at several localities.

Intraformational shearing of this type appears to be in response to local stress conditions which are preferentially accommodated by movement along a sub-horizontal plane in less competent strata such as coal, immediately adjacent to a comparatively more competent bed, such as sandstone. No dislocation of the sandstone floor of the Chamberlain Seam has been observed where this type of shearing occurs in the Chamberlain Seam.

Except for the major thrust faults, which separate Plates 1, 2 and 3 and the six intra-plate faults of Plate 2, with a throw generally exceeding 50 feet, displacements of the sandstone floor of the Chamberlain Seam have not been detected.

The presence of such faults with a throw of up to, say, 20 feet at the floor of the Chamberlain Seam might have been expected. Despite the evidence available, based particularly on the 12,000 feet of outcrop stripping, it is considered that the existence of some minor local faults must yet be considered likely in any thinking in respect of mine planning and cost provisions. These may be normal faults which might not be detected in vertical drill holes. Such small faults would not be obvious from the structure contours and it is not possible to suggest where this type of fault may occur, nor is it possible to postulate the frequency of occurrence.

4.3.7 SUMMARY

1. The gently dipping, essentially unmetamorphosed Lower Cretaceous strata of the project area have been dislocated by a series of thrust faults.

2. The low angle thrust faults are parallel to the regional south-easterly trend and except for one back thrust fault in Plate 1, they dip to the south-west at an average of 10^o.

3. The Chamberlain Fault, separating Plate 1 from Plate 2 and the Skeeter Fault, separating Plate 2 from Plate 3, are of such magnitude that the mining of coal in the project area must be considered separately for each of the Plates.

4. Within Plate 2, which occupies the greater part of the project area, six subsidiary thrust faults, of limited extent, are present at the level of the Chamberlain Seam and the Skeeter Seam.

5. The subsidiary faults of Plate 2 have been delineated on the basis of drill hole data. The maximum throw of any one of these faults at the level of the Chamberlain Seam has been determined as 380 feet, but is generally less than 150 feet on any one fault. However, the throw along the greater part of many of these faults is commonly less than 85 feet. Figure 4.18 shows the throw of these intra-plate faults.

6. Two of the intra-plate faults in the northern part of Plate 2 separate that plate into the sub-plates 2a, 2b and 2c and will govern the layout of the mine in so far as they will act as barriers to mining districts. It is probable that a number of the main headings will have to cut across the intra-plate fault zones.

7. The strata are folded in a series of broad, gently flexed anticlines and synclines. Synchronous faulting and folding is considered to have resulted, almost without exception, in the development of an anticlinal structure on the upper plate adjacent to a fault and a synclinal structure on the lower plate adjacent to the same fault. The theoretical evolution of the concept of this structural pattern is based on observations made in the field and drill hole data; it was sustained by some 9 drill holes specifically sited to check the concept. The application of this concept to the construction of contour maps and the geological

cross sections, where it was in accord with all available data, is considered to have provided the most meaningful interpretation of the sub-surface structure in the project area.

8. Minor thrust faults occur in zones up to 20 feet thick above the Chamberlain and Skeeter Seams, but are mostly confined to less than 10 feet of strata. Eight of these faults were observed along about 12,000 feet of exposure where stripping had been carried out.

9. Sub-horizontal zones of shearing and faulting are confined to as little as 1 foot within the seams at either or both of the top and bottom sections of the seams at a number of localities.

10. Small scale, tightly flexed folds are confined to strata adjacent to the major thrust faults.

4.4 IGNEOUS ACTIVITY

The Lower Cretaceous rocks of the Sukunka River district, which include the coal-bearing Gething Formation, are entirely of sedimentary origin. There is no evidence of contemporaenous or of subsequent intrusive or extrusive igneous activity.

A significant consequence of this is the high degree of confidence in prediction of the absence of cindering of the coal and the absence of igneous sills or dykes in the coal-bearing strata.

SECTION 5

Economic Appraisal of the Coal Seams

5.1 INTRODUCTION

In this section of the report is discussed the economic evaluation of the project area in so far as the thickness and distribution of the Chamberlain and Skeeter Seams, the coal quality and the mineable reserves of coal are concerned.

Volume 3 contains the maps pertinent to the section, the more important maps also being included as text figures.

Reference to the various isopach maps illustrating the thickness of the geological units will show that no allowance has been made for the intra-plate faults within Plate 2 while drawing the isopachs. The apparent disregard for the intra-plate faults is due to the fact that insufficient data are available for contouring Plates 2a, 2b and 2c individually. It is contended that this approach in no way distorts the picture relative to the seam or rock unit thicknesses and that the most meaningful version of the variations of thickness is given, considering the limited overlap of the plates produced by the intra-plate faults. It will be recalled that the structure contour map (Map 7) shows the displacements caused by the intra-plate faults. Isopach maps are constructed for Plates 1, 2 and 3; Plates 1 and 3 have been combined on one map; Plate 2 is on a separate map for clarity.

The assessment of the quality of the coal is based on the included data in Appendix A, with its numerous sub-sections. With the exception of Appendix A-10, the data have all resulted from the

1971 field programme carried out on behalf of Coalition Mining Limited. Appendix A-10 is a series of tables reproduced from the April 1971 report to Brameda Resources Limited by Bergey et al, (1971). No responsibility is accepted for its accuracy or completeness.

Ten samples of washed coal resulting from the Brameda Resources drilling were forwarded to Australia for check analysis by Cargo Superintendents' laboratory. Appendix A-6 contains the results. The agreement between the two sets of values is such as to confirm confidence in the analytical data resulting from the S-series drill hole information, in so far as laboratory accuracy is concerned, and its consequent inclusion in the overall study.

Cargo Superintendents Co.(A/sia) Pty. Ltd., of Sydney, Australia carried out all the laboratory work on the drill core, face and bulk samples, in part. The drill core data (proximate analyses, washability and sizing tests) are included with each drill hole record in Appendix F and are summarised in Appendix A.

Washability tests were conducted on the face samples from Adits #2, #3, #4 and #5, and on representative samples of the bulk samples taken from Adits #2, #4 and #5. The complete 30 ton bulk sample was treated by Coal Science and Mineral Testing Ltd. of Calgary, Alberta.

5.1.1 SAMPLING METHODS - BULK SAMPLES

The following procedure was adopted when collecting the bulk samples from Adits #2, #4 and #5.

The adit was driven until a constant C.S. No. was achieved, based on field testing. In general, driving was continued until the C.S. No. reached at least 7. In driving the new adits, #4 and #5, the C.S. No. generally reached an acceptable figure within 30 feet from the portal. When sampled, the C.S. No. for Adits #2, #4 and #5 was 7, 8½ and 7 respectively.These figures are an average for the total face, while the range of values was between 6½ and 9.

Extension of the adit #3, for face sampling only, was carried forward until a similar condition was satisfied.

When the point was reached where the C.S. No. indicated unoxidized coal, the face was squared down and a face sample taken.The face samples varied in weight from 500 to 800 pounds, this volume being coned and quartered until approximately 100 to 150 pounds was obtained for laboratory testing. Adit #4 was sampled by hand,while Adits #2, #3 and #5 were sampled using an air pick.

After face sampling, the face was drilled and blasted using light charges of permissible explosive. It was normal for 3 rounds to be taken to provide enough coal for a 30 ton bulk sample. During drilling, 8 feet rods were used, but because of the lightness of the charge, usually 6 to 7 feet of coal was blasted free. After each round of firing, the coal was removed from the adit using an air-driven slusher. The mucked-out coal was stored on a 12 inch thick bed of coal, previously removed from the adit, in order to eliminate contamination from the ground.

The stored coal was then loaded into trucks by way of a front end loader, the tray of the trucks having been previously cleaned, again in order to eliminate contamination. From each face,three 10 ton truck loads were taken for delivery to Coal Science and Mineral Testing Laboratories Limited in Calgary. Each truck was covered with canvas before departure from the site.

In Calgary, the truck loads were tipped on steel plating and then loaded into 45 gallon steel drums which were then sealed, preparatory to washability testing.

5.1.2 RESERVE CALCULATIONS

As the matter of reserve calculation is of critical importance, considerable thought was given to the method of treatment of the total data and the accuracy of the data resulting from the 1969 and 1970 field seasons, D.D.H's S-1 to S-50.

In order to incorporate into the isopach map construction, and consequently the reserve calculations, the seam thickness from D.D.H's S-1 to S-50 (Brameda Resources Ltd) a statistical analysis was made of this data relative to the data resulting from the fully controlled 1971 drilling programme, i.e. the C, CS and CM series of drill holes. Only the Chamberlain Seam, the most extensive seam, was evaluated.

Firstly, the log of every S-series drill hole was individually assessed, and where practicable, corrections made for discrepancies. In some instances no corrections or critical evaluation could be made due to the lack of detail in the core logging.It is emphasized however that the coal sampled during the 1969 and 1970 field seasons was not available for inspection and thus the figures are accepted at face value only.

The method of statistical analysis adopted is described below.

Triangles were constructed on a plan of the bore holes between the S and C series drill holes separately, such that each bore hole forms an apex of one of these triangles. The average thickness (t_{av}) of the three bore holes forming each triangle was then calculated. This thickness was multiplied by the area of each triangle, giving the average volume of coal for the Chamberlain Seam, within each triangle; expressed as

$$(\text{Area} \times t_{av})$$

The total volume of coal in the Chamberlain Seam for the area under consideration was calculated using the expression:

$$\sum (\text{Area} \times t_{av})$$

Thus T_{av}, the average thickness for the total Chamberlain Seam, can be calculated from:

$$T_{av} = \frac{\sum (\text{Area} \times t_{av})}{\sum (\text{Area})}$$

Using this method, T_{av} for the S series was found to be 8.85 feet and for the C series, 9.86 feet.

For each of the calculations which produced the above figures all bore holes were included, including those which intersected a thickened seam due to faulting. When the drill holes which intersected thickened seam sections were excluded, the two figures for the average thickness of the Chamberlain Seam were found to be 8.47 feet and 8.62 feet for the Skeeter and Chamberlain series drill holes respectively.

It is contended that since the seam thicknesses are within 0.15 foot of each other that both sets of data may be validly incorporated into any reserve calculations for the Chamberlain Seam.

The aspect of core recovery during the drilling programme was given constant attention, as the quality data and, more particularly, the reserve calculations are entirely dependant on completeness of information. It is important to note that the use of the split inner tube during drilling increased the accuracy of the estimate of core recoveries with a consequent higher degree of confidence in the information so produced. Appendix A-1.1, "Comments on Core Recovery in Relation to Reserve Calculations", discusses the use and advantages of the split inner tube, and the method of proportional distribution of core loss. Both these factors, while recognised in Australia, do not appear to be in general use in North America.

The reserve calculations, detailed in Section 5.3.4 and 5.4.4 for the Chamberlain and Skeeter Seams respectively, and summarised in Section 5.2, below, are based on the drill core data. The figure of 70% for extraction has been used, after discussion with the mining engineers of Austen & Butta Limited and with Mr. H.C. Collins, a world recognised consulting mining engineer of London.

Yields, or recoveries after washing, of 80% and 85% for the Chamberlain Seam and 70% and 75% for the Skeeter Seam are based on analytical data from drill cores.

*

In considering the Gross Reserves of the Chamberlain Seam, only the coal in the seam has been taken into account. It is apparent that the run-of-mine coal will contain the "bone" band above the seam and some of the overlying roof strata, especially in the early stages of development, when the roof must be dropped to give an adequate working height. As the volume of these non-coal materials cannot be accurately assessed, they must be excluded from the reserves calculation.

For the Chamberlain Seam, a yield of 80% and 85% was used in the reserves calculations being related to the drill core coal only. These figures are significantly different from the 75% to 78% yield anticipated for the run-of-mine coal for the purpose of washing plant design. See Appendix A-9. These latter

* See page 5.7 for note.

SECTION 9

SELECTED BIBLIOGRAPHY

ATKINS, W.F. and LATTANZI, C.R., 1971: Coal Mine Inspections, Report No. 1, *Strip Mining Operations in Maryland Smoky* River Project in Alberta. David S. Robertson & Associates Ltd. (unpub.).

BANKS, R.L., 1971: Western Canadian Coal: A Broadening Industry. Presented to 23rd Canadian Conference on Coal, Ottawa, Ontario.

BERGEY, W.R., 1970: Interim Report on the Sukunka River Project; Brameda Resources Ltd. (unpub.).

____, 1971: Report on Potential Coal Resources, Teck Corporation Option - Sukunka Area. Teck Corporation. (unpub.).

____, BILHEIMER, L., MITCHELL, J.C. and TRENHOLME, L.S., 1971: Summary Report, Sukunka Coal Project, Peace River District, British Columbia; Brameda Resources Ltd. (unpub.).

____, and TRENHOLME, L.S., 1971: Report on the proposed Coal Exploration Program, Teck Corporation Option - Sukunka Area. Brameda Resources Ltd. (unpub.).

BIRMINGHAM, T.F. and CAMERON, A.R., 1971: Petrography of the Chamberlain Seam; Geol. Surv. Can. (Dept. of Energy, Mines and Resources). (Reproduced in this report as Appendix D).

BURK, C.F., Jr., 1963: Structure, Isopach and Facies Maps of Upper Cretaceous Marine Succession, West-Central Alberta and Adjacent British Columbia; Geol. Surv. of Can. (Dept. Min. and Tech. Sur.), Paper 62-31.

CLARKE, T.M., 1971: The Mechanisation and Development of the N.S.W. Coal Industry over the last Twenty Years; Preprint of paper presented at the 1971 Annual Conference of the Aust. Inst. Min. Met.

CLIFFORD McELROY & ASSOCIATES, 1971: Progress Notes on an Appraisal of the Coal Resources of the Sukunka River Area. Unpub. rpt. for Austen & Butta Ltd. Rpt. No. 1/4/2, 22nd May, 1971.

5.2 SUMMARY

Throughout the total project area, the Chamberlain Seam is workable, varying in thickness from 4.5 feet in the north to 13 feet in the south east of the area. Over much of the area the seam thickness is between 8.5 and 9.0 feet. The ash content of the washed product, based on a washing gravity of 1.60 is predicted to be less than 5.3%. The C.S. No. will be about 7½.

The Gross Measured Reserves of the Chamberlain Seam in Plate 2 have been calculated at 58.5 million long tons, producing 32.80 million long tons of washed coal. Additionally considerable Measured Reserves of coal for Plate 1 and Indicated Reserves exist in Plate 3.

The Skeeter Seam is more restricted in distribution than the Chamberlain Seam, not being economic south of grid line E. The minimum average thickness of this seam for more than 50% of the area deemed to be economic is 6 feet, ranging up to a maximum of 9.5 feet for the working section.

An ash content of 4.8% is predicted for the washed product, while the C.S. No. will be in the vicinity of 7½.

In Plates 1 and 2, 2.52 and 9.32 millions long tons of Gross Measured Reserves have been proven. These reserves will produce 5.79 tons of washed coal under the conditions specified in Section 5.4, below.

Table 5.1 summarises the total washed coal reserves for the project area. It can be confidently predicted that the Indicated Reserves of coal in the Chamberlain Seam in Plate 3 and external to the grid area, and in the Skeeter Seam in Plate 3 can be up-graded to the Measured category with the additional drilling outlined in Section 7, of this report.

TABLE 5.1

SUMMARY OF RESERVE FIGURES

(a) Measured Reserves

Seam	Millions of Long Tons, Washed Coal#		
	Plate 1	Plate 2	Total
Chamberlain	2.02	32.80	34.82
Skeeter	1.23	4.56	5.79
TOTALS	3.25	37.36	40.61

(b) Indicated Reserves

(Millions of long tons, washed coal#)

convert to in-place reserves

(a) Plate 3

Chamberlain Seam	3.65	.56	6.52
Skeeter Seam	1.22	.49	2.49
Total	4.87		

(b) External to Grid

Chamberlain Seam	12. 0	@ .52	23.0

Total Indicated Reserves: 16.87 million long tons

\# The above reserve figures are based on 70% extraction during mining and a washing yield of 80% and 70% for the Chamberlain and Skeeter Seams respectively.

Detailed reserve figures and categories are included in Tables 5.6 and 5.16, below.

5.3 CHAMBERLAIN SEAM

5.3.1 GENERAL STATEMENT

The Chamberlain Seam has been described in general terms in Section 4.2.3 (ii). For convenience and for completeness, a resume of the previous description is included here. The Chamberlain Seam is continuous at depth throughout the area covered by the exploration grid, and crops out on the steep slopes of the high ground bounded by Skeeter and Chamberlain Creeks, and to the south of Bullmoose Mountain.

To the south of Chamberlain Creek, the seam is split by a sandstone band dividing the seam into 3 sub-units, designated in ascending order, Units 1a, 1b and 1c. Reference to Figure 4.4 shows that Units 1a and 1c are, respectively, the Upper and Lower Splits of the seam, while Unit 1b is the intermediate stone band. Map 12 shows the variation in thickness of Unit 1b. The band varies from grey, medium grained quartz-lithic sandstone to grey siltstone and locally includes minor dark grey claystone interbeds. Coaly partings are not uncommon within this unit. The Chamberlain Seam, and the Upper and Lower Splits south of Chamberlain Creek, are notably free of stone bands or partings.

Immediately overlying the Chamberlain Seam throughout most of the project area is a bed of stony coal/carbonaceous claystone, or a dark grey brown claystone. This unit has been locally referred to as "bone". See Figure 6.5. Throughout most of the project area, fine to medium grained carbonaceous sandstone forms the floor of this seam. In three isolated areas of limited extent, dark grey mudstone overlies the sandstone and forms the floor of the Chamberlain Seam. Only one of these zones is of significance. In a zone along grid line H, the mudstone ranges in thickness between 0.5 feet and 3 feet except in D.D.H. S-4 where a thickness of 36 feet is attained. See Figure 6.4.

5.3.2 SEAM THICKNESS AND DISTRIBUTION

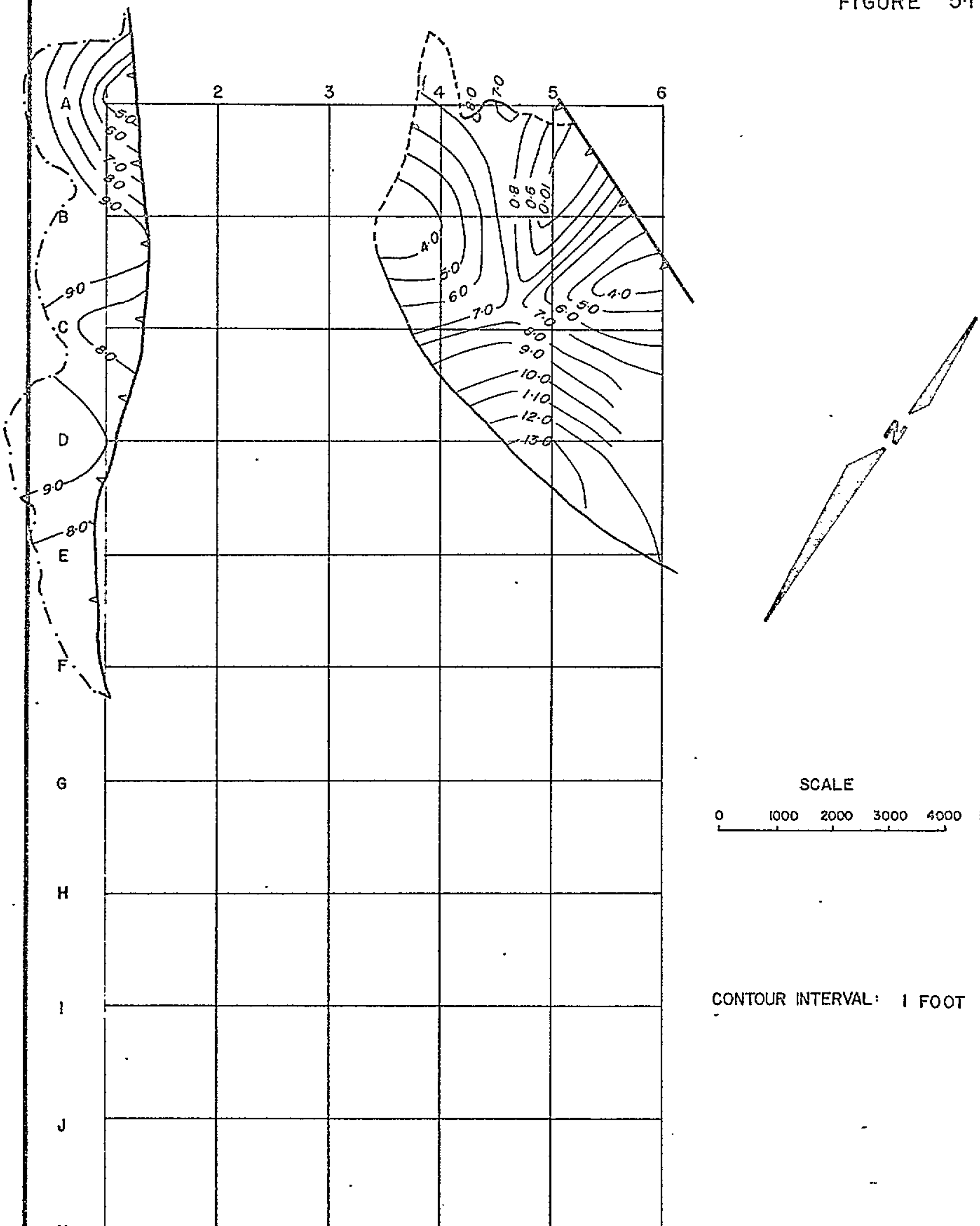
The thickness of the Chamberlain Seam in Plate 1 ranges up to 10 feet, as in D.D.H. S-43, and over much of this plate is between 8 and 9 feet.

The Chamberlain Seam in Plate 3 has been intersected in seven drill holes and exposed along about 1600 feet of out-crop stripping. The maximum thickness, 13.6 feet, was intersected in D.D.H. S-31, while the minimum thicknesses were 3.67 feet in D.D.H. S-6 and 3.9 feet in D.D.H. C-39. Over much of the area of Plate 3, the seam is in excess of 5 feet and this area constitutes a particularly workable block of coal. Further drilling in this plate is required, however, to up-grade the reserve category from Indicated to Measured. See Figure 5.7. Map 9 and Figure 5.1 show the thickness of this seam in Plates 1 & 3.

Map 10 and Figure 5.2 show the variation in seam thickness of the Chamberlain Seam within Plate 2. In the southern part of the area, this map includes the thickness of the Lower Split of the Chamberlain Seam. The Upper Split is not considered economically workable. The variation in thickness of the Upper Split is shown on Map 11.

For much of Plate 2, the seam is in excess of 8 feet thick and is up to 12.98 feet thick in D.D.H. C-20. The 7 feet isopach line roughly parallels the northern outcrop of the seam in Plate 2, some 2500 feet to the south. Except in

FIGURE 5·1



SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1 FOOT

SKETCH ISOPACH MAP

CHAMBERLAIN SEAM

PLATES 1 & 3

COALITION MINING LIMITED

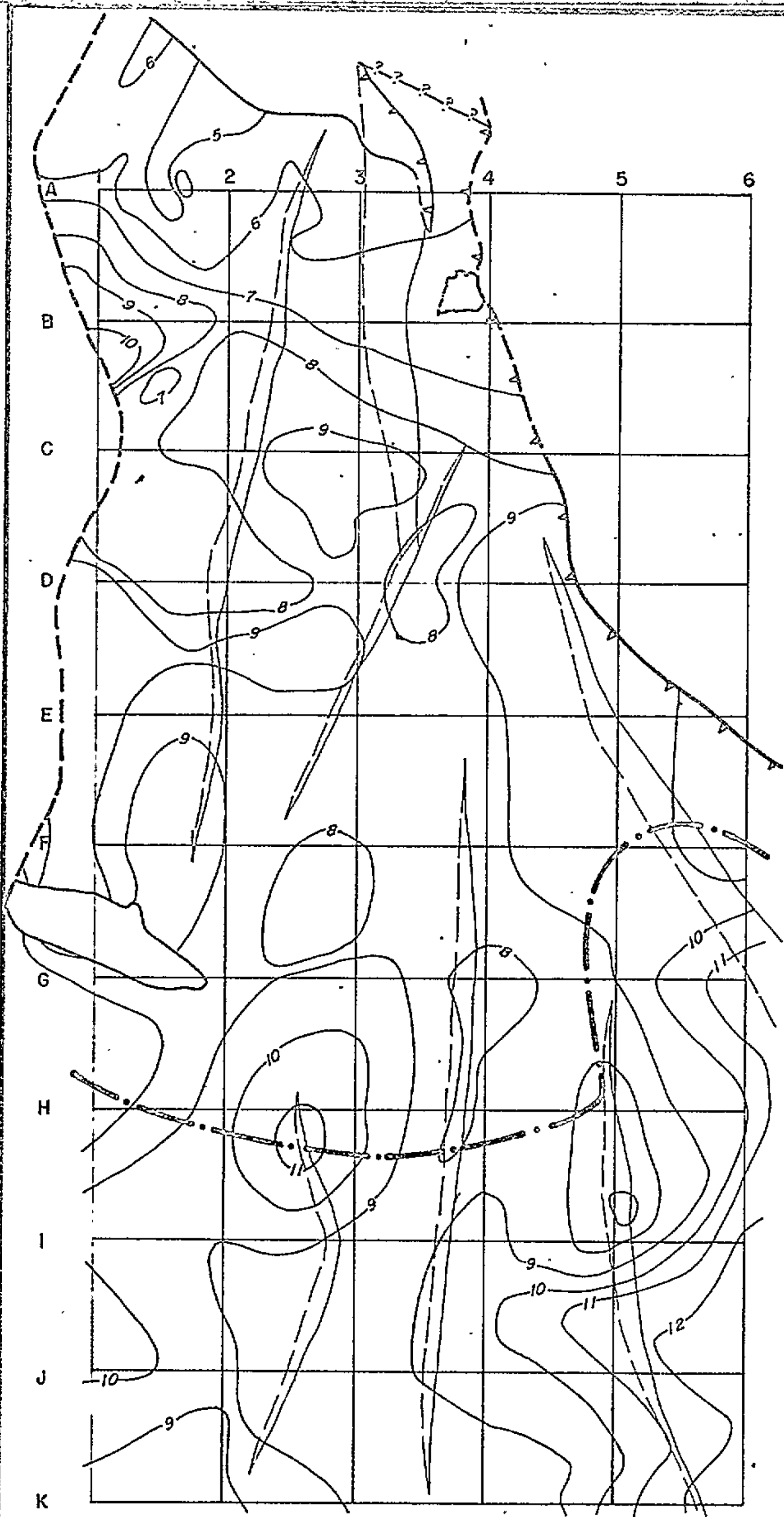
SUKUNKA COAL PROJECT

January 1972.

