DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

LITTLE PARA DAM - MAIN QUARRY SLOPE

STABILITY ANALYSIS

Hds. Yatala and Munno Para

- Engineering and Water Supply Department -

by

J.C. BEAL
GEOLOGIST

Rept.Bk.No.75/55
G.S. No. 5590
DM. No. 624/72
Eng.Geol.No. 1964/38

24th April, 1975

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

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SUMMARY AND CONCLUSIONS

The orientation and nature of discontinuities in the quartzite and dolomite to be excavated in the proposed rockfill quarry have been observed to determine stability of the quarry faces. As a water treatment works will be sited on the quarry floor long term stability is required.

The survey indicates that

..... Intersection of joints will form unit blocks along all quarry faces. These blocks may be unstable and will require selective removal or stabilizing with rock bolts.

..... There will be no large scale instability along the eastern wall of the quarry.

..... Rock fall into the quarry should be expected along the western end of the quarry. For long term stability stabilization such as by rock bolting should be carried out.

..... During excavation some rockfalls along the central part of the main quarry face should be expected from the folded quartzite.

..... Correct quarrying sequence will greatly reduce risk of rockfalls. All final batters should be presplit.

INTRODUCTION

This report supplements an earlier report; Rept. Bk.No.74/133 entitled 'Little Para Dam - Water Treatment Works, Quarry Site and Main Separation Pipe', dated 20th June, 1974.

The proposed quarry will initially provide rockfill for the several zones of the dam. It is then planned to site the water treatment works on the quarry floor.

The maximum height of the proposed quarry will be from EL 110 to EL 183 with berms at EL 123, EL 138, EL 153 and EL 168. All elevations are given in metres.

Dip and strike measurements of joint and bedding planes in the quartzite and dolomite to be excavated during quarry operations have been taken in order to assess the possibility of rock falls during both the construction of the quarry and its long term life as a site for the water treatment works (Fig. 1).

GEOLOGY

Shaley dolomite and quartzite are the two rock types found within the quarry site. In the central area of the proposed quarry the quartzite stratum (Unit 10) which traverses the length of the quarry has been folded (see plate 6, Rept. Book No. 74/133 and Fig. 3), into a shallow anticline. In this area of folding the dolomite beneath the quartzite tends to be siliceous.

The strata strike 010^{o} - 025^{o} and dip approx. 20^{o} - 35^{o} eastwards, i.e., into the hillside. Diamond drilling in the vicinity of folding (D.M.16) shows quartzite Unit 10 to be approximately 10 metres thick although it is emphasized that the contact between the quartzite and dolomite is gradational and an exact thickness cannot be given.

Away from the folding the quartzite thins considerably to 5.0 m - 2.0 m thick.

ROCK SLOPE STABILITY

Quartzite Unit 12

Quartzite Unit 12 outcrops above the quarry (approx. EL 190) and the larger loose boulders should be removed prior to quarrying excavations.

Quartzite Unit 10

Main Face

Folding of the quartzite stratum which traverses the quarry has altered the direction of dip of the beds away from its normal direction, eastwards, to a direction dipping into the quarry (Fig. 2). This unstable condition will be removed once the folded stratum has been excavated. Figure 3 shows the relationship of the quartzite stratum to designed topography of excavated quarry.

Joints within the quartzite are spaced 0.50 m - 2.00 m apart and any falling blocks will have dimensions in the range 0.5 m x 0.5 m x 1.0 m to 2.0 m x 1.0 m x 1.0 m. The possibility of mass movement of the units blocks is thought to be unlikely.

Eastern End

Apart from falls of individual joint blocks there will be no large scale stability problem at this end of the quarry.

Western End

The alignment of batters at the western end, is sub-parallel to the strike of the quartzite and as the beds dip into the proposed quarry rock falls should be expected. However, tests on the values of friction along the bedding planes (see notes on figures 4 and 5) suggest that movement along the bedding planes dipping less than 30^{o} is unlikely to occur.

Falls of individual joint blocks are more likely to occur than mass movement of the quartzite.

After excavation the quartzite will intersect the batters at the maximum height EL 145.

Dolomite Units 9 and 11

During folding of the quartzite the less competant shaley dolomite accommodated the forces by multiple bedding plane movements and therefore there has been no folding of the shaley dolomite except immediately adjacent to the top and base of the quartzite. In these areas some instability of the dolomite should be expected.

The strike and dip of the dolomite in the vicinity of the quarry is similar to the regional value i.e. $100^{0}/30^{0}$E. This easterly dip will allow stable batters to be formed along the main face of the quarry and along the eastern end. Rockfalls may be expected in those parts of the western end where the face runs approximately north-south i.e. particularly between EL 110 and EL 153 (see shaded areas in Fig. 1). Large falls will be confined to rock material made unstable by the intersection of joints and bedding planes and movement will be along the bedding plane into the quarry. Dimensions of falls may range from individual unit blocks (1.5 m x 1.0 m x 0.5 m) to mass movement of the blocks. For permanent stability some rock bolting along western faces will probably be required.

