DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 87/100
CAVITY INVESTIGATION OVER PROPOSED ETSA SUBSTATION

OIL, GAS AND COAL DIVISION

by

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GEOPHYSICS

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CONTENTS PAGE NO.

APPENDIX

PLANS

DRG. NO.	FIG NO.	TITLE	SCALE
S19352	1	PROPOSED ETSA SUBSTATION LOCALITY PLAN	1 : 50 000
87-455	2	PROPOSED ETSA SUBSTATION RESISTIVITY CURVES AND INTERPRETATION LINE 210E	1 : 8 000
87-449	3	PROPOSED ETSA SUBSTATION CORRELATION OF RESISTIVITY ANOMALIES	1 : 1 000
87-456	4	PROPOSED ETSA SUBSTATION DEPTH TO WATER TABLE	1 : 1 000
87-457	5	PROPOSED ETSA SUBSTATION ELEVATION OF TOP OF BRIDGEWATER FORMATION	1 : 1 000
87-458	6	PROPOSED ETSA SUBSTATION THICKNESS OF SAND AND CLAY ABOVE BRIDGEWATER FORMATION	1 : 1 000

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Rept. Bk. No. 87/100
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CAVITY INVESTIGATION OVER PROPOSED ETSA SUBSTATION Hd. MINGBOOL CLIENT : ETSA

ABSTRACT

At the request of the Electricity Trust of South Australia a survey using the pole-dipole resistivity technique was carried out over the proposed site of an ETSA substation north of Mount Gambier. A series of correlateable anomalies were delineated which could be attributed to subsurface cavities or variations in the thicknesses of clay and sand above the Bridgewater Formation. Investigation of the anomalies by drilling proved them to be caused by the latter.

INTRODUCTION

At the request of the Electricity Trust of South Australia a survey using electrical methods was carried out over a proposed sub-station site in part of sections 390 and 391 of the Hundred of Mingbool as shown in fig 1. The aim of the survey was to detect the presence of cavities below the surface as an aid to the decision to acquire the land. The fieldwork was done between 30/3/87 and 8/5/87 with a crew of 3. A series of north-south lines 20m apart were traversed using a pole-dipole configuration. A baseline and sighter pegs at 100S and 195 S were established by ETSA surveyors and distances from the baseline were measured using a 100m measuring tape.

The method used is described by Smith (1986). Basically the method consists of a pole-dipole array which incorporates two current and two potential elecrodes arranged linearly. One current electrode is placed at an "effective infinity" (approximately 300m north of the baseline). Measurements are made with the two potential electrodes in the vicinity of the other current electrode.

The field measurements were made with the two potential electrodes at a fixed separation of 4m and moved incrementally over intervals of up to 40m either side of the current electrode along the north-south line. Each "set up" consisted of three current electrodes spaced 16m apart with wires to a distribution box such that they can be selected singly for transmitting current between the one selected and the remote current electrode. A pair of potential electrodes was placed between 40m and 36m north of the most northerly current electrode of the set up and the apparent resistivity was then read using the most northerly current electrode as the current electrode. The potential electrodes were then shifted at 4m intervals towards the current electrodes and readings taken. When the potential electrodes position lay within 36 to 40m of the other current electrodes, apparent resistivity readings were taken using them. Hence a maximum of three readings could be taken for one position of the potential dipole. The readings were tabulated and plotted on log-linear paper and curves drawn for each set of readings relating to each current electrode. An average trend of the curve was delineated and perturbations from the curve were identified as high or low resistivity anomalies from the general trend. On a scale drawing of the vertical section along the line surveyed, arc pairs centred at the local current electrode positions were drawn for each potential electrode pair position for which anomalies were recognised. The actual source of the anomaly was delineated by the intersection of arcs as shown in figure 2.

As an aid to obtaining the general trend of resistivities in the area two vertical electrical soundings with a common centre but at right angles to each other were read at 100E, 100S.

The equipment used to obtain the readings was a BGRM Syscal R2 resistivity meter which was on loan from Wollongong.

Results

Figure 2 shows the resistivity curves and its graphical interpretation for line 210E. This method was used for all lines traversed and the data are held in the Geophysics section. Figure 3 is a plan of the area surveyed showing the resistivity anomalies (both high and low resistivity), a correlation of the

anomalies and location of exploration holes. It was considered that these anomalies could be caused by either the existance of cavities (the high resistivity being caused by air filled cavities and low being water or wet clay filled) or by local variations in the thicknesses of sand and clay layers. From these results a drilling programme was devised to test the anomalies. This programme was carried out by the SADME Drilling Branch using a Mayhew drill and holes were geophysically logged using density and caliper probes. The drilling programme was supervised by F. Stadter, senior geologist Naracoorte.

A total of 32 holes were drilled in the area, 18 of which were sited to investigate the resistivity anomalies. The rest were over an area to the east of the area surveyed. This was done because ETSA decided to move the substation site some 70m to the east.

Appendix A contains logs of the holes drilled and Figure 3 shows the locations of the drill holes.

The general lithological sequence at the site comprises sand and clay, overlying sandstones and sands (known as the Bridgewater Formation).

In summary, no significant sub-surface cavities were intersected by any of the exploration holes. Only one hole (number 24) intersected silts and clay at a depth of between 7 and 9 metres, which may represent an infilled cavity within the Bridgewater Formation. Holes 31 and 32 were drilled on either side of hole 24 to examine the lateral extent of the infilled cavity but these holes only penetrated the typical Bridgewater Formation sequence. The interpretation of the geophysical logging results of selected holes was inconclusive in determining the presence of minor cavities due to the nature of the drilling method and the presence of unconsolidated sands within the Bridgewater Formation.