See also map 9 for details of contours at Scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 5·2



SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1 FOOT.

REFERENCE

North western limit of rock band (Unit 1b) between Upper and Lower Splits of Chamberlain Seam

SKETCH ISOPACH MAP

CHAMBERLAIN SEAM

PLATE 2

SHOWING LOWER SPLIT ONLY IN SOUTH

See also Map 10 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

D.D.H. C-4, the seam south of this isopach line is in excess of 7 feet thick.

Unusually thick intersections of coal were recorded in six of the drill holes in Plate 2. In five of these holes, the coal was in excess of 20 feet thick and in one was in excess of 13 feet thick. Detailed logging of the core from these holes established that these thickened intersections were due to faulting causing repetition of the strata. Consequently, the data from these holes has been disregarded in the construction of the isopachs presented in Map 10.

An unusually thin interval, 2 feet, of the Chamberlain Seam was recorded in D.D.H. S-39 in the south-eastern part of the exploration grid. It was not possible to check on this recorded thickness using the geophysical well logs as this hole, drilled in the 1970 field season, had collapsed. From a knowledge of the adjacent strata and their variation in thickness, it is considered that this 2 feet interval is not a true record of the Chamberlain Seam in this area. Throughout the project area, there is positive evidence of the absence of washout structures in the coal seams and since the intersection in D.D.H. S-39 is not in accord with the values obtained in the surrounding drill holes, that data has been excluded during the construction of the isopachs. Some further discussion of the Chamberlain Seam in this area is included in Section 4.2.3.

Map 12 illustrates the variation in thickness and overall extent of Unit 1b. This medium-grained quartz-lithic sandstone or siltstone band, which attains a maximum thickness of 42 feet in D.D.H. S-46, thins rapidly to the south-east where, in D.D.H. S-12, a thickness of 16.5 feet was recorded; it forms the roof of the working section of the Chamberlain Seam (Lower Split) in the south-eastern part of the exploration grid.

The Upper Split of the Chamberlain Seam, separated from the Lower Split by the sandstone band, attains a maximum thickness of 5.59 feet in D.D.H. C-18. The variation in thickness of the Upper Split is shown on Map 11. Since the Upper Split is generally less than 4.5 feet thick, it is considered not to be commercially mineable and has not been included in the calculation of reserves of the Chamberlain Seam.

5.3.3 COAL QUALITY

The Chamberlain Seam is remarkably free from bands of stone in any form. The coal predominantly ranges between dull with minor bright bands and dull with frequent bright bands. In bore cores the coal has the appearance of being entirely of bright coal; however, on close inspection, the bright coal is seen to be in smaller proportion than appears at first sight.

A petrographic examination on three samples of Chamberlain Seam coal from bore cores was carried out by Dr. A.C. Cook of Wollongong University College. The vitrinite content of these three samples ranges between 57% and 75%, and are termed by Cook as being of "moderate vitrinite content..." The reflectance values range between 1.33% and 1.37%. Cook's report is reproduced in Appendix C.

In Appendix D is a report by Birmingham and Cameron of the Geological Survey of Canada, also dealing with the petrography of the Chamberlain Seam. The reflectance figure produced by these workers is 1.37%, while they report 86% of the particular section analysed was bright coal. Of the 86%, 66% was attributed to Vitrinertite V. The seam section selected for analysis is not considered representative of the general character of the Chamberlain Seam throughout the area.

The analytical data referable to the Chamberlain Seam is included in Appendices A-5 and A-2.1. The former table lists in detail the proximate analyses as determined during the laboratory studies on the coal cores. The latter table summarizes the coal quality data and lists the means and standard deviations of the analysis figures for the various structural plates.

TABLE 5.2

Range of Mean Values of Analytical Data for Washed Product at S.G. 1.60 (Air Dry Basis).

Chamberlain Seam (Various elements - Plate 2)
(Data for Upper Split excluded)

Moisture %	0.8	to	1.0
V.M. %	19.2	to	22.2
V.M. % (DAF)	20.6	to	26.2
Ash %	3.9	to	5.3
Fixed Carbon %	73.0	to	73.9
C.S. No.	7	to	7½
C.V. (BTU/lb.)	14520	to	15030
Sulphur %	0.35	to	0.45
Phosphorous %	0.021	to	0.035

See Appendices A-2.1 and A-5 for full details of Proximate Analyses.

Table 5.2 above, lists the ranges of mean values of the analytical data, for the washed product at a specific gravity of 1.60 from the drill cores from Plate 2. Of particular note is the range of ash values in the seam, from 3.7% to 5.3%. It will be noted from Table A-2.1 that of 58 samples tested, 36 were less than 3.9% ash in Plate 2.

The mean values of the analytical data for Plates 1 and 3 are included as Table 5.3.

TABLE 5.3

Mean Values of Analytical Data for Washed Product at S.G. 1.60 (Air Dry Basis).

Chamberlain Seam (Plates 1 & 3)

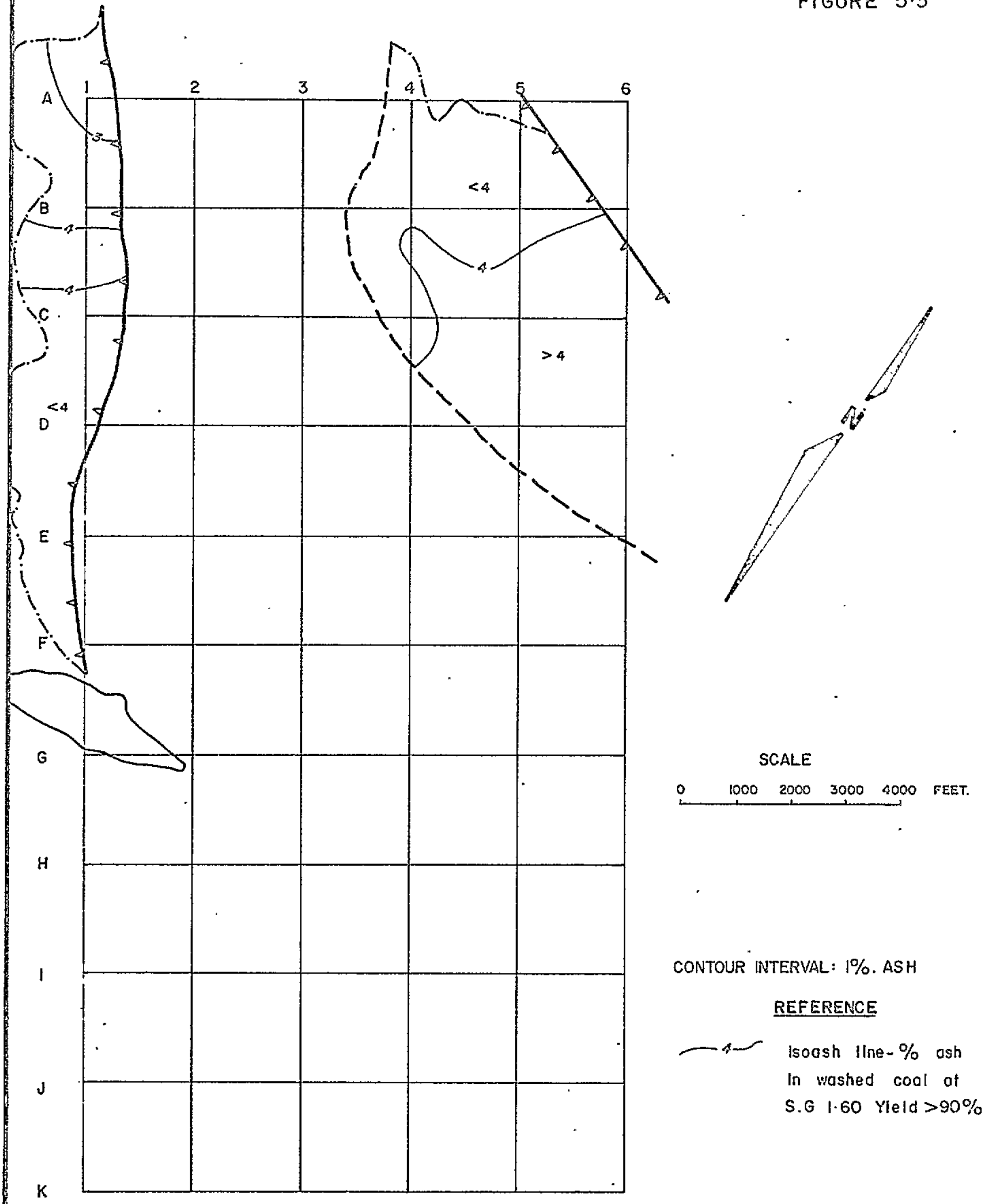
	Plate 1	Plate 3
Moisture	1.1%	0.9%
V.M. (A.D.B.)	21.4%	20.1%
Ash	3.7%	4.1%
Fixed Carbon	73.9%	74.9%
C.S. No.	5	6½
Sulphur	0.30	0.30
C.V. (BTU/1b)	15000	14670

Comparison with the range of values for Plate 2 shows that there is no significant variation in seam quality in the three plates.

The Upper Split of the Chamberlain Seam, which is regarded as of uneconomic thickness, varies in quality to the Lower Split, with a mean ash content of 7.2% and a C.S. No. of 5½.

Reference to Map 24, the Isoash map for the Chamberlain Seam, (and Figures 5.3 & 5.4), illustrating the percentage of the ash in the washed product at S.G. 1.60 will show that some 70% of the area will produce a washed product with less than 5% ash, at a yield in excess of 90%. It is important to note,however,

FIGURE 5·3



SKETCH ISOASH MAP

CHAMBERLAIN SEAM

PLATES I and 3

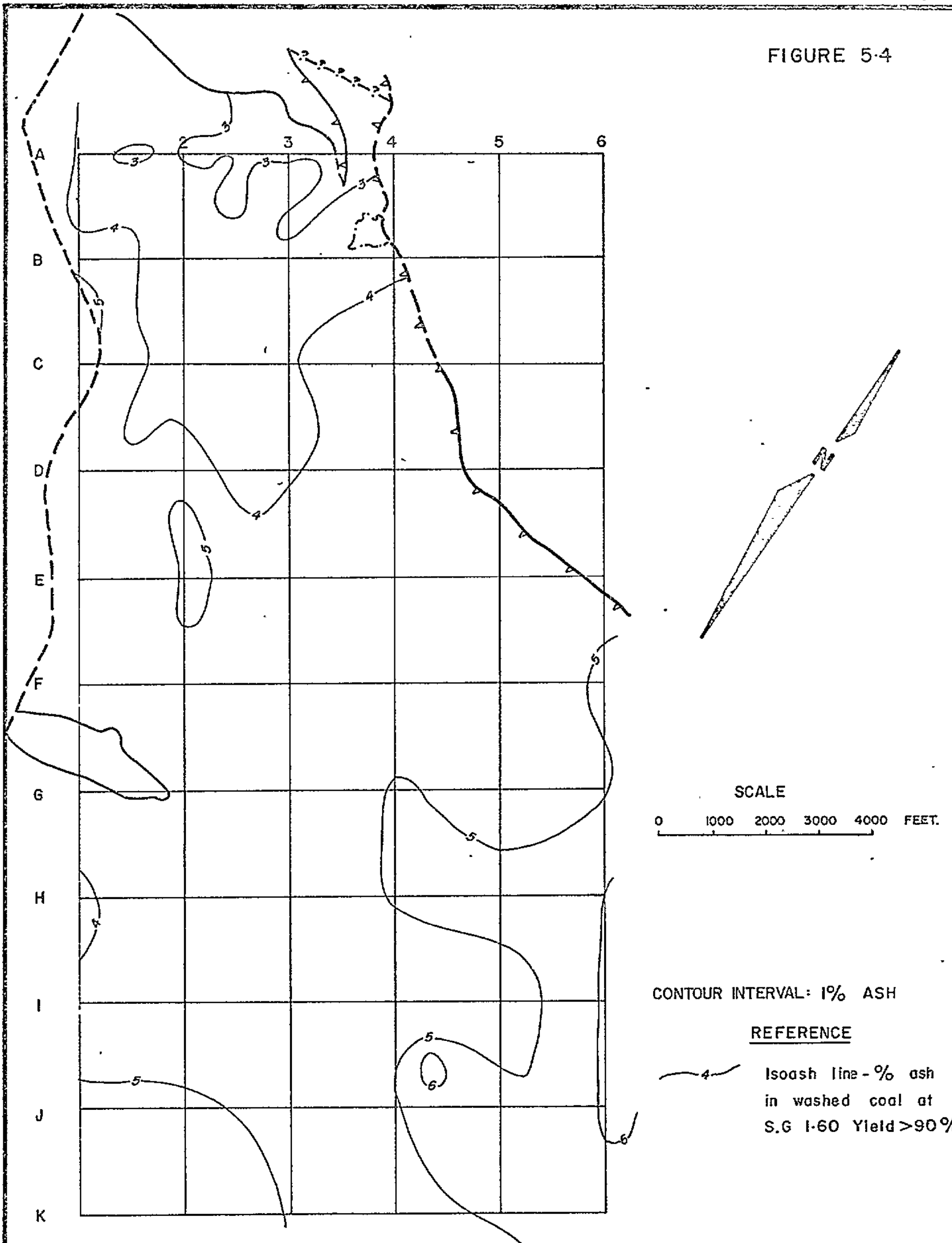
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 5·4



SKETCH ISOASH MAP

CHAMBERLAIN SEAM

PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

that this ash value is based on drill core analytical data, and not on a final washed product from coal as mined.

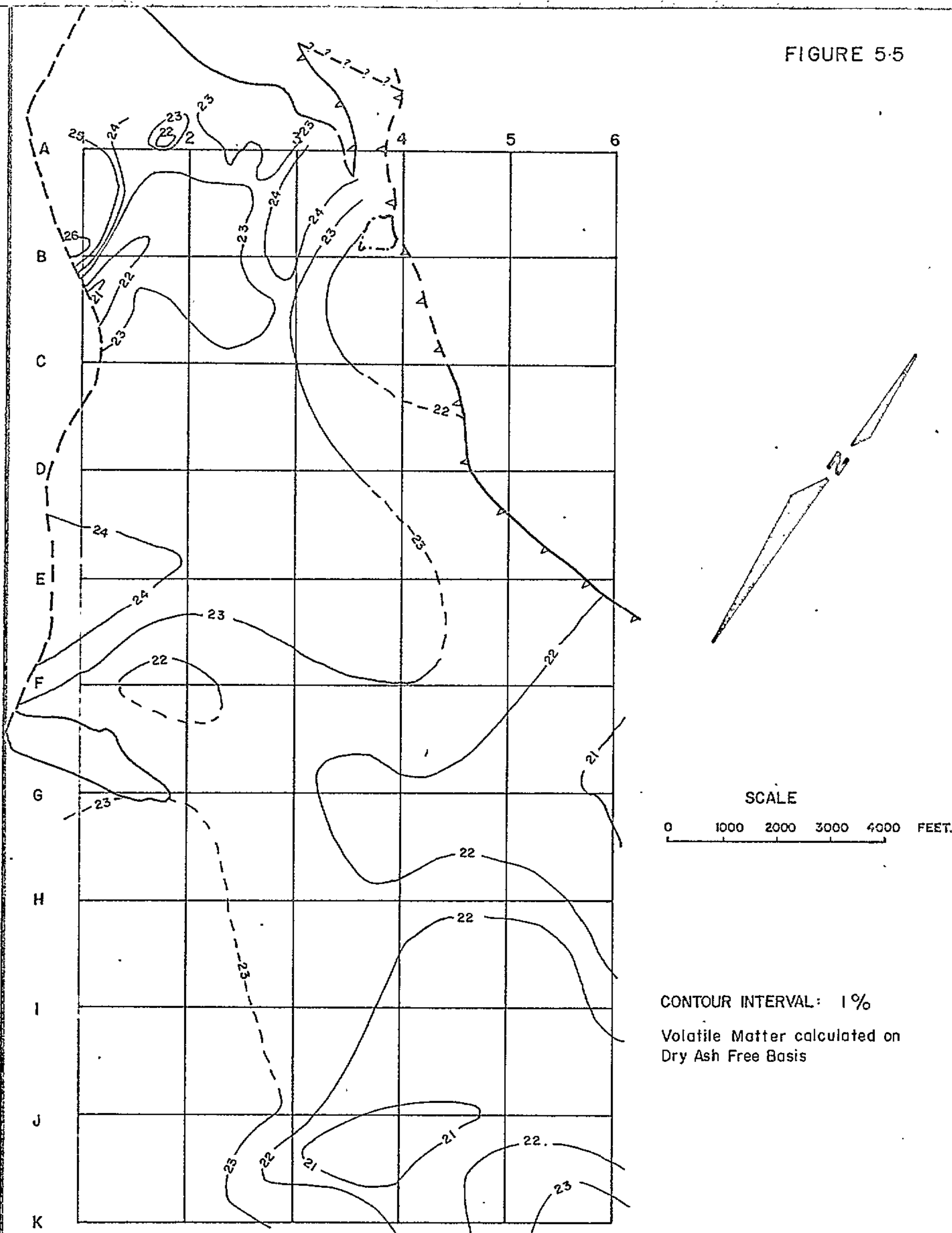
During mining, the "bone" band will inevitably be taken with the desired working section. This will increase the ash content of run-of-mine coal with a consequent reduction in yield figure. Washability studies carried out on the bulk samples, taken from Adits #2 and #4, are discussed in detail in the report by Cargo Superintendents, reproduced in Appendix A-9. This indicates that a yield of between 74% and 78% with an ash content of 2.8% to 5.4% will be achieved during the washing operation.

The volatile matter content of the Chamberlain Seam on an air dry basis is of the order of 20% while on the basis of ash free and dry, is 22.5%. Figure 5.5 illustrates the general lack of variation of the volatile matter in the seam.

Cargo Superintendents carried out a series of tests to determine the washability characteristics on face samples and a representative sample of the 30 ton bulk samples collected from Adits #2 and #4. These results are reported in Appendix A-8.1, A-8.3 and A-9. Table 5.4 summaries the conclusions from the main washability report reproduced in Appendix A-9.

Giesler Plastometer test and Hardgrove Grindability Index results are included in Appendix A-9.

FIGURE 5·5



SKETCH ISOVOL. MAP

(DRY ASH FREE BASIS)

CHAMBERLAIN SEAM

PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

TABLE 5.4

Predicted Product After Washing by Heavy Media Separation and Froth Flotation

	Adit #2	Adit #4
Yield %	74.0	78.0
Air Dried Moisture %	1.0	1.0
Ash %	2.8	5.4
Volatile Matter %	22.8	22.2
Fixed Carbon %	73.4	71.4
Total Sulphur %	0.50	0.48
C.S. No.	8½	8½
Calorific Value (BTU/1b.)	14800	14400
Phosphorus %	0.020	0.034

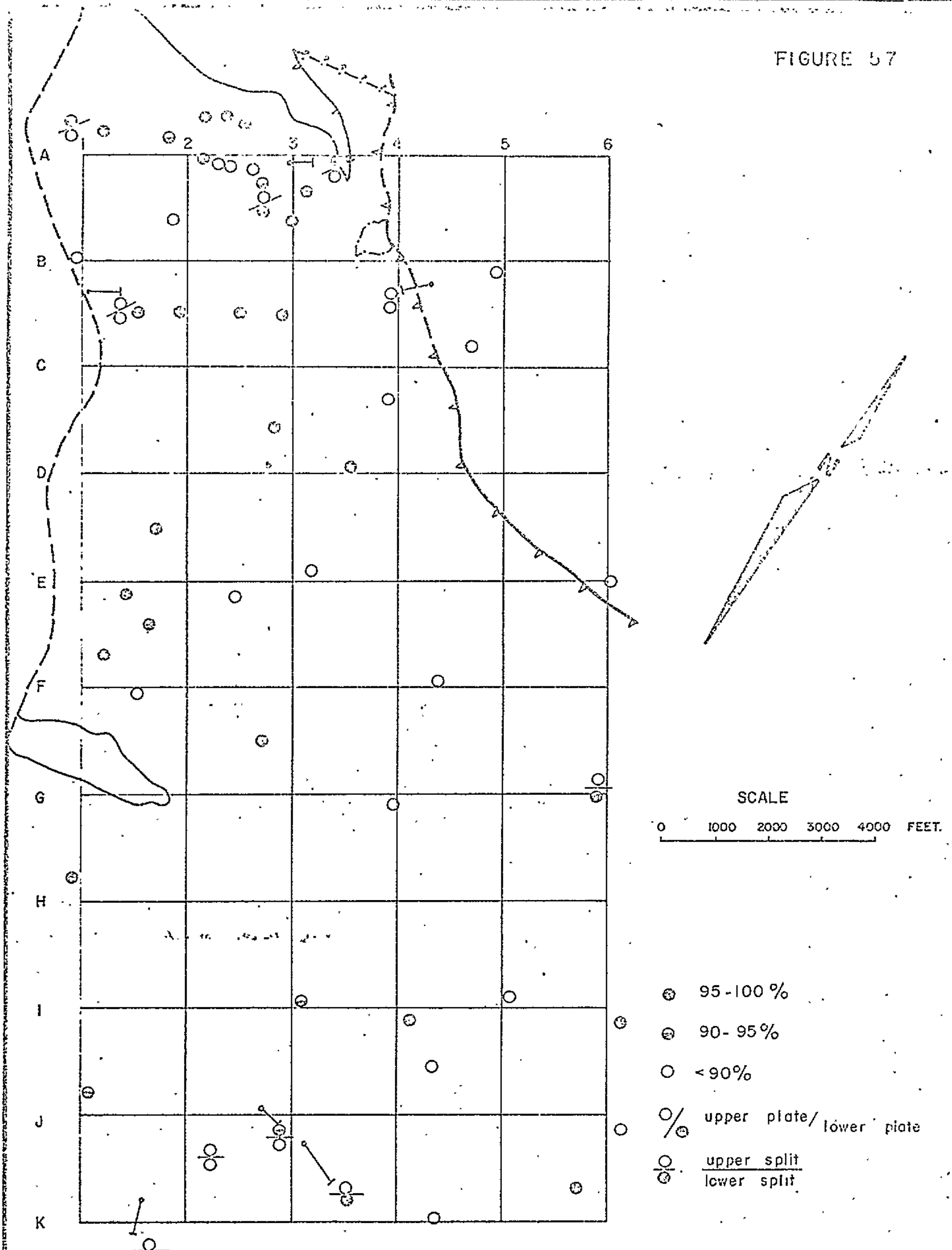
5.3.4 COAL RESERVES

Reserves have been calculated for the Chamberlain Seam based on the isopachs shown on Maps 9 and 10. The reserves have been classified according to the "Code for Calculating and Reporting Coal Reserves" of the Standing Committee on Coalfield Geology of New South Wales and are shown in Table 5.5 and illustrated in Figure 5.6. The above Code is reproduced in Appendix A-1.2.

In calculating the reserves, the seam thickness from the holes drilled on behalf of Coalition Mining Limited and Brameda Resources Limited were used. A check was made to assess the accuracy of the seam thicknesses, which resulted from the Brameda drilling (D.D.H.'s S-1 to S-50); Section 5.1.2 refers.

The recoveries for the holes drilled is shown on Figure 5.7 and relevant aspects of the overall recovery figures has been fully ventilated in Appendix A-1.1.

FIGURE 57



PERCENTAGE RECOVERY
OF COAL IN DRILL HOLES
CHAMBERLAIN SEAM

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

5.4 SKEETER SEAM

5.4.1 GENERAL STATEMENT

The Skeeter Seam or its equivalent occurs throughout the total project area. In the southern part of the area, generally south of grid line G, a lateral facies variation has resulted in the Skeeter Seam being represented by a dominantly carbonaceous claystone with coaly bands designated the Skeeter Seam Equivalent.