CONCLUSIONS

Small falls of individual joints blocks may be expected along all faces of the quarry batters during and after excavation. Large unstable boulders should be individually removed from the batter faces or rock bolted for long term stability.

During excavation of the quartzite in the central portion of the main face, rockfalls can be expected until the folded quartzite is completely removed. Larger rock falls especially within the dolomite are anticipated along the batter faces of the western end.

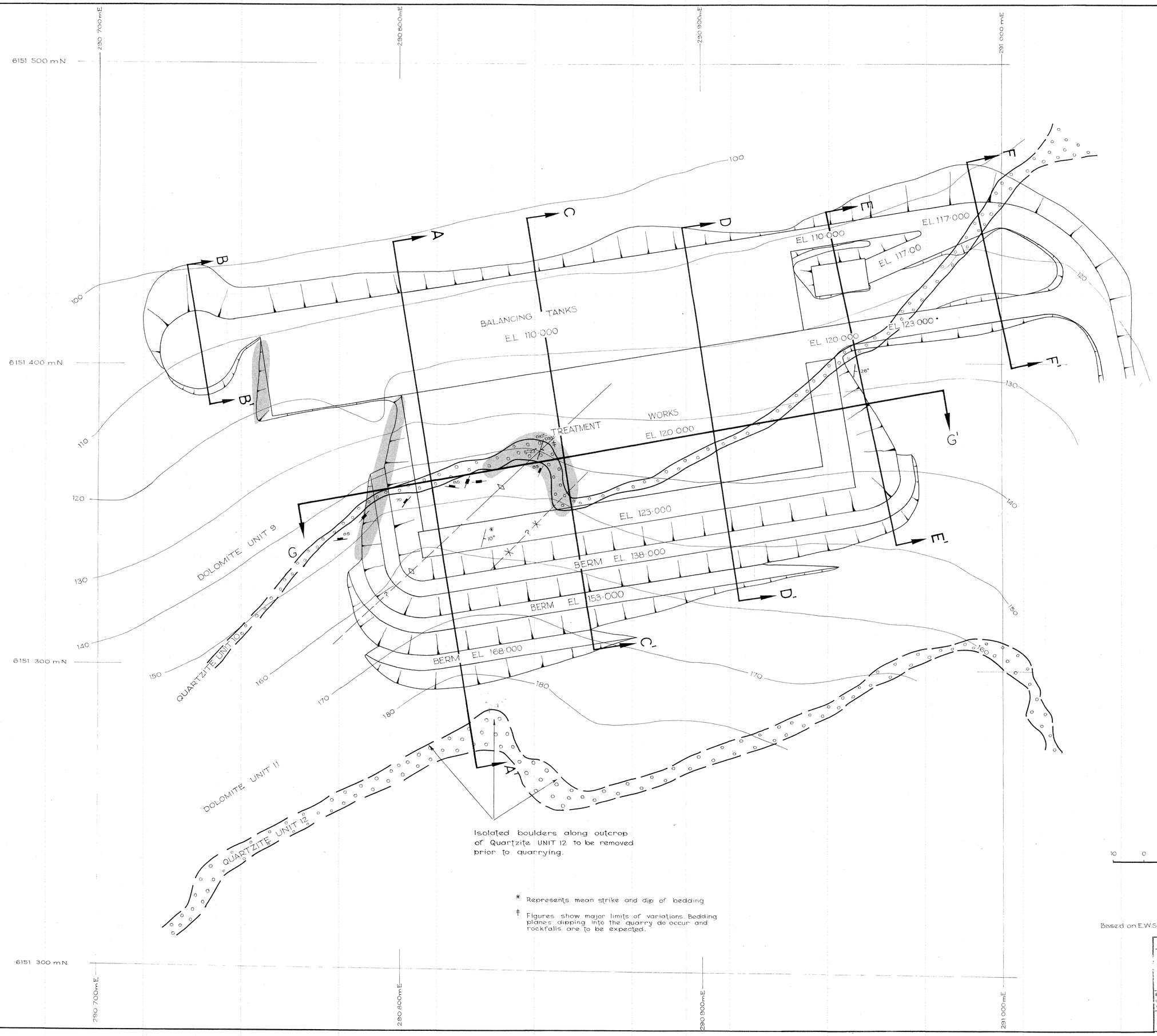
Below is a suggested sequence for quarry excavation:-

1. Removal of large unstable blocks in quartzite - Unit 12 (see Figure 1). For aesthetic reasons this should be kept to a minimum.
2. Excavation of Unit 10 along the central part of the Main Face, down to 2-3 m depending at what depth folded strata dipping into the quarry is completely removed.
3. Commence excavation of dolomite from lowest elevations at western end, extracting in strips running west to east. Extraction should commence at the westward end and work easterly.

