APPENDIX D

PETROGRAPHY OF THE CHAMBERLAIN SEAM

IN THE SUKUNKA RIVER AREA, BRITISH COLUMBIA

by

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Ottawa

1971

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ABSTRACT

A petrographic examination has been made of a core sample of the Chamberlain seam obtained in the Sukunka River area, British Columbia. From the analysis a seam profile was made, representing the petrographic composition from roof to pavement. From the compositional variations thus defined it was possible to divide the seam into seven intervals in which certain banded ingredients predominated, or showed specific succession.

Maceral determinations, chemical analyses, and reflectance measurements were carried out on each of the intervals. From the compiled data a determination of the coking potential was made and possible variations in coking characteristics within the seam have been noted.

In general there is a preponderance of bright coal components in the seam, the organic constituents remain reasonably constant, and mineral matter is low. The seam ranks as a medium volatile coal with a calculated stability value of 59 and shows the potential of being a premium coking coal.

INTRODUCTION

The Sukunka River area lies in the Peace River District of northeastern British Columbia (See Fig. 1). The present sample of the Chamberlain seam was obtained from a borehole (BH_{24}), of which the approximate location is 55°15'N 121°40'W, about 30 miles south of Chetwynd on the east side of the Sukunka River. Coal exploration is being conducted in the area by Brameda Resources Limited.

This study is part of a larger project encompassing the petrography of coal seams in the northern part of the Rocky Mountain Foothills Belt. The sample was collected from 909½-918 feet in Borehole 24 and is placed about 175 feet below the top of the Gething formations of lower Cretaceous age.

The sample was studied in order to characterize it in terms of petrographic and chemical composition and rank. Variations in these parameters between roof and pavement were defined and the data used to assess the coking potential of this coal. It thus constitutes an evaluation of coal quality in advance of mining.

DATA ON CHAMBERLAIN SEAM

Sample No. WC-44 Chamberlain seam

Core Sample: from Borehole 24, at 909'6" to 918'1"

Location: east side of Sukunka River, Peace River District, about 30 miles south of Chetwynd, B.C.

Sampling Date: June 19, 1970

Total thickness of seam: 8'7" (103 inches)

Total thickness examined: 8'1½" (97.5 inches on coal log)

Number of polished sections: 55

Number of intervals for grain mounts: 7

PROCEDURE AND NOMENCLATURE OF PETROGRAPHIC ANALYSES

Petrographic examination of coal by microscopic methods usually involves the description of a given coal in terms of macerals and/or microlithotypes. Macerals are the basic constituents of coal and are analogous to the minerals of inorganic rocks. Microlithotypes are distinctive assemblages of macerals roughly equivalent to the "rock types" of inorganic petrography. For example, granite is a "rock type" composed predominantly of the minerals quartz and potash feldspar along with varying amounts of accessory minerals. In coal petrography a description in terms of microlithotypes helps to establish the texture or banded character of the coal.

The International Committee for Coal Petrology (1963) recognizes three major groups of macerals, namely vitrinite, inertinite and exinite. Exinite (the coalified remains of spores, pollen and cuticles) tends to disappear in the higher rank coals and therefore has not been detected in the Chamberlain seam. The macerals which have been identified in this seam are shown below in Table 1, and are essentially as defined by the International Committee with some modifications. These include the differentiation of vitrinite into normal vitrinite and pseudo-vitrinite according to the ideas of Benedict et. al. (1968). Also the inertinite macerals have been subdivided following the ideas of Stach and Alpern (1966). Finally an intermediate category, designated as semi-inertinite has been introduced, distinguished by reflectances intermediate between vitrinite and inertinite and with many of the textural properties of the latter. These modifications were made in part for the calculation of coke

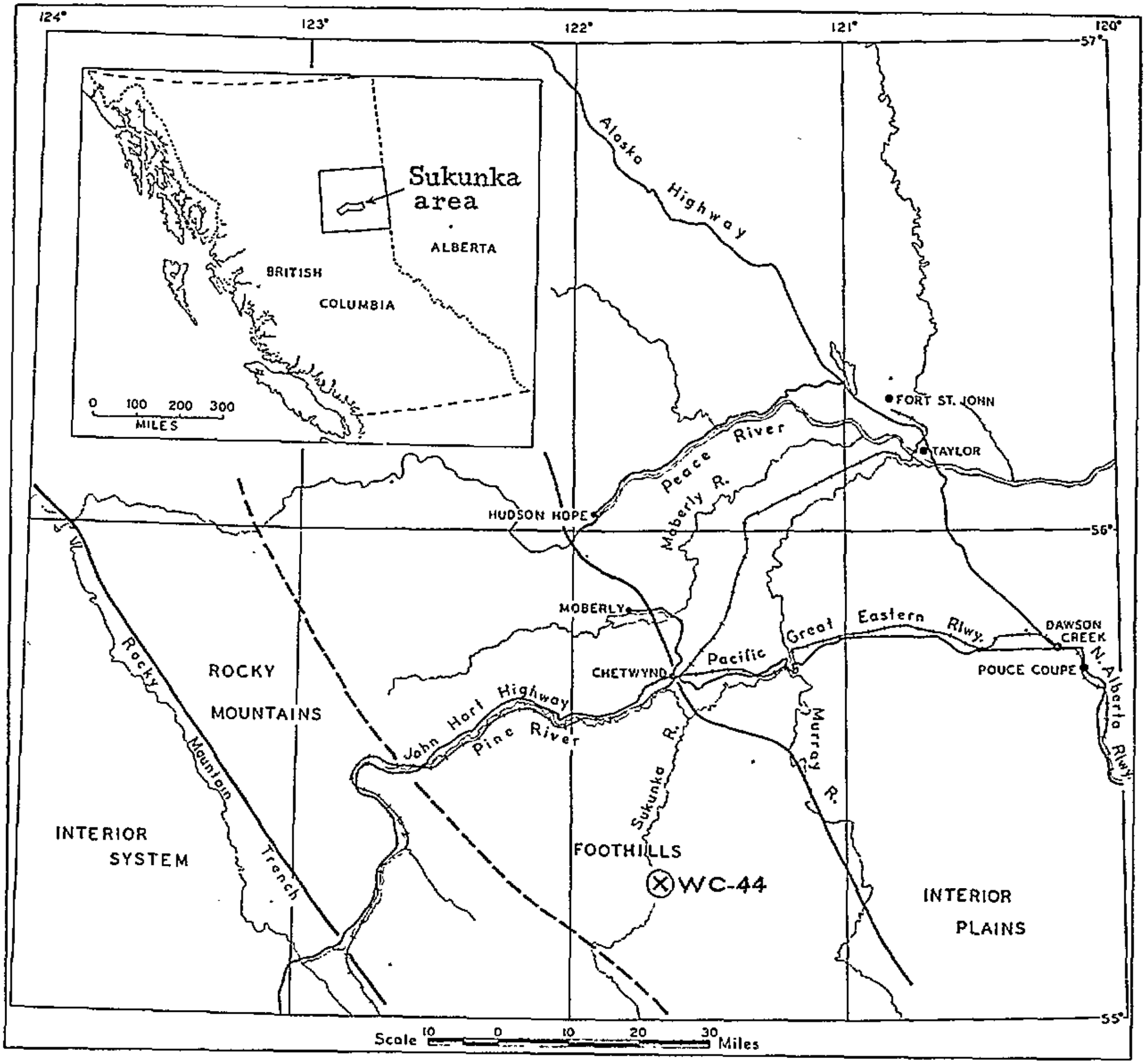

Figure 1. Sukunka River area, British Columbia, showing sample location (from Hughes, 1967).

stabilities.

TABLE 1

MACERALS IDENTIFIED IN THE CHAMBERLAIN SEAM

Vitrinites	(Normal vitrinite (Pseudovitrinite
Semi-inertinites (Low reflectance)	(Semifusinite (Macrinite (Inertodetrinite
Inertinites (High reflectance)	(Semifusinite (Fusinite (Micrinite (Macrinite (Inertodetrinite
Mineral matter	(Inorganic constituents; (calcite, quartz, pyrite, etc.

The preliminary step in the study of sample WC-44 was the examination of a polished master column according to the technique described by Hacquebard (1951). Such an examination is necessary in order to establish the broad petrographic divisions or intervals within the seam. The master column was prepared with 55 sections of coal, oriented with respect to top and bottom and position in the column. Each was embedded in Plaster of Paris (for later removal), appropriately labelled and surface polished prior to microscopic study.

The column was examined microscopically under incident light at a low magnification (x125) and using an oil immersion lens. A simplified microlithotype terminology was employed in identifying the various banded layers in the coal. This terminology is defined in Table II.

TABLE II

NOMENCLATURE AND CLASSIFICATION OF MICROLITHOTYPES

Microlithotypes*	Proportions of constituent macerals, in per-cent by volume
Vitrite	90% vitrinite, well-defined bright bands or lenses
Vitrinertite V	50-95% vitrinite; 5-50% inertinite ("V", Rich in vitrinite)
Vitrinertite I	5-50% vitrinite; 50-95% inertinite ("I", Rich in inertinite)
Inertite	5% vitrinite; 95% inertinite (includes semifusinite, fusinite, micrinite, etc.)
Impure Coal	up to 50% mineral content in the layer

*Vitrinertite terms are used because the coal is essentially a vitrinite-inertinite system with no exinite.

The various layers in the column were identified according to the general banded appearance and their maceral content estimated in order to correctly name the microlithotypes. The widths of the layers are measured on the polished sections and these are plotted true to scale on "coal-logs". The layers were measured down to a minimum width of 1 mm.

From the estimations made in the coal-log it is possible to see changes in the petrographic composition from top to bottom in the seam. Based on groupings of the predominating banded ingredients it was possible to subdivide the column into seven intervals.

The next step was carried out in order to provide precise data on the maceral content of each interval. Coal from each interval was crushed to minus 20 mesh, and made into a grain mount with a thermoplastic bonding agent (Lucite).

The grain mounts of coal pellets were polished on a Beuhler Automet and then examined microscopically under oil immersion lens by incident reflected light at a magnification of x250. Macerals were determined on each of the grain mounts by the point count method for a minimum count of 500 points per interval.

Finally, reflectance measurements were carried out on each of the grain mounts. A total of 65 points were measured on the two types of vitrinite in each interval and the maximum reflectance recorded for each point. The procedure and instrumentation (Schapiro and Gray, 1960; Harrison et. al. 1964) are essentially that used in several principal coal petrological laboratories in North America.

PETROGRAPHY OF THE CHAMBERLAIN SEAM (SAMPLE WC-44)

The petrographic data obtained on the Chamberlain seam are shown graphically on Figure 2 and are also presented in Tables III and IV. On Figure 2 the maceral and microlithotype distributions by intervals are shown in percentage diagrams with a seam total plotted as a separate percentage bar at the base of each drawing. The seam profile represents a summary of the vertical microlithotype distribution. The microlithotypes vitrite and vitrinertite V may be considered bright coal components while vitrinertite I, inertite and impure coal are referred to as dull coal.

TABLE III

MICROLITHOTYPE DISTRIBUTION IN THE CHAMBERLAIN SEAM

(Data in volume percent)

INTERVAL	HEIGHT	VITRITE	VITRINERTITE V	VITRINERTITE I	INERTITE	IMPURE COAL
VII	37"	13	67	17	3	-
VI	6"	56	41	-	3	-
V	9"	10	59	22	7	2
IV	11"	10	86	4	-	-
III	6"	9	62	27	-	2
II	20"	18	77	4	1	-
I	8.5"	60	36	4	-	-
Seam Total	97.5"	20	66	12	2	-

The seam total for microlithotypes indicates that the bright coal components amount to 86%, and the dull coal to 14%. Vitrinertite V is the predominant component at 66%, with vitrite amounting to 20%, vitrinertite I at 12%, and the inertite (fusite, etc.) at 2%.

The highest vitrinertite I concentration is shown in intervals III and V, with the latter being highest for inertite also. The paucity of inorganic components reflects the clean character of the seam, with only 2% impure coal noted in the above-mentioned intervals III and V (shown in horizontal hatching on the extreme right of the microlithotype profile in Figure 2).

In the maceral percentage diagram the distribution pattern conforms to that of the microlithotypes. Here the seam aggregate amounts to 66% for (total) vitrinites, 6% semi-inertinites, 27% inertinites, and 1% mineral matter (see Table IV).

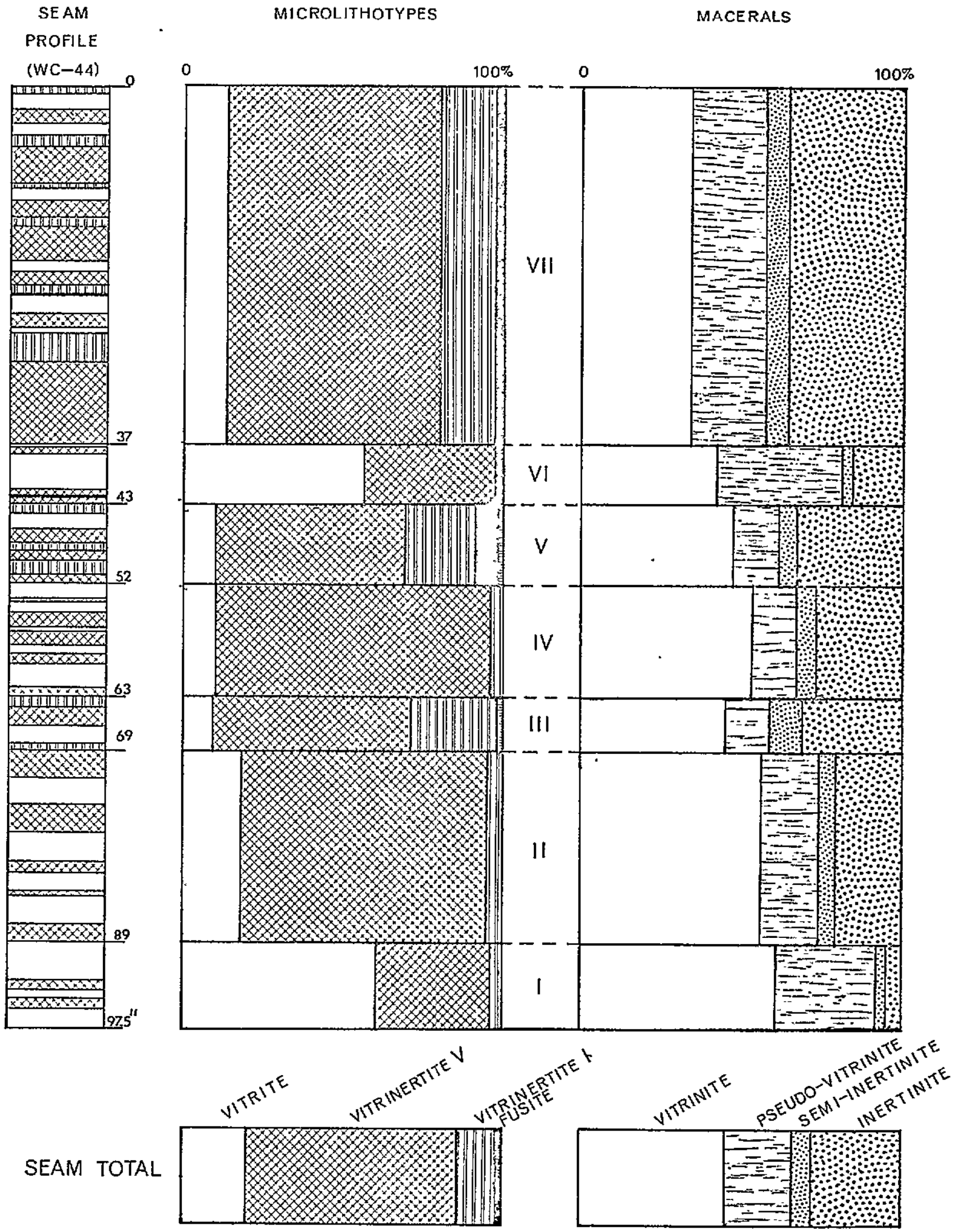

Figure 2. PETROGRAPHIC COMPOSITION OF THE CHAMBERLAIN SEAM

TABLE IV
MACERAL DISTRIBUTION
IN THE
CHAMBERLAIN SEAM

(Data in volume percent)

INTERVAL	HEIGHT IN INCHES	REFLECTANCE % RO	Vitrinites			Semi-inertinites (Low Reflectance)				Inertinites (High Reflectance)						Mineral Matter	TOTAL
			NORMAL	PSEUDOVITRINITE	SUBTOTAL	SEMIFUSINITE	MACRINITE	INERTODETRINITE	SUBTOTAL	SEMIFUSINITE	FUSINITE	MICRINITE	MACRINITE	INERTODETRINITE	SUBTOTAL		
VII	37	1.37	34	23	57	2	4	1	7	4	12	4	2	13	35	1	100
VI	6	1.39	42	39	81	2	1	-	3	2	6	1	1	5	15	1	100
V	9	1.34	47	14	61	3	2	1	6	3	12	3	1	12	31	2	100
IV	11	1.39	53	14	67	3	2	1	6	2	9	4	-	11	26	1	100
III	6	1.30	45	14	59	5	3	2	10	2	10	3	3	12	30	1	100
II	20	1.37	56	18	74	3	1	1	5	4	7	2	2	5	20	1	100
I	8.5	1.38	61	31	92	1	1	1	3	1	1	1	-	2	5	-	100
Seam Total	97.5	1.37	45	21	66	3	2	1	6	3	9	3	2	10	27	1	100

Interval I with 92%, and interval VI with 81% (total) vitrinite are well above the seam average and the two brightest in the column. The pseudovitrinite is also highest in these two intervals with 39% in interval VI and 31% in interval I. The remaining intervals range from 14 to 23% in pseudovitrinite.