In the earlier stages of investigation, some confusion existed as to the true position of a coal unit, which is now established as the Upper Split of the Chamberlain Seam now referred to as Unit 1c. Formerly this was considered to be the Skeeter Seam. With the acquisition of additional drill hole data and an increasing knowledge of the detailed stratigraphy of the Upper Gething sequence, it was possible to establish the composite sections presented in Figure 4.4. These demonstrate the facies change and enable correlation of the lower part of the Upper Gething sequence throughout the project area. This aspect is discussed in detail in Section 4 above.

Mineable thicknesses of the Skeeter Seam only occur in the northern sector of the project area.

The Skeeter Seam may be divided into five principal elements, which in ascending order are:

1. A thin band of coal which is generally not economically mineable.

2. A unit which has been termed informally in this report the Lower Rock Band, which is generally continuous over much of the northern half of the area.

3. The Upper Split of the seam which comprises the main working section of the seam.

4. A band or bands which have been termed the Upper Rock Band, generally thin and discontinuous throughout the area under discussion.

5. A thin coal split, between the Upper Rock Band and the roof of the seam.

The configuration of the various units of the Skeeter Seam is diagrammatically illustrated in Map 4. Isopach maps are included which show the variation in the thickness of the total seam, the theoretical working section, the total coal in that working section, the Upper Split of the Seam and the Lower Rock Band.

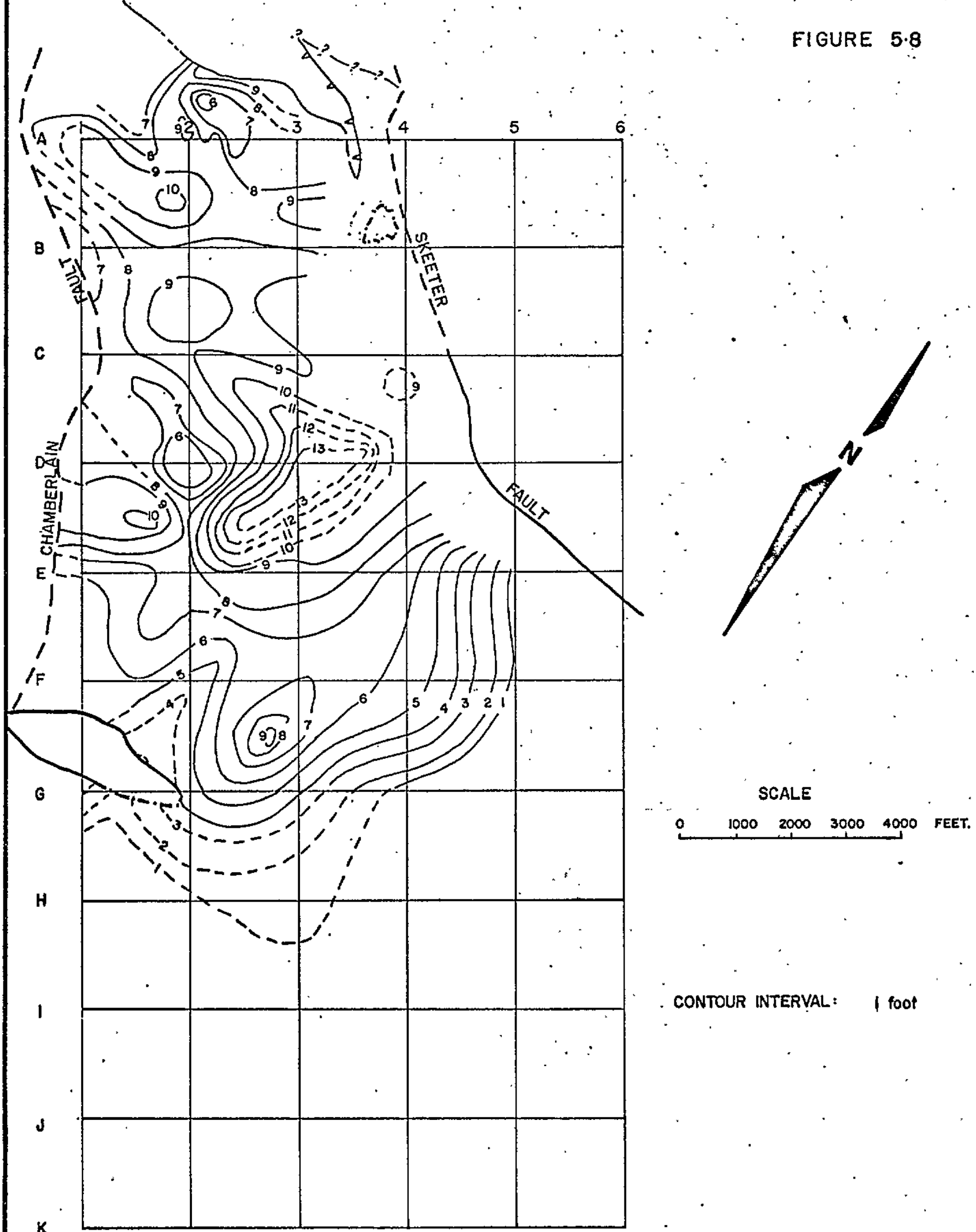
5.4.2 SEAM THICKNESS AND DISTRIBUTION

The thickness of the Skeeter Seam in Plate 1 varies from 4.3 feet in D.D.H. C-31 to 11.6 feet in D.D.H. S-14. Mostly the seam in this plate exceeds 7 feet in thickness; in a small area in the north-west part of the plate, the thickness varies between 4.3 ft. and 7 ft. (see Map 13)

Map 14 and Figure 5.8 show the isopachs of the total seam thickness in Plate 2. The seam exceeds 7 feet in thickness for approximately half the area north of grid line F, decreasing to 2 feet in the headwaters of Chamberlain Creek. The maximum thickness of 13 feet occurs in D.D.H. S-37. The extent of the Skeeter Seam in this plate does not extend below grid line H, being represented to the south of this line by the Skeeter Seam Equivalent.

A comparison of the Isopach Maps 10 and 14 (Total Seam Thickness) for the Chamberlain and Skeeter Seams shows that there is consid-

FIGURE 5·8



SKETCH ISOPACH MAP

SKEETER SEAM
TOTAL SEAM THICKNESS
PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

erably more variation of the thickness of the Skeeter Seam than of the Chamberlain Seam. (See also Figures 5.2 and 5.8).

No isopachs have been drawn for the thickness of the Skeeter Seam in Plate 3 owing to a paucity of data. Map 13 shows the thickness in the 7 drill holes which intersected the Skeeter Seam in this plate. The thickness range is from 0.5 foot in D.D.H. C-17 to 37 feet in D.D.H. S-31, some 3000 feet to the west. The thickness of 37 feet is not regarded as meaningful as the drill hole intersected a fault zone. Also it is considered that the 14 feet of Skeeter Seam intersected in D.D.H. S-41 a further 2500 feet from D.D.H. S-31, is also of no value in relation to reserve figures as a fault zone was intersected.

From the drill hole data, it is concluded that the average seam thickness in this plate is between 6 and 7 feet.

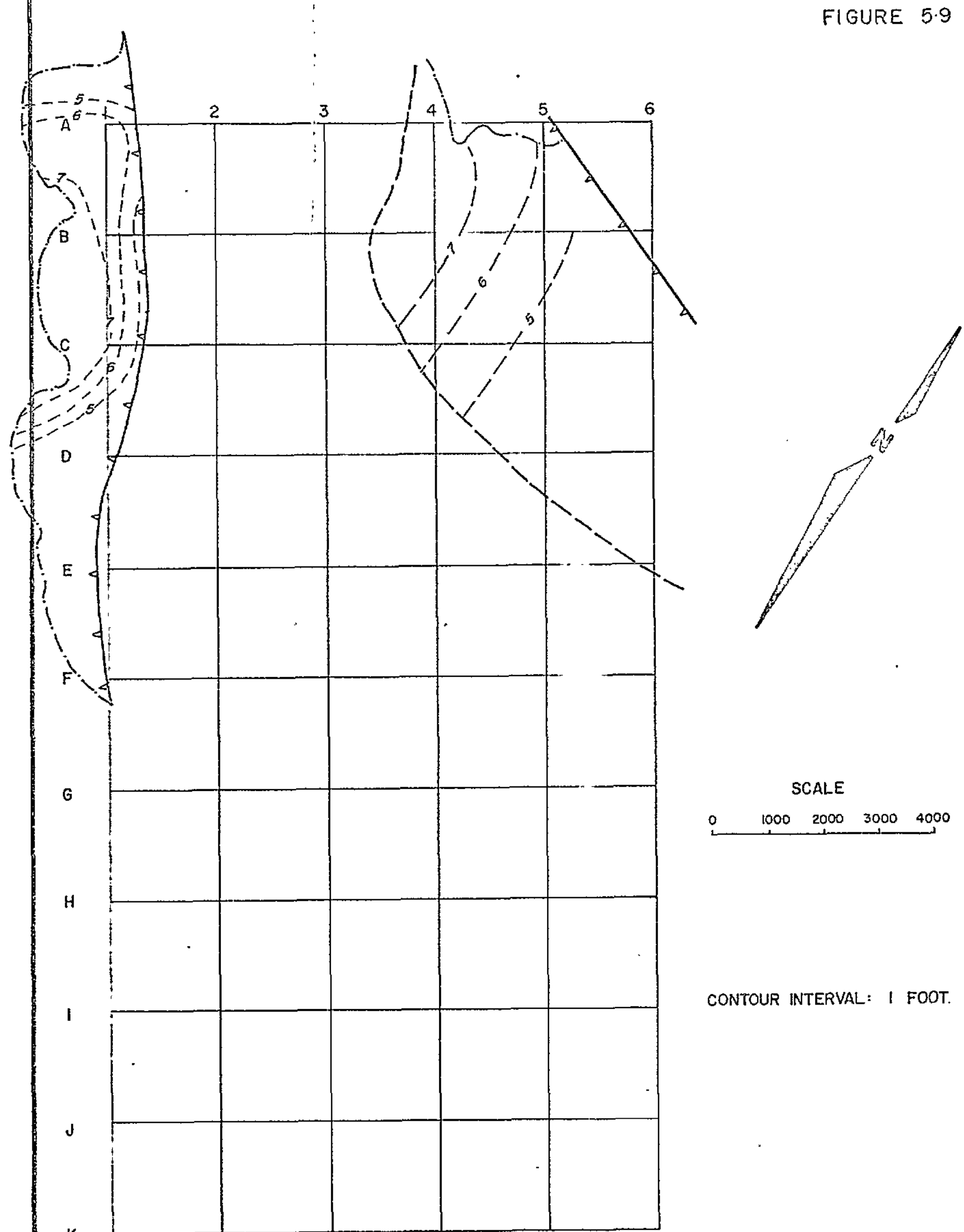
Working Section

Economic considerations dictate that, due to the thickness of the Lower Rock Band in the Skeeter Seam, the total seam cannot be considered as workable.

The "working section" of the Skeeter Seam has been defined as the theoretical thickness of the seam, including the Lower Rock Band, to a minimum working height of 4.5 feet, where the maximum thickness of the lower band is less than 12 inches. It thus will be realized that the working section of the Skeeter Seam (see Maps 15 and 16,and Figures 5.9 and 5.10) which usually includes the Upper Split of the Skeeter Seam, may include the Upper Rock Band and the coal below the roof of the seam and less frequently includes the Lower Rock Band and the coal above the floor of the seam.

In Plate 1, the working section of the Skeeter Seam has been reduced

FIGURE 5·9



SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1 FOOT.

SKETCH ISOPACH MAP

SKEETER SEAM
THEORETICAL WORKING SECTION
PLATES 1 and 3

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

See also Map 15 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

by a number of rock bands to generally less than 6 feet, 7.4 feet in D.D.H. S-17 being the maximum thickness. In this plate, the general thickness of the total Skeeter Seam, as opposed to the working section, is greater than 7 feet, however, since 4.5 feet has been defined as a probable minimum working height,the majority of the seam in this plate is considered workable. A comparison of Maps 13, 15 and 17 illustrates the relationship between the total seam thickness, the thickness of the working section and the total coal in the working section.

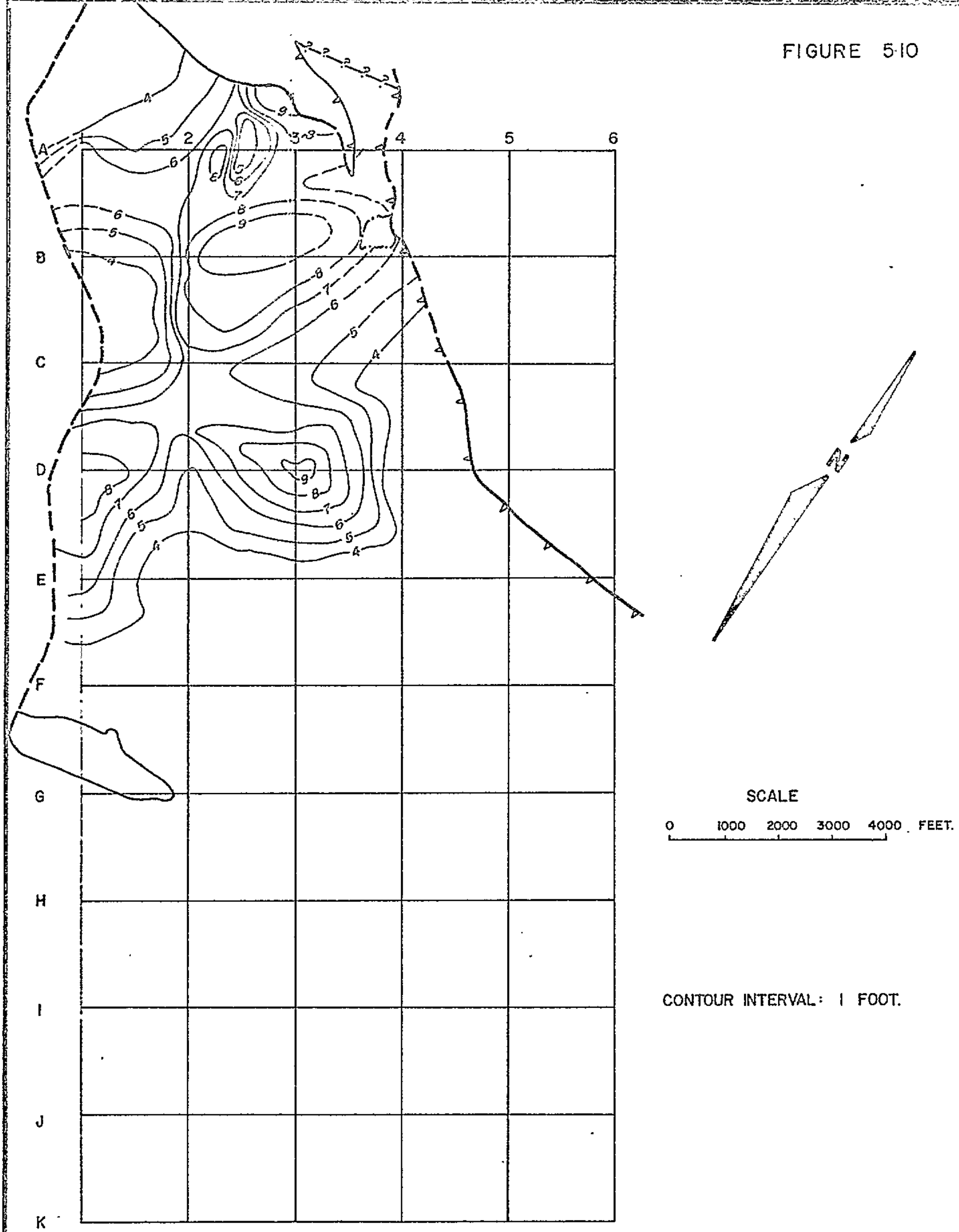
The average thickness of the working section in Plate 3 is between 5 and 6 feet. Toward the top of the seam a band occurs which reduces the coal in the working height by approximately 0.5 foot. Further drilling is required in this plate to fully quantify the seam thickness variations and reserves.

The working section of the Skeeter Seam in Plate 2 is shown on Map 16 and Figure 5.10. The maximum thickness is 9.5 feet (D.D.H. S-21) and thins rapidly to the south to 5.3 feet (D.D.H. S-37). To the north of D.D.H. S-21, the seam thins to 6.4 feet in D.D.H. CM-8; further north it maintains a moderately constant thickness in excess of 7 feet. In Adit #5, 9.8 feet of seam is recorded. Over more than half the working section the maximum thickness is in excess of 6 feet.

Appendix E to this report contains seam sections measured in Adits #2, #3, #4 and #5 and in the various outcrop exposures.

Within the working section, the Upper Split comprises the majority of the coal in that working section; compare Figures 5.11 & 5.12. The maximum thickness of this Upper Split is recorded as 8.4 feet in D.D.H. S-21, thinning rapidly to the south and somewhat more

FIGURE 5·10



SKETCH ISOPACH MAP

SKEETER SEAM
THEORETICAL WORKING SECTION
PLATE 2

COALITION MINING LIMITED

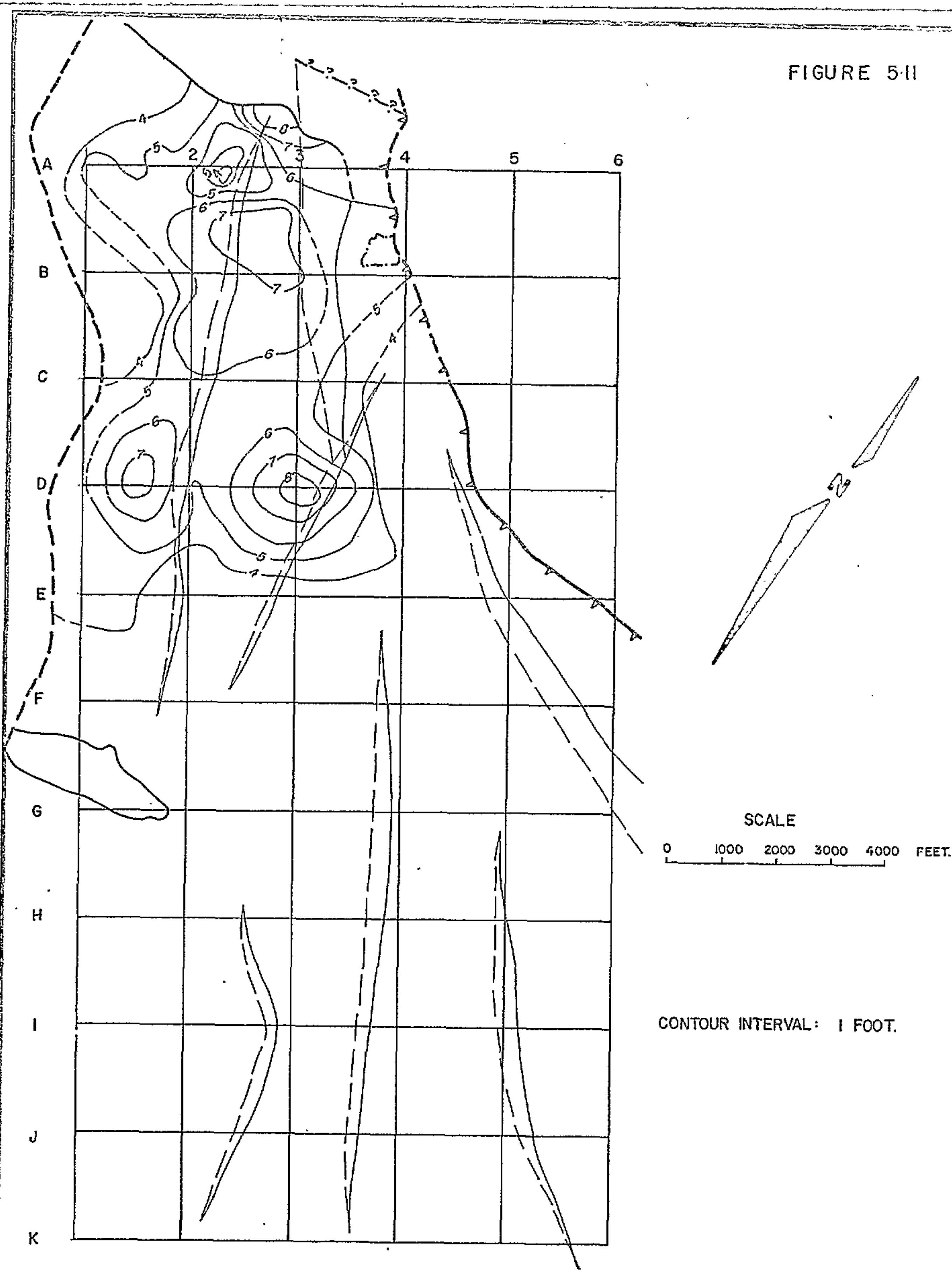
SUKUNKA COAL PROJECT

January 1972.

See also Map 16 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 5·11



SKETCH ISOPACH MAP

SKEETER SEAM

PLATE 2

TOTAL COAL IN WORKING SECTION

COALITION MINING LIMITED

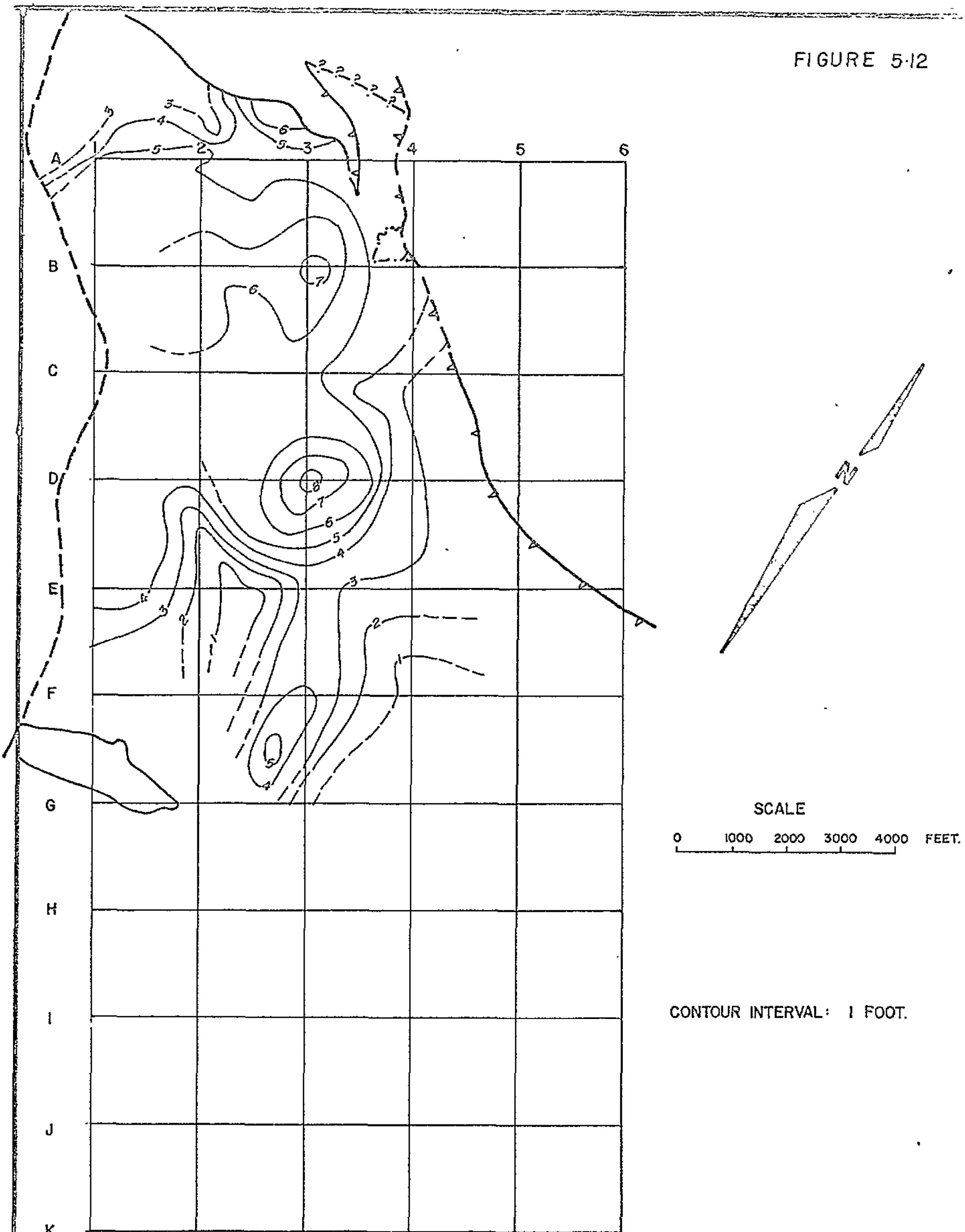
SUKUNKA COAL PROJECT

January 1972.

See also Map 18 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

FIGURE 5·12



SKETCH ISOPACH MAP

SKEETER SEAM
UPPER SPLIT
PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

See also Map 19 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

evenly to the north of this drill hole.

The distribution of the Lower Rock Band in the Skeeter Seam is shown on Figure 5.13 as thinning rapidly to the south and north from a north easterly trending zone of approximately 5 feet.