The depth of the water table was measured in most holes and this was found to vary from 2.2 to 4.5 metres, with this variation being due to the differences in topographic elevation. The depth of the water table for each hole is shown in Figure 4.

A plan showing the elevation of the top of the Bridgewater Formation has been prepared (Figure 5). These data show that the top of the Bridgewater Formation is undulating with a number of depressions which have been filled with sand and clay. The thickness of sand and clay varies from 2 to 15+ metres and the variation in thickness across the site is shown in Figure 6.

Conclusions and Recommendations

As no significant cavities were intersected, it would appear that the resistivity anomalies obtained are caused by the variations in the thicknesses of sand and clay above the undulating Bridgewater Formation, which also has depressions in it. It is recommended that the bearing capacity of the sediments in the depressions be considered in the design of the foundations of any structures. It is considered by the senior geologist at Naracoorte that the Bridgewater formation would provide an adequate base for the foundations of structures.

B.J. Taylor
Supervising Technical Officer

REFERENCE

Smith, D.L., 1986. Application of the pole-dipole resistivity technique to the detection of solution cavities beneath highways. Geophysics, 51, 833-837.

APPENDIX A.

Drill logging sheets; holes 1 to 32

HOLE NO.
1

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	320	EAST	35	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	CLAY - mottled orange and light brown
2	3	SANDSTONE - orange, strongly cemented to uncemented (Transition zone)
		20 - 30% clay
3	5	colour changing to light brown, essentially uncemented
5	9	pale yellow
9	12	finely grained, strongly cemented chips, with medium grained uncemented material.
		0 - 2m recent
		2 - 12m Bridgewater Formation.

FINAL DEPTH (M)	12	WATER CUT (M)	4.45

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Hard drilling 3.5 - 6m. Some lost circulation due to the cuttings packing around the bit. Cleared with foam. Drilled quickly 6 - 12m. Bit blocked with unconsolidated Sandstone. - finished hole at 12m.

S ..... OF ....

HOLE NO.
2

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	320	EAST	85	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	3	CLAY – Varies from light brown to pale orange
3	4	Transition zone with some clay and Sandstone
4	8	SANDSTONE – white to off white, mainly uncemented
8	12	Strongly cemented to uncemented
		0 – 3.5m Recent
		3.5 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.45

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Hole collapsing at 10m - unable to drill to 15m.....

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.....

SHEET ..... OF ....

HOLE NO.
3

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	320	EAST	160	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	CLAY – light brown to pale orange Pliable
2	9	SANDSTONE – grades from a pale orange through to a pale yellow. Essentially unconsolidated, although some strongly cemented fragments.
9	12	Strongly cemented, finely grained fragments, with some uncemented material.
		0 – 2m Recent
		2 – 12m Bridgewater formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.86

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Hole collapsing at approx 11m.

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.....

SHEET ..... OF ....

HOLE NO.
4

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	320 EAST	205 SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	4	SAND – when washed, clear, subangular to subrounded; Average grain size 0.2 – 0.3mm
4	5	30% clay – light blue
5	6	CLAY – light blue
		30 – 40% Sand – as above
6	12	SAND – As above
		minor clay (probably downhole contamination)
		0 – 12m Recent

FINAL DEPTH (M)	12	WATER CUT (M)	Collapsed

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Sand blocking the bit and first drill stem at 12m, hole abandoned due to the collapsing.....

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.....

SHEET ..... OF ....

HOLE NO.
5

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	290	EAST	35	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	3	CLAY – varies in colour from brown, light grey to pale orange
3	9	SANDSTONE – pale yellow, strongly cemented to uncemented
9	12	mainly strongly cemented, finely grained fragments.
		0 – 3m Recent
		3 – 12m Bridgewater formation

FINAL DEPTH (M)	12	WATER CUT (M)	4.23

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Hole collapsing at 10m.

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HOLE NO.
6

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	290	EAST	95	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	18m	SAND – clear to frosted, angular to subrounded; Varies 0.1mm to 1.2mm average grain size 0.2mm.
		0 – 18m Recent
		(possibly 15 – 18m BRIDGEWATER FORMATION).

FINAL DEPTH (M)	18	WATER CUT (M)	2.0

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: ...Top. of Bridgewater. 14.5. - .15m. (Driller. Rept) . -. didn't show in. the. sampling. .....

.....No evidence of. any. cavities. . Site. in. the. middle. of. a. depression which. appears to. be. .....

.....infilled. with. sand. . Sample. recovery. poor. .....

HOLE NO.
7

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	290	EAST	160	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	CLAYEY SAND – brown to light orange
2	3	CLAY – mottled brown and orange
3	8	SANDSTONE – grades from pale orange to light yellow, essentially unconsolidated
8	10	strongly cemented, finely grained chips now the dominent constituent.
		0 – 3m Recent
		3 – 10m Bridgewater formation

FINAL DEPTH (M)	10	WATER CUT (M)	3.91

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

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COMMENTS: ....Drilled easily.....

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HOLE NO.
8

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	290	EAST	205	SOUTH

DEPTH (M)		GEOLOGICAL LOG
FROM	TO	
0	1	SAND
1	3	CLAY - light grey
3	9	SANDSTONE - pale yellow, strongly cemented to uncemented
9	15	greater percentage is strongly cemented fragments

FINAL DEPTH (M)	15	WATER CUT (M)	Collapsed

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: .....Hole collapsing at 11m.....