The inertinite content is only 5% in interval I, the brightest, and 15% in interval VI. The other intervals range between 20 and 35% which is comparable to the seam average of 27%. Visible mineral impurities mainly quartz and calcite are dispersed through the column and reach a high of only 2% in interval V. Some finely disseminated specular pyrite was noted in intervals I and VII, and some pyritized fusite cells in intervals II and IV. The low mineral matter content of 1% in the seam average indicates a very clean coal although inherent mineral matter, that is mineral matter organically combined with the coal, which is not noticeable microscopically will increase the ash content to some extent.

Although a high content of the maceral vitrinite is often expressed by a high content of the microlithotype vitrite the relationship is by no means clear cut and points up one of the purposes of a microlithotype analysis in that it provides information on the placement of macerals or the texture of the coal. For example intervals I and VI with high (total) vitrinite contents also have the highest vitrite contents but interval II with a (total) vitrinite content of 74% as compared to 81% for interval VI has a vitrite content of only 18% as compared to 56% for interval VI. This suggests that in interval II the vitrinite occurs predominantly as a groundmass and not in distinct bands. Such textural differences play a part in the breaking properties of a coal and also can affect the petrography of screen fractions.

RESULTS OF CHEMICAL ANALYSES

A proximate analysis was carried out on each of the seven intervals of the Chamberlain seam and these chemical data were provided by Mr. W.J. Montgomery, Fuels Research Centre, Mines Branch, Ottawa. The results of the analysis are given in Table V.

TABLE V

PROXIMATE ANALYSIS (AS RECEIVED) OF THE CHAMBERLAIN SEAM

(Data in weight percent)

Interval	Height (in inches)	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur
VII	37	0.69	24.58	70.72	4.02	0.60
VI	6	0.55	23.02	69.11	7.32	0.43
V	9	0.55	22.63	70.34	6.48	0.53
IV	11	0.66	23.24	69.34	6.76	0.43
III	6	0.62	24.41	70.01	4.96	0.45
II	20	0.53	23.22	71.24	5.01	0.43
I	8.5	0.66	22.33	73.50	3.51	0.48
SEAM COMPOSITE*	97.5	0.63	23.67	70.74	4.98	0.51

*calculated

There is some variation shown in the ash content between the intervals. This ranges from a low of 3.5% in interval I and 7.3% in interval VI. The higher ash contents occur in intervals IV, V, and VI, encompassing 26 inches of coal, which is approximately in the middle of the seam. The microscopic study has shown that quartz, calcite and pyrite are the prime inorganic constituents noted in the seam. From a coking stand point the overall ash and sulphur contents appear to be most favourable.

In a given coal the inertinite macerals are thought to have a higher carbon content than the accompanying vitrinite although this gap narrows as the rank of coal increases.

Calculations on a mineral-matter-free basis for fixed carbon in the intervals of the Chamberlain seam show a slight variation from 74.6 to 77.0%, and on an ash-free basis the inertinites range from 4% to 31%. There is no evident correlation between the fixed carbon content and the inertinite constituents of the coal. These type of correlations are difficult to establish by a normal proximate analysis because such an analysis treats the coal as a single substance and not as a composite of various constituents with different physical and chemical compositions. These differences in the organic composition and rank of coal are more clearly indicated by a petrographic evaluation.

RANK DETERMINATIONS AND CALCULATED COKE STABILITIES

Reflectance measurements on coals are used in two ways: as an alternative to the chemical method in designating rank and as a necessary parameter in the calculation of coke quality from petrographic data. The vitrinite component is the best suited for reflectance measurement since it is usually the most abundant maceral and exhibits continuous rank changes. These changes in rank or metamorphism display corresponding reflectance levels and as the rank of the coal increases the reflectance increases. The minute differences in reflectivity can be measured by using a photocell and amplification system attached to a microscope. Maceral reflectance variations have been shown by Stach and Michels (1955), and the relationship between reflectance and volatile matter content has been demonstrated on a large number of coals by Kotter (1960). Standardized reflectance equipment and methods for using reflectance and maceral data for coke strength calculations have been discussed in several publications by Schapiro and Gray (1960); Schapiro, Gray and Eusner (1961); Jackman and Simon (1964); Benedict, Thompson and Wenger (1968).

On the basis of reflectance measurements the vitrinite can be subdivided into a number of entities designated as V types. Such entities are identified by number as V 10, V 11, etc. and the number is indicative of the range in reflectance covered, e.g. V 11 had a reflectance of 1.10 to 1.19 percent. Reflectance data are reported on in two ways, as percentages of the V types and as a mean maximum reflectance calculated from all the measurements made on a particular coal. From two to five V types are usually present in a coal and the quantity of each is determined for calculating the coke stability factor for the coal according to the method of Schapiro et. al. (1961). The reflectance data for WC-44 are presented in Tables VI and VII and in Figure 3.

In the seven intervals of the seam the mean maximum reflectance ranged from 1.30 to 1.39 percent (see Table VII). Although variations between intervals are not great such differences as between intervals III and IV are probably real. Reproducibility in the method of measuring is ± 0.02 percent. The average reflectance (Av.Ro) for the seam is 1.37 percent, a value indicative of a medium volatile coal. The better coking coals occur in the reflectance range of 1.0 to 1.7 percent.

In order to calculate the coke stability factor by the method of Schapiro et. al. 1961, it is necessary by microscopic examination of the coal to acquire rank data by reflectance in terms of the V types present and their amounts, along with the maceral compositional data. The maceral entities are subdivided into the reactives, semi-inerts, and inerts on the basis of their thermal behaviour. Vitrinite forms the bulk of the reactives which soften and resolidify during the carbonization process. The reactives also include 1/3 of the semi-inertinites plus 1/3 of the high reflectance semifusinite. The inerts include 2/3 of the semi-inertinites and high reflectance semifusinite plus all of the other high reflectance inertinites. Mineral matter calculated from the ash and sulphur contents and reduced to the volume percent basis is also included in the inerts. In the method of Schapiro and his colleagues the total vitrinite is considered as reactive and pseudo-vitrinite is not separately identified.

The theory concerning the roles of reactives and inerts in the coking process is analagous to that of gravel and cement in the making of concrete. The particles of inert material are cemented in a bond provided by the more fluid reactives. Experiments have shown that to provide a maximum strength coke from a given coal it is necessary to have an optimum amount of reactives to inerts. This ratio varies with the rank of the coal and therefore precise rank data of V types and reflectances are required.

The raw data for the calculation procedure on each interval of WC-44 and on the total sample are given in Table VI, while Table VII shows the relevant indices developed in the calculation as well as the calculated stabilities. A sample calculation showing the procedure followed is given in Appendix I.

In Table VI the predominant vitrinite types are V 12, V 13 and V 14 which are indicative of a medium volatile coal. The distribution of reactives (67.7%) to inerts (32.3%) along with the low mineral matter content suggest very favourable carbonization characteristics for this coal. The calculated stability of 59 for the whole coal supports this view. Although there is considerable variation among the intervals as regards the inert content (see Table VI) the calculated stabilities all remain fairly high (above 50). It may be noted however that the lowest stabilities are associated with those intervals which have the highest inert content, namely III and VII. Also it may be noted that intervals I, II and VI show some variation in the ratio of reactives to inerts yet their calculated stabilities are roughly similar. Such observations are in line with data on actual cokes obtained by Schapiro et. al. (1961) and Benedict et. al. (1968) which indicate that coals of a rank such as the Chamberlain seam can tolerate fairly wide variations in the inert content without unduly depressing the calculated and presumably the actual stabilities. In contrast lower rank coals such as high volatile A with similar variations in the reactives-inerts ratio would fluctuate widely in terms of stability and stability factors obtained would be lower than those for the Chamberlain Seam.

It may be noted that although higher in inert content the Chamberlain seam compares quite well with the Sewell and the Pocahontas No. 3 seams in the United States according to published data. The comparison is shown in Table VIII.

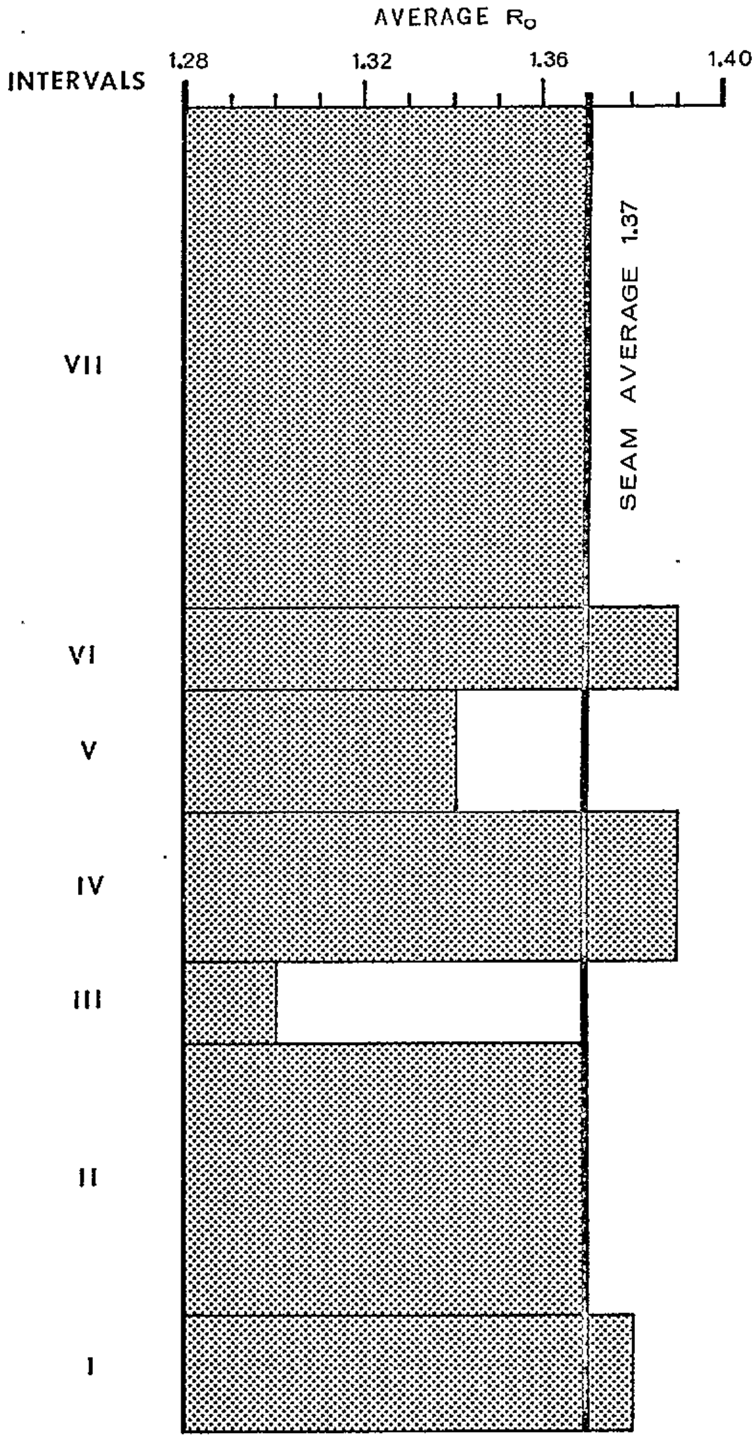

Figure 3. MEAN MAXIMUM REFLECTANCE FOR INTERVALS IN THE CHAMBERLAIN SEAM.

TABLE VI

PETROGRAPHIC AND COKE STABILITY DATA FOR THE CHAMBERLAIN SEAM

	REACTIVES (volume %)						INERTS (volume %)			
Intervals	V 11	V 12	V 13	V 14	V 15	Total	Semi-Inert*	Inert	Mineral Matter**	Total
VII		7.2	34.1	18.6		59.9	7.2	30.6	2.3	40.1
VI		6.4	39.2	34.5		80.1	3.2	12.6	4.1	19.9
V	1.9	23.3	32.7	5.0		62.9	5.9	27.5	3.7	37.1
IV		2.0	36.6	29.1		67.7	5.2	23.3	3.8	32.3
III		35.3	24.7	1.9		61.9	7.9	27.4	2.8	38.1
II		12.9	47.6	13.6	1.5	75.6	5.9	15.7	2.8	24.4
I		9.1	46.6	33.0	2.7	91.4	2.6	4.0	2.0	8.6
Seam Average	0.1	11.3	37.5	18.3	0.5	67.7	5.9	23.6	2.8	32.3

*1/3 of semi-inerts is applied to reactives; 2/3 to the inerts

**mineral matter calculated according to Parr's formula and reduced to volume percent basis.

TABLE VII

REFLECTANCE, VOLATILE MATTER, AND CALCULATED COKING INDICES

INTERVAL	MEAN MAXIMUM Ro	VOLATILE MATTER*	COMPOSITION BALANCE INDEX**	STRENGTH INDEX***	CALCULATED STABILITY INDEX
VII	1.37	22	2.79	5.76	53
VI	1.39	22	1.08	6.29	65+
V	1.34	24	2.16	5.30	54
IV	1.39	22	2.10	6.19	60
III	1.30	24	2.17	5.04	52
II	1.37	22	1.30	5.92	65
I	1.38	22	.40	6.13	65+
Seam Average	1.37	22	1.95	5.87	59

* Volatile matter determined from reflectance according to diagram by Kötter, 1960

TABLE VIII

COMPARISON OF CHAMBERLAIN SEAM DATA

WITH DATA* FOR TWO UNITED STATES COALS

	Petrographic Data		Chemical Data				Coke Indices		
	Reactives	Inerts	VM	FC	Ash	S	Str.Ind.	Comp. Bal.Ind.	Calc. Stab.
1	76.4	23.6	28.3	69.6	2.1	0.59	4.41	1.07	61
2	67.7	32.3	22.0	70.6	4.98	0.51	5.87	1.95	59
3	81.6	18.4	17.6	77.2	5.2	0.47	6.89	2.70	58

1 Sewell

2 Chamberlain

3 Pocahontas No. 3

*data on U.S. Coals from Schapiro et. al., 1961.

In 1968 Benedict and his colleagues at Bethlehem Steel dealt with the problem of correlating coke quality and coal petrography in two separate papers. Their approach differs from that of Schapiro and his co-workers in that they consider a portion of the vitrinite to be inert. In their microscopic analysis of coal they separate vitrinite into two categories namely normal vitrinite and pseudovitrinite. Actual examination of cokes plus information from other studies have led them to conclude that the pseudovitrinite is at least partially inert. Pseudovitrinite has a higher reflectance than normal vitrinite, it occurs in relatively large, pure masses often with distinctive cracks and serrated edges. In their reflectance measurements the Bethlehem group determine values separately for the normal vitrinite and the pseudovitrinite. In their method for calculating coke stability they assign all the normal vitrinite to the reactives along with 1/3 of the semi-inerts. The pseudovitrinite is in part assigned to the reactives and in part to the inerts; the proportions assigned depending on the rank of the coal and the difference between the mean maximum reflectance of the normal vitrinite and that of the pseudovitrinite. The greater is this difference the higher the percentage of pseudovitrinite assigned to the inerts. The rank of the coal is determined by the reflectance of the normal vitrinite only. V types are not determined and only the mean maximum reflectance values are used.