5.4.3 COAL QUALITY

The Skeeter Seam is for the most part similar in quality to the Chamberlain Seam having, on the basis of bore core analysis averages, only a slightly higher ash content, (4.8% as against 4.0%) and a slightly higher volatile matter content, dry ash free, (24.9% as against approximately 22%).

The appearance of the coal in bore cores is similar to that in the Chamberlain Seam, being predominantly dull with bright bands. The petrographic analysis by A.C. Cook (Appendix C) has shown that the vitrinite content for the two samples studied is 56% and 59%, the reflectance being 1.32% for both.

Table 5.6 lists the mean of the coal quality figures for Plate 2 included in Appendix A-4.

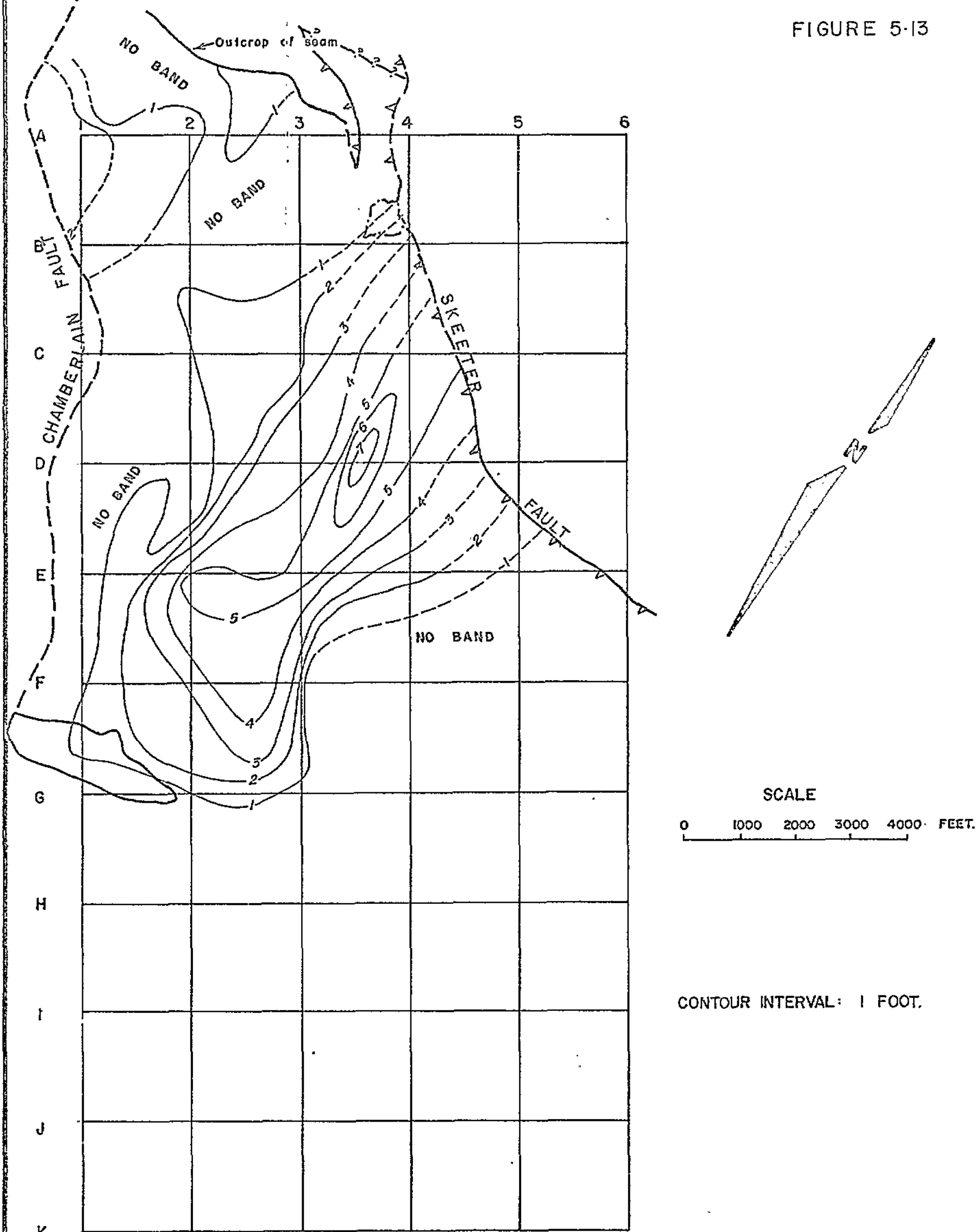
TABLE 5.6

Mean Values of Analytical Data for Washed Product at S.G. 1.60 (Air Dry Basis)

Skeeter Seam (Plate 2)

Moisture	0.9%
Volatile Matter	22.7%
Volatile Matter (D.A.F.)	24.9%
Ash	4.8%
Fixed Carbon	71.6%
C.S. No.	7½
C.V. (BTU/lb.)	14550
Sulphur	0.45%
Phosphorus	0.023%

FIGURE 5·13



SKETCH ISOPACH MAP

SKEETER SEAM
LOWER BAND
PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

See also Map 20 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

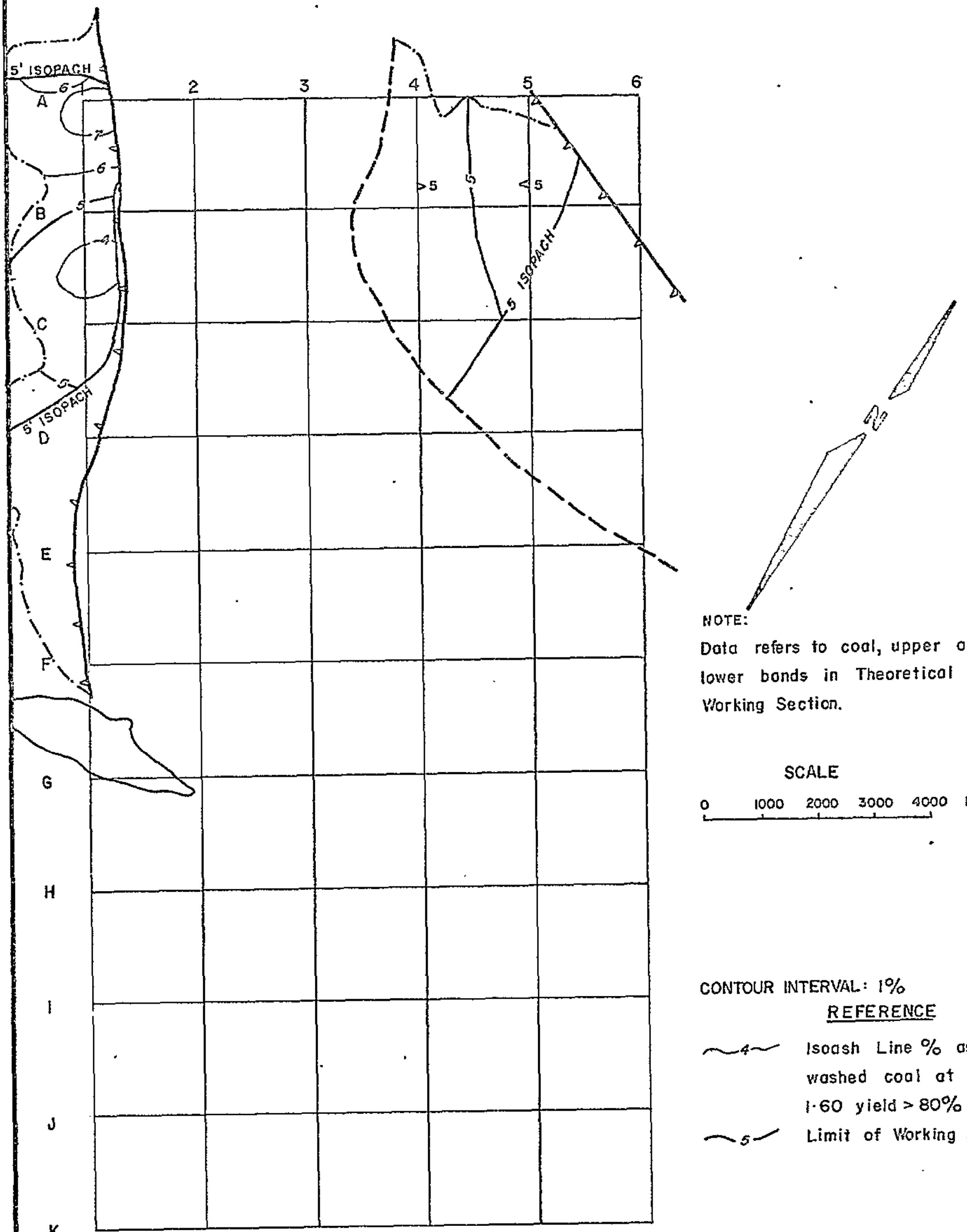
It will be noted that the ash content and the sulphur content is very slightly higher than for the Chamberlain Seam; however, the C.S. No. is of the same order.

Map 25,the isoash map, and Figures 5.14 and 5.15 show that, on the basis of the ash content of the washed product at a specific gravity of 1.60, from the majority of the working section it will be possible to produce a washed product of less than 5% ash. This figure is based on a yield, after washing, of greater than 80%. It should be noted that the data on Map 25 is based on bore core samples and refers to the coal and the Upper and Lower Rock Bands, in the theoretical working section defined above. Appendix A-2.2, a summary of the yield after washing, indicates that approximately 50% of the bore core samples produced a yield of greater than 90%, the average being 87.3%.

Face samples from Adits #3 and #5, and a representative sample of the 30 ton bulk sample from Adit #5, were tested by Cargo Superintendents for washability characteristics. These results are reported in A-8.2, A-8.4 and A-9. Reproduced below is the projected specifications of a washed product using heavy media separation and froth flotation:

	Adit #5
Yield	75.0
Air Dried Moisture %	1.0
Ash %	4.5
Volatile Matter %	22.7
Fixed Carbon %	71.8
Total Sulphur %	0.50
C.S. No.	8½
Calorific Value (BTU/lb.)	14600
Phosphorus %	0.035

FIGURE 5·14



NOTE:
Data refers to coal, upper and lower bands in Theoretical Working Section.

SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1%

REFERENCE

~4~ Isoash Line % ash in washed coal at S.G. 1·60 yield > 80%

~5~ Limit of Working Section

ISOASH CONTOURS
SKEETER SEAM
PLATES. I and 3

COALITION MINING LIMITED

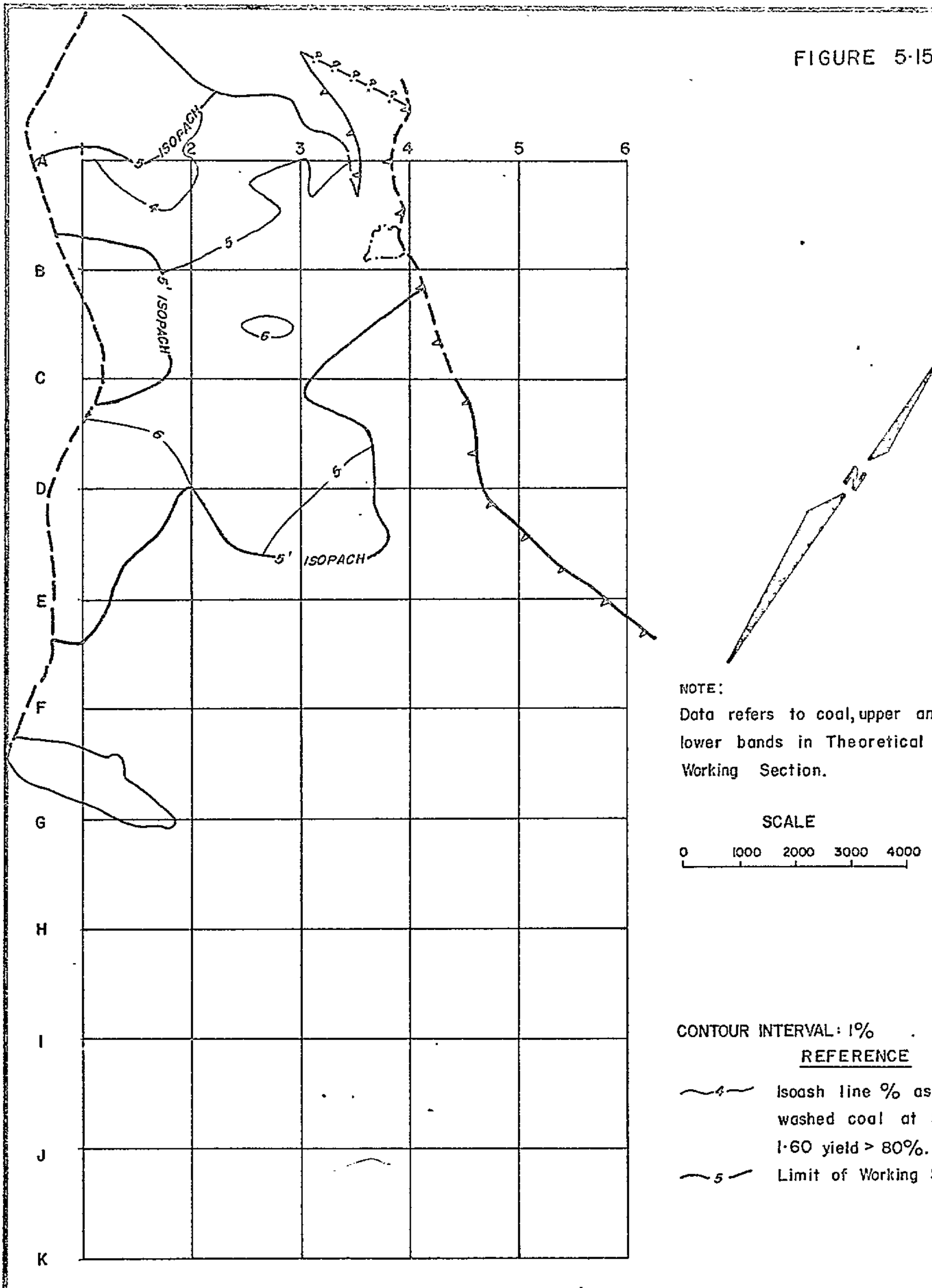
SUKUNKA COAL PROJECT

January 1972.

See also Map 25 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 5-15



NOTE:
Data refers to coal, upper and lower bands in Theoretical Working Section.

SCALE
0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1%

REFERENCE

~4~ Isoash line % ash in washed coal at S.G. 1·60 yield > 80%.

~5~ Limit of Working Section.

ISOASH CONTOURS
SKEETER SEAM
PLATE 2

COALITION MINING LIMITED

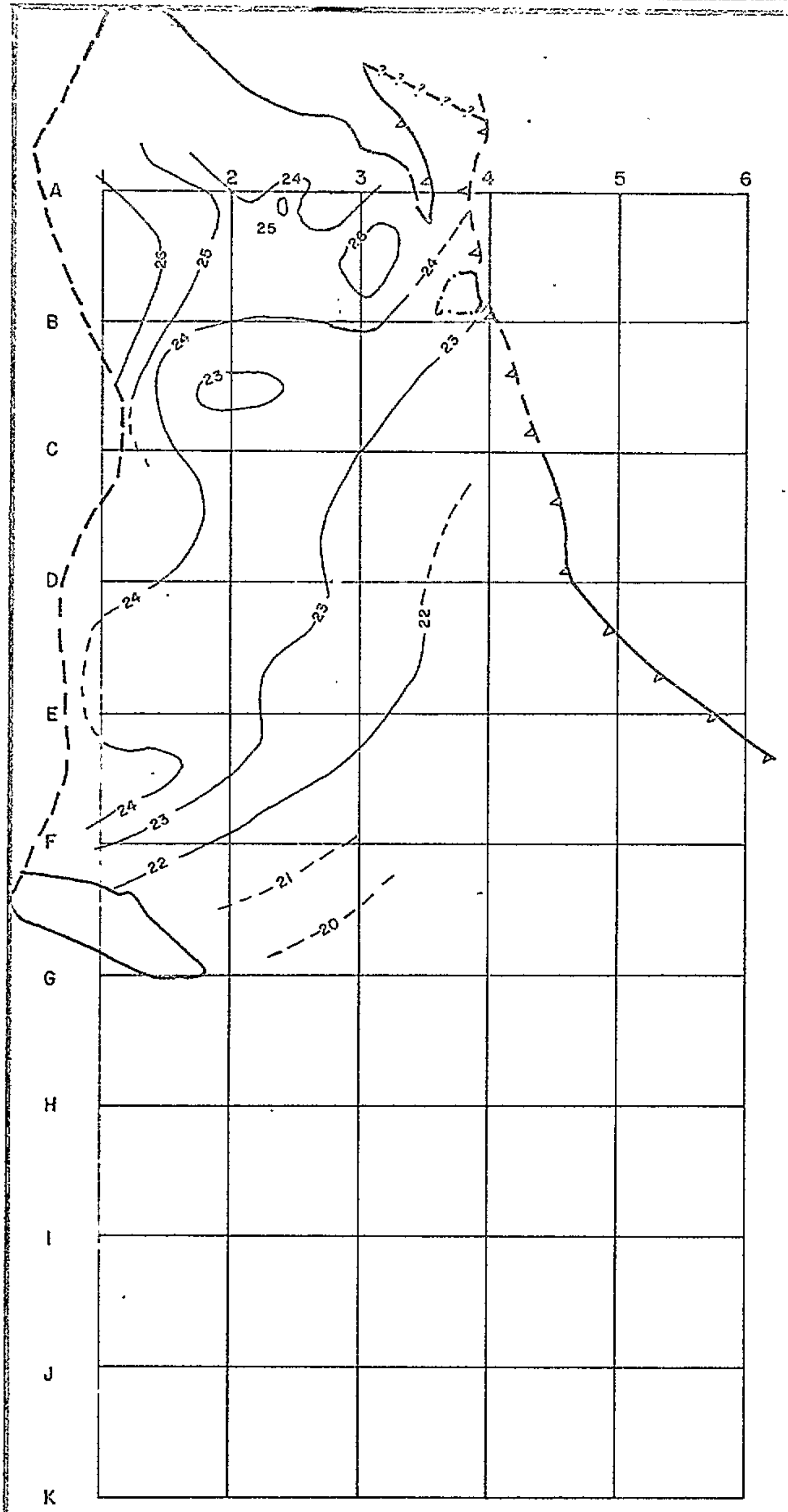
SUKUNKA COAL PROJECT

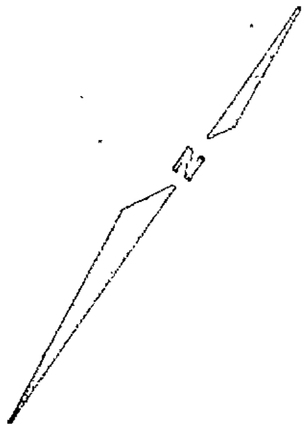
January 1972.

See also Map 25 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE 5-15A





SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1%

Volatile Matter calculated on a Dry Ash Free Basis.

SKETCH ISOVOL MAP

(DRY ASH FREE BASIS)

SKEETER SEAM

PLATE 2

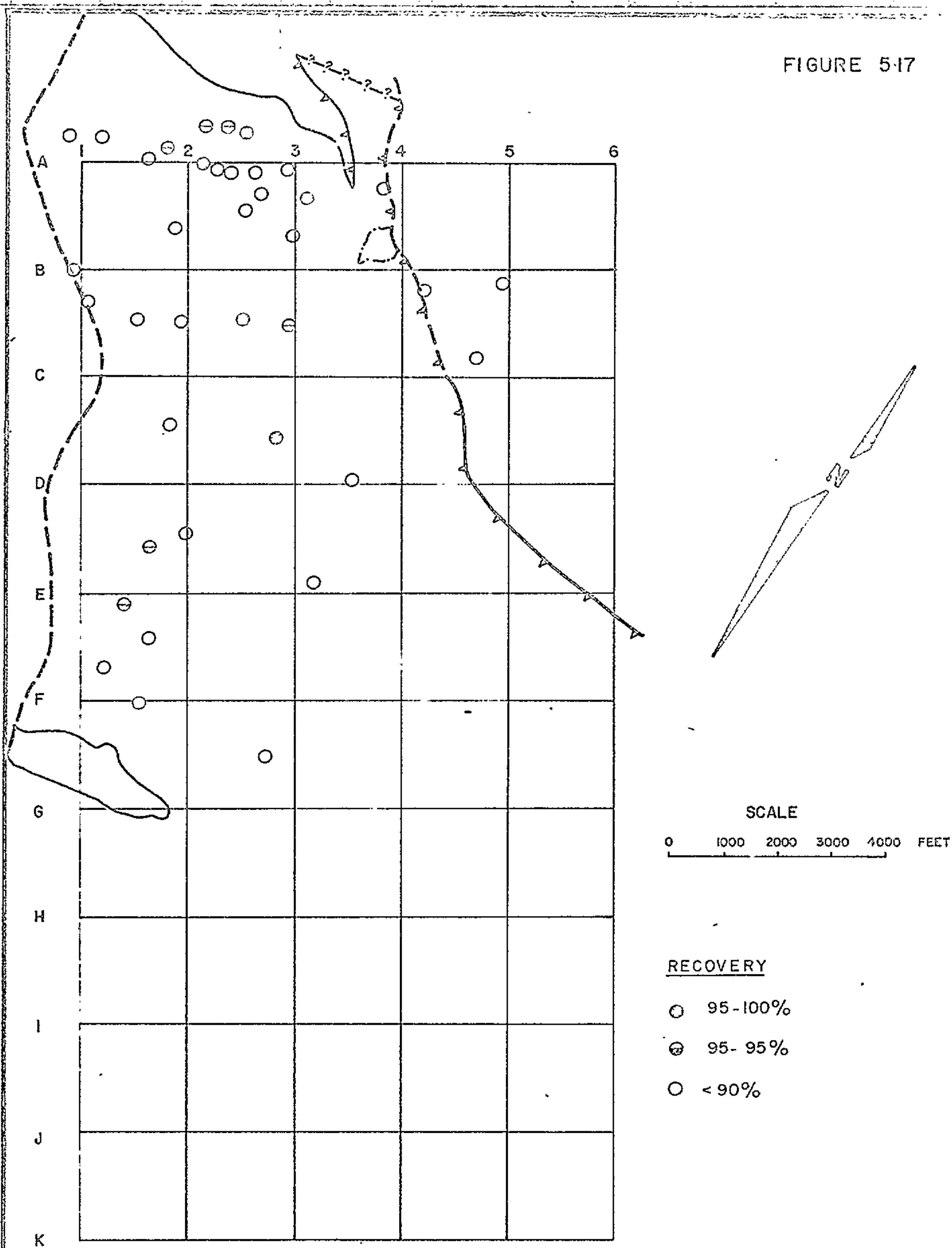
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

FIGURE 5·17



PERCENTAGE RECOVERY
OF COAL IN DRILL HOLES
SKEETER SEAM

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

Because of the variation in the distribution of both the Upper and the Lower Rock Bands in the Skeeter Seam, a variation in the ash content of the run-of-mine coal must be expected. However, as the range of yields for the bore core analyses is between 66% and 100%, and the average for these figures is 87.3%, it is considered that the figure of 75% for the bulk sample from Adit #5 is realistic.

5.4.4 COAL RESERVES

Reserves have been calculated for the Skeeter Seam in the previously defined working section using the 5 feet isopach shown on Maps 15 & 16. The reserves have been classified according to the "Code for Calculating and Reporting Coal Reserves" of the Standing Committee on Coalfield Geology of New South Wales and are shown in Table 5.7 and illustrated on Figure 5.16.The above Code is reproduced in Appendix A-1.2.

In calculating the reserves, the seam thickness from the holes drilled on behalf of both Coalition Mining Limited and Brameda Resources Limited were used. A check was made to assess the accuracy of the seam thicknesses, which resulted from the Brameda drilling (D.D.H.'s S-1 to S-50); refer to Section 5.1.2.

The recoveries for the holes drilled is shown on Figure 5.17 and relevant aspects of the overall recovery figures has been fully ventilated in the notes to accompany Appendix A-1.1.

As a check of the reserve figures, a second reserve calculation was made using the isopachs of the total coal in the working section of the seam (refer Map 18). It will be seen from Table 5.8 below, that the percentage variation is between 5.0% and 17.8%. The percentage variation for Plate 2 reserves, 78% of the total Skeeter Seam reserves, is 5.0%.

Table 5.8 (continued)

(1) Calculations for this column are based on the isopachs of the coal in the theoretical working section, Map 18, allowing an extraction during mining of 70%. A figure of 95% for recovery has been used as only the coal in the working section is under consideration; this figure is based on the laboratory results of the bore core figures.

(2) Column 2 lists the figures as calculated, using the isopachs on Map 16, the theoretical working section, which includes the rock bands. A figure of 70% for extraction and 75% for recovery has been used; the latter figure is based on the washability studies carried out on the bulk samples.

(3) Column 3 represents the percentage variation of the two methods of reserve calculations. It is calculated as the difference between the two reserve figures divided by the reserve figure in column 2, and expressed as a percentage.