.....

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EET ..... OF ....

HOLE NO.
9

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	250	EAST	30	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	3	CLAY – mottled brown & orange
		10 – 20% Sand
3	6	SANDSTONE – pale orange to white, strongly cemented to uncemented.
6	12	As above with a colour change to pale yellow to white.
		0 – 3m Recent
		3 – 12m Bridgewater Formation.

FINAL DEPTH (M)	12	WATER CUT (M)	About 4

LOST CIRCULATION AT: 11.5m due to the cuttings packing around the bit.

GEOPHYSICAL LOGGING RESULTS:

COMMENTS: Hole collapsing at 6m (sand)

SHEET ..... OF ....

HOLE NO.
10

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	250	EAST	85	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	4	CLAY – varies in colour from light and dark greys, pale orange to red streaks.
4	9	SANDSTONE – off white, mainly uncemented with some strongly cemented fragments.
9	10	finely grained, strongly cemented fragments the dominant constituent.
		0 – 4m Recent
		4 – 10m Bridgewater formation

FINAL DEPTH (M)	10	WATER CUT (M)	3.67

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

COMMENTS: .....Hole collapsing at 7m.....

SHEET ..... OF ....

HOLE NO.
11

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	250	EAST	~~85~~ 160	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	CLAY – light brown to light orange
2	3	SANDSTONE and CLAY Transition zone
3	7	SANDSTONE – light orange grading to light yellow, mainly uncemented
7	10	strongly cemented fragments increasing in percentage
		0 – 2.5m Recent
		2.5 – 10m Bridgewater Formation

FINAL DEPTH (M)	10	WATER CUT (M)	4.10

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

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COMMENTS: Drilled easily.

.....

.....

SHEET ..... OF ....

HOLE NO.
12

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	250	EAST	205	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – mottled yellow & brown. Plastic.
1	2	CLAY – light grey
2	4	SANDSTONE – pale orange in colour, essentially uncemented
4	7	pale yellow, uncemented
7	13	SANDSTONE – pale yellow to light orange, fine grained strongly cemented to uncemented reworked fossil material.
13	15	strongly cemented percentage increasing.
		0 – 2m Recent
		2 – 15m Bridgewater Formation

FINAL DEPTH (M)	15	WATER CUT (M)	3.2

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logging depth 14m. Both Caliper and density show minor airlift cavities.

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COMMENTS: Top of Bridgewater approximately 1.5m. Reasonable consolidated.

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HOLE NO.
13

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	230	EAST	174	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – grey to pale orange
1	3	CLAY – light grey, pliable
3	4	SANDSTONE – brown, strongly cemented to uncemented
4	5	colour lightening to a pale yellow.
5	6	essentially unconsolidated.
		0 – 3m Recent
		3 – 6m Bridgewater Formation

FINAL DEPTH (M)	6	WATER CUT (M)	3.8

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Log depth 5m. Density shows water level at 3.7m Caliper shows well variations.

COMMENTS: Indurated Bridgewater from approximately 3m.

SHEET ..... OF ....

HOLE NO.
14

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	230	EAST	202	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – grey to brown
		40% Topsoil – organic material
1	2	CLAY – mottled orange, grey and red
2	4	SANDSTONE – pale orange, strongly cemented to uncemented.
4	6	pale yellow, finely grained, strongly cemented fragments to moderately grained uncemented material.
		0 – 2m Recent
		2 – 6 m Bridgewater Formation

FINAL DEPTH (M)	6	WATER CUT (M)	3.5

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

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COMMENTS: ....Top of Bridgewater is approximately 2.7m .....

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SHEET ..... OF ....

HOLE NO.
15

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	230	EAST	230	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	SAND - clear, subangular to subrounded. Average grain size 0.2 - 0.3mm
2	3	10 - 20% Silt - black
3	5	Sand when unwashed has a white colour
5	6	Changing to a light orange.
		0 - 6m recent

FINAL DEPTH (M)	6	WATER CUT (M)	___

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: ...Logging depth 5m. Density shows water level at 3m Caliper shows little variation.....

COMMENTS: ..Sand to 6m - caving at 6m, unable to drill further.....

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SHEET ..... OF ....

HOLE NO.
16

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	230	EAST	334	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	SAND – clear to frosted, subangular to subrounded. Average grain size 0.2mm – 0.3mm.
2	6	Minor black silt.
		0 – 6 Recent

FINAL DEPTH (M)	6	WATER CUT (M)	Collapsed

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: .....Sand persisted to 6m . . . caving at 6m Unable to drill further.....

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SHEET ..... OF ....

HOLE NO.
17

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	210	EAST	94	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	CLAY – mottled brown & orange
2	4	SANDSTONE – dark brown, strongly cemented to uncemented.
4	6	pale yellow, moderately grained.
6	9	essentially unconsolidated material.
9	12	now becoming strongly cemented & finely grained as the dominant feature.
		0 – 2m Recent
		2 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.4

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .... Logging depth 10.5m Density shows water table at 3.4m Caliper ..... shows normal well variation. .....

COMMENTS: .. Hole collapsing at 10m. .....