The result of such a manipulation of data is that in a coal with a fairly high percentage of pseudovitrinite the calculated stability is generally below that which would be obtained by Schapiro's method. Benedict and his colleagues claim that this is more in line with strength data obtained on actual cokes. There are difficulties in the method however. Pseudovitrinite in some of its optical properties overlaps normal vitrinite and its quantity is difficult to determine accurately without considerable experience. Also the appropriate curves and tables have not been well established for inert contents of greater than 40-45% nor have they been well established for the medium volatile coals (to which the Chamberlain seam belongs).

However, because the Chamberlain seam appeared to contain significant amounts of pseudovitrinite it was decided to determine the quantities of this material present and to determine separately reflectances on it and on the normal vitrinite. With this information in hand stability calculations were carried out according to the Bethlehem method on the individual intervals and on the whole coal basis. The results when compared with the calculations by Schapiro's method are shown in Table IX. They indicate a drop in the calculated stabilities of 2 to 15 points. The greatest discrepancy of 15 is found for interval VI.

TABLE IV IX

COMPARISON OF CALCULATED STABILITY FACTORS

DETERMINED BY TWO METHODS

Interval	Benedict et. al. (1968)	Schapiro et. al. (1961)
VII	50	53
VI	50	65+
V	45	54
IV	54	60
III	50	52
II	57	65
I	59	65+
Av. for whole seam	54	59

This interval has the highest content of pseudovitrinite (see Table IV). The stabilities for the whole seam on the other hand compare fairly well with the Bethlehem method giving approximately 54 as compared to 59 for Schapiro's method.

The results obtained by the Bethlehem method must at this time be considered as approximations only for the reasons cited above. However, on the basis of their experimentation Benedict and his colleagues probably have good grounds for developing their ideas on the inert property of pseudovitrinite. They are confident enough to define the coking behaviour of this constituent with a fair degree of precision for high volatile and low volatile coals of moderate inert content (less than 40% including varying amounts of pseudovitrinite). The petrographic examination of coal has proved to be a useful guide in the evaluation of its coking properties. In this regard it is useful to have knowledge of the petrographic variation that occurs vertically across the thickness of a esam. It is also useful to have knowledge of the petrographic variations obtaining in the screen fractions of a given coal. From such knowledge the placement or concentration of petrographic components can be manipulated and this information can be useful in improving coke quality. The evaluation of a coal by petrographic examination could minimize expensive carbonization tests or provide information where carbonization tests are impossible as in the case of small samples from bore-holes.

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APPENDIX I

CALCULATION OF COKE STABILITY FOR CHAMBERLAIN SEAM, SAMPLE WC-44

1. Maceral Composition; mineral-free basis: (see Table VI)

Vitrinite	Semireactives*	Inerts*	
66.7	9.1	24.2	= 100%

2. Mineral Matter by volume; determined from chemical analysis

$$\frac{(1.08 \times \text{ash})+(0.55 \times \text{sulphur})}{2} = \frac{(1.08 \times 4.98)+(0.55 \times 0.51)}{2} = 2.8$$

3. Recalculation of seam composition including mineral matter.

Vitrinite	Semireactives	Inerts	Mineral Matter	
64.8	8.8	23.6	2.8	=100%

4. Division into reactives and inerts

Reactives = Vitrinite 1/3 Semireactives

64.8 2.9 = 67.7

Inerts = 2/3 Semireactives Inerts Mineral Matter

5.9 23.6 2.8 = 32.3

5. Breakdown of reactives by V types based on reflectance data

V 11	V 12	V 13	V 14	V 15	
.19	11.29	37.50	18.29	.45	= 67.7

6. Calculation of Composition Balance Index

	V 11	V 12	V 13	V 14	V 15	Total
Reactives by V types	.19	11.29	37.50	18.29	.45	67.7
Optimum ratio of reactives** to inerts	2.7	3.2	4.0	5.2	7.0	

Optimum inerts for WC 30

$$= \frac{.19}{2.7} + \frac{11.29}{3.2} + \frac{37.50}{4.0} + \frac{18.29}{5.2} + \frac{.45}{7.0} = 16.56$$

$$\text{Comp. Bal. Index} = \frac{\text{Total Inerts in Coal}}{\text{Optimum Inerts for coal}} = \frac{32.3}{16.56} = 1.95$$

* Semireactives include all semi-inertinites plus the semifusinite from the inertinite category (Table IV).

** Data obtained from tables; those used were prepared by Bituminous Coal Research.

7. Calculation of Strength Index of Coal

	V 11	V 12	V 13	V 14	V 15	Total
Reactives by V types	.19	11.29	37.50	18.29	.45	67.7
Strength Index of V types**	4.39	4.66	5.78	6.79	6.95	

Total Str. Index for reactives in WC 30 =

$$(.19 \times 4.39) + (11.29 \times 4.66) + (37.50 \times 5.78) + (18.29 \times 6.79) + (.45 \times 6.94) = 397.50$$

$$\text{Strength index of coal} = \frac{\text{Total Strength index of Reactives}}{\text{Total Reactives}}$$

$$= \frac{397.50}{67.7} = 5.87$$

8. Using Composition Balance Index (1.95) and Strength Index (5.87), predicted stability of 59 is obtained from tables.**

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APPENDIX E

SURFACE & SUBSURFACE EXPOSURE DATA

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APPENDIX E

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GEOLOGICAL BRANCH
ASSESSMENT REPORT

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APPENDIX E

SURFACE AND SUB-SURFACE EXPOSURE DATA

APPENDIX E

LIST OF CONTENTS

APPENDIX E

1. Introduction

The contents of this appendix refer to the outcrop stripping programme and underground mapping carried out in Adits Nos. 1 to 5, during the 1971 field season.

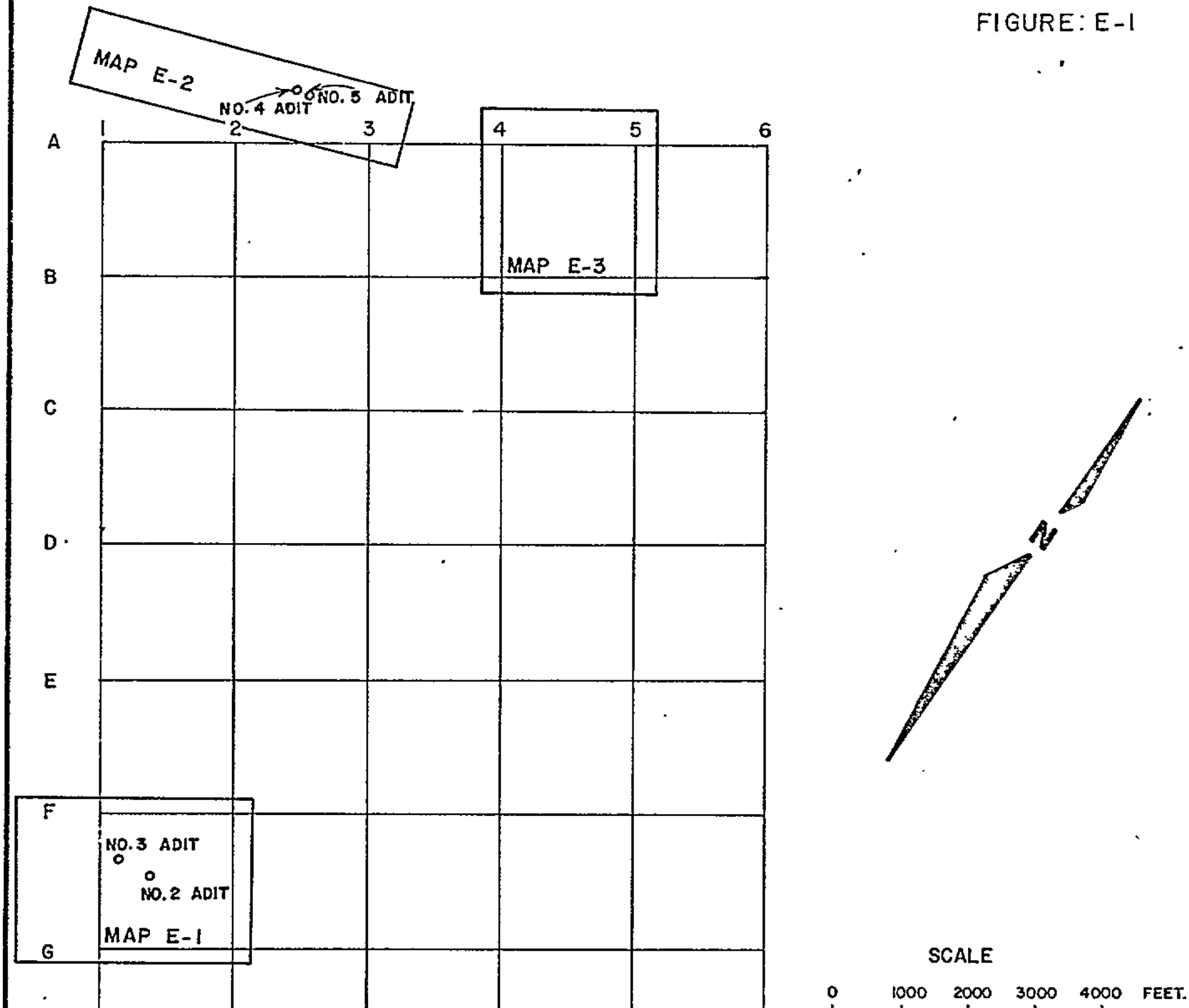
1.1 Outcrop Stripping

Outcrop stripping was completed on the north salient of Plates 1 and 3 and on the north and south sides of Chamberlain Creek adjacent to Adits 1, 2 and 3 in Plate 2.

Refer to Figure E-1 and Maps E-1 to E-3 and the following notes for details of the exposures produced as a result of the stripping programme.

Listed hereunder are the footages exposed in the various localities.

LOCALITY	FULLY EXPOSED	INTERMITTENTLY EXPOSED	TOTAL
Plate 2 - (Chamberlain Ck.) (Map E-1)			
Chamberlain & Skeeter Seams. (The two seams are basically coincident, due to the steep topography).	5400	1600	7000
Plate 2 - (North Outcrop) (Map E-2)			
Chamberlain Seam.	3300	900	4200
Skeeter Seam.	1700	200	1900
Plate 3 (Map E-3)			
Chamberlain Seam.	1300	-	1300
Skeeter Seam.	450	-	450
TOTALS :	12150	2700	14850



Maps E-1 to E-3 show outcrop stripping details.

Figures E-2 to E-6 shows plans and sections of Adit Nos. 1 to 5

Refer to Appendix E text for details of Maps and Figures.

LOCALITY MAP OF OUTCROP OBSERVATIONS AND ADIT DATA

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1972.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

The outcrop stripping programme was designed to expose all accessible locations either by continuous side cuts or cross trenching by bulldozer.

The return of information from a 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 exposed in an otherwise unobtainable manner, 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, high control on the continuous sections, so displayed, has given valuable information on the overall geological structure.

1.2 Underground Data

Details regarding the 5 adits which have been driven in the project area are included in the following notes and accompanying Figures E-2 to E-6. A brief summary of the relevant facts are included hereunder. Analytical data referable to the adits are included in Appendix A.

Adit No. 1 - Driven by Brameda Resources Limited in 1970 for a total distance of 187 feet. It is approximately level for 140 feet when it rises at a grade of about 1 in 4 for the last 40 feet.

Adit No. 2 - Driven by Brameda Resources Limited in 1970 for a distance of 104 feet with approximately 8 feet cuts into each rib 20 feet from the final face of the adit. The adit was extended in 1971 by a distance of 25 feet into the original side cut in the right hand rib. From this extension a 30 ton bulk sample and a face sample were taken for washability tests.

Adit No. 3 - In 1970 Brameda Resources Limited completed Adit No. 3 having driven a distance of 52 feet. It was extended in 1971 by 18 feet in order to enable an unoxidised sample of coal to be taken.

After the collection of the face sample, 6 feet of the roof was dropped to allow inspection of the immediate roof rocks.

Adit No. 4 - Driven in 1971 on behalf of Coalition Mining Limited for a total distance of 76 feet. After face sampling a 30 ton bulk sample was taken for washability tests, the roof then being dropped for a distance of 9 feet above the seam to allow an inspection of the roof rocks.

Adit No. 5 - Driven in 1971 on behalf of Coalition Mining Limited for a total distance of 65 feet. After face sampling a 30 ton bulk sample was taken for washability evaluation. The top half of the seam was mined out of each rib for a distance of 10 feet by 6 feet; 4 feet of the roof rocks above the seam were taken to allow inspection.

2. OUTCROP OBSERVATIONS OF EXPOSED SEAMS

2.1 PLATE 2 - CHAMBERLAIN CREEK
(Refer Map E-1)

Location 1.1 (Ch.Sm.)

Roof:	Interbedded siltstone and claystone with 0.7' of claystone immediately above the coal; bedding strike 314°, dip 22.5°SW.
Jointing:	Strike 316°, dip 87°NE; strike 224°, dip 84°NW.
Floor:	0.7' claystone overlying massive sandstone; with a thin shear zone in claystone.
Coal:	Bright and dull.
Cleat in Coal:	Strike 330°, dip 89°NE; strike 318°, dip 39°SW; strike 286°, dip 77°SW.
Seam Thickness:	8.0', two minor claystone bands up to 0.2' thick.

Location 1.2 (Ch.Sm.)

Roof:	Interbedded siltstone and mudstone, bedding strike 313°, dip 20°SW.
Floor:	Massive sandstone.
Cleat in Coal:	Strike 281°, dip 83° to NE: strike 212°, dip 30°SE.
Seam Thickness:	12.0 ft.

Location 1.3 (Ch.Sm.)

Roof:	Interbedded siltstone and mudstone, bedding strike 025°, dip 13°NW.
Floor:	Massive sandstone.
Seam Thickness:	10.0 ft.

<u>Location 1.4</u> (Ch.Sm.)

Roof:	Interbedded siltstone and mudstone, bedding strike 292°, dip 22°S.
Jointing:	Strike 308°, dip 72°NE; strike 022°, dip 81°NW.
Floor:	Massive sandstone.
Coal:	Bright and dull.
Cleat in Coal:	Strike 343°, dip 68°NE.
Seam Thickness:	9.78', minor claystone bands as in 1.1 (above).

<u>Location 1.5</u> (Ch.Sm.)

Roof:	Siltstone and mudstone.
Floor:	Massive sandstone.
	The seam thickens to 15 feet at a minor thrust which dips at 30° to the NW.

<u>Location 1.6</u> (Ch.Sm.)

Roof:	Fine grained sandstone and mudstone, dip 6° to 165°.
Jointing:	Strike 147°, dip 87°SW; Strike 160°, dip 73°NE.
Floor:	Massive sandstone.
Coal:	Dull and Bright.
Seam Thickness:	9.0 feet, 0.35' band 0.4' from roof.

<u>Location 1.7</u> (Ch.Sm.)

Roof:	Mudstone.
Floor:	Mudstone.
Coal:	Bright with minor dull bands.
Seam Thickness:	9.0 feet, claystone band 0-0.15' thick.

Location 1.8 (Ch.Sm.)

Roof:	Sandstone and mudstone, bedding strike 010°, dip 11° to SE.
Floor:	Massive sandstone.
Seam Thickness:	Greater than 6.0 feet.

Location 1.9 (Sk.Sm.)

Roof:	Sandstone and mudstone.
Floor:	Coarse grained massive sandstone.
Seam Thickness:	6.0 feet.

Location 1.10 (Ch.Sm.)

Roof:	Thinly bedded mudstone, strike 124°, dip 11°N.
Floor:	No outcrop.
Coal:	Dull with bright bands, top 0.05' sheared.
Cleat in Coal:	Strong, strike 024°, dip 78°W; weak 320° subvertical.
Seam Thickness:	Greater than 6.0 feet.

Location 1.11 (Ch.Sm.)

Roof:	Mudstone with 1.0' of coaly stone at the base, strike 114°, dip 7°N.
Jointing:	Dip 9° to 280°.
Floor:	2.25' of mudstone overlying carbonaceous, quartz/lithic sandstone.
Coal:	Dull with bright bands.
Seam Thickness:	8.4 feet.

Location 1.12 (Ch.Sm.)

Roof:	Mudstone.
Floor:	Sandstone.
Coal:	Dull with bright bands.
Seam Thickness:	8.4 feet, 0.5' thick mudstone band 0.05' below the roof of the seam.

Location 1.13 (Ch.Sm.)

Roof: Mudstone, strike 050°, dip 10° to N.
Floor: Sandstone.
Coal: Hard, bright and banded.
Seam Thickness: Greater than 6.0 feet.