5.5 OTHER SEAMS

5.5.1 COMMOTION SEAMS

The several coal seams in the Gates member of the Commotion Formation are collectively known as the Commotion Seams and as noted in Section 4.2.5 are not of economic significance in the project area.

The seams occur from 500 ft. to 1000 ft. above the base of the Commotion Formation, are not laterally continuous, and are generally less than 4 feet in thickness; they include numerous bands of carbonaceous claystone or stony coal. The seams were encountered in comparatively few bores and no analyses were carried out during the 1971 drilling programme.

The few analyses done for Brameda Resources Limited (reproduced in Appendix A-10) during the 1970 drilling programme show the raw coal to have a high ash (20-60%) and that unacceptably low yields are achieved for a washed product of ash content less than 10%.

5.5.2 BIRD SEAM

The Bird Seam is the uppermost of the three significant coal seams in the Upper Gething Formation and within the project area it is considered to be of low economic potential.

Refer to section 4.2.3 (ii), Unit 11 - Bird Seam.

The seam is generally less than 4 feet in thickness and the only analyses available (from Brameda Resources' 1970 drilling Appendix A-10) show the coal to have a high sulphur content (>2%) even after washing. The raw coal is high in ash (13-50%) and only low to moderate yields can be expected for a washed product of ash content less than 10%.

5.5.3 MIDDLE COALS

Two coal seams, referred to as the "middle coals" by Hughes (1969/70) occur approximately 150 feet above the base of the Lower Gething Formation, i.e. approximately 450 feet below the floor of the Chamberlain Seam. (Refer to Section 4.2.3 (i), the Lower Gething sequence.)

None of the drill holes sunk during the 1971 programme penetrated to these seams and the only sparse information available from the Brameda Resources 1970 drilling shows the upper seam to be up to 7 feet in thickness and the lower seam 23 feet thick in one drill hole. The few analyses that were carried out show the raw coal (excluding bands) to be of low ash (8%) but low C.S. No. (1½ to 3). (See Appendix A-10)

In the light of such a small amount of information on the "middle coals", the economic potential of these seams is at this stage unknown.

SECTION 6

MINING CONDITIONS

This discussion of the mining conditions which it is anticipated will occur in a mine established in the Sukunka Project area, must be read in conjunction with Section 4 of this report - Geology.

6.1 GEOLOGICAL STRUCTURE

The most significant feature governing the mining conditions of the project area is the geological structure, notably faulting and folding. The structures which are illustrated in the various maps of this report for the Chamberlain Seam are considered to have equal relevance to the Skeeter Seam as the distance between the two seams, where the Skeeter Seam is workable, reaches a maximum of only 30 feet.

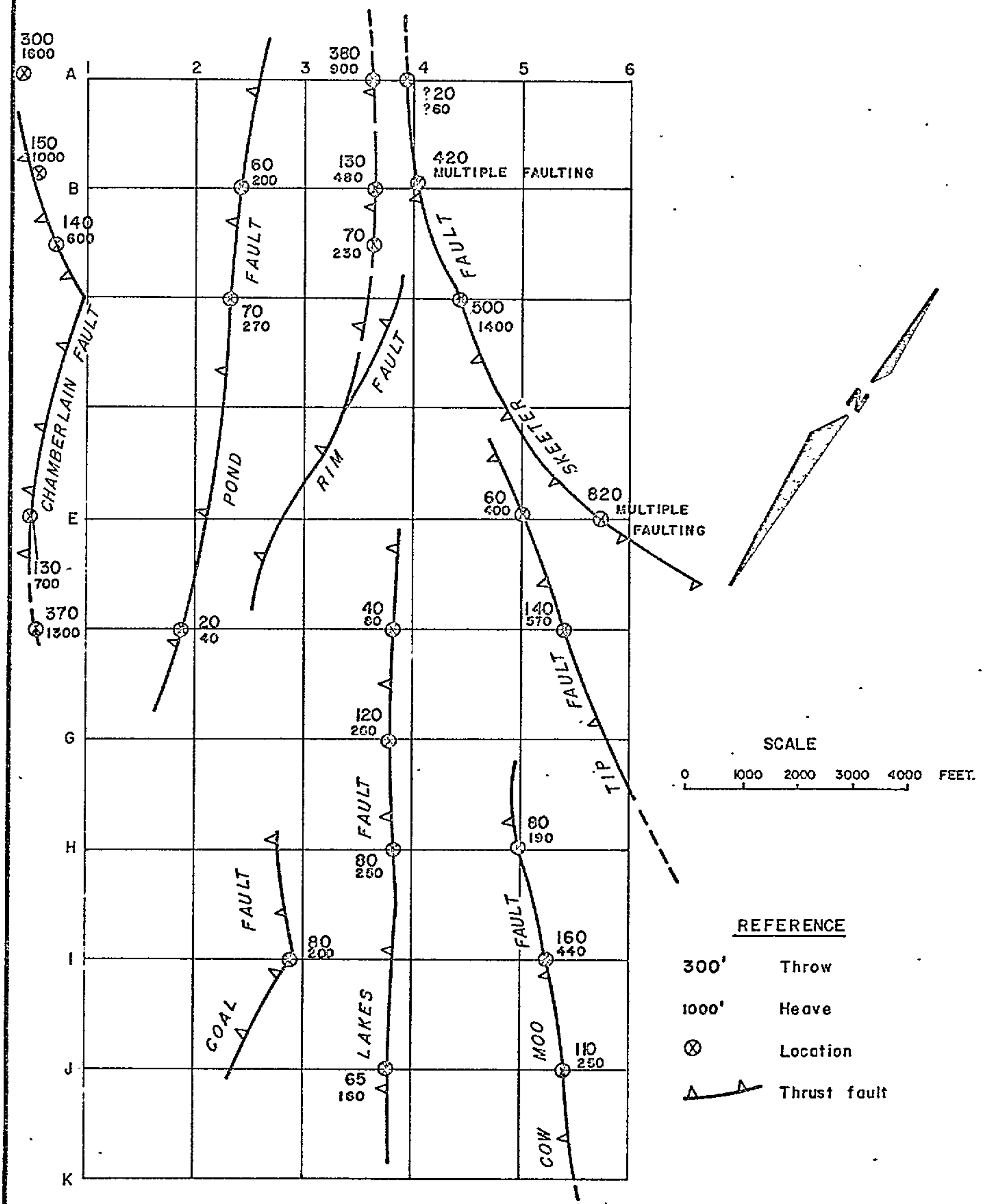
6.1.1 FAULTING

The structural trend is dominantly north-west/south-east, being controlled by a series of major thrust faults. These have been fully discussed in Section 4.3.2 and are shown diagrammatically on Figure 6.1, but for convenience are briefly outlined here.

The two most significant faults are the Chamberlain Fault, which divides Plate 1 from Plate 2 and the Skeeter Fault which divides Plate 2 from Plate 3.

Within Plate 2 there are six intra-plate faults. In the northern area, the two intra-plate faults, Pond Fault and Rim Fault, divide Plate 2, north of grid line F into Plates 2a and 2b and into Plate 2b and Plate 2c, respectively.

FIGURE: 6-1



SKETCH MAP

ILLUSTRATING THRUST FAULT LOCATIONS AT LEVEL OF CHAMBERLAIN SEAM FLOOR

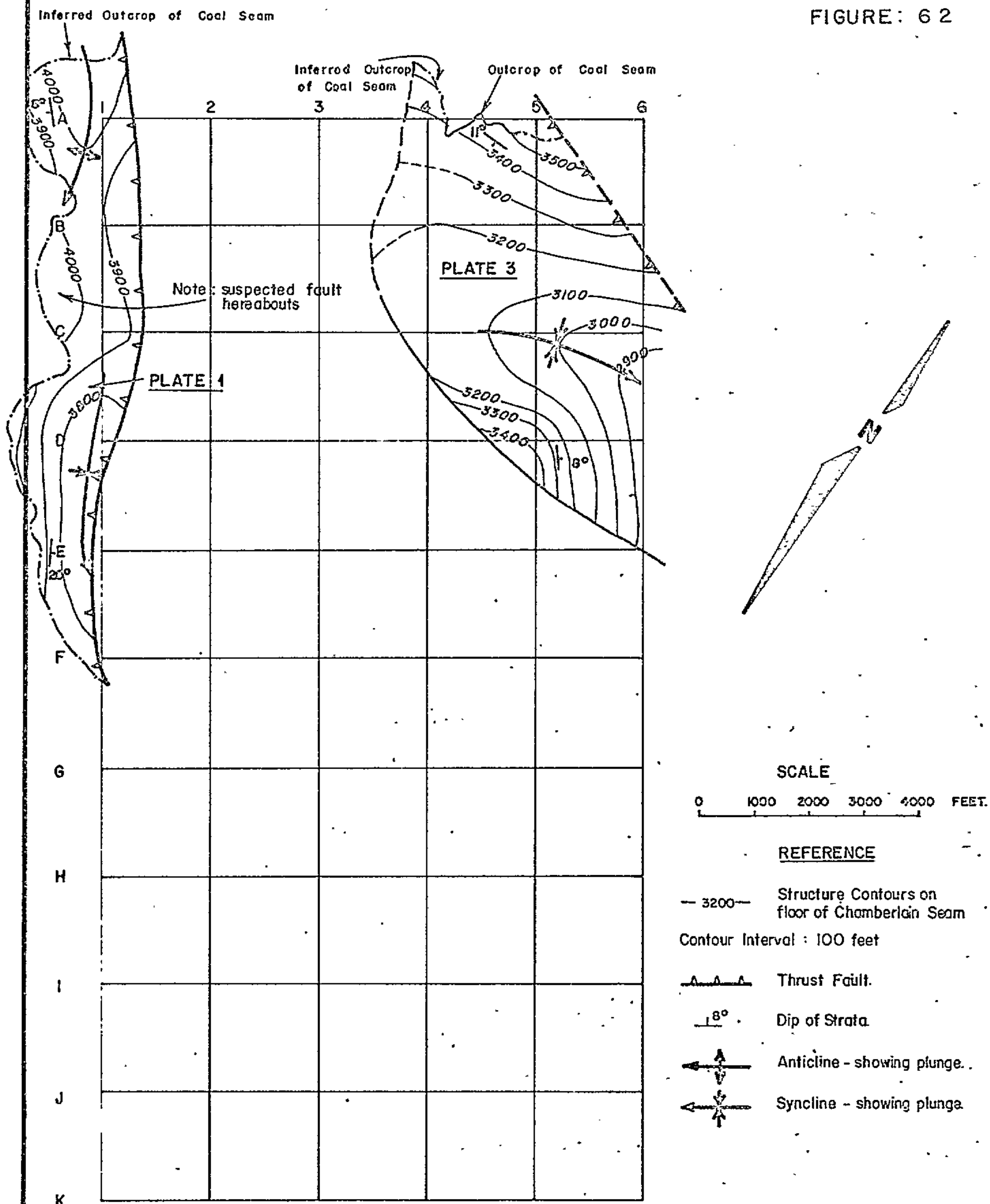
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

FIGURE: 62



SKETCH MAP

REGIONAL STRUCTURAL FEATURES PLATES I and 3

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 6 FOR DETAILED STRUCTURE CONTOURS

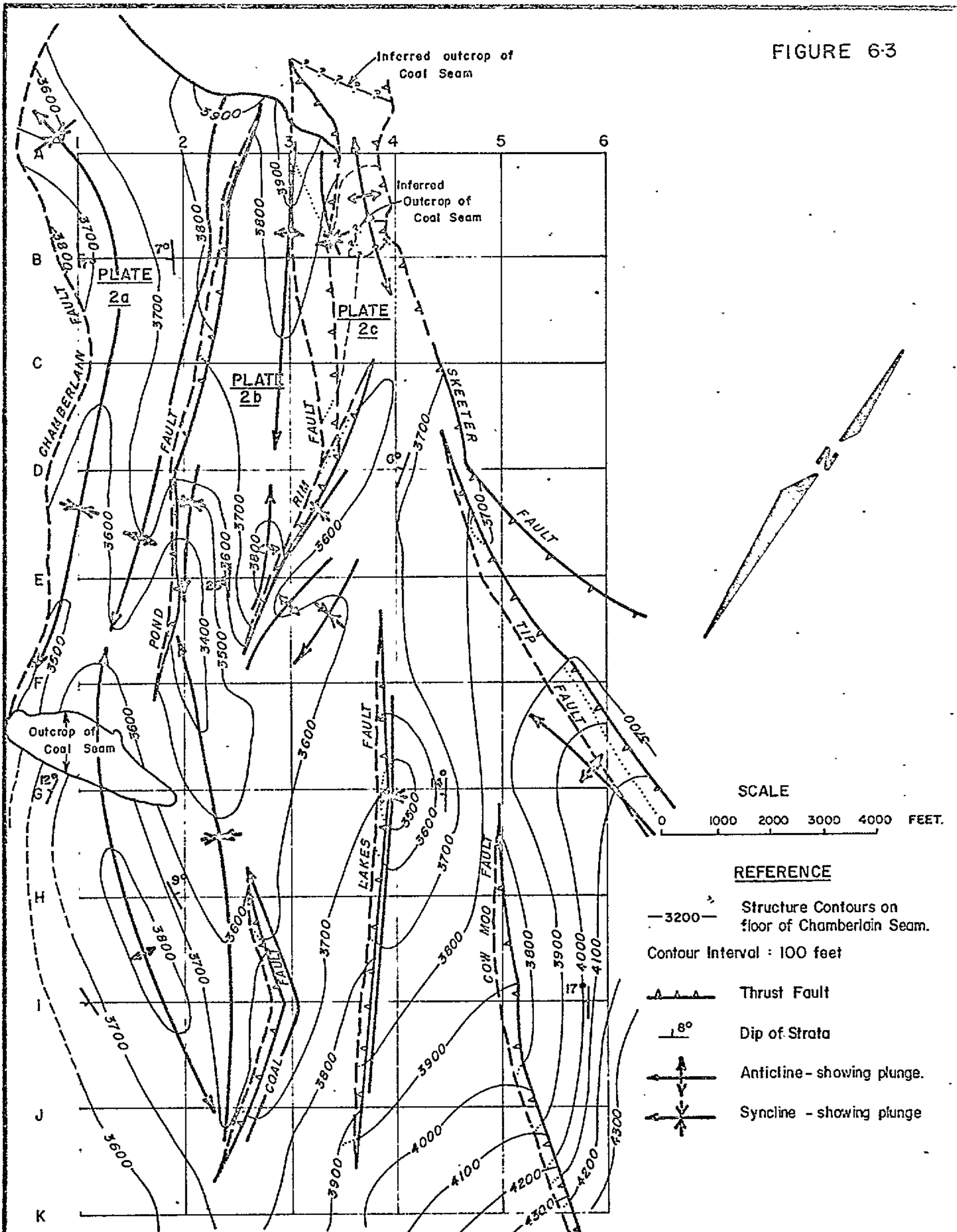
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

FIGURE 6-3



SKETCH MAP

REGIONAL STRUCTURAL FEATURES PLATE 2

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 7 FOR DETAILED STRUCTURE CONTOURS

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972

To the south of grid line G, 3 faults, the Coal, Lakes and Cow Moo Faults divide the southern area into 3 general areas which will govern the development of the mine in the southern portion of the grid area.

On the eastern limit of the grid area, the Tip Fault roughly parallels the Skeeter Fault and forms an effective eastern limit to the south-central part of Plate 2.

While the Chamberlain and Skeeter Faults form definite boundaries between their adjacent plates in respect of mine development, the intra-plate faults do not have such a significant constraint on the mine development.[1]

Map 6 and 7 have been reproduced in the text as Figures 6.2 and 6.3 (Structure Contour Maps of Plates 1 and 3 and Plate 2, respectively). Figure 6.1 shows the throw on the various intra-plate faults as well as the throw on both the Chamberlain and Skeeter Faults.

The definition of the northern extent of the Rim Fault between Plates 2b and 2c and consequently the dimensions of Plate 2c, requires further clarification. Section 7 of this report details recommendations for further investigations on the site area, among them being proposals for four drill holes to further elucidate this problem. Until this problem is fully clarified, final planning details in respect of a mine entry into Plate 2c must be deferred.

The throw on this northern extension to the Rim Fault is shown as being 380 feet at its northern extent decreasing to the south to 70 feet close to grid line B'.

1. Where the Chamberlain Seam is exposed near the northern end of the Chamberlain Fault, deformation of the seam extends for 250 feet east of the fault. Although allowed for in reserve calculations, one such point of observation does not provide a real basis for general extrapolation of such deformation.

While the intra-plate faults operate as constraints on mine development, it is believed that it may, in some instances, be preferable to use cross-measure drifts between adjacent plates. For example, in the vicinity of grid line E, where the throw of the Pond Fault would be of the order of 30 to 40 feet, it would be practicable to drift from Plate 2a to Plate 2b. By drifting across a fault it would obviate the necessity of driving around it, possibly through an area of residual stress.

Although the major faults within the area have been defined by the extensive drilling programme within the project area, it is not considered possible to fully define minor faulting. In this respect, it is particularly relevant to point out that except for the major thrust faults, which separate Plates 1, 2 and 3 and the intra-plate faults of Plate 2, displacements of the sandstone floor of the Chamberlain Seam have not been detected. It is reasonable to have expected the incidence of such faults with a throw of up to say 20 feet. However, despite contrary evidence available based on the extensive outcrop stripping programme, it is still considered that the possibility of the existence of some minor local faults must be constantly borne in mind. It is not possible to suggest where these faults would occur, nor is it possible to postulate the frequency of occurrence of these minor faults.

During the outcrop stripping programme where some 12,000 feet of continuous exposure was produced, some 8 minor thrust faults were detected. These faults were confined to a zone of the order of 20 feet thick above the Chamberlain and Skeeter Seams. In many instances, the zone in which they occurred, was less than 10 feet thick. These small thrust faults have been discussed fully in Section 4.3.6 (iv) and while considered to be of significance in respect of local mining conditions, i.e. the roof conditions, these faults will not have a major effect in respect of overall mine planning. They will, however, have considerable effect in the density of roof bolting and/or timber sets which may be required. As it is impossible to predict the frequency of these zones of structural weakness, allowance must be made in any mining plan in the early development stages for such conditions until their effect and frequency have been fully assessed under actual mining conditions.

6.1.2 FOLDING

Reference again is made to the Structure Contour Maps 6 and 7, and Figures 6.2 and 6.3.

The general style of folding in the project area is a broad series of anticlines and synclines plunging generally from the north of the area toward grid line F. South of this area there is a general plunge from the south-eastern edge of the project area to the north.

On a regional scale, it will be noted that only one area has dips which may be considered too steep for continuous miner operation. This area is between grid lines D and F and between lines 2 and 3. This area has been excluded from the reserve calculations, some 0.5 million long tons being involved. No explanation for this area of steep dips can be offered at this stage. There is the probability that a normal fault trending approximately north-west/south-east between the Rim and Pond Faults exists. This zone of steeply dipping strata is anomalous when considered relative to the total area.

The dip of the floor of the Chamberlain Seam, from the numerous drill holes completed in the 1971 field programme, has been plotted on Map 23 at a scale of 1 inch to 1000 feet. The floor dips, while ranging up to 35^{o}, are generally less than 14^{o}. Where steep dips are shown, they can in many instances be related to fault planes.

While it may be inferred that such steep dips are indicative of a regional dip of the seam floor, it is apparent from the exposures of the Chamberlain Seam floor in both the adits and the outcrop stripping that such dips are of local significance only.

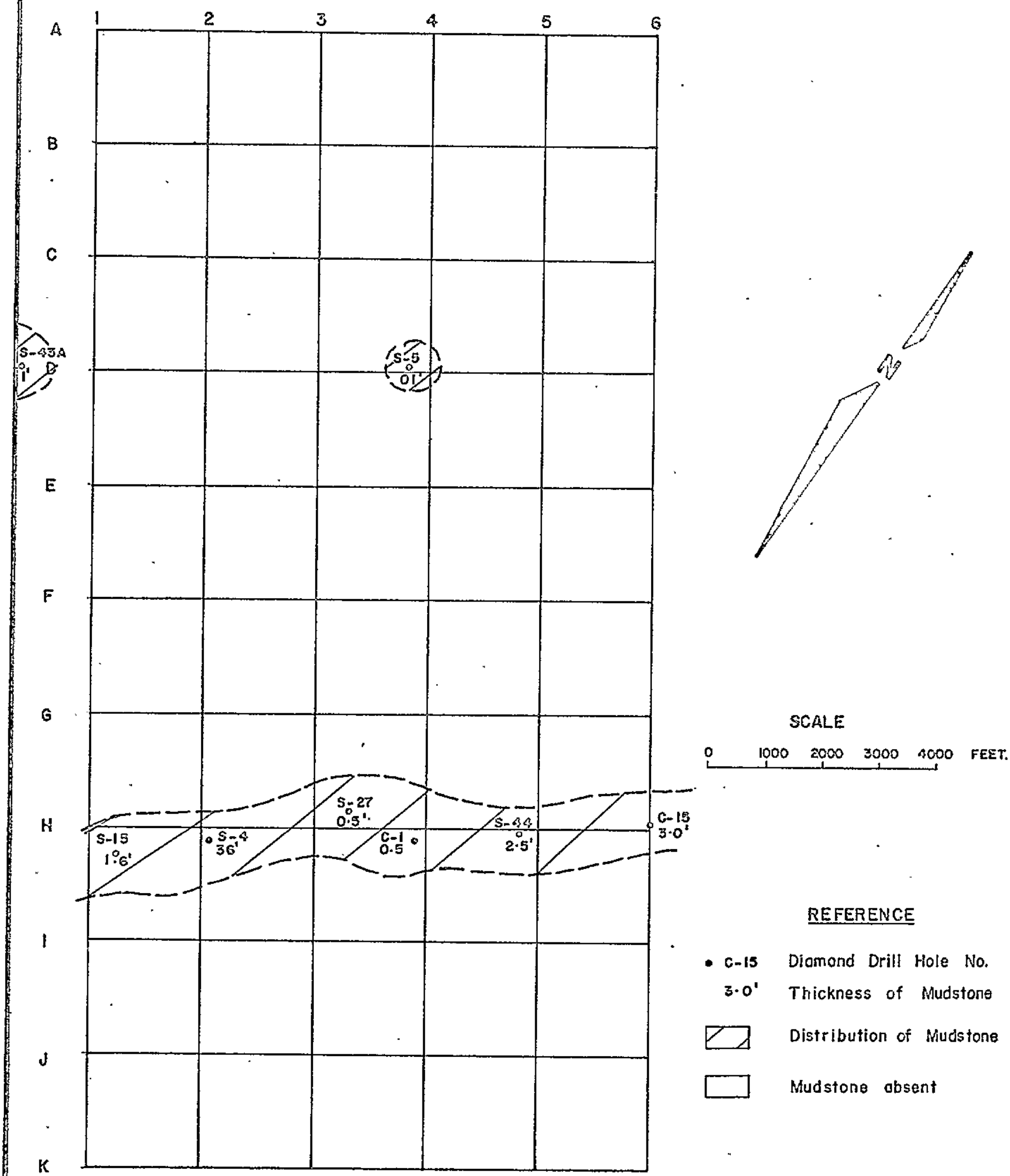
In Adits #2 and #4, the floor of the Chamberlain Seam exhibits substantial changes in dip within a distance of less than 2 feet. This feature is sedimentary in origin and is not considered to have any direct relevance to the gross structure of the seam floor.

6.2 FLOOR AND ROOF CONDITIONS

6.2.1 CHAMBERLAIN SEAM

The floor of the Chamberlain Seam is fine to medium-grained carbonaceous sandstone, which is extremely competent and has been dislocated only by major thrust faulting. It will provide a particularly good surface for the operation of trackless equipment, however, in some instances where the grade may become somewhat steep, it is possible that polishing of the surface may occur. In the vicinity of grid line H (see Figure 6.4), a thin mudstone band occurs over the carbonaceous sandstone floor. The thickness of this band ranges between 0.5 and 3.0 feet. A thickness of 36 feet was recorded in D.D.H. S-4 and until verified by further drilling or mining within the area, is possibly anomalous. In two other localities in the vicinity of D.D.H.'s S-43 and S-5, minor thicknesses of this mudstone occur.

FIGURE 6·4



REFERENCE

• C-15	Diamond Drill Hole No.
3·0'	Thickness of Mudstone
▨	Distribution of Mudstone
☐	Mudstone absent

SKETCH MAP

DISTRIBUTION OF MUDSTONE FLOOR
OF CHAMBERLAIN SEAM

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Observations in Adits #2 and #4 and in the 12,000 feet of outcrop stripping, indicate that the floor will be a particularly difficult member through which to drift, should this be necessary. The thickness of this carbonaceous sandstone is generally in excess of 50 feet.