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HOLE NO.
18

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	190	EAST	82	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – mottled brown & orange
1	2	SANDY CLAY – brown.
2	4	CLAY – light brown
4	7	SANDSTONE – pale orange, essentially unconsolidated reworked fossil material
7	8	colour changing to pale yellow
8	12	strongly cemented, finely grained chips and uncemented material.
		0 – 4m Recent
		4 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.35

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Log depth 10.5m Density shows water table at approximately 3.3m, unable to determine interface. Caliper shows more side of hole weathering after 4m.

COMMENTS: Drilled quickly from 7 – 9m Hole collapsing at 9m.

SHEET ..... OF ....

HOLE NO.
19

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	190	EAST	170	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – mottled orange and brown
1	2	CLAY – light grey
2	3	SANDSTONE – orange, strongly cemented to uncemented
3	4	essentially unconsolidated
4	10	colour changing to a pale yellow. Medium grained.
10	12	strongly cemented finely grained chips to moderately grained uncemented fragments.
		0 – 2m Recent
		2 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.4

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logging depth 9.5m Density shows water table at 3.4m caliper shows minor hole variations.

COMMENTS: Top of Bridgewater approximately 2.8m. Fairly unconsolidated, some hard bands.

SHEET ..... OF ....

HOLE NO.
20

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	190	EAST	244	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	SAND – natural state coloured brown to white, when washed, subangular to subrounded. Average grain size 0.2mm – 0.3mm
1	2	CLAY – light blue to light grey
2	3	CLAY – Light grey.
3	4	Interface between the clay and the sandstone
4	5	SANDSTONE – Light orange, some strongly cemented fragments but mainly uncemented reworked fossil fragments.
5	7	SAND – clear; Average grain size 0.3 – 0.4mm 30% Sandstone – unconsolidated
7	9	SANDSTONE – mainly strongly cemented chips with some uncemented material. 20 – 30% Sand – as above
9	12	40 – 50% sand – as above
		0 – 3.5m Recent
		3.5 – 12m Bridgewater formation

FINAL DEPTH (M)	12	WATER CUT (M)	2.3

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logging depth approximately 8m, both caliper and Density show an airlift cavity at 4m.

COMMENTS: Fairly unconsolidated (easy drilling), Unconsolidated sand at approximately 8m. Blocked bit and caving – unable to drill further.

HOLE NO.
21

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	150	EAST	140	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	7	CLAYEY SAND – clear, subangular to subrounded. Average grain size 0.2mm
		Minor clay component.
7	9	CLAY – light grey
9	12	SANDSTONE – pale yellow to off white, essentially strongly cemented fragments.
12	15	SAND – clear, average grain size 0.2mm to 0.3mm
		10 – 20% Sandstone – strongly cemented.
		(Hard to ascertain whether the 12 – 15m is genuine or merely downhole contamination).
		0 – 9m Recent
		9 – 12m Bridgewater Formation
		12 – 15m ?

FINAL DEPTH (M)	15	WATER CUT (M)	3.7

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Due to hole collapsethe Caliper & Density could only reach 6.5m and both show cavities created by the airlifting.

COMMENTS: Drilled slowly from 6 – 9.5m (Top of the Sandstone)

HOLE NO.
22

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	150	EAST	200	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	CLAY – Light orange
1	3	CLAY – Light grey
3	5	SANDSTONE – light orange, strongly cemented to uncemented
5	8	colour changing to a pale yellow
8	12	varies from strongly cemented, finely grained chips to uncemented reworked fossil fragments.
12	15	increasing amount of strongly cemented material
		0 – 3 Recent
		3 – 15m Bridgewater Formation

FINAL DEPTH (M)	15	WATER CUT (M)	3.45

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: ...Log depth 11m.. Density shows very little... Caliper shows an..... airlift cavity between 9 – 10m.

COMMENTS: .....Hole collapsing at 10.5m with foam used to lift the cuttings.....
Hard drilling 14 – 15m.

HOLE NO.
23

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	110	EAST	34	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	CLAY – mottled orange and light brown
2	3	SANDSTONE – light orange, unconsolidated shell and reworked fossil material
3	7	colour lightening to a white
7	10	strongly cemented, orange to light brown, finely grained chips with white, uncemented fossil and shell gragments.
		0 – 2m Recent
		2 – 10m Bridgewater formation

FINAL DEPTH (M)	10	WATER CUT (M)	3.51

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logging depth 5.5m Caliper shows minor hole variations

COMMENTS: Drilled easily

SHEET ..... OF ....

HOLE NO.
24

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	110	EAST	136	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	TOPSOIL & CLAY
1	2	CLAY – light grey. Plastic.
2	3	CLAY – pale orange. Plastic.
3	4	SANDSTONE & CLAY – transition zone.
4	5	SANDSTONE – light brown, strongly cemented to uncemented.
5	7	colour changing to a light grey, mainly uncemented.
7	9	SANDSTONE – white, strongly cemented.
		20 – 30% Silt & clay – black
		20 – 30% Sand – clear, average grain size 0.2mm.
9	12	SANDSTONE – light orange, strongly cemented, finely grained to pale yellow
		uncemented matter.
		0 – 3.5m Recent
		3.5 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.36

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logs could only penetrate to 6m. Density shows the top of the water table at 3.4m. Airlift cavity at approximately 5.5m.

COMMENTS: Anomaly at 7 – 9m.