Location 1.14 (Ch.Sm.)

Roof: Mudstone with 0.62' of coaly stone at the base, dip 21° to 215°.
Floor: Medium grained, quartz/lithic sandstone.
Cleat in Coal: Strike 215°, dip 80°E.
Seam Thickness: 7.55 feet.

Location 1.15 (Ch.Sm.)

Roof: Mudstone with 0.60' of coaly stone at the base, dip 0°-2° to 010°.
Floor: Quartz/lithic sandstone with 0.08' mudstone at the top.
Coal: Dull with bright bands.
Seam Thickness: 9.44 feet, no bands.

Location 1.16 (Ch.Sm.)

Roof: Mudstone with 0.60' of coaly stone at the base, dip 42° to SE.
Floor: 2.0' mudstone overlying quartz/lithic, carbonaceous sandstone.
Coal: Dull with bright bands.
Seam Thickness: 9.05 feet, no bands.

Location 1.17 (Sk.Sm.)

Roof:	Medium grained, quartz/lithic sandstone overlying 20.0' of interbeds.
Jointing:	Strike 308°, dip 52°N; strike 112°, dip 46°N; strike 126°, dip 34°S.
Floor:	Mudstone.
Coal:	Dull and bright with mudstone bands of total thickness 2.17 feet.
Cleat in Coal:	Sub-vertical, strike 167°.
Seam Thickness:	6.5 feet.

Location 1.18 (Ch.Sm.)

Roof:	Flaggy, medium grained sandstone.
Floor:	No outcrop.
Coal:	Hard.
Seam Thickness:	9.7 feet with a stone band 0.3 foot thick.

Location 1.19 (Ch.Sm.)

Roof:	Strike 025°, dip 7° to N.
Floor:	No outcrop.
Seam Thickness:	Greater than 8.0 feet.

Location 1.20 (Ch.Sm.)

Roof:	Mudstone, strike 195°, dip 12°W.
Floor:	Sandstone.
Coal:	Dull with bright bands.
Cleat in Coal:	Strike 190°, dip 85°W.
Seam Thickness:	10.17 feet, no bands.

2.2 PLATE 2 - NORTH SALIENT

(Refer Map E-2)

Location 2.1 (Ch.Sm.)

Roof:	Poorly bedded siltstone overlying 0.63' of claystone.
Jointing in siltstone:	Strike 328°, dip 84° to SW; strike 257°, dip 72° to N; strike 67°, dip 64° to NW.
Floor:	Sandstone, carbonaceous, bedding strike 112°, dip 4°NE.
Coal:	Sheared zone in the claystone above the coal.
Cleat in Coal:	Strike 132°, dip 49° to SW, closely spaced; strike 155°, dip 87° to SW, widely spaced; strike 129°, dip 8° to SW, closely spaced.
Seam Thickness:	5.73 feet, no bands.

Location 2.2 (Ch.Sm.)

Roof:	Siltstone overlying 1.24' of claystone (0.97' of claystone is sheared).
Floor:	Sandstone, carbonaceous.
Cleat in Coal:	Strike 171°, dip 45° to NE, widely spaced; strike 337°, dip 60° to SW, closely spaced; strike 206°, dip 40° to SE, closely spaced; strike 232°, dip 89° to NW, closely spaced; strike 242°, dip 72° to N, closely spaced.
Seam Thickness:	6.68 feet, no bands.

Location 2.3 (Ch.Sm.)

Roof:	Siltstone, strike 170°, dip 12°NE.

Location 2.4 (Sk.Sm.)

Roof:	Sandstone/siltstone, dip 5^{o} to 183^{o}.
Floor:	Siltstone/claystone.
Seam Thickness:	9.59 feet, 1.12' thick brown claystone band 5.43' below the roof of the seam. Sheared zone 0.2' to 0.3' thick at the base of the upper split.
Cleat in Coal:	Strike 186^{o}, dip 58.5^{o}W, widely spaced; strike 215^{o}, dip 34^{o}SE, closely spaced.

Location 2.5 (Sk.Sm.)

Roof:	Sandstone/siltstone.
Floor:	Mudstone.
Coal:	Dull with bright bands.
Seam Thickness:	10.0 feet, 1.0' thick claystone band 2.8' above the floor of the seam, weakly sheared zone in the top 1.5' of the upper split.

Location 2.6 (Ch.Sm.)

Roof:	No outcrop.
Floor:	Sandstone, strike 200^{o}, dip 7^{o}NW.

Location 2.7 (Ch.Sm.)

Roof:	Sandstone/siltstone.
Floor:	Mudstone.
Coal:	Dull with bright bands.
Seam Thickness:	8.8 feet, 0.7' thick claystone band 2.5' above the floor of the seam.

Location 2.8 (Ch.Sm.)

Roof: Poorly bedded, grey siltstone, dip 24°S.

Floor: Not exposed. 0.87' to 0.5' of sheared coal at the top of the seam.

Cleat in Coal: Strike 246°, dip 38°SE.

Jointing in Siltstone: Strike 105°, dip 85° to NE, strike 217°, dip 76°NW.

Location 2.9 (Ch.Sm.)

Roof: Sandstone/siltstone, bedding strike 240°, dip 15°S.

Floor: Not exposed. 0.68' thick claystone band 7.85' below the top of the coal seam.

Jointing in Sandstone: Strike 158°, dip 86°N; strike 93°, dip 68°N; strike 105°, dip 75°N.

Cleat in Coal: Strike 003°, dip 51°W, widely spaced; strike 147°, dip 70°SW, closely spaced; strike 190°, dip 51°SE, widely spaced.

Location 2.10 (Ch.Sm.)

Roof: Siltstone/mudstone laminite.

Floor: Quartz/lithic sandstone, medium grained, carbonaceous, bedding strike 340°, dip 23°W.

Coal: Dull with bright bands.

Seam Thickness: 6.85 feet, no bands.

Location 2.11 (Ch.Sm.)

Roof: No outcrop.

Floor: Sandstone, strike 324°, dip 19°SW.

Location 2.12 (Ch.Sm.)

Roof:	Siltstone/mudstone laminite, bedding strike 125°, dip 14°SW.
Floor:	Quartz/lithic sandstone, medium grained, carbonaceous, bedding strike 264°, dip 2°N.
Coal:	Bright and dull.
Seam Thickness:	6.1 feet, no bands.

Location 2.13 (Ch.Sm.)

Roof:	Siltstone/mudstone, bedding strike 230°, dip 14°NW.
Floor:	Not exposed.

Location 2.14 (Sk.Sm.)

Roof:	Sandstone.
Floor:	Mudstone.
Coal:	Dull with bright bands, mudstone bands.
Seam Thickness:	9.5 feet.

2.3 PLATE 3

(Refer Map E-3)

Location 3.1 (Ch.Sm.)

Roof:	No outcrop.
Floor:	Medium grained, quartz/lithic sandstone, carbonaceous.
Coal:	Dull with bright bands.
Seam Thickness:	7.45 feet, no bands.

Location 3.2 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 272^o, dip 16^{o}S.

Floor: Medium grained, quartz/lithic sandstone, carbonaceous.

Coal: Dull with bright bands, top 1.75' of seam sheared.

Seam Thickness: 7.25 feet, no bands.

Location 3.3 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 243^o, dip 19^{o}SE.

Floor: Quartz/lithic sandstone, carbonaceous.

Coal: Dull with bright bands, soft.

Seam Thickness: 8.7 feet, no bands.

Location 3.4 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, overall dip 12^{o}S.

Floor: Quartz/lithic sandstone, carbonaceous.

Coal: Dull with bright bands, hard.

Seam Thickness: 6.35 feet, no bands.

Location 3.5 (Ch.Sm.)

Roof: Siltstone/mudstone laminite.

Floor: Quartz/lithic sandstone, carbonaceous.

Coal: Dull with bright bands, hard.

Seam Thickness: 7.15 feet, no bands. Shear zone extends 2.2 feet into the seam from the roof.

Location 3.6 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 170°, dip 13°SW.
Floor: Quartz/lithic sandstone, carbonaceous.
Coal: Dull with bright bands, very hard.
Seam Thickness: 7.6 feet, no bands.

Location 3.7 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 254°, dip 12.5°S.
Floor: Quartz/lithic sandstone, carbonaceous.
Coal: Dull with bright bands, hard.
Seam Thickness: 7.25 feet, no bands. Shear zone extends 0.5' into the seam from the roof.

Location 3.8 (Ch.Sm.)

Roof: Siltstone/mudstone laminite.
Floor: Quartz/lithic sandstone, carbonaceous.
Coal: Dull with bright bands, soft.
Seam Thickness: 7.85 feet, no bands.

Location 3.9 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 275°, dip 11°S.
Floor: Quartz/lithic sandstone, carbonaceous.
Coal: Dull with bright bands, soft.
Seam Thickness: 6.5 feet, no bands.

Location 3.10 (Ch.Sm.)

Roof: Siltstone/mudstone laminite, bedding strike 290°, dip 11.5°S.
Floor: Quartz/lithic sandstone, carbonaceous.
Coal: Dull with bright bands, soft.
Seam Thickness: 7.0 feet, no bands.

Location 3.11 (Ch.Sm.)

Roof:	Siltstone/mudstone laminite.
Floor:	Quartz/lithic sandstone, medium grained.
Coal:	Dull with bright bands.
Seam Thickness:	6.4 feet, no bands. Shear zone 1.1 feet thick in coal.

Location 3.12 (Ch.Sm.)

Roof:	Siltstone/mudstone laminite, bedding strike 266^{o} dip 9^{o}S.
Floor:	Quartz/lithic sandstone, medium grained.
Coal:	Dull with bright bands.
Seam Thickness:	6.6 feet, no bands.

Location 3.13 (Sk.Sm.)

Roof:	Iron stained, medium to fine grained quartz/lithic sandstone overlying 0.87 feet of sheared claystone, bedding strike 078^{o}, dip 8^{o}S.
Floor:	Dark grey carbonaceous mudstone.
Coal:	Dull and bright.
Seam Thickness:	5.75 feet, no bands.

Location 3.14 (Sk.Sm.)

Roof:	Iron stained, quartz/lithic sandstone overlying sheared claystone, bedding strike 067^{o}, dip 11^{o}S.
Floor:	Dark grey carbonaceous mudstone.
Coal:	Dull and bright.
Seam Thickness:	6.32 feet, claystone band (0.38 feet thick) 5.66 feet above the floor of the seam.

3.

UNDERGROUND DATA

3.1 ADIT NO. 1 - CHAMBERLAIN SEAM

(Refer to Figure E-2 reproduced from data supplied by Brameda Resources Limited)

Driven by Brameda Resources Limited for a distance of 187 feet, the grade being approximately level, except in the last 40 feet, after which it rises sharply.

The left hand rib of this adit is approximately parallel to the thrust plane of the Chamberlain Fault. In this rib, there is exposed, in part, the floor of the Chamberlain Seam where it has been overthrust above the coal.

The coal is greatly disturbed and distorted, being very soft and friable, and now having little inherent strength.

This adit is important in that it graphically illustrates conditions which may be expected on closely approaching any of the major thrust faults in the area. It is not possible to ascertain from Adit No. 1 what effect the minor faults may have on the coal seam, as the Chamberlain Fault is a major feature in the area.

3.2 ADIT NO. 2 - CHAMBERLAIN SEAM

(Refer Figure E-3)

Driven in 1970, a distance of 104 feet with 8 feet cuts into each rib, 20 feet from the face; cut into right hand rib extended by 25 feet in 1971.

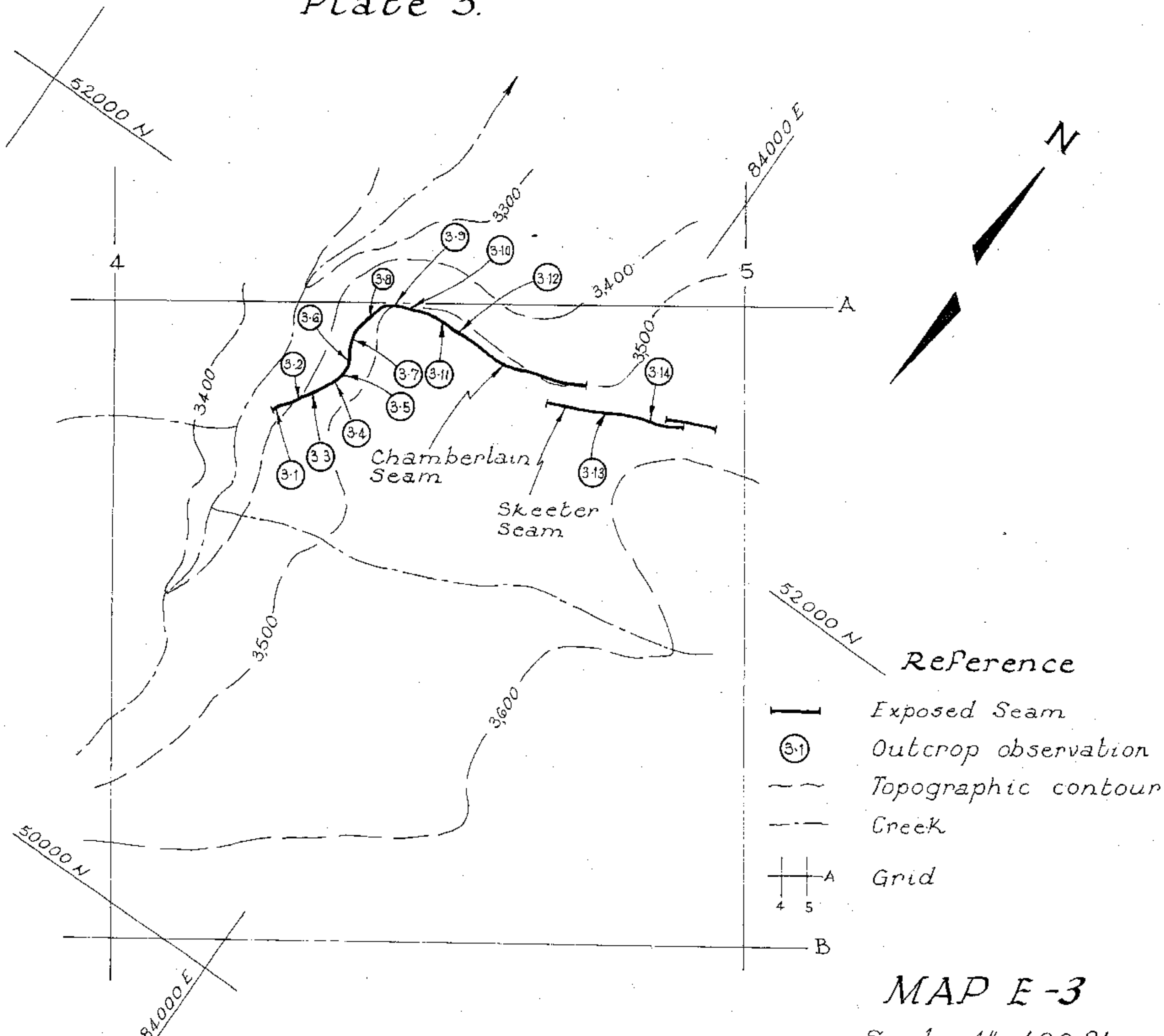
Roof: Claystone, dip 9.5^{o} to 045^{o}.

Seam Section:

0.50'	0.50	stone, coaly.
0.69	1.19	coal - dull with bright bands.
0.09	1.28	coal - bright.
0.70	1.98	coal - dull with bright bands.
0.08	2.06	coal - bright.
1.04	3.10	coal - dull with bright bands.
0.32	3.42	coal - bright.
0.12	3.54	coal - dull.
1.63	5.17	coal - dull and bright.
0.18	5.35	coal - dull.
0.40	5.75	coal - dull and bright.
0.58	6.33	coal - bright.
0.18	6.51	coal - dull banded.
1.72	8.23	coal - bright banded.
0.98	9.21	coal - bright banded.
0.08	9.29	mudstone.

Floor: Sandstone

SEAM OUTCROP
Plate 3.