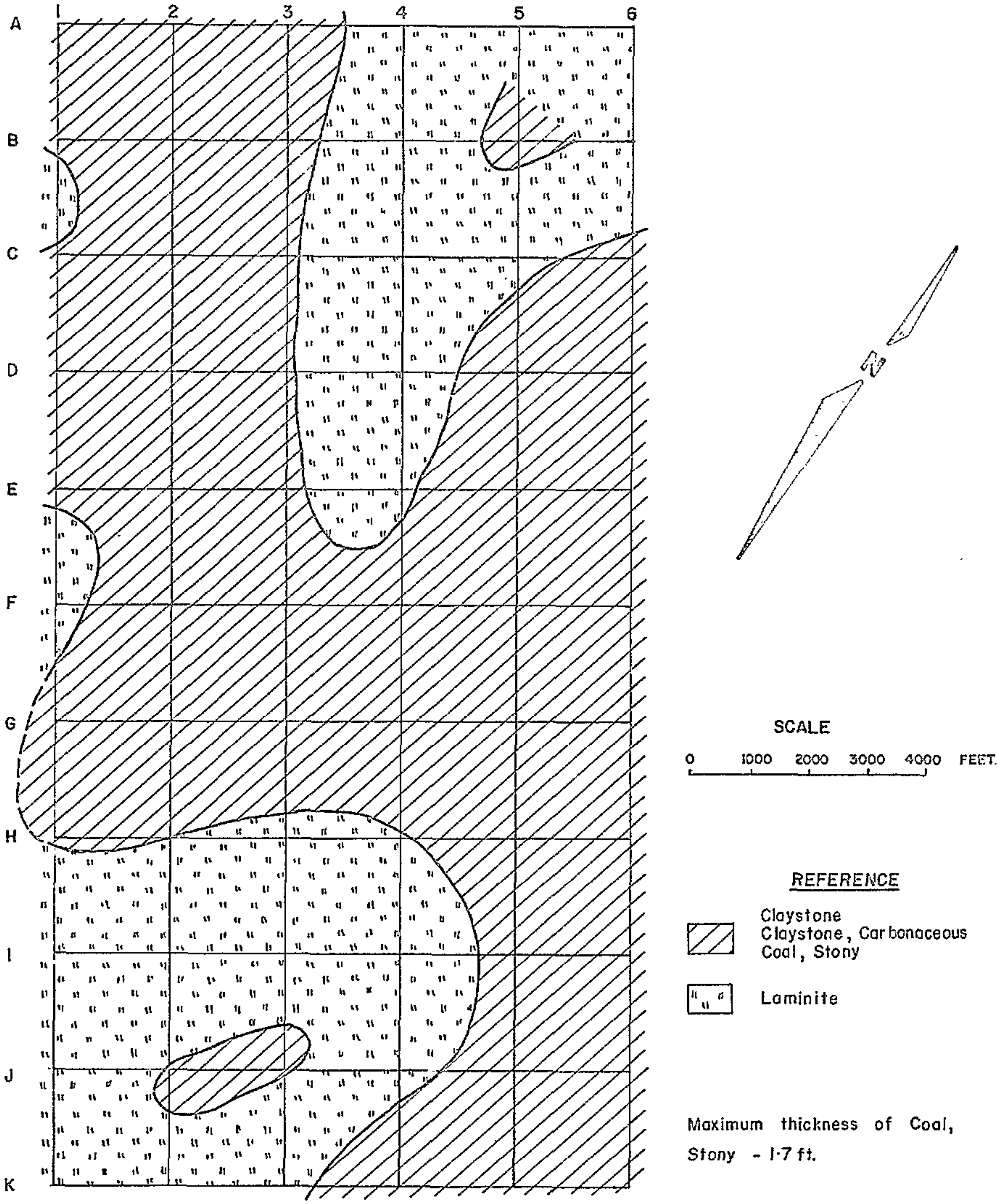
The roof of the Chamberlain Seam for the most part, is claystone or carbonaceous claystone. Stony coal occurs throughout much of the area varying in thickness up to 1.7 feet. The average thickness of this stony coal, however, is of the order of 0.8 feet. Above the stony coal, in many instances, is a thin band of sheared coal, up to 8 inches thick. It will be necessary during mining to allow such a band to drop, or to be taken during mining. Figure 6.5 illustrates the distribution of this claystone roof of the Chamberlain Seam. Where the claystone is absent, laminite forms the immediate roof of the Chamberlain Seam. Appendix E contains the geological observations of the outcrop stripping and underground work. During the early stages of the development of the Chamberlain Seam, it will be necessary to brush the roof for some 3,500 feet until a working height of 8 feet is achieved. As the roof in this area is laminite and claystone, coaly in part, this will present no major mining problems.

The influence of small scale thrust faults in and above the Chamberlain Seam has been discussed above, Section 6.1.1.

6.2.2 SKEETER SEAM

The configuration of the rock bands in the Skeeter Seam is fully discussed in Sections 4.2.3 (ii) and 5.4.1 above. In general terms the seam is split by a Lower Rock Band and an Upper Rock Band. In much of the area the Lower Rock Band and a thin split of coal beneath it are not considered as part of the working section of the Skeeter Seam.

FIGURE 6·5



SKETCH MAP

UPPER GETHING - DISTRIBUTION OF LITHOLOGICAL UNITS FORMING ROOF OF CHAMBERLAIN SEAM.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

The floor of the Skeeter Seam is primarily a relatively massive brown grey siltstone which, in a typical section, is of the order of 20 feet thick. (Refer Figure 4.4).

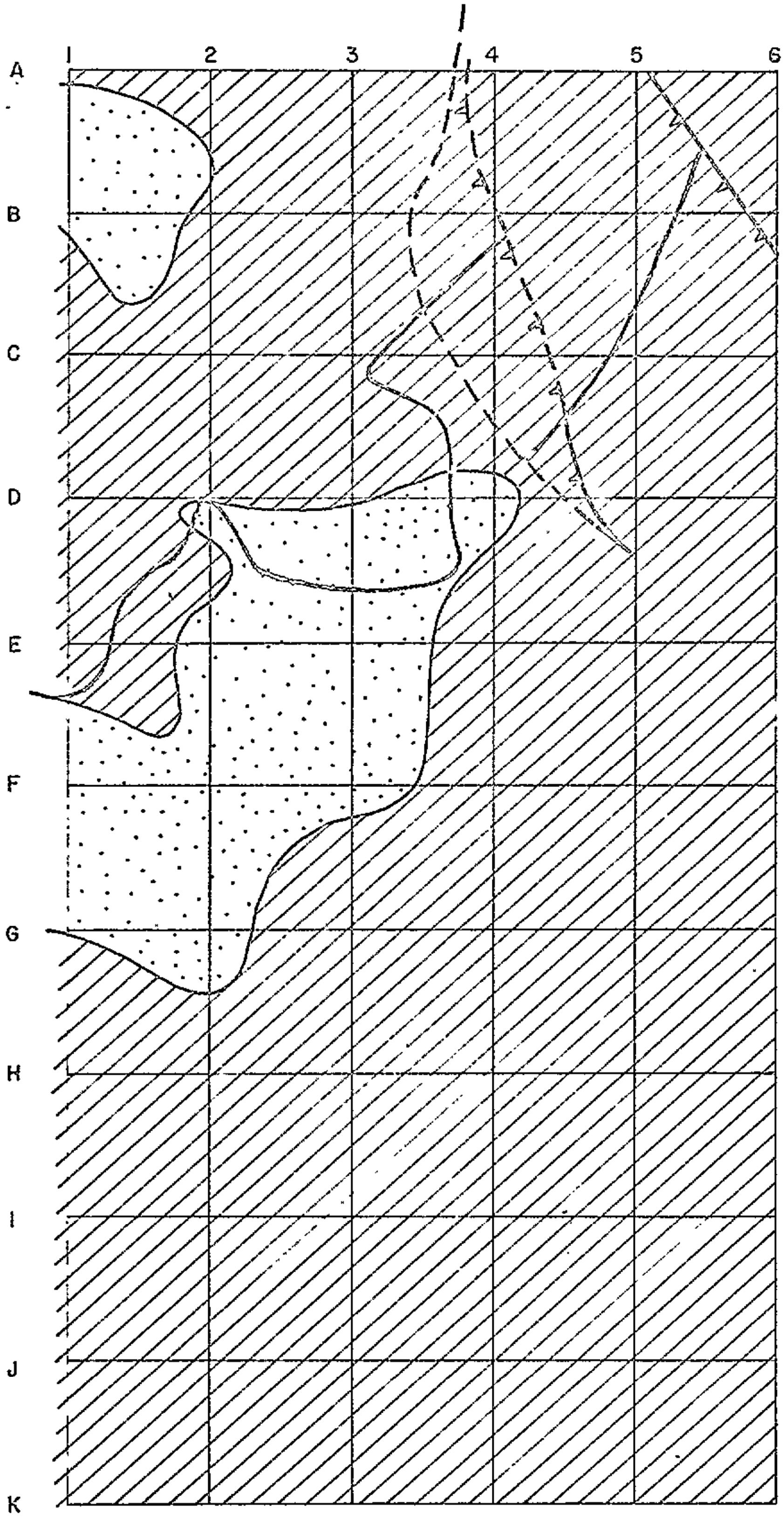
Due to the thickness of the Lower Rock Band, which is a carbonaceous claystone or siltstone, this unit will commonly form the floor of the Skeeter Seam throughout much of the working section. It reaches a maximum thickness of 7.6 feet.

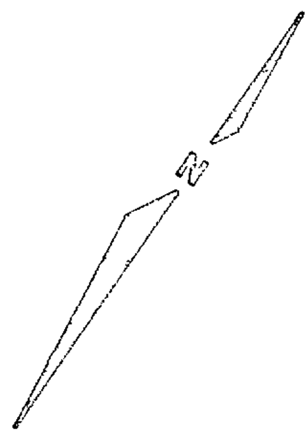
Neither the actual floor of the seam nor the Lower Rock Band are as competent as the floor of the Chamberlain Seam. However, both are considered to be suitable floors for continuous miner operation, although when operating on the full dip, it will be necessary to keep the floor well drained.

Unit 5 of the Upper Gething sequence forms the roof of the Skeeter Seam throughout the majority of the working area. This unit is dark grey to dark brown carbonaceous siltstone, usually 1 to 3 feet thick. The distribution of this unit is shown on Figure 6.6 as occurring over the majority of the working section. In the extreme south and in the north-western corner of the working section this unit is absent, being replaced by a sandstone or siltstone unit 20 to 30 feet thick.

The Upper Rock Band, while occurring in many instances below an uneconomic thickness of 1 foot of coal, will have to be dropped or taken with the coal during mining operations. It may be possible to hold this band up as the roof in the working districts, where it reaches a maximum thickness of more than 1 foot. It will need to be dropped in the main headings for safety and ease of roof support.

FIGURE 6·6





SCALE

0 1000 2000 3000 4000 FEET.

REFERENCE

Carbonaceous Claystone.

Sandstone or Siltstone (Unit 6) where claystone absent.

Thrust Fault.

Generalised limit of working section.

SKETCH MAP

UPPER GETHING SEQUENCE
DISTRIBUTION OF CARBONACEOUS CLAYSTONE.
(SKEETER SEAM ROOF)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

6.3 DEPTH OF COVER

Map 22 illustrates the thickness of cover over the floor of the Chamberlain Seam. As the distance between the Chamberlain and Skeeter Seams is small, a separate isopach map has not been constructed for the Skeeter Seam.

The depth of cover over the proposed workings generally north of grid line E' is less than 1000 feet. South from this area the cover increases to the south-east of the project area until 1800 feet is attained in the extreme south-eastern corner. Due to the incision of Chamberlain Creek and its headwaters, the depth of cover for much of this southern part of the area is less than 1000 feet. However, 60% of the area is under a cover of less than 1200 feet.

6.4 INTERSEAM THICKNESS

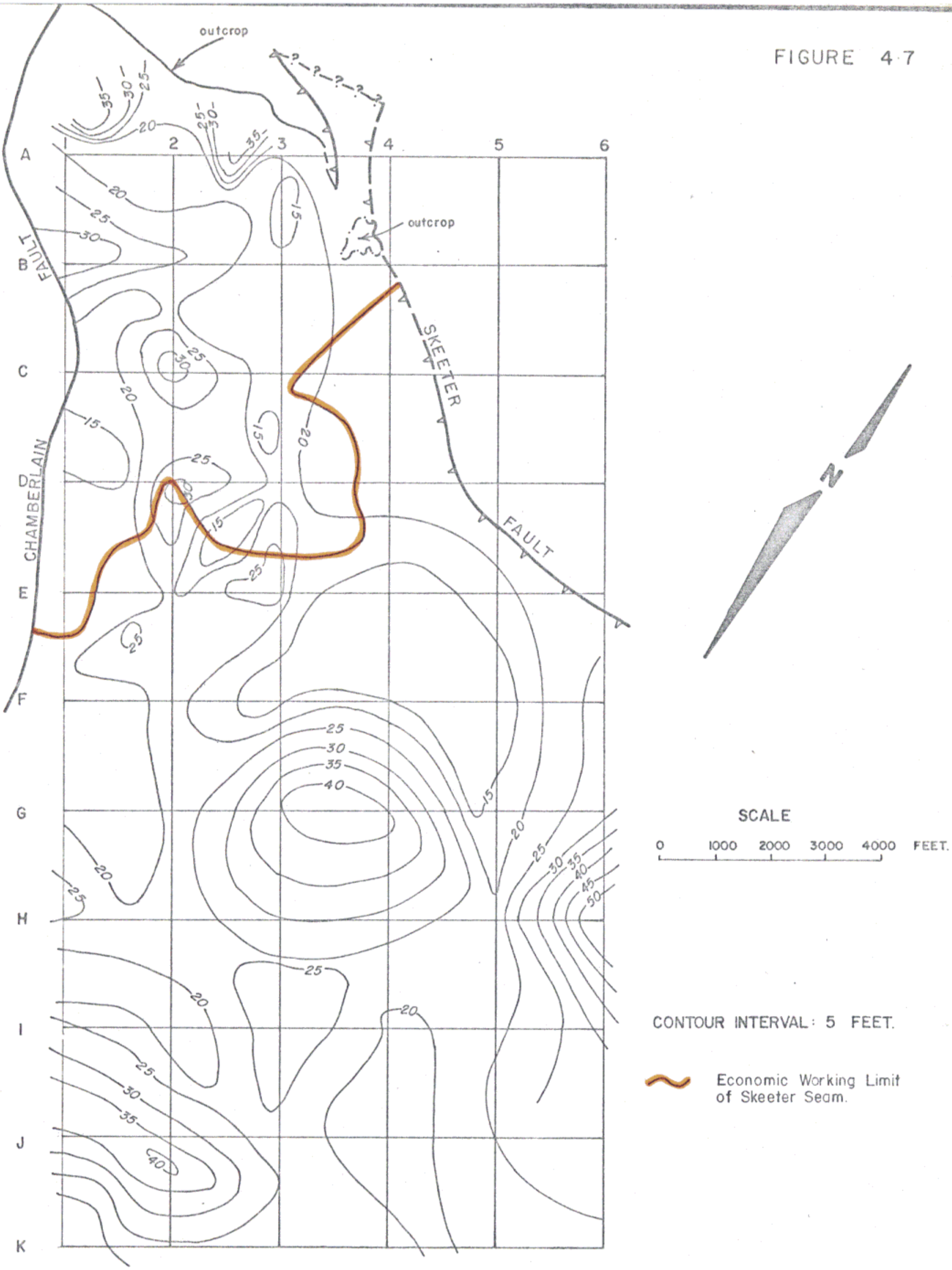
The distance between the Chamberlain and Skeeter Seams is illustrated on Map 21 and Figure 6.7, reaching a thickness of 32.4 feet in D.D.H. S-24.

For most of the area under the working section of the Skeeter Seam in excess of 20 feet of interseam sediments exist, the maximum being 30 feet and the minimum 15 feet.

The sediments are primarily argillaceous with arenaceous phases and are fully described in Section 4.2.3(ii), as Units 2, 3 and 4.

The small interseam thickness will place a number of constraints on the mining plan. In particular, it will govern the layout of the headings and roadways for the Skeeter Seam development. Such headings must be driven coincident with those of the underlying

FIGURE 4·7



SKETCH ISOPACH MAP

INTERSEAM SEDIMENTS

BETWEEN

CHAMBERLAIN & SKEETER SEAMS

PLATE 2

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

See also Map 21 for details of contours at scale 1" = 1000'

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

Chamberlain Seam. Of equal importance is the fact that the Skeeter Seam workings must be kept ahead of the Chamberlain Seam workings, in order to allow full extraction of the Skeeter Seam. This aspect is fully discussed in the report on the mining plan by Austen & Butta Limited.

Such a mining plan will have the benefit of assisting in de-gassing the area worked and relieving any residual stresses existing within the rock prior to the mining of the Chamberlain Seam.

6.5 STRESS CONDITIONS

It is anticipated, but is by no means certain, that much of the stress condition which existed prior to and during the formation of the thrust faults has been released by the thrusting action. However, some residual stress may still exist within the rock strata. It is patent that considerable stress has been imposed to bring about the dislocation resulting in the Chamberlain Fault. It will be noted that the Pond Fault does not extend southward to Chamberlain Creek. Additionally, the southern end of the Rim Fault appears to be in the vicinity of grid line F. It is possible that, even though the intensity of faulting appears to be dying out along these faults in a southerly direction, as indicated by the throw of these faults, stress conditions may well exist in the rock strata on the line of extension of these 2 faults. Should these conditions exist, the driving of roadways in a direction approximately at right angles to the fault planes and south of their southern ends, will encounter particularly poor roof conditions.

As an alternative to avoid these probable areas of residual stress, main headings could be driven between adjacent plates using cross-measure drifts. While it would entail substantial "hard-rock" mining, this may well prove to be a more satisfactory approach.

In order to assess the intensity of any residual stress within the rock strata in these areas it is considered that investigations aimed at evaluating such stress phenomena should be undertaken. The services of an experienced rock mechanics engineer should be engaged to this end.

6.6 GROUND WATER

An attempt was made during drilling operations to ascertain the general level of the water table in the project area. This proved to be impracticable due to an almost continuous loss of water during the drilling of any hole below a depth of 100 to 150 feet. It was noted however, that at various depths in the drill holes an apparent water table was struck when the loss of drilling water was reduced. This situation commonly occurred at least 4 to 5 times throughout the progress of any one drill hole. It is interpreted that due to the varying lithologies, and to what may be termed a self-draining physiographic feature, a series of perched water tables exist in the project area.

During the electric logging of the drill holes, only 8 holes gave any indication of a water table. The height of the water level above the top of the Gething Formation varied between 61 and 289 feet, however, the water table in 5 of these holes was between 80 and 106 feet above the top of the Gething Formation, in the Moosebar Formation; see Table 6.1 for a tabulation of this information.

TABLE 6.1

Ground Water Levels as Determined from Gamma Ray-Neutron Logs

Hole No.	Water Level Below Collar (feet)	Height of Water Level Above Top of Gething Formation (feet)
CS5	45	106.5
CS6	32	85
C 3	159	80.5
C 4	85	86
C 4a	109	106
C 7	627	61
C10	356	289
C11	551	127

During the driving of the 5 adits on the project area, all were reported to be moderately dry, taking into consideration the proximity of these adits to the outcrop line.

Conditions in these short adits are not considered to be necessarily indicative of conditions at depth. Should there be excessive free water in the workings, the variation in the dip of the Chamberlain Seam floor, with hollows and rises, will result in a ponding of water, which will require attention.

6.7 GASSINESS

The medium to high rank coals in the western foothills of the Rocky Mountains are known to contain gas. A series of gas tests was made during the 1971 field programme under the direction of Dr. A. Hargraves, B.H.P. Co. Ltd., of Wollongong, Australia.

The gas, collected in sealed containers from the coal core immediately after being removed from the core barrel, was analysed by the laboratory of Imperial Oil Refinery Ltd. at Taylor, near Fort St. John, B.C.

The results of the programme are reported by Dr. Hargraves in the mining feasibility report of Austen & Butta Limited.

Local occurrences of gas were reported in a number of drill holes during the 1969 drilling programme. Notably, gas was struck in D.D.H. S-11 which caused the hole to be abandoned. The amount and composition of the gas was such that it could be ignited, having an orange-yellow colour. It was reported that the gas was not struck until the hole was below the Chamberlain Seam, but no depth was stated.

Minor occurrences were reported during drilling in the recently completed programme, mainly in the form of "bumping" of the drill rods. Regrettably, no details were recorded by the drilling contractors. Further testing is recommended for the coming field season to fully ascertain the gas potential of the area and to assess the likelihood of "blowouts".

SECTION 7

RECOMMENDATIONS FOR FURTHER FIELD INVESTIGATIONS

7.1 INTRODUCTION

Following the 1971 field programme and the detailed evaluation of the results from the data which resulted from that programme, certain recommendations are made in this section of the report, based on the assumption that the financial study will indicate that a viable mining concern can be established in the Sukunka area. The recommendations, put forward in this section for consideration, have been formulated so that a number of contingent factors may be elucidated.

The programme recommended may be considered in a number of phases, basically short term and long term. Additionally, a number of elements of the programme need to be considered, such as diamond drilling, outcrop stripping, surface geological mapping and underground mapping during all mining operations.

Diamond drilling operations are required to elucidate a number of structural features which have, as yet, not been clearly defined; also the reserves in Plate 3 and in the area externally marginal to the current exploration grid area, require upgrading to the "Measured" category.

Outcrop stripping is required along Plates 1, 2c and 3.

Underground mapping, further gassiness and rock mechanics studies, together with limited test driving, are required as mining proceeds in order to fully understand the structural complexities which will be exposed and to guide mine development. This is of particular importance during the early stages of mining.

Geological mapping is required in the coal licence blocks adjacent to the current project area in order to add to structural and stratigraphic knowledge. Reconnaissance mapping in the Peace River District generally may indicate other areas of economic interest. All the foregoing are considered in some detail in the following pages.

A cost estimate is included in Section 7.4.

7.2 SHORT TERM PROPOSALS

The short term proposals include diamond drilling, outcrop stripping and surface and underground geological mapping.

7.2.1 DIAMOND DRILLING

(i) The northern extent of the Rim and Skeeter Faults requires further clarification, in order that a mining plan for Plate 2c can be laid down. Four holes are required in order to adequately carry out this investigation. The location of the 4 holes, sites A, B, C and D, is illustrated on Figure 7.1.

(ii) Six drill holes, sites E to J, inclusive, shown on Figure 7.2, are required to more fully document the structural configuration in Plate 3, and to upgrade the reserve category from Indicated to Measured.

7.2.2 OUTCROP STRIPPING

(i) In conjunction with the diamond drilling in 7.2.1 (i) above, outcrop exposure of the Skeeter and Chamberlain Seams along Skeeter Creek in Plate 2c is required. As the stripping programme already carried out has proved extremely valuable, it is considered that this phase of the programme is most important particularly as, in these areas, the geology is not well documented due to limited exposure.

(ii) In order to verify the absence of east-west trending structures at the level of the Chamberlain Seam, it is important that at least part of the outcrop of the Chamberlain Seam in Plate 1 is exposed. It is realised that to expose a length of 16,000 feet of seam is costly; nevertheless, continuous exposure is proposed, in the first instance, until the required degree of confidence had been achieved for the verification of absence of such east-west trending structures. After this level of confidence had been achieved, partial exposure of the outcrop would be sufficient.

(iii) In conjunction with the diamond drilling in 7.2.1 (ii), above, the outcrop of the Chamberlain Seam and Skeeter Seam where practicable, should be exposed by bulldozing.

7.2.3 GEOLOGICAL MAPPING

(i) SURFACE

Within the block of 41 coal licences held under option by Coalition Mining Limited and to the west of the present project area, approximately 3½ coal licences are located on the opposite side of the Sukunka River. Reconnaissance geological mapping, which was carried out by Hopkins & Gluskoter of the Illinois Geological Survey for Brameda Resources Limited, during the 1971 field season, in part touched upon these areas. Should their report indicate the probability of potential coal seams in this area, a more detailed geological survey of the area would be required. Additionally, at least one drill hole should be completed to establish the stratigraphic succession.

(ii) SUB-SURFACE

Detailed geological mapping of any underground openings made during the 1972 field season must be carried out.

7.2.4 GASSINESS TESTING

In all future drilling programmes, it is proposed that gas samples be collected from as many drill cores of coal as practicable.

During driving of the main headings, gas testing should be carried out as a routine operation in order to establish the likely incidence of gas bursts.

7.2.5 STRESS CONDITIONS

The probable existence of residual stresses within the rocks adjacent to the thrust faults has been mentioned in Section 6.

In order to assess the intensity of such residual stress in these areas, it is considered that investigations aimed at evaluating such stress phenomena should be undertaken. The services of an experienced rock mechanics engineer should be engaged to this end.

7.3 LONG TERM PROPOSALS

Further recommendations in this category, while not necessarily exhaustive, nevertheless cover the foreseeable requirements at this stage. In line with the immediate objectives of Coalition Mining Limited, the following recommendations, except for 7.3.1, apply only to the Sukunka Coal Project area.

7.3.1 REGIONAL APPRAISALS

A number of occurrences of coal seams have been reported in the Peace River District generally. Some of these seams have been worked or opened up in preliminary fashion. A varying degree of confidence exists as to the accuracy of such reports, and there is little doubt that an appraisal of the occurrences would be advantageous to Coalition Mining Limited. Reconnaissance geological mapping would be a necessary adjunct to such an appraisal.

7.3.2 DIAMOND DRILLING

(i) Further drilling is required in the area between the Pond Fault and the Rim Fault from grid line D to grid line F. Present indications are that the extraction of coal from this area will not be economically possible, due to dips of up to 25^{o} on the Chamberlain Seam floor. It is suggested, however, that drilling in this area may not be entirely successful as it is probable that a high angle normal fault may well explain the steep dips. Should this situation obtain, it is not likely that 2 or even 3 drill holes could be sited so as to intersect such a fault. However, mining operations conducted before this area is reached should provide evidence which may render this drilling unnecessary.