HOLE NO.
25

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	110	EAST	188	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	1	CLAY – light brown to pale orange.
1	3	CLAY – light grey
3	4	SANDSTONE – light orange, essentially unconsolidated material with some strongly cemented fragments.
4	8	pale yellow, uncemented.
8	15	light orange coloured, strongly cemented, fine grained chips with white, unconsolidated material.
		0 – 3m Recent
		3 – 15m Bridgewater Formation

FINAL DEPTH (M)	15	WATER CUT (M)	3.25

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Log depth 7.5mm. Caliper shows several small cavities caused by the airlifting.

COMMENTS: Drilled easily from 12 – 15m.

SHEET ..... OF ....

HOLE NO.
26

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	90	EAST	94	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	4	SAND – overall light brown, when washed clear to frosted, subangular to subrounded. Average grain size 0.2mm – 0.3mm.
4	6	CLAY & SAND – clay is grey and pliable. Sand is as above.
6	7	CLAY – light blue. Pliable.
7	15	SANDSTONE – pale yellow, strongly cemented – fine grained. 30 – 40% Sand – possible downhole contamination
		0 – 7m Recent
		7 – 15m Bridgewater Formation

FINAL DEPTH (M)	15	WATER CUT (M)	2.72

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Logs extend to 8m. Density shows probable water table at 2.6m. Caliper shows airlift cavities in the first 4m of Sand.

COMMENTS: Soft drilling between 8 – 9m. Hole collapsing 11 – 15m behind the bit.

HOLE NO.
27

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS:	150	EAST	24	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	CLAY - mottled brown & orange. Pliable
2	9	SANDSTONE - light brown, essentially unconsolidated shell and fossil material
9	12	finely grained, strongly cemented fragments appearing
		0 – 2m Recent
		2 – 12m Bridgewater Formation

FINAL DEPTH (M)	12	WATER CUT (M)	3.89

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Density log depth 8m - shows wall variation and little else.

Caliper log depth 9.4 - shows airlift cavity around 8m in the unconsolidated Bridgewater.

COMMENTS: Very hard drilling 8 – 12m hole collapsing at approximately 10m.

HOLE NO.
28

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	170	EAST	12	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	CLAY – light brown
2	5	SANDSTONE – Light brown, strongly cemented to uncemented
5	7	pale yellow, essentially unconsolidated
7	10	strongly cemented, finely grained pale orange fragments along with pale yellow uncemented material.
		0 – 2 Recent
		2 – 10 Bridgewater Formation

FINAL DEPTH (M)	10	WATER CUT (M)	3.75

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: Log depth 7m Density shows water table at 3.7m and an airlift cavity at 1.8m & 5.5 Caliper shows the same airlift cavities

COMMENTS: Drilled easily

SHEET ..... OF ....

HOLE NO.
29

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	310	EAST	205	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	SAND - Clear, average grain size 0.2mm - 0.3mm
2	5	CLAY - light grey, Pliable
5	11	SAND & SANDSTONE - strongly cemented to uncemented Ironstone - red brown, ferruginous nodules.

FINAL DEPTH (M)	11	WATER CUT (M)	2.57

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

.....

COMMENTS: Infill hole

.....

.....

SHEE ... 0 ...

HOLE NO.
30

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	300	EAST	205	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	1	SAND – brown
1	2	SAND – white
2	5	SAND – grey
5	7	SAND and clay – light blue
7	12	SAND – grey
		30 – 40% Sandstone – pale orange, strongly cemented to uncemented.
		0 – 12m Recent

FINAL DEPTH (M)	12	WATER CUT (M)	2.21

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

COMMENTS: Sand infill pocket. The driller commented that the last 4m drilled like it was Bridgewater formation, possibly with the cuttings blowing into the sand cavity created by the airlifting.

SHEET ..... OF ....

HOLE NO.
31

PROPOSED ETSA SUB-STATION
DRILLING PROGRAMME

HOLE CO-ORDS.	130	EAST	135	SOUTH

DEPTH (M) FROM	TO	GEOLOGICAL LOG
0	2	CLAY – grey to light brown
2	4	SANDSTONE – light orange, strongly cemented to uncemented
4	10	colour graduating to a light yellow, essentially unconsolidated although still a high percentage of strongly cemented material
		0 – 2m Recent
		2 – 10m Bridgewater Formation

FINAL DEPTH (M)	10	WATER CUT (M)	3.36

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

COMMENTS: Drilled easily.

SHEET ..... OF ....

HOLE NO.
32

PROPOSED ETSA SUB-STATION

DRILLING PROGRAMME

HOLE CO-ORDS.	90	EAST	140	SOUTH

DEPTH (M) FROM	DEPTH (M) TO	GEOLOGICAL LOG
0	2	CLAY -- grey to light brown
2	6	SANDSTONE - light orange changing to light yellow; strongly cemented to uncemented.

FINAL DEPTH (M)	6	WATER CUT (M)	3.50

LOST CIRCULATION AT: .....

GEOPHYSICAL LOGGING RESULTS: .....