MAP E-3

Scale: 1" = 400 ft

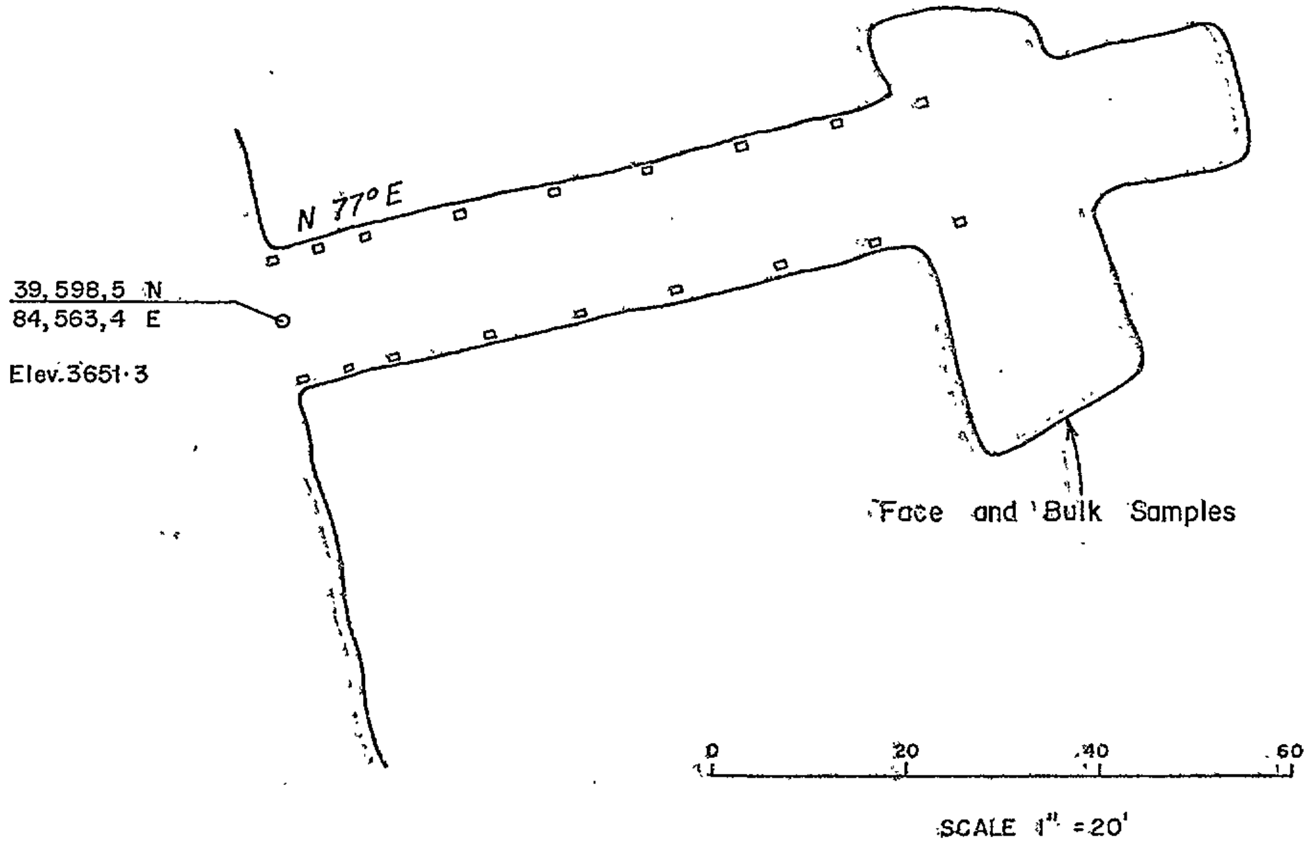
645

FIGURE: E-3

Note: 1. See Appendix A.
for analytical data -
Face Sample: A-9
Bulk Sample: A-13 & A-14·2

2. See Appendix E.
for seam sections.

Surveyed by R. E. Shields.



PLAN OF No. 2 ADIT (CHAMBERLAIN SEAM)

COALITION MINING LIMITED
SUKUNKA COAL PROJECT
February, 1972.

PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED

Cleat:- major 205^{o}, subvertical, spacing 0.01' vitrain bands and 0.03' in durain.

Joints in the stony coal parallel to cleat with spacing average 1.5 ft.

3.3 ADIT NO. 3 - SKEETER SEAM

(Refer Figure E-4)

Driven in 1970, for a distance of 52 feet and extended by 18 feet in 1971.

Roof: Mudstone, well bedded, dip 8^{o} to 056^{o}.

Seam Section 1:

0.5'	0.5'	coal - dull with bright bands, some shearing.
1.5	2.0	coal - bright.
0.85	2.85	coal - dull with bright bands, soft, sheared.
0.28	3.13	claystone - carbonaceous, coal bands.
0.30	3.43	coal - bright with dull bands, well cleated.
1.30	4.73	claystone.
1.48	6.21	coal - dull and bright.

Floor: Mudstone

Roof: Mudstone

Seam Section 2:

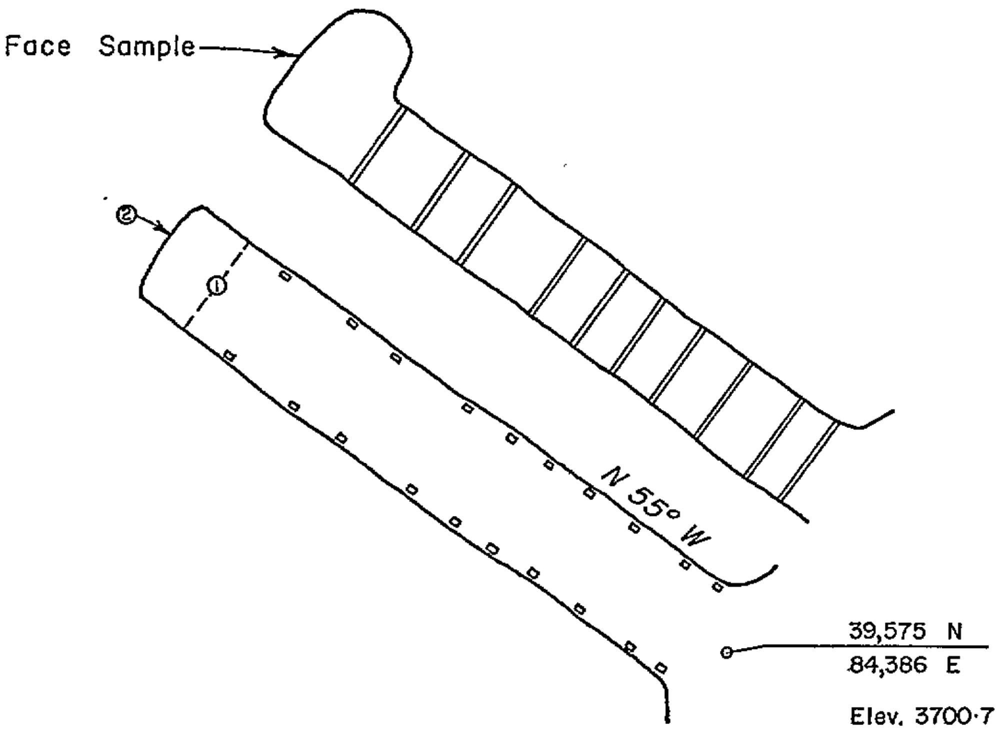
0.65'	0.65'	coal - bright, cleat moderately well developed - subvertical, 200^{o}.
1.40	2.05	coal - bright and dull, blocky and slightly sheared. Shearing strikes 039^{o} to 080^{o}, 068^{o} to 085^{o} cleat variable, subvertical 170^{o} and 075^{o}, up to 0.08' spacing.
0.06	2.11	mudstone - variable thickness across the face, up to 0.15' maximum.
0.08	2.19	coal - sheared.
0.20	2.39	coal - bright and dull, cleat well developed. Slight shearing, 035^{o} to 120^{o}.
0.20	2.59	mudstone - coaly wisps throughout, moderate shearing.

FIGURE: E-4

Note: 1. See Appendix A.
for analytical data-
Face Sample: A-10
Bulk Sample: A-13 & A-14·3

2. See Appendix E.
for seam sections at points ① & ②.

Surveyed by R.E. Shields.



0 20 40 60

SCALE 1" = 20'

PLAN AND SECTION OF No. 3 ADIT (SKEETER SEAM)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February, 1972.

PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED

0.40'	2.99'	coal - bright, cleat well developed and closely spaced (0.04' to 0.02') subvertical 000° to 060°.
1.40	4.39	siltstone - fine grained, massive, dip 5° to 020°.
0.85	5.24	coal - bright and dull, cleat moderately well developed - subvertical.
0.55	5.79	coal - bright, highly sheared, friable.

Floor: Mudstone, well bedded, hard, dip 7° to 040°.

3.4 ADIT NO. 4 - CHAMBERLAIN SEAM

(Refer Figure E-5)

Total distance 76 feet driven in 1971.

<u>Location 1</u>

Roof - mudstone, dip 4° to 110°.
Floor - sandstone, carbonaceous.
Coal - bright, no bands.
Cleats- strike 195°, 256°, subvertical.

<u>Location 2</u>

Cleats - strike 141°, dip 74.5°N; strike 57°, dip 42°N, widely spaced; strike 183°, dip 44°E.

<u>Location 3</u>

Roof: Mudstone - dip 8° to 140°.

Seam Section:

0.4'	0.75'	coal - sheared.
3.95'	4.70'	coal - bright and dull
1.36'	6.06'	coal - bright minor dull bands, slight shearing at the base.

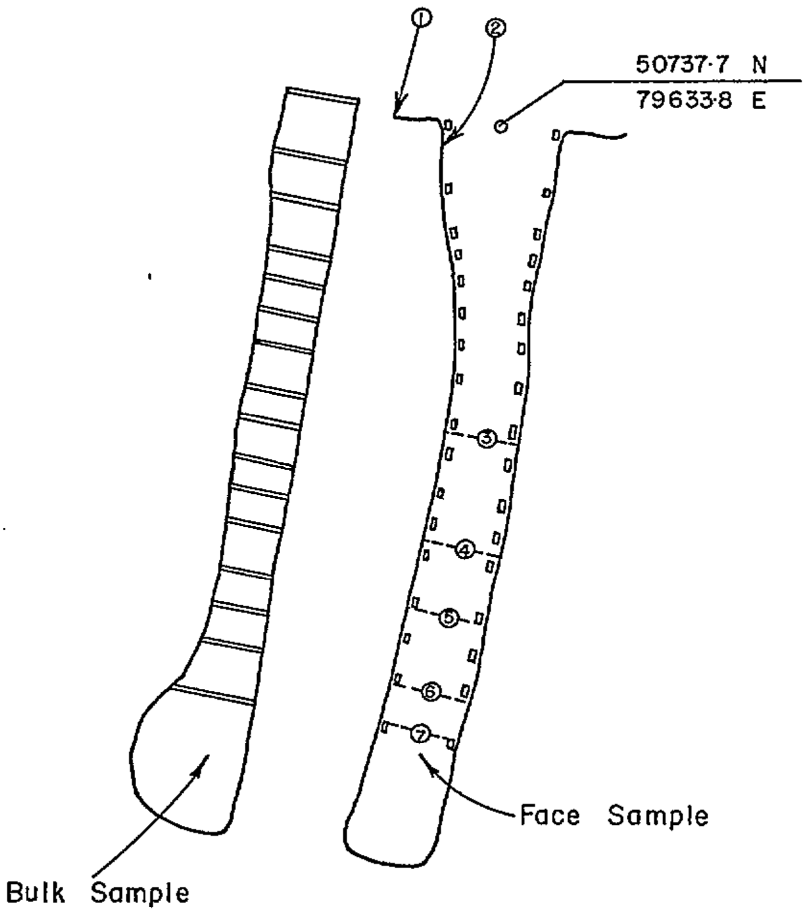
cleats - strike 133°, 253°, subvertical

FIGURE: E-5

Note: 1. See Appendix A.
for analytical data -
Face Sample: A-11
Bulk Sample: A-13

2. See Appendix E.
for seam sections at points ① to ⑦

Surveyed by R.E. Shields.



SCALE 1" = 20'

PLAN AND SECTION OF No. 4 ADIT (CHAMBERLAIN SEAM)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February, 1972

PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED

<u>Location 4</u>

Roof: Siltstone.

Seam Section:

0.7'	0.7'	coal - sheared, contains 0.1' to 0.2' of stone in the centre.
4.95'	565'	coal - bright and dull, no bands.

Cleats - Subvertical, strike 180° and 280°.

<u>Location 5</u>

Roof: Sandstone with 0.28' of mudstone at the base.

Seam Section:

0.4'	0.4'	coal - sheared.
5.5'	5.9'	coal - dull and bright, no bands.

<u>Location 6</u>

Roof: Sandstone with 0.40' - 0'45' of carbonaceous mudstone at the base.

Seam Section:

0.40'	0.40'	coal - slightly sheared, no bands.
5.10'	5.50'	coal - dull and bright, no bands.

Cleats - subvertical, strike 320°, 295°.

<u>Location 7</u>

Roof: Quartz/lithic sandstone with 0.42' of mudstone at base, dip 9° to 135°.

Seam Section:

0.25'	0.25'	stone, coaly.
0.25'	0.50'	coal - sheared.
2.25)	2.75'	coal - bright and dull
2.85)	5.60'	

Jointing in the roof - strike 007°, dip 71°NW; strike 270°, dip 72°N.

3.5 ADIT NO. 5 - SKEETER SEAM

(Refer Figure E-6)

Total distance 65 feet driven in 1971.

Location 1

Roof: Sandstone, dip 4° to 117°.

Seam Section:

6.4'	6.4'	coal - dull and bright, slight shearing in the top 0.5'.
0.3'	6.7'	mudstone - thickness varies 0.2'-0.5'.
2.25'	8.95'	coal - dull and bright.

Location 2

Cleats - strike 323°, dip 60°W; strike 225°, dip 20°SE.

Roof: Siltstone

Seam Section:

5.38'	5.38'	coal
0.14'	5.52'	claystone
0.94'	6.46'	coal
0.75'	7.21'	claystone

Floor: coal

Location 3

Roof: Sandstone, dip 12° to 300°.

Seam Section:

4.9'	4.9'	coal - dull and bright.
0.5'	5.4'	mudstone
1.0'	6.4'	coal - dull and bright.
0.55'	6.95'	mudstone.
3.4'	10.35'	coal - dull and bright.

The floor dips at 14° to 268°.

Location 4

Roof: Sandstone, dip 6^{o} to 260^{o}.

Seam Section:

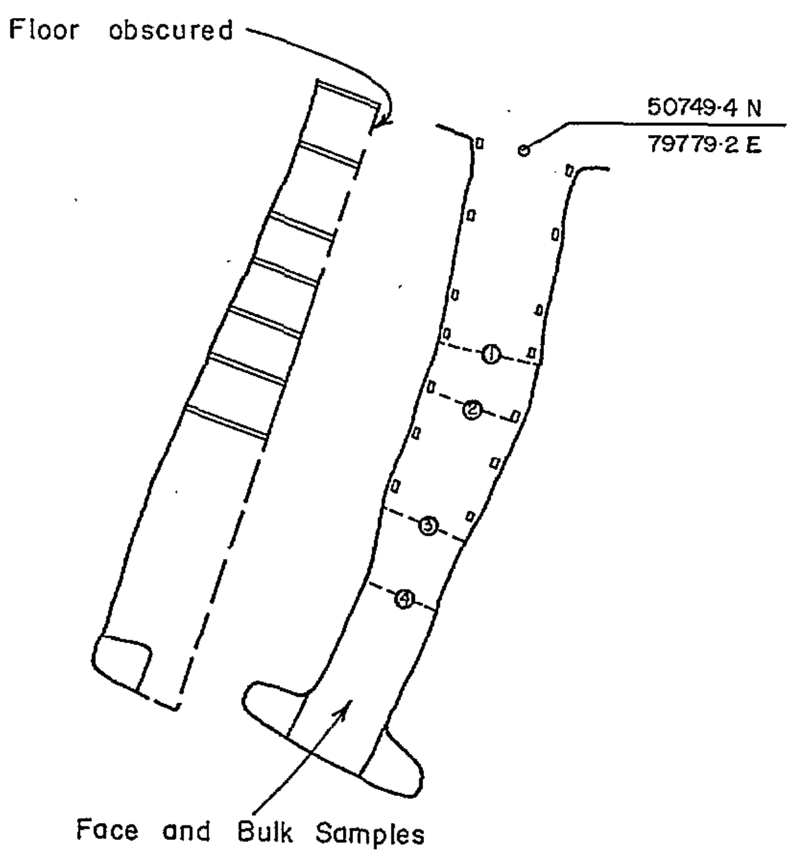
5.05'	5.05'	coal - dull and bright.
0.20'	5.25'	mudstone
1.0'	6.25'	coal - dull and bright.
0.05'	6.30'	mudstone.
0.35'	6.65'	coal - dull.
0.53'	7.10'	mudstone - variable thickness.
0.97'	8.15'	coal - dull and bright.
0.25'	8.40'	mudstone.
1.40'	9.80'	coal - dull and bright.