John C Beal

JCB:FdeA
24th April, 1975

J.C. BEAL
GEOLOGIST

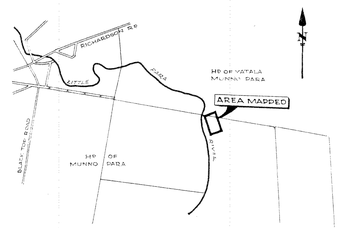


Isolated boulders along outcrop of Quartzite UNIT 12 to be removed prior to quarrying.

* Represents mean strike and dip of bedding

‡ Figures show major limits of variations. Bedding planes dipping into the quarry do occur and rockfalls are to be expected.

LOCALITY PLAN



LEGEND

Parts of quarry face liable to rockfalls.

QUARTZITE

DOLOMITE

Strike and dip of strata

Strike and dip of joints

Vertical joint

150 Contours in 10 metre intervals

Anticline

Syncline

SCALE

10 0 10 20 30 40 50

METRES

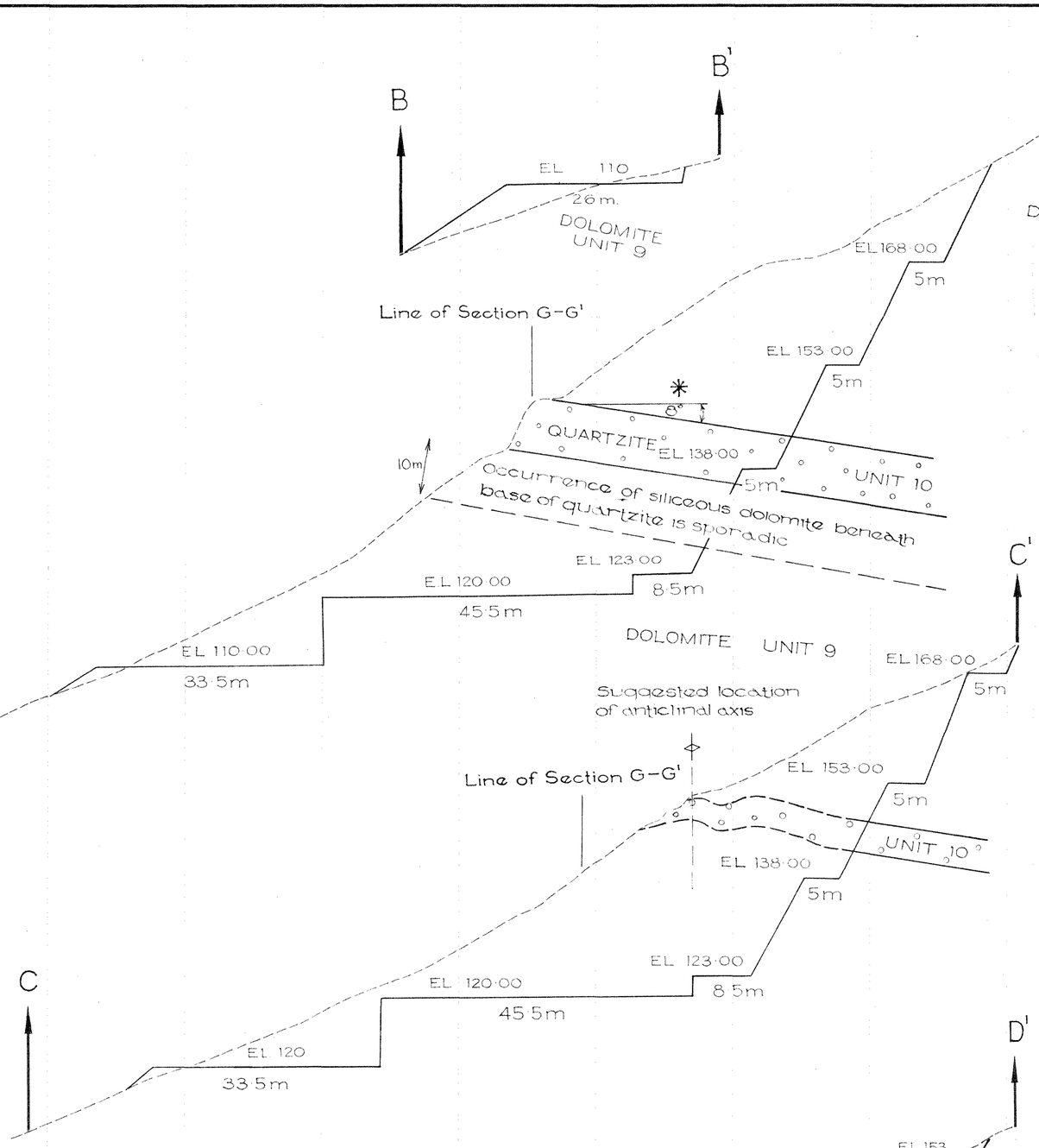
Based on E.W.S. Dept plan 73441

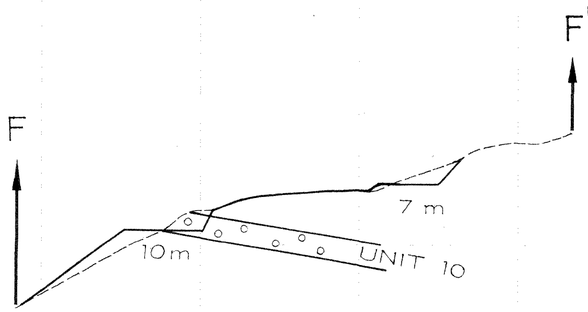
FIG.1

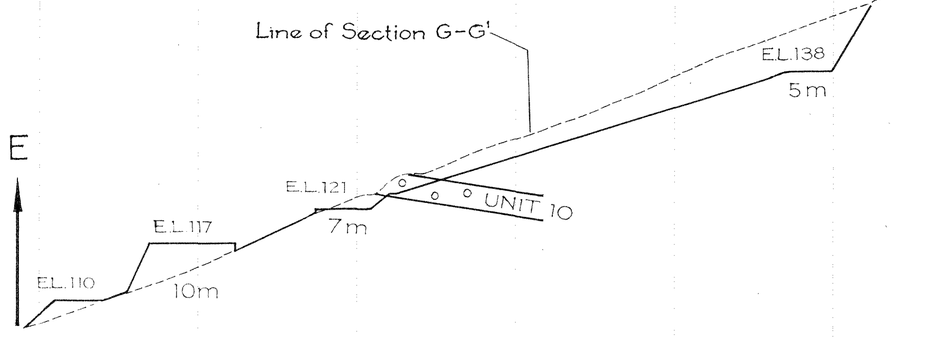
DEPARTMENT OF MINES — SOUTH AUSTRALIA

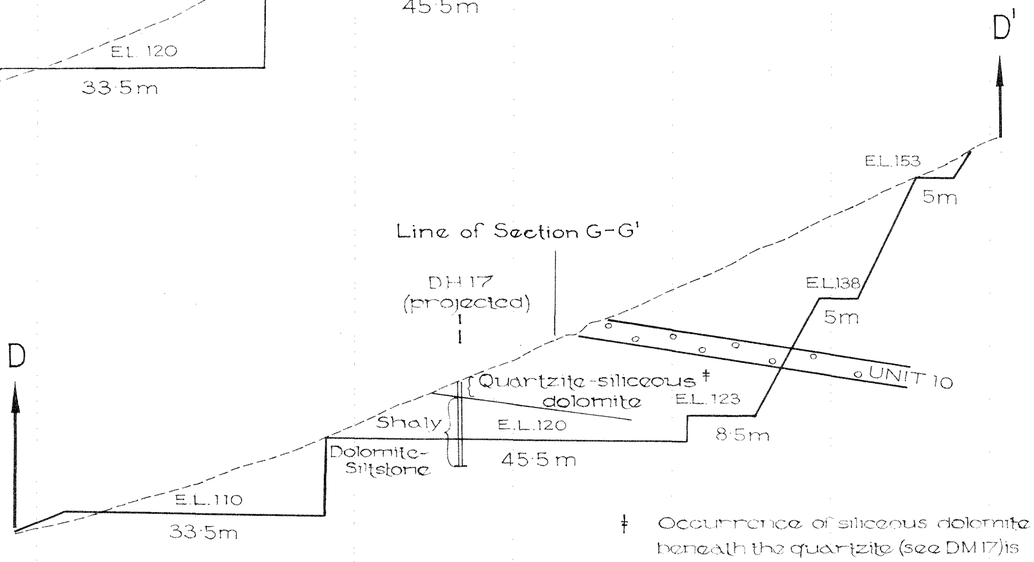
LITTLE PARA DAM—QUARRY AND WATER TREATMENT WORKS
GEOLOGICAL PLAN

ENGINEERING GEOLOGY SECTION	J.C. BEAL Geologist	Compiled J.C. BEAL	Scale 1:500
		Drn. G.M.	Date: 19th March 1974
Director of Mines		Ckd. A.F.	Drg No. 74-274 Hoz 5









LEGEND

- Dolomite / Quartzite
- Natural ground level
- Required construction profile
- DH17 — Diamond drillhole