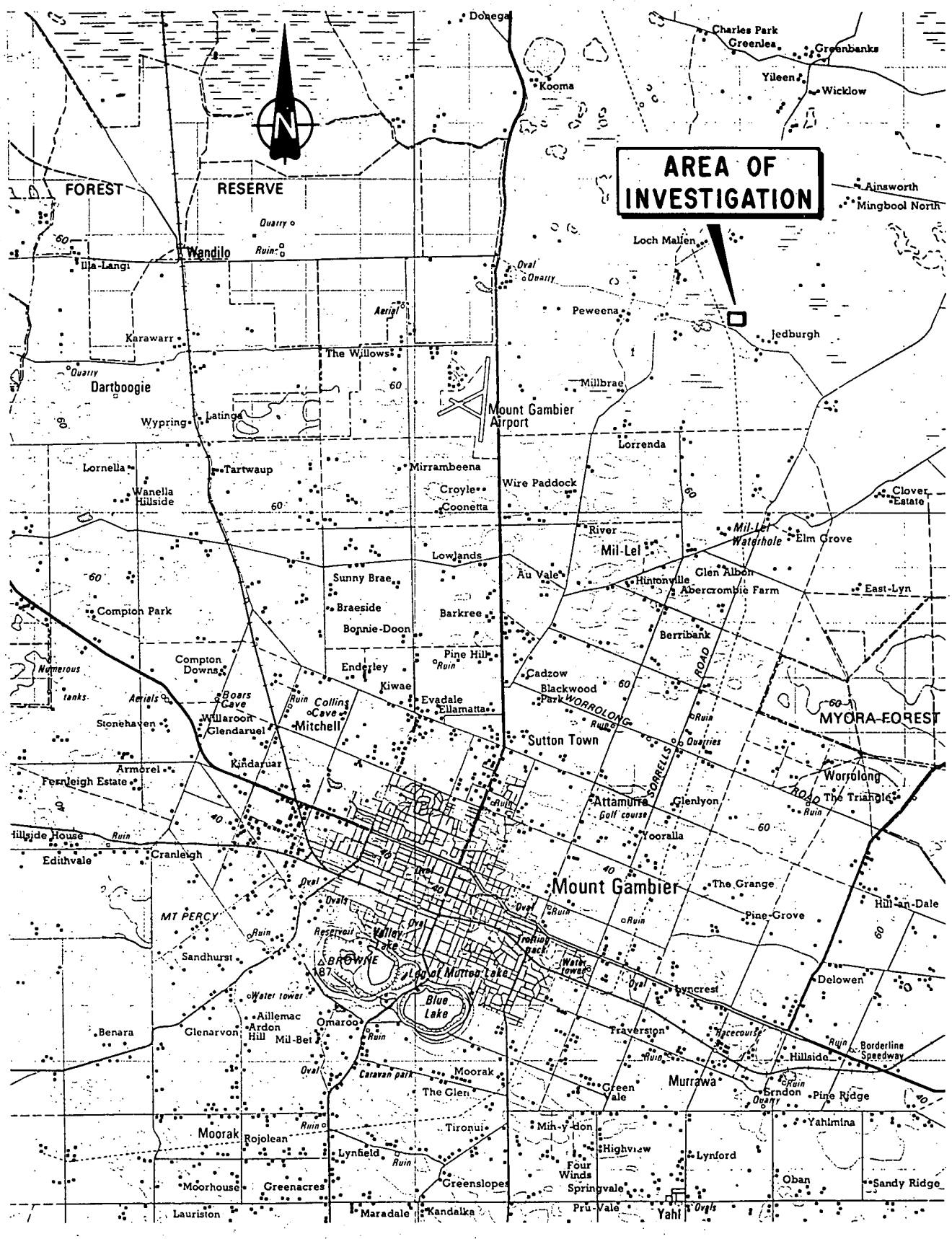
.....

COMMENTS: ....Drilled easily.....

.....

.....

SHEET ..... OF ....