Floor: mudstone, dip 10^{o} to 260^{o}.

Note: 1. See Appendix A. for analytical data -
Face Sample: A-12
Bulk Sample: A-13

2. See Appendix E. for seam sections at points ① to ④

Surveyed by R.E. Shields.



0 20 40 60

SCALE 1" = 20'

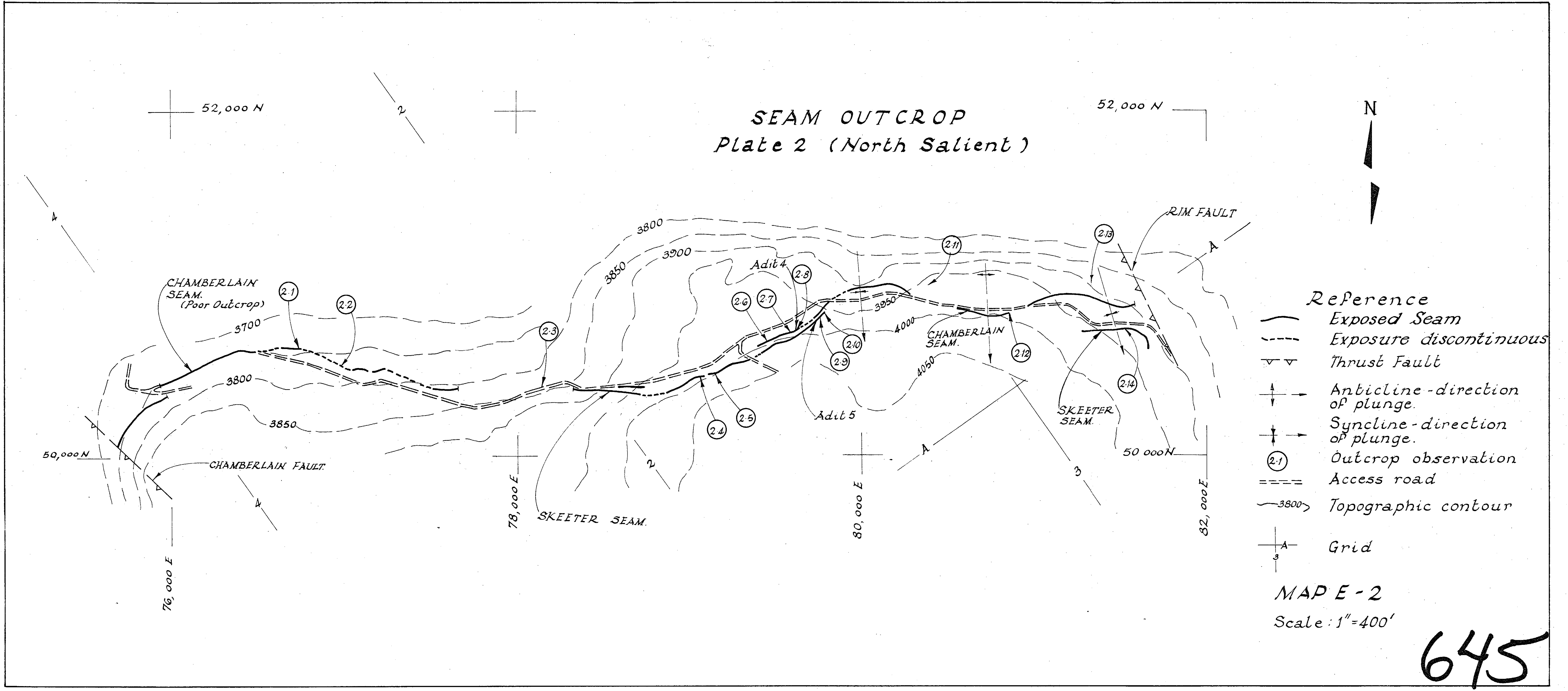
PLAN AND SECTION OF No. 5 ADIT (SKEETER SEAM)

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

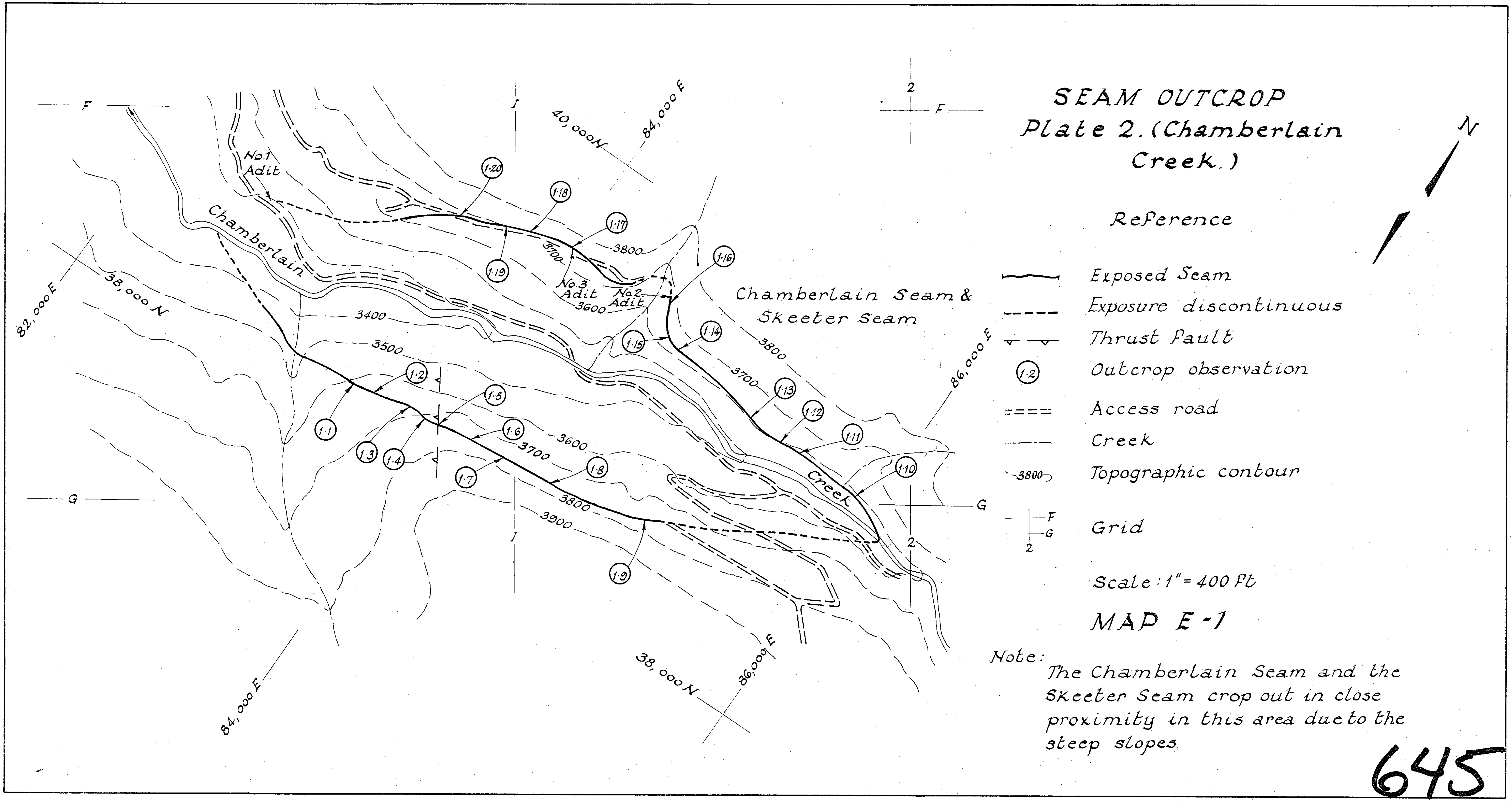
February, 1972

PREPARED BY CLIFFORD Mc ELROY & ASSOCIATES PTY LIMITED



SEAM OUTCROP
Plate 2 (North Salient)
N
52,000 N
52,000 N
50,000 N
50 000 N
76,000 E
78,000 E
80,000 E
82,000 E
CHAMBERLAIN SEAM. (Poor Outcrop)
CHAMBERLAIN FAULT.
CHAMBERLAIN SEAM.
SKEETER SEAM.
SKEETER SEAM.
RIM FAULT
Adit 4
Adit 5
3700
3800
3850
3900
3950
4000
4050
2·1
2·2
2·3
2·4
2·5
2·6
2·7
2·8
2·9
2·10
2·11
2·12
2·13
2·14
Reference
Exposed Seam
Exposure discontinuous
Thrust Fault
Anticline - direction of plunge.
Syncline - direction of plunge.
Outcrop observation
Access road
Topographic contour
Grid
MAP E - 2
Scale: 1"=400'

645


SEAM OUTCROP
Plate 2. (Chamberlain Creek.)
Reference
Exposed Seam
Exposure discontinuous
Thrust Fault
Outcrop observation
Access road
Creek
Topographic contour
Grid
Scale: 1" = 400 Ft
MAP E-1
Note: The Chamberlain Seam and the Skeeter Seam crop out in close proximity in this area due to the steep slopes.
Chamberlain Seam & Skeeter Seam
Chamberlain
Creek
No.1 Adit
No.2 Adit
No.3 Adit
40,000 N
84,000 E
38,000 N
82,000 E
86,000 E
3400
3500
3600
3700
3800
3900
645

PR-SUKUNKA-71(5)D-1

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COALITION MINING LIMITED

SUKUNKA COAL PROJECT

GEOLOGY

VOLUME 3

VOLUME 3

ISOPACH MAPS
ISOASH MAPS

See over for:

1. *List of contents.*
2. *Reference for Isopach Maps, Dwg. No. SKR. 163.*

LIST OF CONTENTS

Thrust fault trace; position accurate.

; position approximate.

Subsidiary faults — Plate 2:

Fault traces at upper & lower levels of seam.

Seam outcrop:

Position accurate.

Position approximate.

—?— —?— *Position inferred.*

Isopachs: (Contour interval 1 foot).

—8— *Position accurate.*

— —7— - *Position approximate.*

o C13 *Diamond drill hole.*

o R5 *Rotary drill hole.*

(E) (4) *Exploration grid.*

Notes:

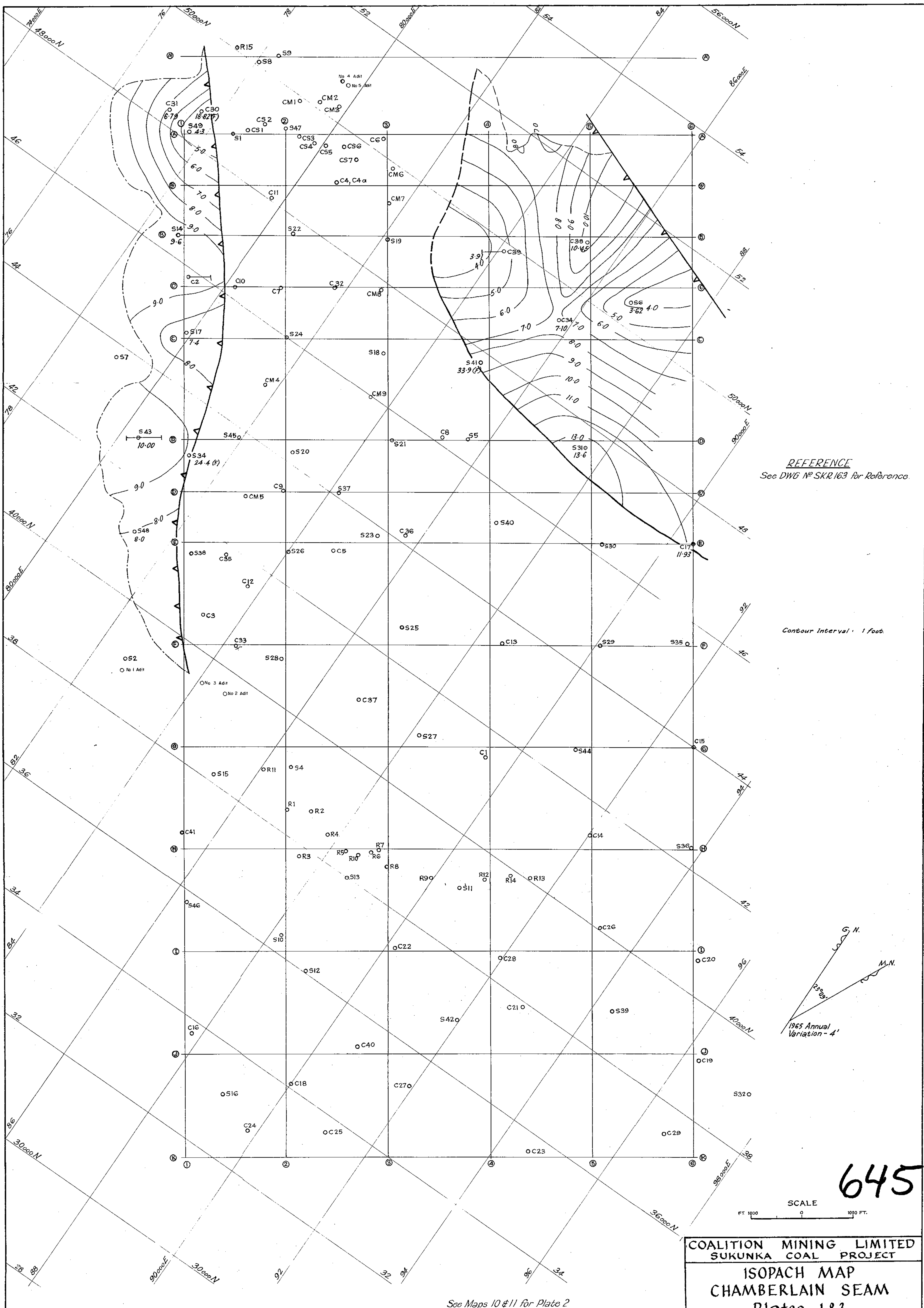
1. *Plate boundary is defined by trace of fault at seam floor.*
2. *This reference applies to Maps 9–20.*

COALITION MINING LIMITED
SUKUNKA COAL PROJECT

REFERENCE FOR ISOPACH MAPS

DATE: 29·2·72 — DWG. Nº: SKR 163

Prepared by Clifford McElroy & Associates Pty. Limited



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SUKUNKA COAL PROJECT

ISOPACH MAP
CHAMBERLAIN SEAM
Plates 1&3
MAP 9

DATE: 29·12·71 DWG. NºSKR 145

Prepared by Clifford McElroy & Associates Pty Limited.


REFERENCE
See DWG Nº SKR 163 for Reference
Approximate maximum extent of rock unit 1b, between Upper and Lower Split of Chamberlain Seam
Contour Interval: 1 foot
G.N.
M.N.
25°09'
1965 Annual Variation – 4'
SCALE
FT. 1000 0 1000 FT.
See Map 9 for Plates 1&3
Prepared by Clifford McElroy & Associates Pty Limited
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
CHAMBERLAIN SEAM
Plate 2
(SHOWING LOWER SPLIT ONLY IN SOUTH)
MAP 10
DATE: 29·12·71
DWG. Nº SKR 146
645


REFERENCE
See also DWG No SKR 163 for Reference
Approximate maximum extent of rock unit 1b, between Upper and Lower Split of Chamberlain Seam
Contour Interval: 1 foot
Inferred isopach:
G.N.
M.N.
25°09'
1965 Annual Variation - 4'
645
SCALE
FT 1000 0 1000 FT.
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
CHAMBERLAIN SEAM
Upper Split
Plate 2
MAP 11
DATE: 29.12.71
DWG. No SKR 147
Prepared by Clifford McElroy & Associates Pty Limited.