SCALE

10 0 10 20 30 40 50

METRES

FIG.2

‡ Occurrence of siliceous dolomite beneath the quartzite (see DM 17) is sporadic but where occurs is suitable as Zone 4 material

* This represents the minimum dip expected to be encountered along the central part of the main face of the quarry. All cross sections are on a bearing 170°. This is at 70° to the true dip of the beds (25-30° on a bearing 100°)

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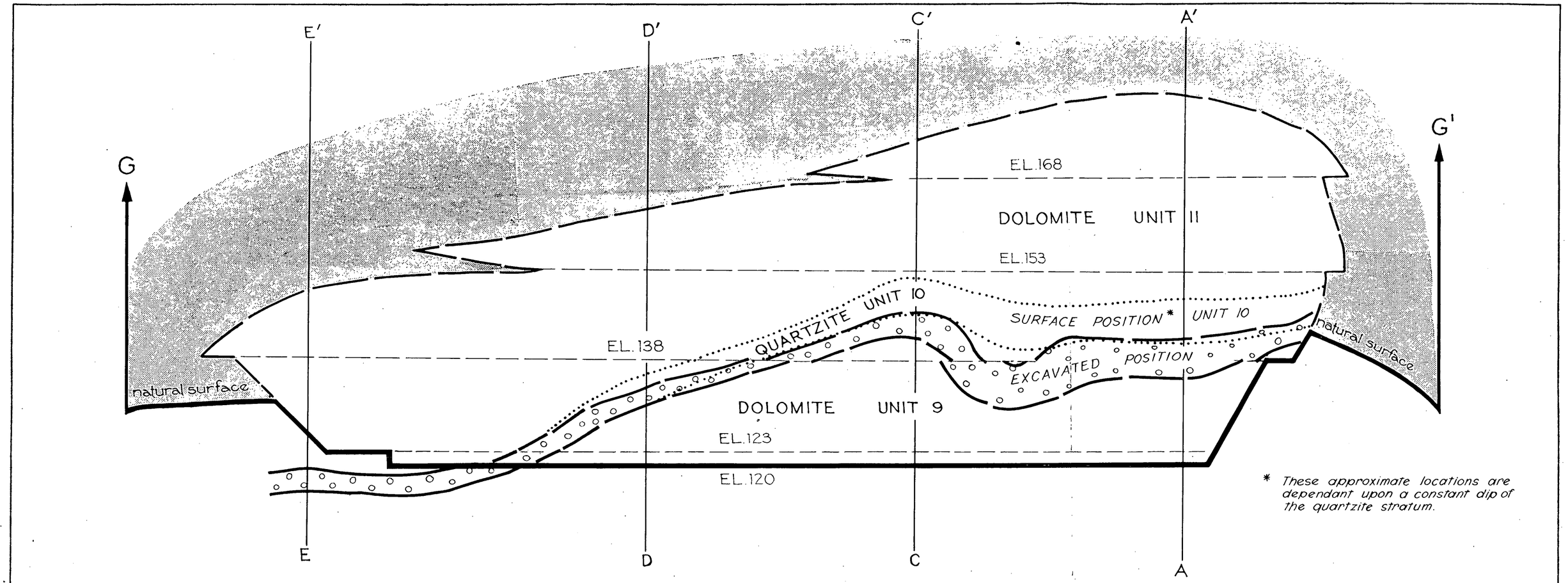
LITTLE PARA DAM-QUARRY AND WATER TREATMENT WORKS
GEOLOGICAL CROSS SECTIONS

	J.C. BEAL Geologist	Compiled J.C.BEAL	Scale: 1:500
			Date: 19 March 1974
		Drn. G.M.	Drg. No. 74-275 Ha2+5
Director of Mines		Ckd.	



* *These approximate locations are dependant upon a constant dip of the quartzite stratum.*