SCALE IN KILOMETRES

1 0 1 2 3 4 5

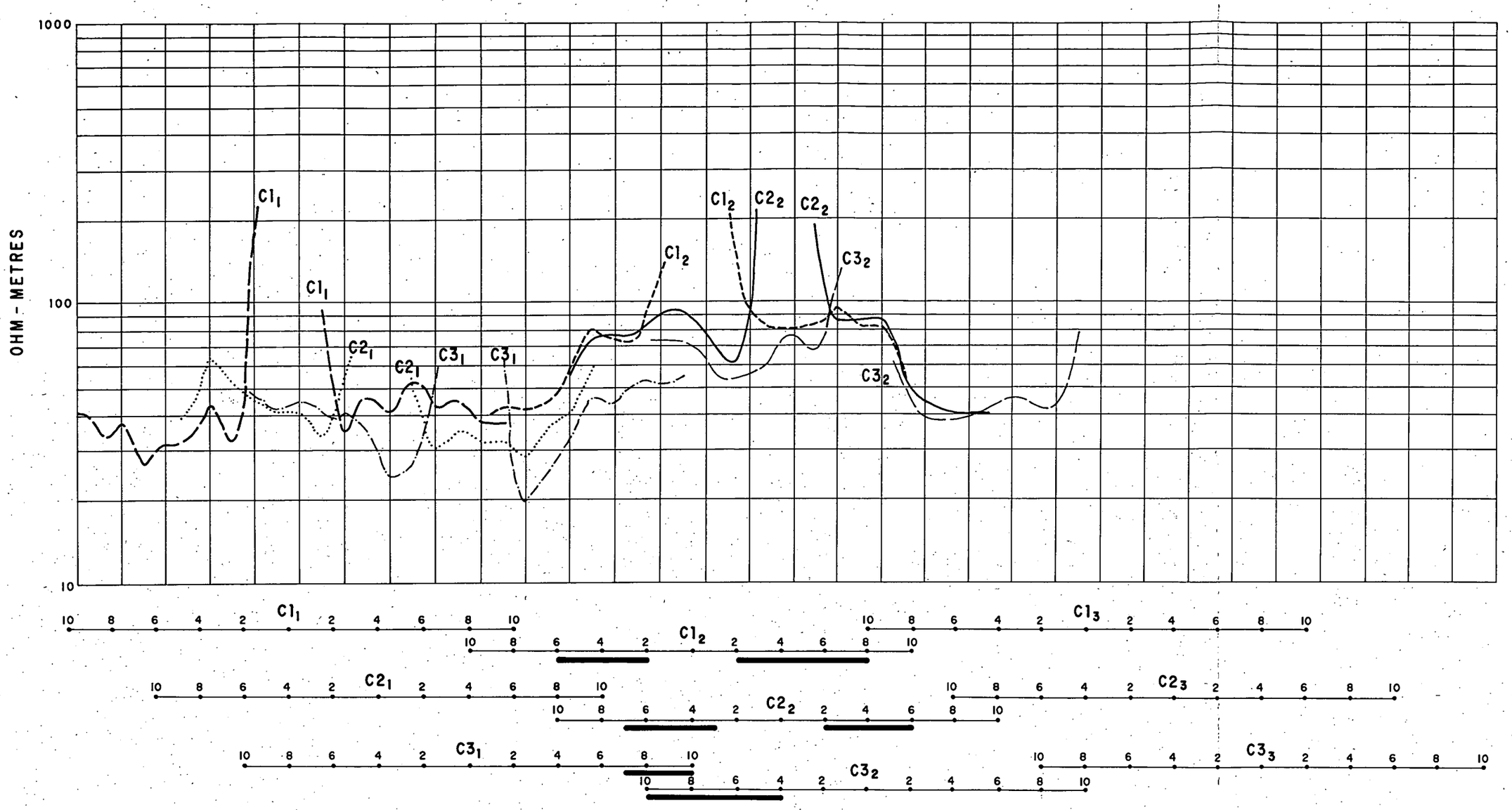
Fig.....1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COMPILED B.J.T.	22.9.87 C.D.O. DATE
DRAWN R.H.	SCALE 1:100 000
DATE JUNE 1987	PLAN NUMBER
CHECKED	S19352

PROPOSED ETSA SUB-STATION , MOUNT GAMBIER
PT. SECS. 390 , 391 HD. MINGBOOL
LOCALITY PLAN

4417



LINE 210E

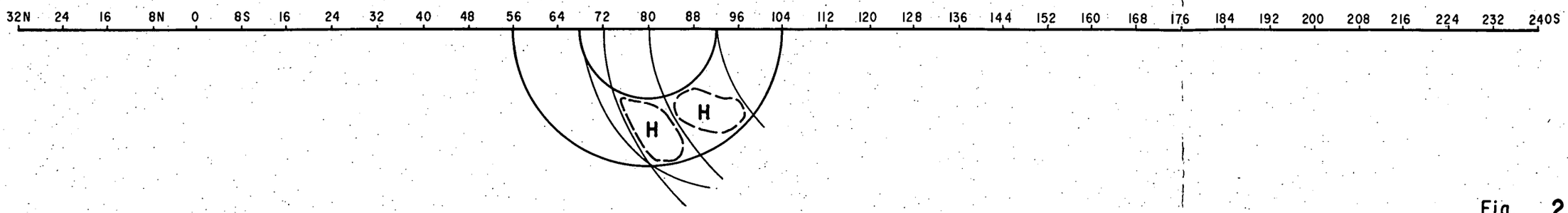


Fig.....2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PROPOSED ETSA SUB-STATION , MOUNT GAMBIER
PT. SECS. 390 , 391 , HD. MINGBOOL

RESISTIVITY CURVES AND INTERPRETATION

COMPILED B.J.T.	C.D.O. 22-9-87 DATE
DRAWN R.H.	SCALE
DATE June 1987	PLAN NUMBER 87-455
CHECKED	

4417

10E 30E 50E 70E 90E 110E 130E 150E 170E 190E 210E 230E

Sec. 390

Sec. 391

PONDA ROAD

LEGEND

- L..... LOW RESISTIVITY ANOMALY
- H..... HIGH RESISTIVITY ANOMALY
- D..... DEEP
- NS..... NEAR SURFACE
- ..... CORRELATION
- 68·5 ..... ELEVATION CONTOUR (mAHD)
- •19 EXPLORATION HOLE