(ii) An alternate interpretation has been proposed for the trend of the Lakes Fault between grid lines H and I. It is suggested that one drill hole in this area should be sufficient to elucidate this problem.

(iii) In order to fully establish the reserves of coal for Chamberlain Seam in the area marginal to the present exploration grid, an extended drilling programme is required. It is known that the Chamberlain Seam continues in a south-easterly direction toward areas currently held under option by Teck Corporation Ltd. Preliminary results available from that company, unpublished, are encouraging enough to suggest that further drilling should be carried out in this direction in order to establish the reserves. It is believed that at a distance of some 2½ miles south of the current project area, the Chamberlain Seam undergoes a considerable lateral facies variation, this variation taking the form of a number of splits of the seam. Such splits would tend to make the seam an uneconomic proposition for much of the area. However, it is probable that an estimated 10 to 15 million tons gross of Chamberlain Seam reserves may be available.

(iv) UNDERGROUND DRILLING

During the development of the mine, a continual awareness must be maintained of the likelihood of occurrence of minor faults. The frequency of such minor faulting cannot be predicted with any degree of confidence.

In many instances when such minor faulting is encountered during mine development, horizontal or holes angled to the horizontal will be particularly useful in determining the throw of these faults. It is anticipated that while the absolute number of minor faults can never be confidently predicted, their lack or frequency of occurrence, would be predictable after some 5 years of mine life.

7.3.3 UNDERGROUND GEOLOGICAL MAPPING

During future operations in the mining development of the Sukunka Coal Project it is important that mapping of all underground openings be carried out, particularly in the first 5 years of the mine life. Not only will such examination provide confirmatory data for the structural interpretation outlined in this report, but it will be essential in the day to day planning of mine development, especially in the early stages.

At the time of writing this report, it is not possible to outline in any detail what the requirements will be for the 1972 field programme, as the extent of the mining operations which will be undertaken for the summer of 1972 has not yet been decided.

7.3.4 EXPLORATORY DRIVING

In order to establish the degree of structural disturbances adjacent to the various thrust faults, it is recommended that a heading be driven at right angles to the trace of a selected fault.

This may be considered as a short or long term proposal.

Adit #1 is approximately parallel and close to the Chamberlain Fault with a consequent exposure of a considerably disturbed strata. It is recommended that a heading be driven at right angles to the existing adit, away from the fault trace, in order that an assessment of tectonic disturbances in relation to proximity to a fault plane may be made prior to the commencement of actual mining.

At an appropriate time during the development of the mine, it is further recommended that a similar heading be driven, under actual mining conditions, adjacent to one or more of the intra-plate faults of Plate 2.

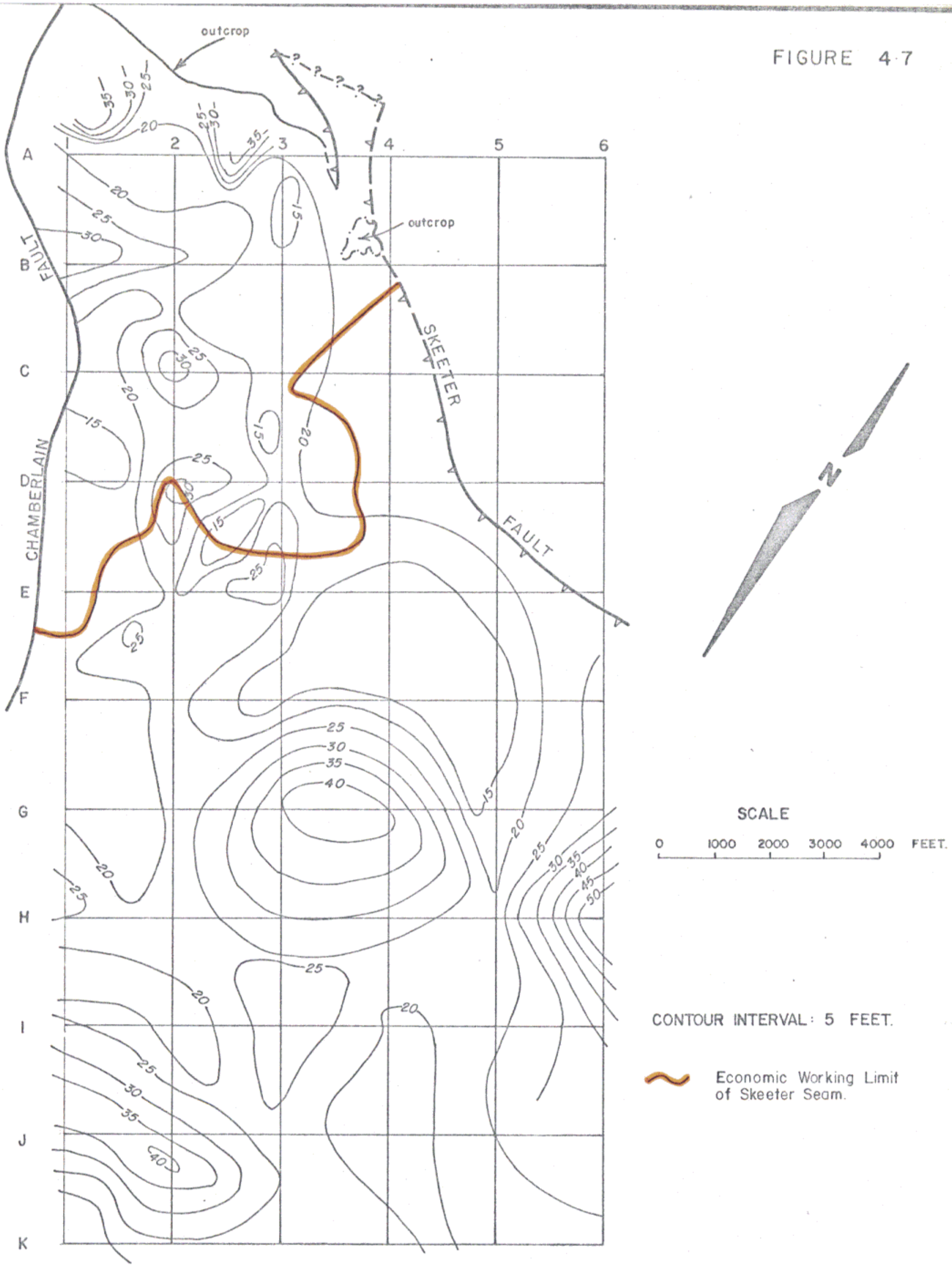
7.4 COST ESTIMATES

A cost estimate for the 1972 field programme, outlined in Section 7.2, above, is included in Table 7.1, below. The estimate should in no way be construed as a budget figure as the final programme and consequent logistic support, requires further definition. Costs are based on the 1971 programme.

Miscellaneous costs provide for motor vehicle running and surveying of the drill hole locations and outcrop stripping. Messing costs do not provide for accommodation of any kind as it is considered that this facility, as would power generation and other support facilities, be included in a larger scale mine development programme.

Should the geological programme commence before any mine development programme, that is, act as a task force, additional costs to those outlined in Table 7.1 must be incurred.

FIGURE 4·7



SKETCH ISOPACH MAP

INTERSEAM SEDIMENTS

BETWEEN

CHAMBERLAIN & SKEETER SEAMS

PLATE 2

See also Map 21 for details of contours at scale 1" = 1000'

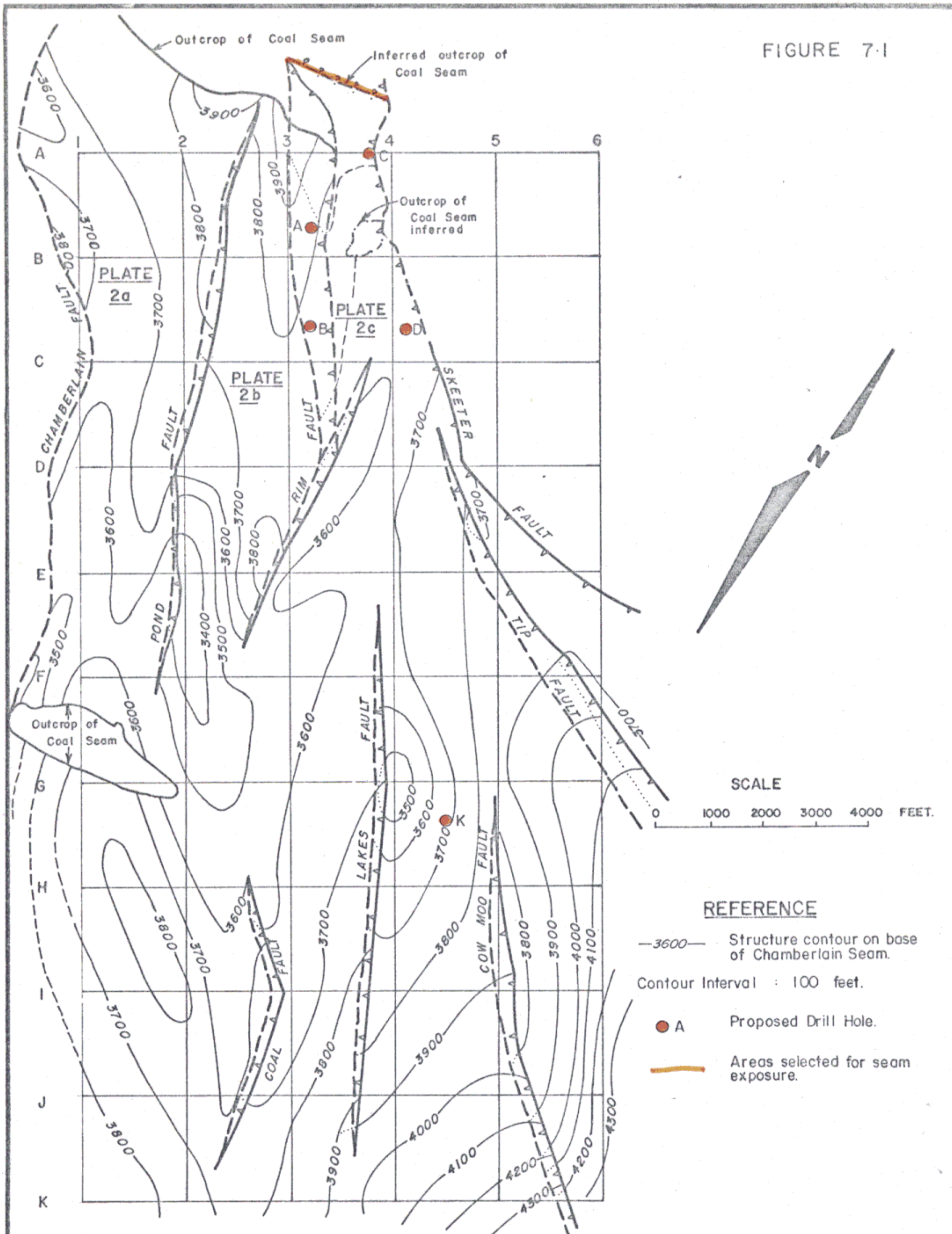
PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

FIGURE 7·1



SKETCH MAP

RECOMMENDED 1972
FIELD PROGRAMME
PLATE 2

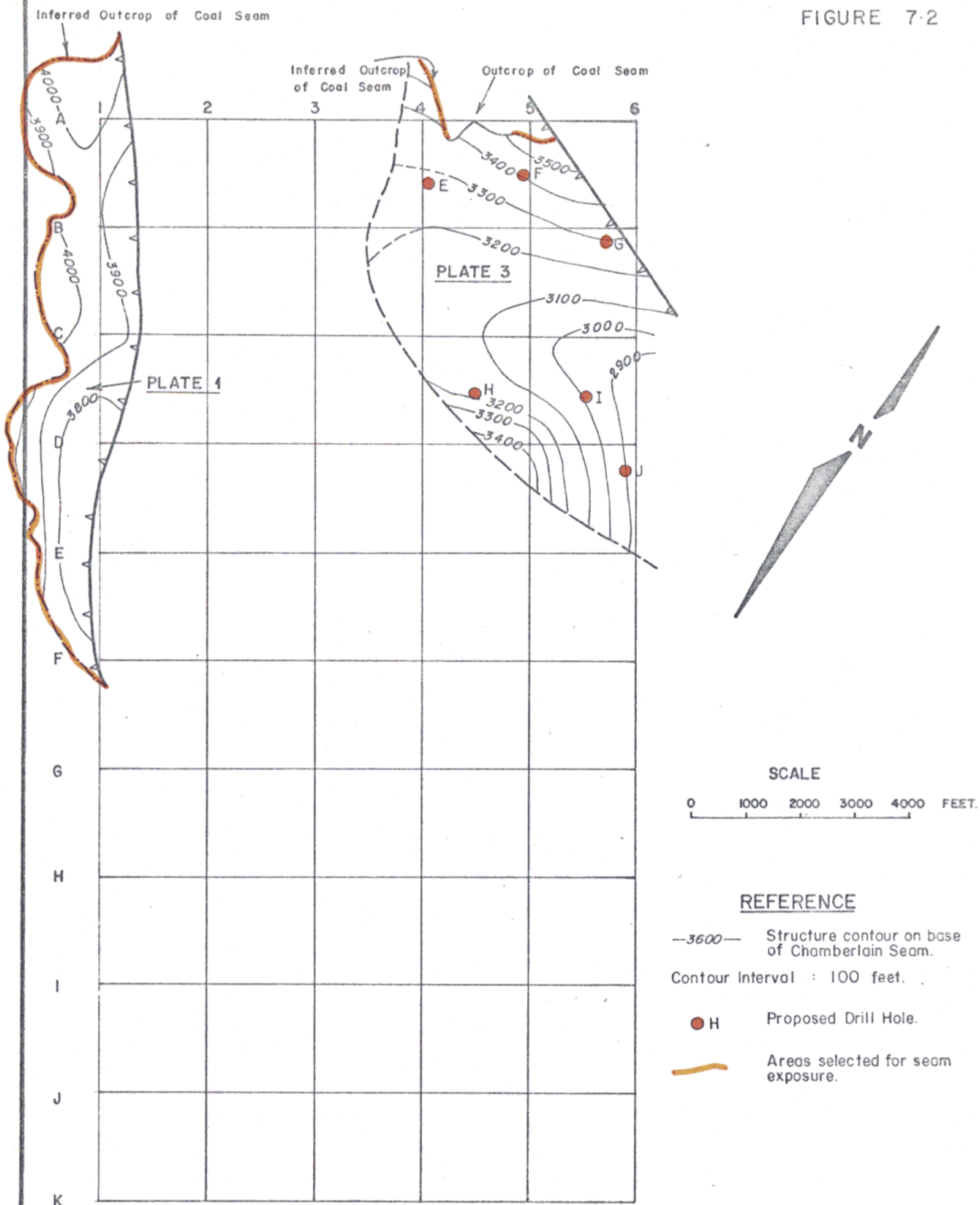
COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED

FIGURE 7·2



SKETCH MAP

RECOMMENDED 1972

FIELD PROGRAMME

PLATES 1 and 3

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

SECTION 8

EXTENDED SUMMARY AND CONCLUSIONS

This section brings together, in condensed form, the most important elements of the report. Included here are summaries of coal reserves and quality, structural considerations, mining conditions and recommendations for further geological investigations.

8.1 TOTAL COAL RESERVES

The coal reserves have been divided into 2 categories - Measured and Indicated.

Within the Measured Reserves category, 74 million long tons of coal exist in place. These may be divided up as shown below.

Measured Reserves

	Millions of Long Tons, Gross		
Seam	Plate 1	Plate 2	Total
Chamberlain	3.62	58.53	62.15
Skeeter	2.52	9.32	11.84
TOTALS	6.14	67.85	73.99

Indicated Reserves

Gross Indicated Reserves of 6.51 million long tons of Chamberlain Seam and 2.59 million long tons of Skeeter Seam exist in Plate 3.

Additionally, 22 million long tons of Gross Indicated Reserves exist external to the southern part of the exploration grid.

Using a figure of 70% for the extraction and a yield of 80% and 70% for the Chamberlain and Skeeter Seams respectively, 40.61 million long tons of washed coal will be produced from the 74 million long tons of Gross Measured Reserves.

8.2 CHAMBERLAIN SEAM

8.2.1 COAL RESERVES

A figure of 62.15 million long tons of Measured Reserves have been proven for the Chamberlain Seam in Plates 1 and 2. Based on an extraction figure of 70% and a recovery of 80% and 85%, 34.8 and 37 million long tons respectively, of washed coal will be available.

Plate 3 reserves have been classed as Indicated; 6.51 million long tons of Gross Reserves and 3.65 and 3.88 million long tons of washed coal based on a recovery of 80 and 85% respectively (an extraction figure of 70% has also been used).

The recovery figures are based on drill core data only.

The thickness of the Chamberlain Seam for the bulk of the area, that is, Plate 2, is in excess of 8 feet and ranges up to 13 feet in the south of the area. Between the northern outcrop of the coal seam and for a distance of some 2,500 feet to the south of the northern outcrop, the coal seam is less than 7 feet thick, the minimum being 4.8 feet.

8.2.2 COAL QUALITY

Quality of the coal in the Chamberlain Seam is remarkably high, having an ash content of between 3.9 and 5.3% and averaging 4.0%

in Plate 2; these figures are based on analytical data of a washed product at S.G. 1.60. The C.S. No. is predicted to be between 7 and 7½ and the volatile matter (DAF) is between 20% and 26%.

Within Plates 1 and 3, the quality of the Chamberlain Seam is essentially the same.

8.3 SKEETER SEAM

8.3.1 COAL RESERVES

Within Plates 1 and 2, 5.8 and 6.2 million long tons of washed coal should be recoverable from the 11.84 million long tons of Gross Measured Reserves; these figures are based on a recovery of 70% and 75% respectively; an extraction of 70% has been used.

Indicated Reserves within Plate 3 are 2.59 million long tons (gross) from which may be produced 1.22 to 1.30 million long tons of washed coal using a recovery of 70% or 75% respectively.

The Skeeter Seam is more confined in its distribution than the Chamberlain Seam primarily occurring in the northern 40% of the project area. The seam is split by a number of rock bands, the Lower Rock Band dictating the thickness of the working section, as defined in the report.

The maximum thickness of the working section in Plate 2 is 9.5 feet thinning to the south to 5.3 feet. Over more than half of Plate 2, the working section of the Skeeter Seam is in excess of 6 feet.

In Plate 3, the average thickness is between 5 and 6 feet.

8.3.2 COAL QUALITY

The quality of the Skeeter Seam is for the most part similar to that of the Chamberlain Seam having, on the basis of bore core analysis, averages only slightly higher for ash content (4.8% as against 4.0%) and a slightly higher volatile content (24.9%, DAF, as against approximately 22%). A C.S. No. of 7½ is predicted for this seam.

8.4 THE STRUCTURAL CONCEPT

The rock units of the project area are essentially unmetamorphosed strata which have been dislocated by a series of low angle thrust faults which have overthrust from the west to the east. The faults have separated the strata into 3 major blocks which have been referred to in the text as Plates.

Two major thrust faults, the Chamberlain Fault and the Skeeter Fault, divide the area into 3 major plates; Plate 1, lying to the west of the Chamberlain Fault, Plate 2, between the Chamberlain and Skeeter Faults and Plate 3, to the east of the Skeeter Fault. These major faults act as confining barriers to mining development of the area.

Within Plate 2, 6 intra-plate faults divide this plate into sub-areas, but as the throw on these faults is substantially less than the 2 major faults, their effect on mine layout will not be as severe.

8.5 STRUCTURAL CONTROLS

The strata within each plate are gently folded in a series of broad anticlines and synclines. In general, the dip of strata is less than 15^{o} and most commonly is from 0^{o} to 10^{o}.

The boundaries between the structural plates, that is, the thrust fault zones,are characterised by shearing and dislocation of strata. The dip of the fault planes is usually less than 10°, the average dip of the Chamberlain Fault being 8°.

The throw on the Chamberlain Fault ranges from 150 to 370 feet and on the Skeeter Fault between possibly 20 feet and 820 feet. The throw on the intra-plate faults is generally in the order of 80 to 120 feet, but is often as little as 20 feet.

At the northern extent of the Chamberlain Fault a zone, some 250 feet wide, has been strongly deformed. The immediate zone of shearing or brecciation of faults with a throw in excess of 50 feet may be as limited as 7 feet.

Minor faulting has been observed above the Chamberlain and Skeeter Seams, the throw of the faults being usually less than 3 feet and the heave less than 50 feet. Some 12,000 feet of continuous outcrop stripping, however, has revealed only 8 of these minor faults. The dip of these faults is relatively flat, varying between 5° and 10°, the dip decreasing such that the fault plane becomes coincident with the bedding some 10 feet above the roof of the seam. Commonly, such faults have induced intra-formational shearing within the coal, usually being confined to the top one foot and/or the lower one foot of the seam.

8.6 MINING CONDITIONS

Underlying the Chamberlain Seam is a particularly competent carbonaceous sandstone which has only been dislocated by the action of major thrust faulting and which will provide satisfactory floor conditions. The roof of the Chamberlain Seam is predominantly a hard claystone; laminite forms the roof where the

the claystone is absent. Satisfactory roof conditions should be experienced during mining.

At the top of the Chamberlain Seam is a stony coal ("bone") band generally up to 6 inches thick. This rock unit, with an S.G. greater than 1.60 will, of necessity, be taken during mining.

The floor of the Skeeter Seam is a relatively massive brown-grey siltstone, although for much of the working section the top of the Lower Rock Band of the Skeeter Seam will form the floor. This band is a carbonaceous claystone or siltstone and will form a suitable floor for continuous miners.

The roof of the Skeeter Seam is a carbonaceous siltstone which will provide a most satisfactory roof.

The interseam thickness between the Skeeter and Chamberlain Seams ranges between 15 feet and 30 feet; over much of the area it is in excess of 20 feet. Such a small interseam thickness will place severe constraint on the mining of the Skeeter Seam, necessitating its extraction prior to, and ahead of, the Chamberlain Seam.

Over approximately 60% of the project area, the rock cover is less than 1,200 feet with respect to the Chamberlain Seam floor. Generally north of grid line E' it is less than 1,000 feet and increases to approximately 1,800 feet in the extreme south-eastern corner.

8.7 THE ECONOMIC POTENTIAL OF OTHER SEAMS

Within the project area, 3 other seams warrant mention, the Commotion Seams, the Bird Seam and the "Middle Coals".

The economic potential of these seams in the project area is considered to be negligible in that the Commotion and Bird Seams have a high ash content (up to 50%) and yields of less than 10%. Little is known of the Middle Coals except that while the ash is low (8%), it has a low C.S. No. (less than 3).

No investigations of other coal bearing strata in the Peace River District have been carried out, but as the area is a potentially coal producing province, it is probable that economic seams in the area may exist.

8.8 RECOMMENDATIONS FOR FURTHER GEOLOGICAL INVESTIGATIONS

Should Coalition Mining Limited exercise its option over the project area, further field investigations are recommended during the 1972 season in order to solve a number of problems still outstanding.

In the short term, the proposals are:

(i) The boundary faults to Plate 2c; the Rim and Skeeter Faults require verification of their exact position; four drill holes are proposed for this, along with outcrop stripping of the Chamberlain Seam of Plate 2c.

(ii) Outcrop stripping and six diamond drill holes are proposed for Plate 3 in order to upgrade the reserves to the Measured category and to fully investigate the structural configuration of this plate.

(iii) In order to verify the absence of east/west trending dislocations, it is considered that the stripping of the Chamberlain Seam along the western boundary of Plate 1 is justified.

(iv) As the area is structurally complex, it is vital that geological investigations be conducted as mine development proceeds, so that constant advice may be provided to the engineers, especially during the early stages of the mine development.

(v) Gassiness and stress studies should be carried out by a specialist in the field of rock mechanics.

Additionally, in the longer term, the proposals are:

(vi) Structural problems associated with the Pond, Rim and Lakes Faults (see Section 7.3.2) will doubtless require a limited amount of diamond drilling, the programme to be determined in the light of information gained as mining proceeds.

(vii) Exposures of coal seams exist at various localities in the Peace River District. Preliminary assessment of selected areas with associated reconnaissance geological mapping is recommended.

(viii) To the south-east of the project area, investigations were carried on by the Teck Corporation with a view to assessing the economic potential of the particular area. Drilling has indicated that a lateral variation has destroyed the familiar character of the Chamberlain Seam. However, while sufficient reserves do not appear to exist for the establishment of a separate mining complex, the indications are that some 10-15 million long tons of Gross Indicated Reserves may exist within the area. These could be usefully added to the coal reserves of the subject project area, whereas they may otherwise be sterilised due to access difficulties and low reserve figures for that south-eastern area, standing on its own. Consideration should be given to acquiring these coal licences.

SECTION 9

SELECTED BIBLIOGRAPHY

ATKINS, W.F. and LATTANZI, C.R., 1971: Coal Mine Inspections, Report No. 1, Strip Mining Operations in Maryland Smoky River Project in Alberta. David S. Robertson & Associates Ltd. (unpub.).