LEGEND

——— Intersection of batters with natural ground surface

EL.138 Indicates level of berms

QUARTZITE UNIT 10

DOLOMITE UNIT 11 & 9

D' — D Location of cross sections shown on drawing 74-274

SCALE

10 0 10 20

METRES

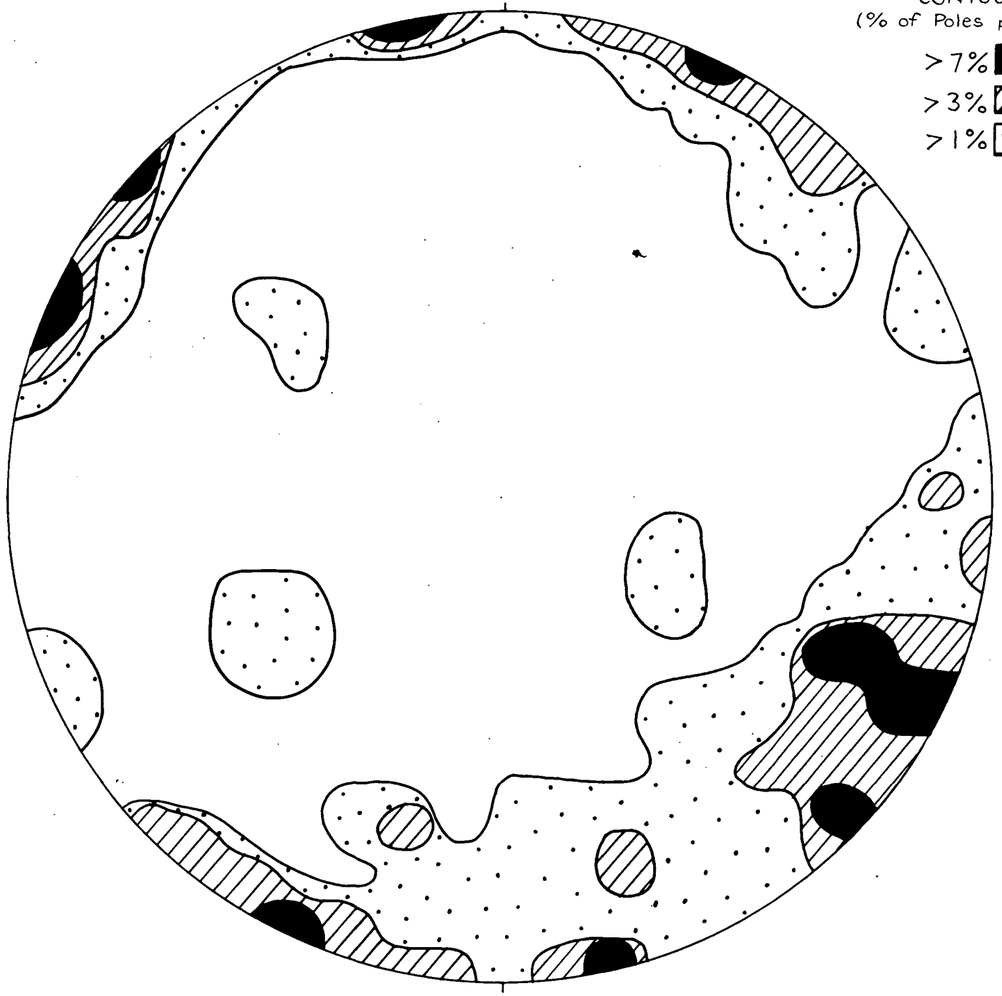
FIG.3

ENGINEERING GEOLOGY SECTION. Compiled: J.C.Beal; Dm.G.M. | Chd. A.F.	DEPARTMENT OF MINES – SOUTH AUSTRALIA LITTLE PARA DAM–QUARRY AREA GEOLOGICAL CROSS SECTION G–G' SHOWING ESTIMATED INTERSECTION OF BATTERS AND QUARTZITE UNIT 10	Scale. 1:500 Date: 3rd May '74 Drg No. 74-335 Ha2+5