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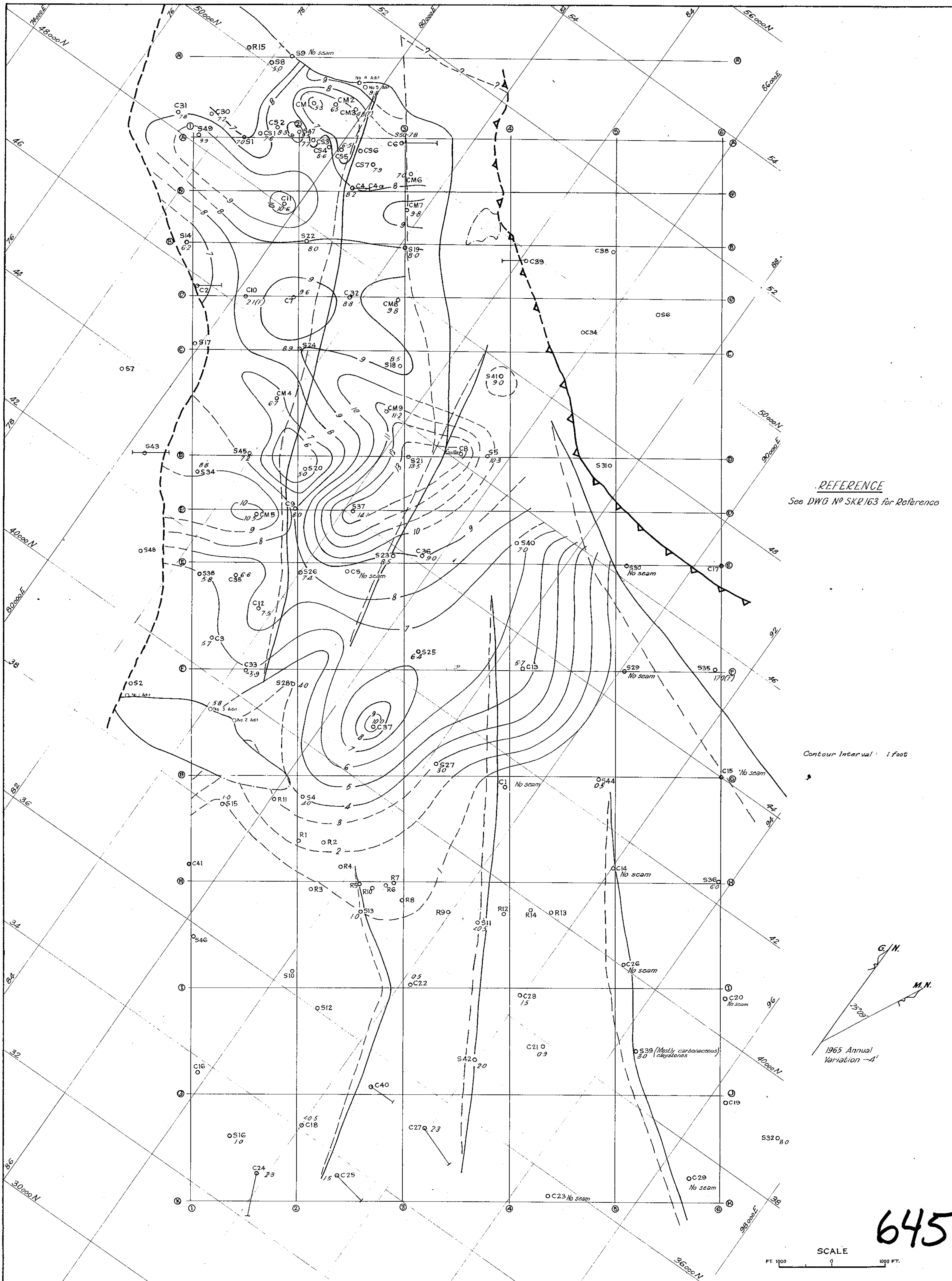
SUKUNKA COAL PROJECT

ISOPACH MAP
CHAMBERLAIN SEAM
Plate 2 Unit 1b
MAP 12

DATE: 29-12-71 DWG. No SKR 148

Prepared by Clifford McElroy & Associates Pty Limited


Note: Plate 3, insufficient data to contour.
REFERENCE
See DWG Nº SKR 163 for Reference
Contour interval: 1 foot
G.N.
M.N.
1965 Annual Variation - 4'
SCALE
FT 1000 0 1000 FT.
645
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
SKEETER SEAM
Plate 1
(TOTAL SEAM)
MAP 13
DATE: 29.12.71
DWG. NºSKR 149
Prepared by Clifford McElroy & Associates Pty Limited



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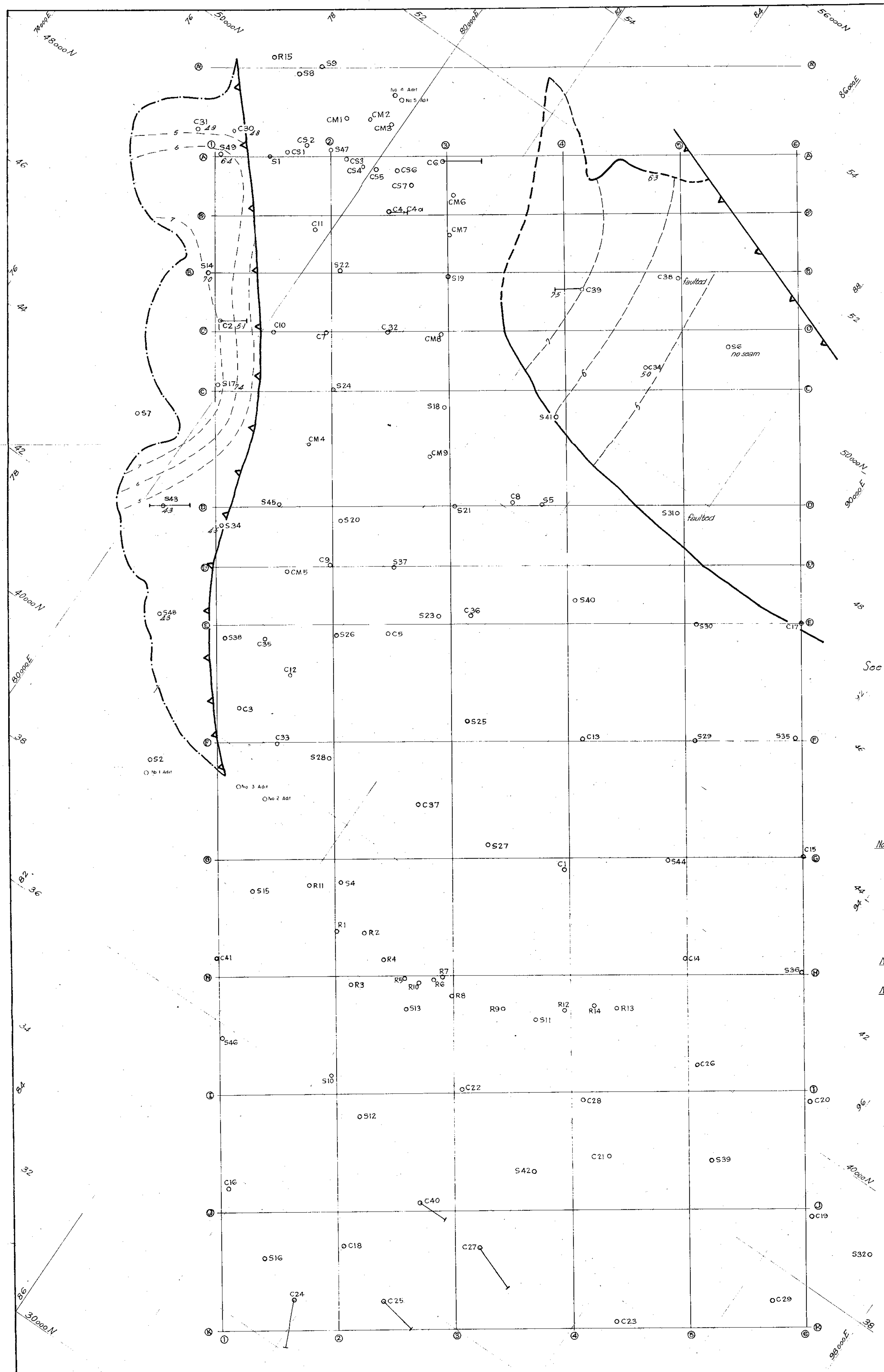
SUKUNKA COAL PROJECT

ISOPACH MAP
SKEETER SEAM
Plate 2
TOTAL SEAM THICKNESS
MAP 14

DATE: 29 · 2 · 72 | DWG. Nº SKR 150



REFERENCE

See DWG. Nº SKR163 for Reference

Contour Interval: 1 foot

Note: The working section is defined as the theoretical thickness of seam, including the Lower Rock Band, to a minimum working height of 4'6". The maximum thickness of the Lower Band in this section is 12".

Note: See Map 17 for Isopach Map of Total Coal in the theoretical working section in Plates 1 and 3.

Note: See Map 16 for working section Plate 2.

1965 Annual Variation -4'

645

SCALE

FT 1000 0 1000 FT.

COALITION MINING LIMITED
SUKUNKA COAL PROJECT

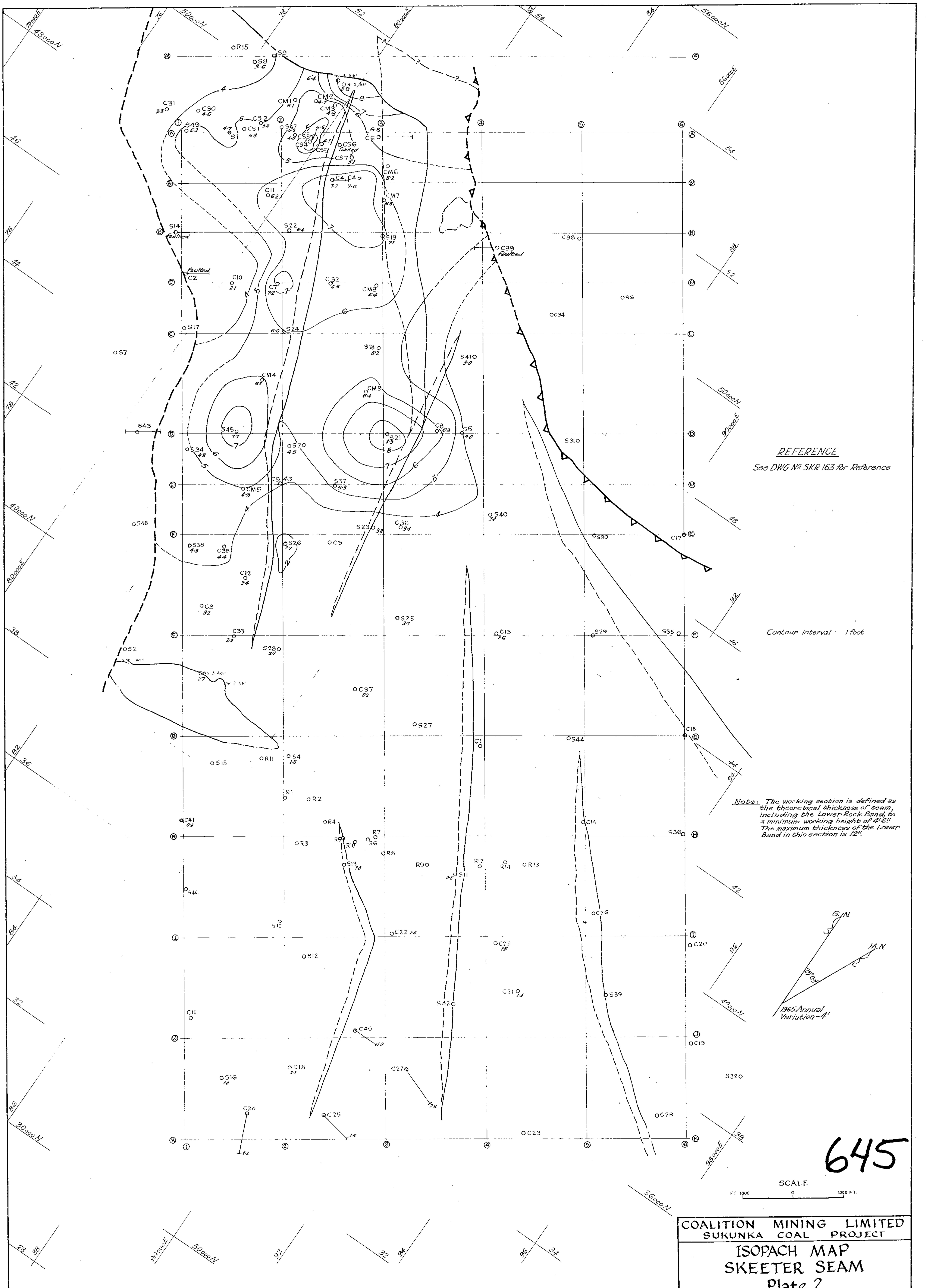
ISOPACH MAP
SKEETER SEAM
Plates 1 & 3
(WORKING SECTION)
MAP 15

DATE: 29.12.71 DWG. Nº SKR 151

Prepared by Clifford McElroy & Associates Pty Limited


Collared below seam
No 4 Adit
No 5 Adit
(S50 data used)
faulted
no seam
no coal
No 3 Adit
No 2 Adit
REFERENCE
See DWG SKR 163 for Reference
Contour Interval: 1 foot.
Note: The working section is defined as the theoretical thickness of seam, including the Lower Rock Band, to a minimum working height of 4'6". The maximum thickness of the Lower Band in this section is 12".
Note: See Map 18 for Isopach Map of Total Coal in the theoretical working section in Plate 2.
Note: See Map 15 for working section, Plates 1 and 3
G. N.
M. N.
25°09'
1965 Annual Variation -4'
645
SCALE
FT 1000 0 1000 FT.
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
SKEETER SEAM
Plate 2
(WORKING SECTION)
MAP 16
DATE: 29 · 2 · 72
DWG. Nº SKR 152
Prepared by Clifford McElroy & Associates Pty Limited


REFERENCE
See DWG № SKR 163 for Reference
Contour Interval: 1 foot
Note: The working section is defined as the theoretical thickness of seam, including the Lower Rock Band, to a minimum working height of 4'6". The maximum thickness of the Lower Band in this section is 12".
G.N.
M.N.
1965 Annual Variation - 4'
645
SCALE
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
SKEETER SEAM
Plates 1 & 3
(TOTAL COAL IN WORKING SECTION)
MAP 17
DATE: 29.12.71
DWG. № SKR 153
Prepared by Clifford McElroy & Associates Pty Limited



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SUKUNKA COAL PROJECT

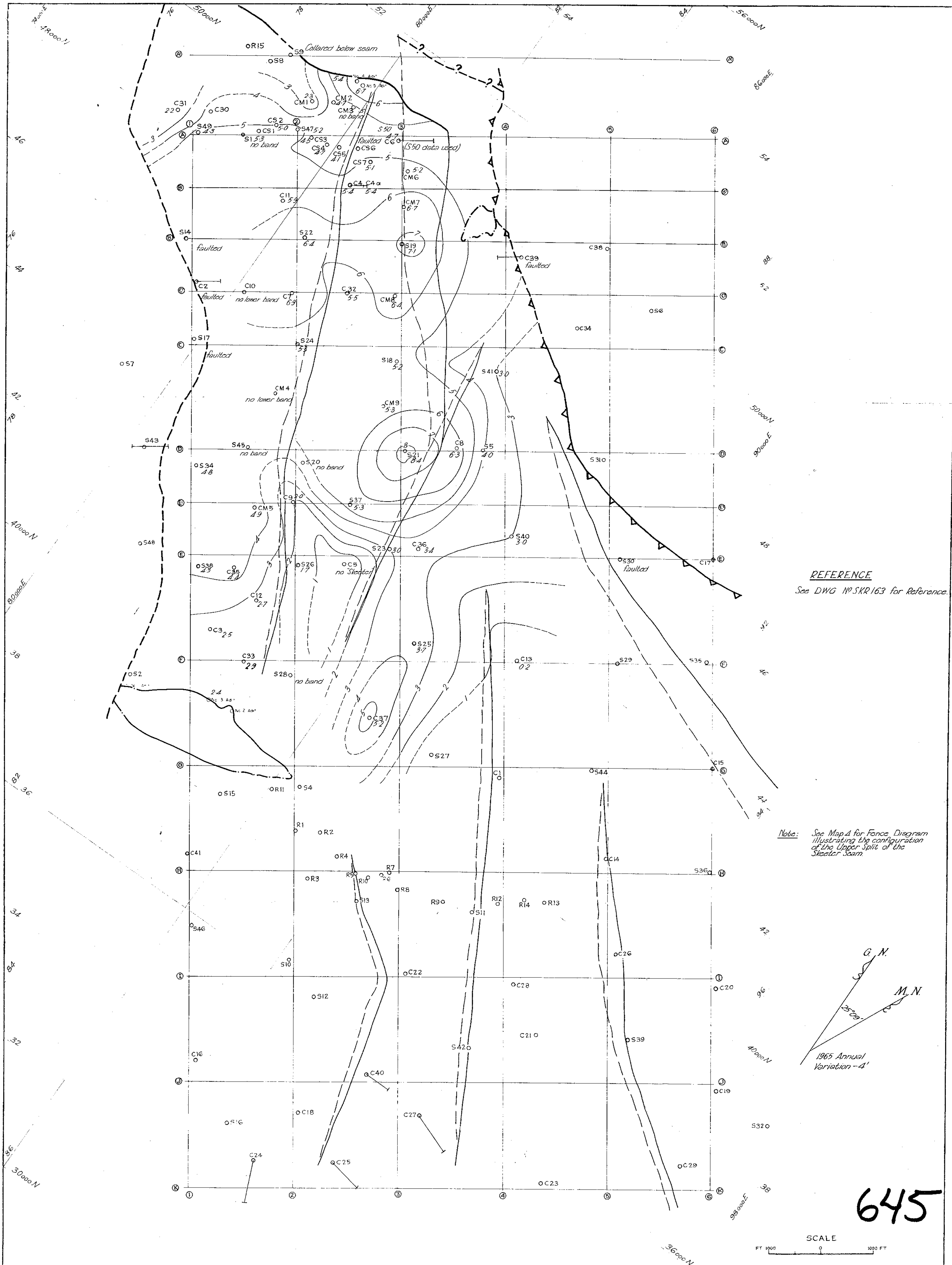
ISOPACH MAP SKEETER SEAM

Plate 2

(TOTAL COAL IN WORKING SECTION)