BANKS, R.L., 1971: Western Canadian Coal: A Broadening Industry. Presented to 23rd Canadian Conference on Coal, Ottawa, Ontario.

BERGEY, W.R., 1970: Interim Report on the Sukunka River Project; Brameda Resources Ltd. (unpub.).

____, 1971: Report on Potential Coal Resources, Teck Corporation Option - Sukunka Area. Teck Corporation. (unpub.).

____, *BILHEIMER, L., MITCHELL, J.C. and TRENHOLME, L.S., 1971:* Summary Report, Sukunka Coal Project, Peace River District, British Columbia; Brameda Resources Ltd. (unpub.).

____, and TRENHOLME, L.S., 1971: Report on the proposed Coal Exploration Program, Teck Corporation Option - Sukunka Area. Brameda Resources Ltd. (unpub.).

BIRMINGHAM, T.F. and CAMERON, A.R., 1971: Petrography of the Chamberlain Seam; Geol. Surv. Can. (Dept. of Energy, Mines and Resources). (Reproduced in this report as Appendix D).

BURK, *C.F., Jr., 1963: Structure, Isopach and Facies Maps of* Upper Cretaceous Marine Succession, West-Central Alberta and Adjacent British Columbia; Geol. Surv. of Can. (Dept. Min. and Tech. Sur.), Paper 62-31.

CLARKE, T.M., 1971: The Mechanisation and Development of the N.S.W. Coal Industry over the last Twenty Years; Preprint of paper presented at the 1971 Annual Conference of the Aust. Inst. Min. Met.

CLIFFORD McELROY & ASSOCIATES, 1971: Progress Notes on an Appraisal of the Coal Resources of the Sukunka River Area. Unpub. rpt. for Austen & Butta Ltd.
Rpt. No. 1/4/2, 22nd May, 1971.

COLLINS, H.E., 1971 (a): Considerations Relevant to the Sukunka River Project following Visits to the Mines of McIntyre Porcupine Ltd. and Kaiser Resources Ltd. Unpub. rpt. for Coalition Mining Limited.

_____, 1971 (b): Report on Visits to the Sukunka River Coal Project. Unpub. rpt. for Coalition Mining Limited.

_____, 1971 (c): Report on Visit to the Smoky River Project of the McIntyre Porcupine Mines, Grande Cache, Alberta. Unpub. rpt. for Coalition Mining Limited.

_____, 1971 (d): Report on Visit to the Mines of Kaiser Resources Ltd., Sparwood, Crows Nest Pass, British Columbia. Unpub. rpt. for Coalition Mining Limited.

CYCLONE ENGINEERING SALES LTD., 1970: Report on Washing and Drying of Coking Coal for Brameda Resources Ltd., Sukunka Coal. (Report No. RI-70.17). (unpub.).

FISHER, A.D., 1971: Metallurgical Coals for the Future; Prepared for presentation at the Twenty-Third Canadian Conference on Coal, Ottawa, Ontario, September 19-22, 1971.

FOUNDATION OF CANADA ENGINEERING CORPORATION LTD., 1970: Preliminary Report. Engineering Study and Capital Cost Estimate. Unpub. rpt. for Brameda Resources Ltd.

HOPKINS, M.E. and GLUSKOTER, H.J., 1969: Reconnaissance Survey, Coals of the Gething Formation, Peace River - Pine River Region, British Columbia. Unpub. rpt. submitted to Brameda Resources Ltd.

_________, 1970: Reconnaissance Survey, Geology of the Bullmoose Creek - Perry Creek - Wolverine River Area, British Columbia. Unpub. rpt. to Brameda Resources Ltd.

HUGHES, J.E., 1964: Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills; B.C. Dept. of Mines and Petroleum Resources, Bulletin No. 51.

_____, 1967: Geology of the Pine Valley; B.C. Dept. of Mines and Petroleum Resources, Bulletin No. 52.

_____, 1969/70: Sukunka Coal Project - Geology (a compilation of data); Brameda Resources Ltd. (unpub.).

IRISH, E.J.W., 1968: Structure of the Northern Foothills and Eastern Mountain Ranges, Alberta and British Columbia, between latitudes 53°15' and 57°20'; Geol. Surv. Can. (Dept. of Energy, Mines and Resources), Bull. 168.

JAPAN OVERSEAS COKING COAL DEVELOPMENT CO. LTD., 1970: Survey Report, Sukunka River Coal Project. (unpub.).

____, 1971: Sukunka River Coal Project, Second Study. Report of Geology and Seam Conditions. (unpub.).

LATOUR, B.A., 1970: The Coal Deposits of Western and Northern Canada; Geological Survey of Canada, Presented to 22nd Canadian Conference on Coal, Vancouver 1970.

____ and CHRISMAS, L.P., 1970: Preliminary Estimate of Measured Coal Resources Including Reassessment of Indicated and Inferred Resources in Western Canada; Geol. Surv. Can. (Dept. of Energy, Mines and Resources), Paper 70-58.

MACKAY, B.R., 1929: Brule Mines Coal Area, Alberta; Geol. Surv. Can., Sum. Rept. 1928, pt. B, pp. 1-29.

MATHEWS, W.H., 1946: Geology and Coal Resources of the Carbon Creek - Mount Rickford Map Area; B.C. Dept. Mines, Bull. 24.

McELROY, C.T., 1970: The Sukunka River Coal Project, British Columbia. Progress Report No. 1. Clifford McElroy & Associates Pty. Limited (unpub.) report to Austen & Butta Limited.

McKECHNIE, N.D., 1955: Hasler Creek - Pine River Area, British Columbia; B.C. Dept. Mines, Bull. 36.

METAL BULLETIN MONTHLY, 1971, No. 4. Western Canada's Coal Resurgence.

PAUL WEIR COMPANY, 1970: Proposed Mining Project, Sukunka Coal Field, British Columbia. Unpub. rpt. to Brameda Resources Ltd.

PUGH, D.C., 1960: The Subsurface Gething and Bluesky Formations of Northeastern British Columbia; Geol. Surv. Can.(Dept. Min. and Tech. Surv.), Paper 60-1.

ROBERTSON, D.S. and ATKINS, W.F. 1971: Interim Report. Brameda Resources Limited, Sukunka Coal Project for Brascan Limited. David S. Robertson & Assoc. Ltd. (unpub.).

STOTT, D.F., 1960: Cretaceous Rocks between Smoky and Pine Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can. (Dept. Min. and Tech. Surv.), Paper 60-16.

____, 1961 (a): Dawson Creek Map-Area, British Columbia; Geol. Surv. Can. (Dept. Min. and Tech. Surv.), Paper 61-10.

____, 1961 (b): Type Sections of Some Formations of the Lower Cretaceous Fort St. John Group near Pine River, British Columbia; Geol. Surv. of Can. (Dept. Min. and Tech. Surv.), Paper 61-11.

____, 1963: Stratigraphy of the Lower Cretaceous Fort St. John Group and Gething and Cadomin Formations, Foothills of Northern Alberta and British Columbia; Geol. Surv. Can. (Dept. Min. and Tech. Surv.), Paper 62-39.

____, 1968: Lower Cretaceous Bullhead and Fort St. John Groups, between Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can. (Dept. Ener., Min. & Res.), Bull. 152.

TRENHOLME, L.S., 1971: Summary Report, Sukunka Coal Project Peace River District, British Columbia; Brameda Resources Ltd. (unpub.).

WALLIS, G.R.,1971: Sukunka Validation Programme, Recommended Exploration Programme and Budget. Clifford McElroy & Assoc., Unpub. rpt. for Coalition Mining Ltd.

WALSH, J.H., BOTHAM, J.C. and MONTGOMERY, E.W., 1970: A Future for Western Metallurgical Coals; Canada Dept. of Energy, Mines and Resources (Mines Branch, Ottawa), Metals Reduction & Energy Centre Divisional Report MREC 69/1.

PR-SUKUNKA-71(1)A-2

SUKUNKA COAL PROJECT
REPORT: 1971

BRAMEDA RESOURCES LIMITED

SUKUNKA COAL PROJECT

Report on Operation September 11, 1970 - July 9, 1971.

1. Between September 22 and November 30, 1970, 16 diamond drill holes were completed for a combined length of 13,039 feet.

   In the same period, 36,800 lineal feet of drill access roads and approximately 82,000 square feet of bulldozer trenching in overburden and coal were completed.

   Concurrently, geological mapping of outcrops and logging of drill cores were completed.

2. From December 1, 1970 to July 9, 1971, the property was on standby basis. Three men were continuously employed at the property for caretaking and miscellaneous duties.

   During February 1971, 33 additional coal licences were staked. These licences were granted April 20, 1971.

   In the same period a geologist and one draughtsman at head office were more or less continuously employed in correlation studies of drill logs, air photo geological interpretation and preparation of geological plans and sections. The company's engineering and administrative staff made extensive appraisals of feasibility reports and of various exploration, mining, processing and financing proposals.

3. No underground work was performed during the period covered by this report although a few additional drums of coal were shipped for testing purposes.

4. Extensive testing was carried on relevant to washing and coking characteristics by:

   a) Eastern Associated Coal Corporation, Everett, Massachusetts.

   b) Cyclone Engineering Ltd., Calgary, Alberta.

   c) Various Japanese steel mills.

   d) Canada: Department of Energy, Mines and Resources.

   e) Dr. William Spackman Jr., Pennsylvania State University.

5. A report on a preliminary feasibility study by Paul Weir Company of Chicago was submitted in November, 1970.

6. As of July 9, 1971 operations at certain of the Sukunka properties of Brameda Resources Limited came under the direction of Coalition Mining Ltd.

7. Submitted herewith are the following:

   (i) Geological Plan : 1 inch = 1000 feet

   (ii) Geological Sections (A - J) 1 inch = 800 feet.

   (iii) Strip Logs - D.D. Holes

   (iv) List of Diamond Drill Holes (attached)

   (v) Work Distribution by Coal Licences (attached)

   (vi) Geological Report by Dr. M. E. Hopkins and Dr. H. J. Gluskoter, August 1971.

   (vii) Coal Quality Data Compilation - including section by Paul Weir Company on washing and coking tests

   (viii) Washing Report by Cyclone Engineering Sales Ltd.

   (ix) Statement: Summary of Expenditures, September 22, 1970 to July 8, 1971.

L. S. Trenholme

L. S. Trenholme
Project Manager for
Brameda Resources Limited
1177 West Hastings Street,
Vancouver 1, B.C.

September 17, 1971..

BRAMEDA RESOURCES LTD.

Summary of Expenditures : September 21, 1970 to July 11, 1971, Relevant to Assessment Work Credit on Group I (41 Coal Licences)

Fixed Assets		$ 641
Property Cost		5,787
Geological Salaries		11,080
Prospecting and Reconnaissance		2,628
Stripping and Trenching		13,273
Exploration Drilling		142,745
Underground Workings		1,410
Bulk Sampling		335
Camp Operations		53,590
Roads and Bridges		23,976
Transportation on Site		13,928
Assaying and Coal Analysis		12,016
Project General Overheads		118,161
Air and Land Survey		11,695
Consultants		41,425
		$ 452,690
Less: Fixed Assets	641	
Property	5,787	6,428
Available for Assessment Work		$ 446,262

STATEMENT OF CERTIFICATION OF ASSESSMENT

WORK BY BRAMEDA RESOURCES LIMITED

This is to certify that the foregoing statement of work prepared by L. S. Trenholme and dated September 17, 1971, is correct in all respects and that to the best of my knowledge the accompanying statement of expenditures accurately sets forth the actual amounts expended on such work.

Morris M. Menzies
Professional Engineer
Province of British Columbia

BRAMEDA RESOURCES LIMITED

SUKUNKA COAL PROJECT

Record of Diamond Drilling
September 22 - November 30, 1970

Hole No.	From	To	Feet Drilled	Location Coal Licence No.
S-37	1388	1408	20	1088
S-38	500	1068	568	1087
S-39	0	1608	1608	1098
S-40	0	1258	1258	1080
S-41	0	628	628	1080
S-42	0	1488	1488	1097
S-43	0	618	618	1087
S-43A	0	657	657	1087
S-43B	0	503	503	1087
S-44	0	1528	1528	1089
S-45	0	1245	1245	1087
S-46	0	898	898	1096
S-47	0	417	417	1079
S-48	0	867	867	1087
S-49	0	518	518	1079
S-50	0	218	218	1072

Total drilling in period 13,039 feet

BRAMEDA RESOURCES LIMITED

SUMMARY OF EXPLORATION WORK BY LICENCES

September 22 - November 30, 1970.

Licence No.	Drilling Feet	Drill Roads Lin. Feet	Trenching Square Ft.
1071	-	-	8,000
1072	218	2,500	12,000
1079	935	4,000	-
1080	1,886	4,400	50,000
1087	4,458	3,400	-
1088	20	-	12,000
1089	1,528	-	-
1096	898	7,500	-
1097	1,488	8,000	-
1098	1,608	3,000	-
1101	-	1,500	-
1102	-	2,500	-
	13,039	36,800	82,000

SUKUNKA VALIDATION PROGRAMME

PROGRESS REPORT - SEPTEMBER 12TH, 1971.

The following progress report is designed to bring all interested parties up to date regarding the Sukunka exploration programme. An interim report will be compiled and forwarded, this report containing more detail than the following progress report.

Geological Mapping

A 1" = 1000' geological map has been completed and is in the final stages of compilation. In addition a 1" = 400' geological map will also be compiled in the immediate future.

The logging of core being produced as a result of the current drilling programme is proceeding satisfactorily with seven holes being completely logged to date. Detailed logging is being undertaken in the Gething Formation, with stratigraphic logging concentrating on structural discontinuities and sedimentary features being applied to the remainder of the sequence. In addition, all holes from the previous drilling programmes, D.D.H. S-1 to S-50, will be logged by September 14. The logging of these cores has been carried out with a view to gaining a wider understanding of the detailed stratigraphy of the Lower Cretaceous units, again with particular reference to the Gething Formation. Also structural discontinuities and sedimentary features have been assessed.

Coal seam intersections, and the recoveries from these intersections is listed in detail in the accompanying table to this report.

Drilling Programme

In the shallow structural drilling phase of the programme 14 holes have been completed, totalling 5,138 ft., using the reverse circulation drilling rig, of Big Indian. This particular aspect of the drilling programme has provided valuable data in respect of the configuration of the coal seam in the Chamberlain Creek area.

Further shallow structural drilling is programmed to be carried out along the northern margin of the property, in the vicinity of D.D.H.s S-1 and S-47. Some 3,000' of drilling in 7 holes is programmed. In this phase of the shallow structural programme, a wireline rig will be used in order that full structural details will be obtained.

Wireline drilling totalling 11,084', in 13 holes has been completed in the deep structural drilling programme. To date a number of faults have been intersected, but until a complete structural interpretation of the rock types of the area has been completed, no comment is made as to the relative importance.

In the grid infill and extension phase of the programme, 10 holes, totalling 10,290' of drilling, have been completed. A further 12,000' of drilling is programmed for this phase in order that a complete assessment of the coal quality and reserves may be completed.

Currently, six rigs are still operating, the Big Indian reverse circulation rig having completed its work. Additionally, rig no. 1, Connors Drilling Co. Ltd., has been stood down owing to its history of bad core recovery.

At the end of the shallow structural (wireline) drilling on the northern limits of the property (7 holes, totalling 3,000') rig no. 4 Connors Drilling Co., will also be stood down. The second rig is being stood down, probably temporarily, in order that a more complete structural evaluation of the rock units may be made. Consequently a temporary hault has been called in the deep structural phase of the programme. It is intended to recommence this aspect of the drilling about September 20.

Coal Seam and Rock Outcrop Definition

As noted in previous progress reports, stripping by use of bulldozer has been carried out in both the northern sector of the property and along Chamberlain Creek. To date the sum of 14,200' of trenching has been completed at an average cost of $3.50 per lineal foot. Of this footage, 9,000' has been completed along the northern outcrop of the Chamberlain and Skeeter Seams. This phase of the exploration programme has proved extremely valuable in providing two dimensional mapping of the coal seams, and providing a picture of the configuration of the coal seam horizons.

Additionally it is planned to expose the Moosebar/Gething contact at a number of localities in order to more fully understand the relationship of these two rock type units.

Geophysical Programme

An experimental seismic reflection survey has been completed and the results are anticipated by September 16. The preliminary data is regarded as encouraging by the geophysicist. However, final results are dependent on computer processing of the digitally recorded data. Should a high degree of certainty be assessed in respect of the results which may be obtained from a large scale programme, sucha programme will be entered into.

Gamma ray - neutron logging of holes has commenced with 6 holes being logged to date. The results achieved so far have justified the use of this technique.

Bulk Sampling

Bulk samples will be collected from the existing adits nos. 2 and 3, after further driving and exposing of unoxidized coal. Additionally, three localities have been selected on the northern outcrop in order that bulk samples may be obtained for testing of washability characteristics. This phase of the programme is timed to start on approximately September 25.

Weather

For the last 4 days, heavy to moderate rainfalls have been recorded at irregular intervals throughout the days and nights. Consequently, the roads are in a somewhat deteriorated condition, making travel times very long. Snow has been recorded on the upper levels and some small patches of snow are still lying on the ground.

Temperatures have been in the vicinity of 40^{o} in the mornings rising to the low 60's during the warmer days. A number of drill hole water lines have already frozen and the drillers will be inserting water heaters in the near future.

Prior to this period of rain, the weather was generally dry and warm, and causing no delays to the programme.

Site Facilities

In addition to the original cook house and bunk room complex, three bunkhouses have been added to the site. A fifth one is anticipated on September 13, bringing the total available bed space to 83. A number of the rooms in one complex is being used for staff on a single room basis.

Motor Vehicles

In addition to the 4 x 4 pick-up and crew cab, one Land Rover and three motorcycles have been purchased. Utilization of all vehicles is at a premium, including the motorcycles which have proved most satisfactory for rapid on-site transport. Regretably the crew cab is not in full utilization due to fairly regular repairs which are required on the vehicle.

Distribution:
C. E. Sawyer
C. T. McElroy (& R. Austen)
R. E. Hallbauer
L. S. Trenholme

G. R. WALLIS
Project Manager

COALITION MINING LIMITED

SUMMARY OF EXPLORATION EXPENDITURES* ON COAL LICENCES** OF BRAMEDA RESOURCES LIMITED, SUKUNKA RIVER AREA, B.C. DURING THE PERIOD JULY 9 TO SEPTEMBER 13, 1971***

Diamond Drilling and Rotary Drilling		$ 305,451
Connors Drilling Ltd.		
Canadian Longyear Ltd.		
Big Indian Drilling Co. Ltd.		
Bulldozing- P. & P. Demeulemeester		
Outcrop Definition	$ 45,500	
Roads	26,000	71,500
Geological Mapping		20,000
TOTAL		$ 396,951

* Main items of expenditure only. Final statement of expenditures to September 21, 1971 to be supplied as soon as possible.

** Coal Licences 1062 - 1066, 1069 - 1102, 1153, 1154.

***Reported by C. D. Watson of Coalition Mining Limited.

per L. S. Trenholme

L. S. Trenholme
Brameda Resources Limited
September 17, 1971.

CERTIFICATION OF ASSESSMENT WORK
SUKUNKA COAL LICENCES

I have examined the foregoing report of work performed by Coalition Mining Ltd. on Coal Licences issued to Brameda Resources Limited, together with statement of expenditures and I am satisfied that both statements are essentially correct.

M. M. Menzies
Professional Engineer

PR-SUKUNKA-71(1)B

645

SUMMARY OF EXPENDITURES BY BRAMEDA RESOURCES LIMITED ON SUKUNKA COAL LICENSES DURING THE PERIOD SEPTEMBER 22/70 TO JULY 8/71

		1970 Sept. 22-30	Oct.	Nov.	Dec.	1971 Jan.	Feb.	Mar.	Apr.	May	June	July 1-8	Tota
FIXED ASSETS													
Trailers & Equipment		$ -	-	-	-	-	-	-	-	-	-	-	-
Mobile Equipment		88	-	-	-	-	-	-	-	-	-	-	88
Laboratory Equipment		-	553	-	-	-	-	-	-	-	-	-	553
Other Equipment		-	-	-	-	-	-	-	-	-	-	-	-
	Sub	88	553	-	-	-	-	-	-	-	-	-	641
PROPERTY COST		5,432	-	-	(566)	116	54	76	-	-	671	4	5,787
GEOLOGICAL SALARIES		1,973	2,805	715	3,495	2,092	-	-	-	-	-	-	11,080
PROSPECTING & RECONNAISANCE													
Surface Prospecting		425	1,475	674	-	-	-	-	-	-	-	-	2,574
Helicopter Support		54	-	-	-	-	-	-	-	-	-	-	54
	Sub	479	1,475	674	-	-	-	-	-	-	-	-	2,628
STRIPPING & TRENCHING		-	9,132	4,141	-	-	-	-	-	-	-	-	13,273
EXPLORATION DRILLING													
Core Drilling		27,799	63,694	42,019	3,503	-	-	-	-	-	-	-	137,015
General		620	2,653	2,457	-	-	-	-	-	-	-	-	5,730
	Sub	28,419	66,347	44,476	3,503	-	-	-	-	-	-	-	142,745
UNDERGROUND WORKINGS													
Primary Exploration		826	406	108	70	-	-	-	-	-	-	-	1,410
Secondary Development		-	-	-	-	-	-	-	-	-	-	-	-
	Sub	826	406	108	70	-	-	-	-	-	-	-	1,410

	1970				1971							
	Sept. 22-30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July 1-8	Total
BULK SAMPLING	235	100	-	-	-	-	-	-	-	-	-	335
CAMP OPERATIONS												
Establish & Maintain Camp	732	4,066	1,027	1,616	1,120	409	1,776	915	557	475	680	13,373
Mine Dry	(367)	-	-	-	-	-	-	-	-	-	-	(367)
Catering & Food	2,280	5,826	5,212	1,203	402	254	1,983	467	705	444	380	19,156
Room & Board Deductions	(129)	(333)	(300)	(275)	(225)	(225	(225)	(225)	(225)	(300)	(50)	(2,512)
Equipment Rentals	886	2,635	3,464	2,140	6,045	(3,400)	4,162	2,874	2,112	2,187	835	23,940
Supervision	-	-	-	-	-	-	-	-	-	-	-	-
Sub	3,402	12,194	9,403	4,684	7,342	(2,962)	7,696	4,031	3,149	2,806	1,845	53,590
ROADS & BRIDGES												
Road Bldg. Incl. to Drill Sites	4,134	4,624	1,605	(32)	-	-	-	-	-	560	295	11,186
Main Road Maintenance	1,000	1,500	1,000	1,000	500	500	500	100	100	200	71	6,471
Secondary Road Mtce	786	2,835	1,151	611	-	-	-	936	-	-	-	6,319
Sub	5,920	8,959	3,756	1,579	500	500	500	1,036	100	760	366	23,976
TRANSPORTATION ON SITE	493	3,555	2,482	882	1,049	964	838	970	1,428	1,067	200	13,928
ASSAYING & COAL ANALYSIS	887	4,076	456	3,503	1,990	570	437	48	49	-	-	12,016
PROJECT GENERAL OVERHEADS												
Communications	126	289	90	959	324	251	317.	208	188	87	132	2,971
Sukunka Office	34	79	84	96	33	(14)	16	108	16	10	-	462
Vancouver Office	71	190	259	284	156	403	815	256	63	449	55	3,001
In & Out Expense	-	165	-	-	-	-	-	-	-	-	-	165
Employment Expense	-	-	-	-	-	-	-	-	-	-	-	-
Travel (Brameda Staff)	267	2,818	1,533	754	448	104	162	7,346	598	758	-	14,788
Travel (Sukunka Staff)	46	121	10	23	49	21	27	177	73	110	12	669
Unallocated Freight	61	-	16	3	-	6	4	-	-	-	-	90
Insurance	-	-	-	588	-	-	29	-	376	119	-	1,112
Employee Benefits	26	119	55	58	110	66	71	44	37	186	-	772
Salaries Vancouver Office	2,855	8,935	8,086	10,556	7,017	7,645	5,773	5,277	4,356	5,750	1,400	67,650
Salaries Field Office	974	1,375	1,375	3,766	3,045	2,965	3,061	3,029	2,997	2,944	950	26,481
Sub	4,460	14,091	11,508	17,087	11,182	11,447	10,275	16,445	8,704	10,413	2,549	118,161

	1970 Sept. 22-30	Oct.	Nov.	Dec.	1971 Jan.	Feb.	Mar.	Apr.	May	June	July 1-8	Total
CONSULTANTS												
Geology Consulting + General Consultants	1,493	5,580	7,145	13,844	6,033	575	6,677	(95)	-	173	-	41,425
Airborne & Land Survey	647	987	-	10,061	-	-	-	-	-	-	-	11,695
Fenco Consultants	-	-	-	-	-	-	-	-	-	-	-	-
Geology	-	-	-	-	-	-	-	-	-	-	-	-
Sub	2,140	6,567	7,145	23,905	6,033	575	6,677	(95)	-	173	-	53,120
GRAND TOTAL	54,754	130,260	84,864	58,142	30,304	11,148	26,499	22,435	13,430	15,890	4,964	452,690

Brameda Resources Limited

[signature]

Treasurer.

September 15, 1971