1M–2,70 A1811

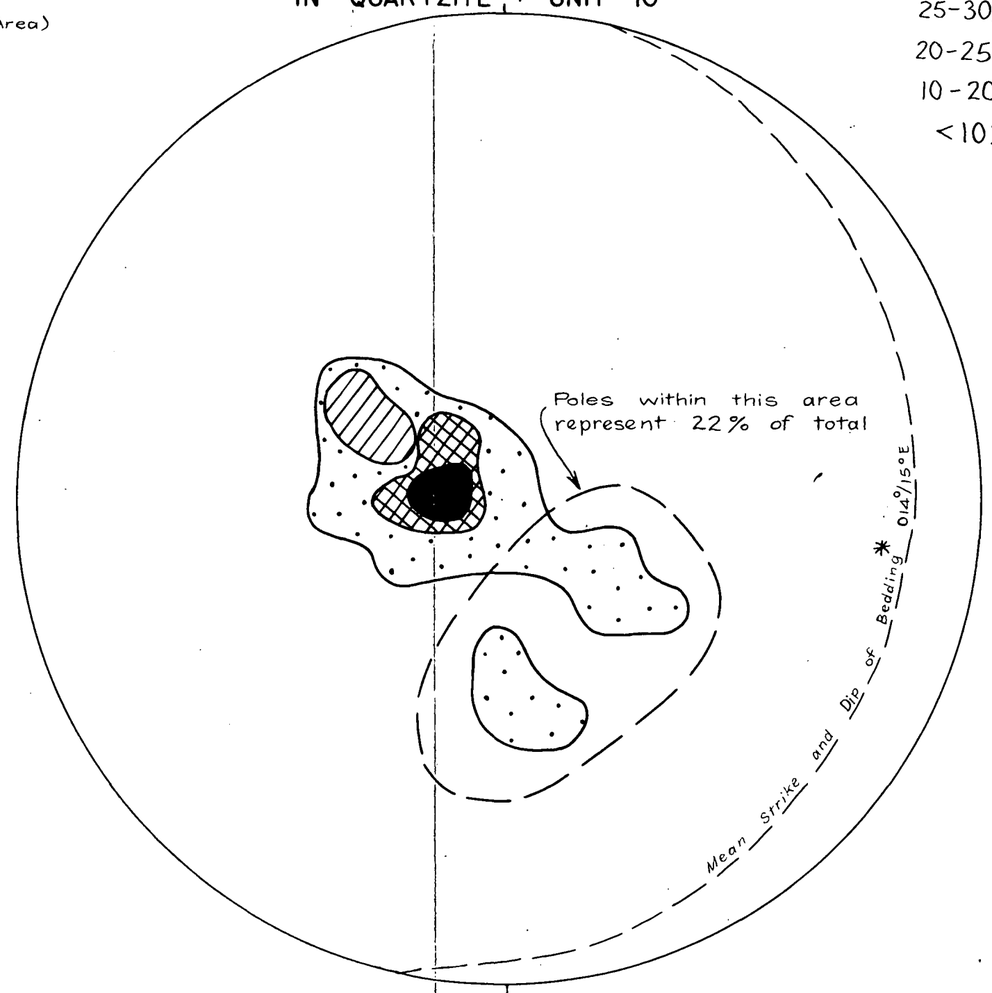
CONTOURS ON 85 POLES TO JOINT PLANES IN QUARTZITE : UNIT 10

CONTOURS
(% of Poles per 1% Area)
- > 7%
- > 3%
- > 1%



CONTOURS ON 17 POLES TO BEDDING PLANES IN QUARTZITE : UNIT 10

CONTOURS
(% of Poles per 1% Area)
- 25-30%
- 20-25%
- 10-20%
- < 10%



* 22% of bedding planes dip at 10°-30° towards the quarry face. This is a change of the normal bedding dip direction, due to folding, which has affected the northern end of the quartzite escarpment. HOEK shear box gives ϕ (WET) 40°-50° across the bedding planes. Therefore, until the limb of the fold has been excavated, some rock slope instability should be expected

FIG. 4

See also Plan No. 75-2

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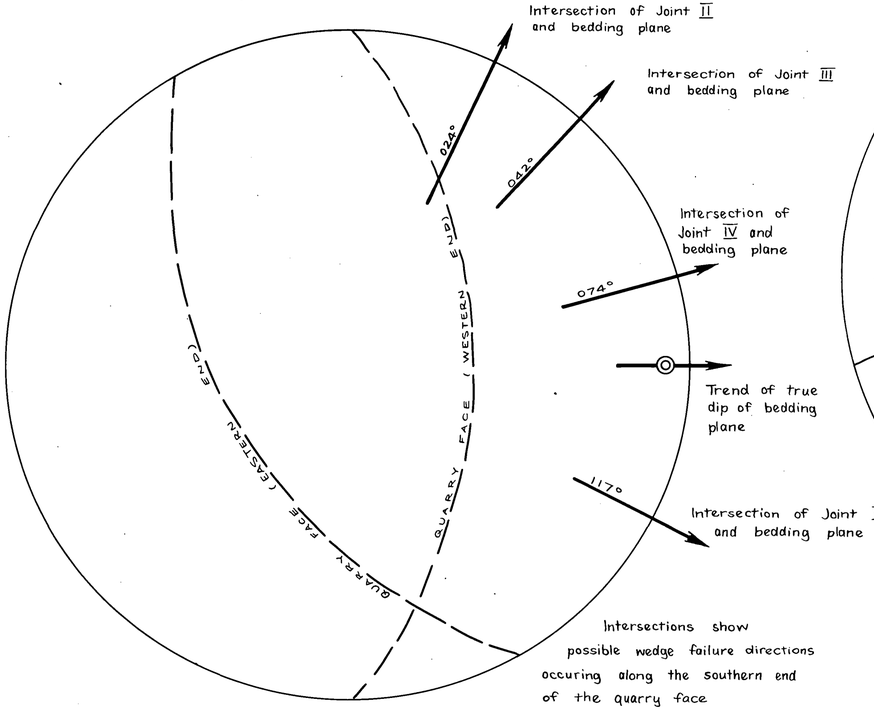
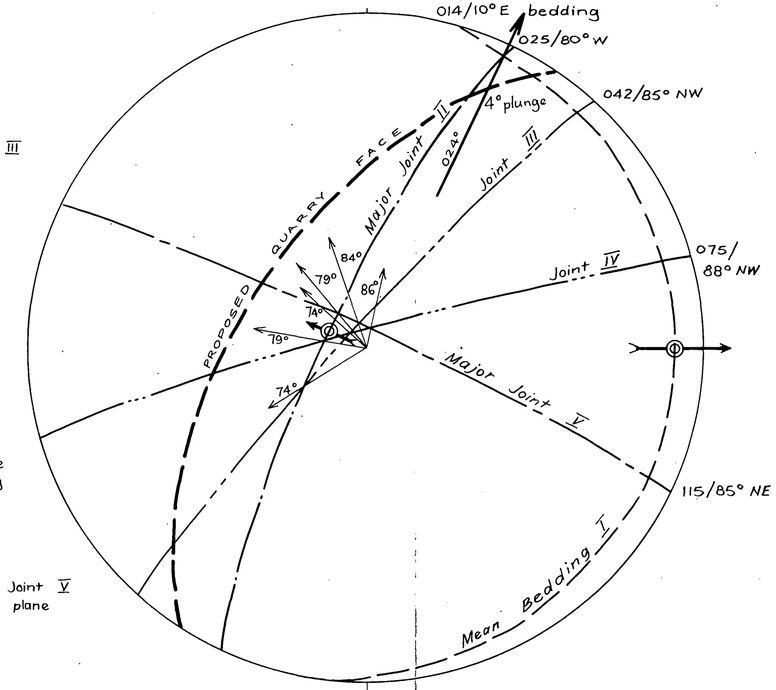
LITTLE PARA DAM
QUARRY AND WATER TREATMENT WORKS
JOINT AND BEDDING SURVEY CONTOURS