MAP 18

DATE: 29.12.71 DWG. Nº SKR 154



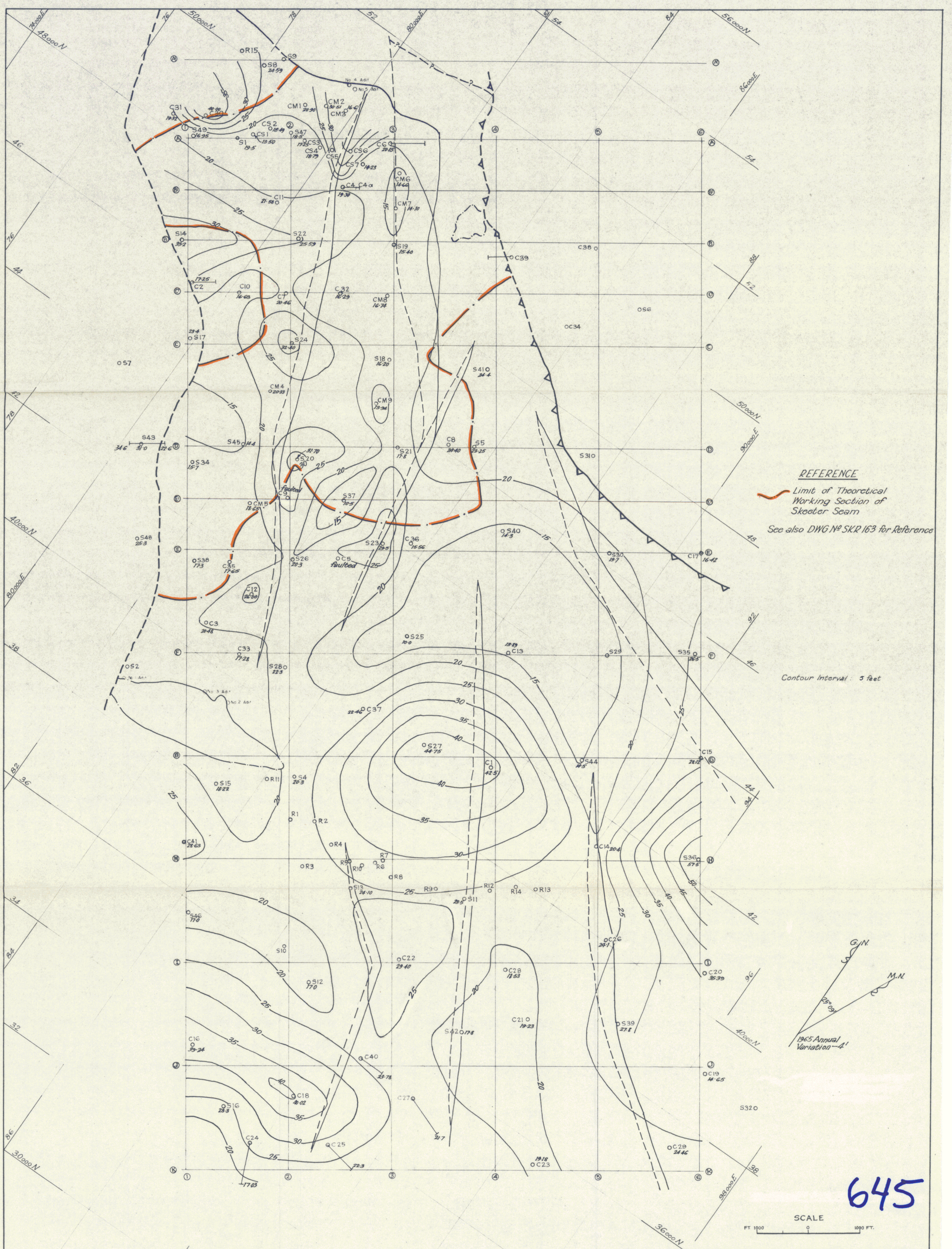
COALITION MINING LIMITED
SUKUNKA COAL PROJECT

ISOPACH MAP
SKEETER SEAM
Plate 2
(UPPER SPLIT OF SEAM)
MAP 19

DATE: 29·12·71 DWG. No SKR 155

Prepared by Clifford McElroy & Associates Pty Limited

REFERENCE
See DWG № SKR 163 for Reference.
Note: See Map 4 for Fence Diagram illustrating configuration of the Lower Rock Band in the Skeeter Seam
Contour Interval: 1 foot
G.N.
M.N.
1965 Annual Variation −4'
SCALE
645
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOPACH MAP
SKEETER SEAM
Plate 2
(LOWER ROCK BAND)
MAP 20
DATE: 29·12·71
DWG. № SKR 156
Prepared by Clifford McElroy & Associates Pty Limited.



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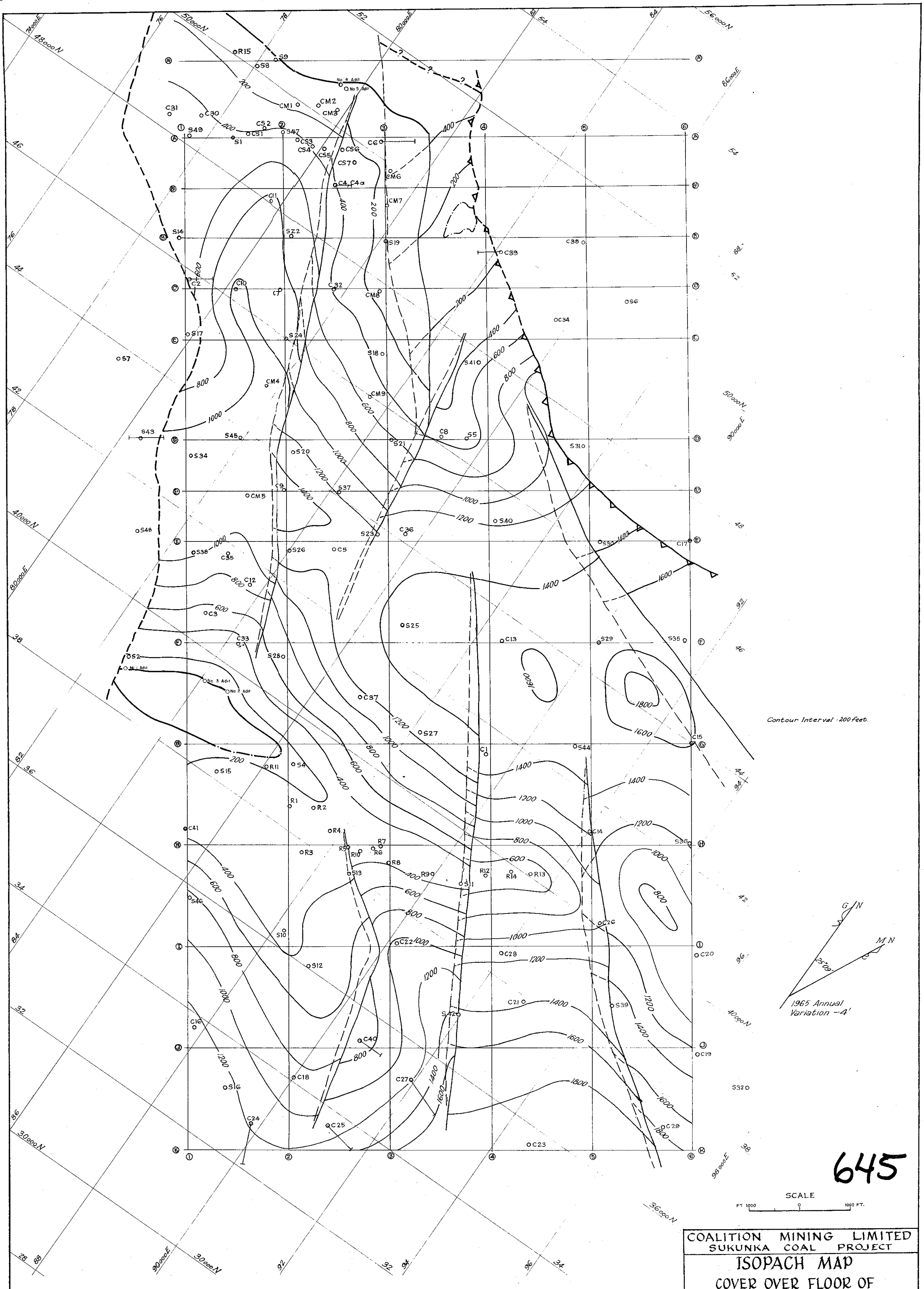
ISOPACH MAP
INTERSEAM SEDIMENTS
Plate 2
(BETWEEN CHAMBERLAIN & SKEETER SEAMS)
MAP 21

DATE: 29.12.71 DWG. Nº SKR 157

Prepared by Clifford McElroy & Associates Pty Limited



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SUKUNKA COAL PROJECT

ISOPACH MAP

COVER OVER FLOOR OF CHAMBERLAIN SEAM

Plate 2
MAP 22

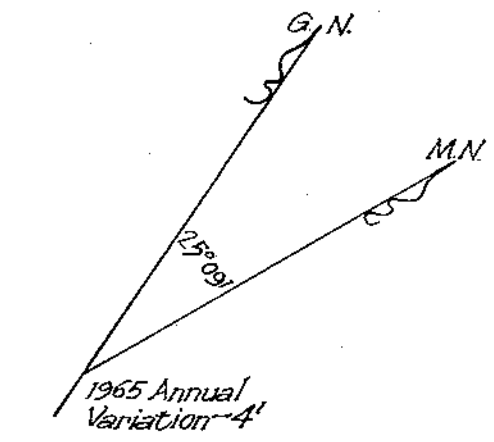
DATE: 1·3·72 DWG. No SKR 158

Prepared by Clifford McElroy & Associates Pty Limited.

Reference.

3° Dip of floor of Chamberlain Seam measured from drill core.

○S35 Diamond drill hole.



645

SCALE

FT 1000 0 1000 FT.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

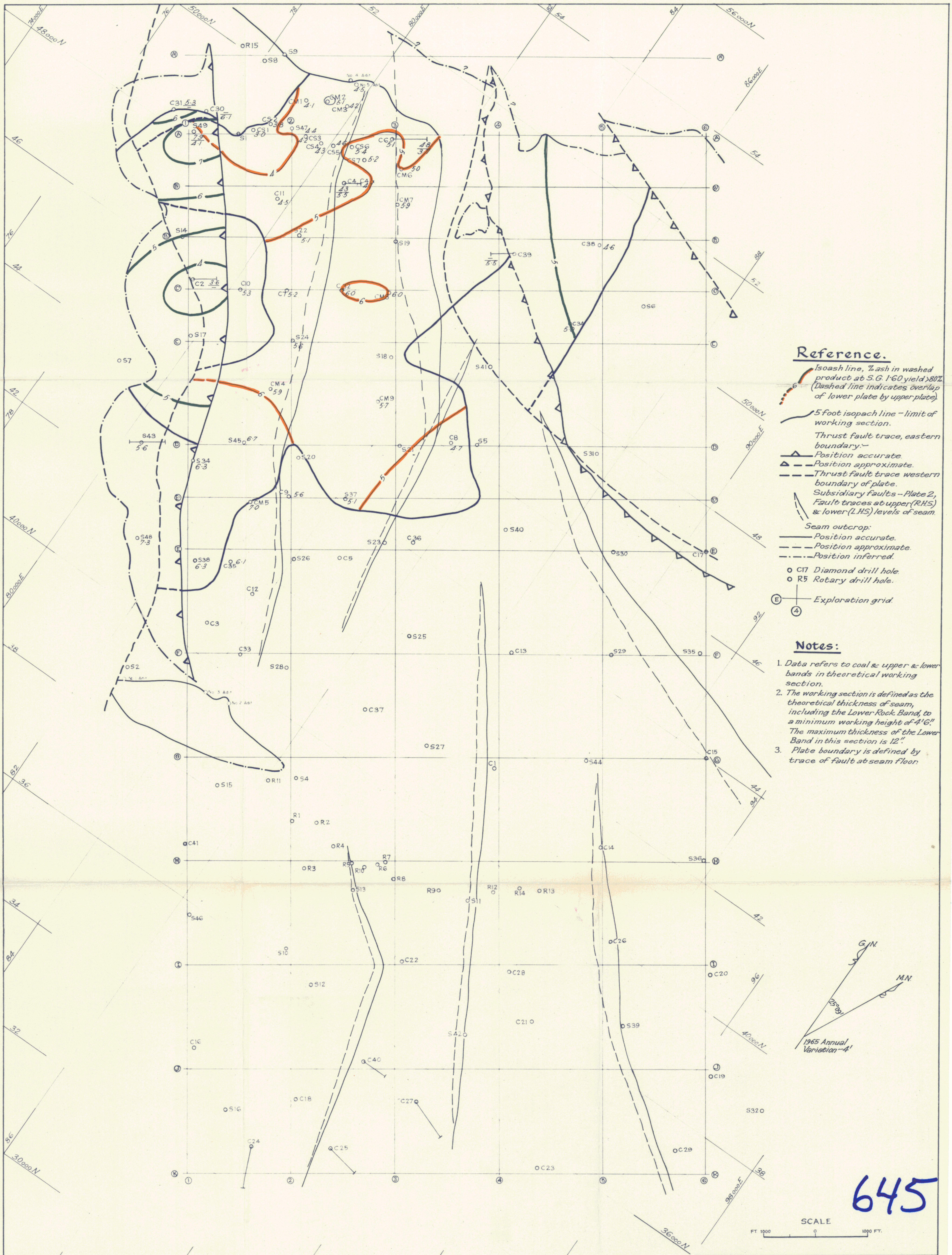
MAP SHOWING DIPS OF FLOOR OF CHAMBERLAIN SEAM

MAP 23

DATE: 29·12·71 DWG. No SKR 159

Prepared by Clifford McElroy & Associates Pty Limited


Reference.
Isoash line, %ash in washed product at S.G. 1·60 yield >90% (Dashed line indicates overlap of lower plate by upper plate).
Thrust fault trace, eastern boundary:-
Position accurate.
Position approximate.
Thrust fault trace western boundary of plate.
Subsidiary faults - Plate 2, Fault traces at upper (RHS) & lower (LHS) levels of seam.
Seam outcrop:
Position accurate.
Position approximate.
Position inferred.
C17 Diamond drill hole
R5 Rotary drill hole.
Exploration grid.
Notes:
1. Plate boundary is defined by trace of fault at seam floor.
G.N.
M.N.
25°09'
1965 Annual Variation -4'
SCALE
FT 1000 0 1000 FT.
645
COALITION MINING LIMITED
SUKUNKA COAL PROJECT
ISOASH CONTOURS
CHAMBERLAIN SEAM
% Ash in Washed Product at S.G.1·60 yield >90%
MAP 24
DATE: 29·12·71
DWG. No SKR160
Prepared by Clifford McElroy & Associates Pty Limited



COALITION MINING LIMITED
SUKUNKA COAL PROJECT

ISOASH CONTOURS
SKEETER SEAM
(Working Section)

% Ash in Washed Product at S.G. 1·60 yield >80%

MAP 25

DATE: 29·12·71 DWG. Nº SKR 161

Prepared by Clifford McElroy & Associates Pty Limited