ENGINEERING GEOLOGY SECTION		Drn. J.C.B.	SCALE: —
		Tcd. D.J.M.	75-1
		Ckd.	
Director of Mines		Exd.	DATE: 2-1-75



STABILITY ASSESSMENT OF QUARRY ENDS



MEAN STRIKE AND DIP OF BEDDING AND JOINTS IN QUARTZITE : UNIT IO

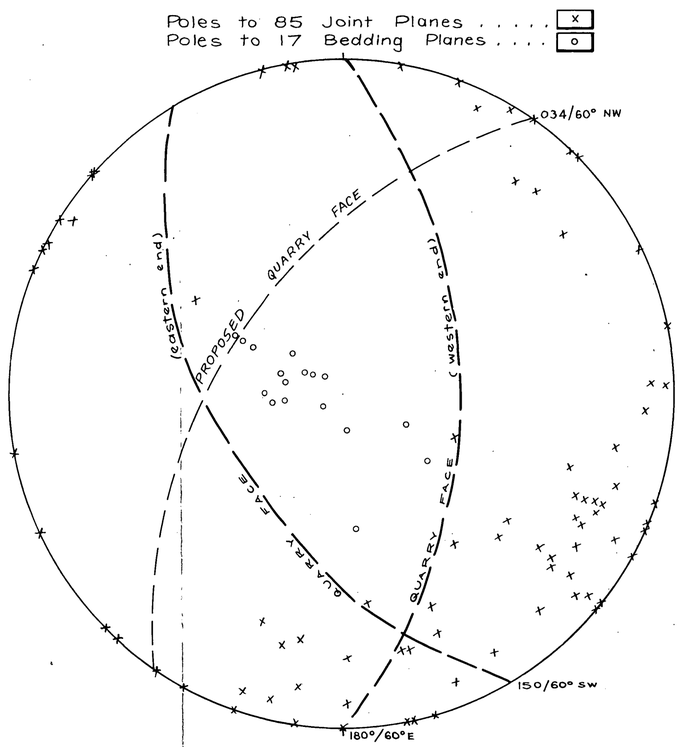
LEGEND

86° — Intersection of Joint Planes showing plunge of possible wedge failures — NO INSTABILITY. (All intersections are inspected in relation to alignment of the proposed quarry faces.)

4° — Intersection of Joint Planes and Bedding. One possible instability along bearing 024°, plunge 4°. High friction angles makes possibility of movement minimal.

Trend of true dip of fractures or bedding plane (Not all shown.)

See also Plan No. 75-1



POLES TO JOINT AND BEDDING PLANES IN QUARTZITE : UNIT IO

FIG. 5

DEPARTMENT OF MINES — SOUTH AUSTRALIA

LITTLE PARA DAM
QUARRY AND WATER TREATMENT WORKS
JOINT AND BEDDING SURVEY

ENGINEERING GEOLOGY SECTION		Drn. J.C.B.	SCALE: —
		Tcd. R.J.M.	75-2
		Ckd. A.F.	
Director of Mines		Exd.	DATE: 2-1-75

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