SCALE IN METRES

20 0 20 40 60 80 100

Fig.....3

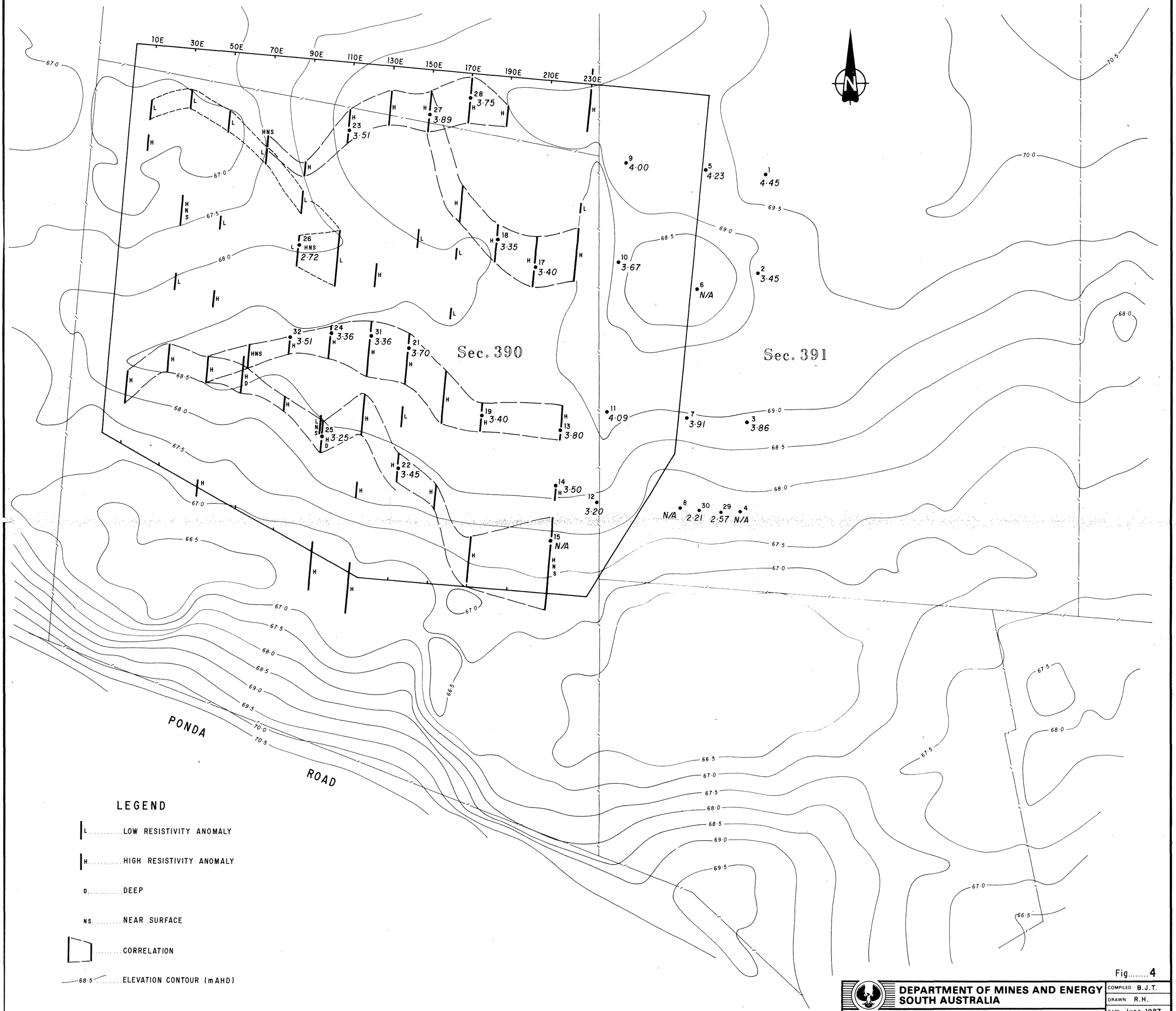
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PROPOSED ETSA SUB-STATION , MOUNT GAMBIER
PT. SECS. 390 , 391 , HD. MINGBOOL

CORRELATION OF RESISTIVITY ANOMALIES AND LOCATION OF EXPLORATION HOLES

COMPILED	B.J.T.
DRAWN	R.H.
DATE	June 1987
CHECKED	
C.D.O.	22.9.87 DATE
SCALE	1:1000
PLAN NUMBER	87-449

4417



LEGEND

- L ..... LOW RESISTIVITY ANOMALY
- H ..... HIGH RESISTIVITY ANOMALY
- D ..... DEEP
- NS ..... NEAR SURFACE
- ..... CORRELATION
- 68·5 ..... ELEVATION CONTOUR (mAHD)
- 3·25 ..... DEPTH TO WATER TABLE (m)
- N/A ..... MEASUREMENT NOT AVAILABLE
- ● 27 ..... EXPLORATION WELL

SCALE IN METRES

20 0 20 40 60 80 100

Fig. 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PROPOSED ETSA SUB-STATION , MOUNT GAMBIER
PT. SECS. 390 , 391 , HD. MINGBOOL

DEPTH TO WATER TABLE

COMPILED	B.J.T.
DRAWN	R.H.
DATE	June 1987
CHECKED	
C.D.O. DATE	22·9·87
SCALE	1:1000
PLAN NUMBER	87-456

10E 30E 50E 70E 90E 110E 130E 150E 170E 190E 210E 230E

Sec. 390

Sec. 391

28 66·8
27 66·7
23 66·6
9 66·1
5 66·4
1 67·6
18 64·5
17 66·6
10 65·0
2 65·0
6 52·5 ?
32 66·6
24 65·0
31 66·6
21 59·6
19 66·7
13 65·7
11 66·5
7 66·0
3 67·0
25 65·4
22 65·4
14 66·5
12 66·5
8 64·7
30 55·7
29 57·7
4 54·6
15 62·0
60·9 26 HNS

PONDA ROAD

LEGEND

- L ..... LOW RESISTIVITY ANOMALY
- H ..... HIGH RESISTIVITY ANOMALY
- D ..... DEEP
- NS ..... NEAR SURFACE
- ..... CORRELATION
- 68·5 ..... ELEVATION CONTOUR (mAHD)
- ●29 EXPLORATION HOLE
- 55·7 ELEVATION OF TOP OF BRIDGEWATER FMN. (mAHD)
- 65 STRUCTURE CONTOUR, TOP OF BRIDGEWATER FMN. (mAHD)

SCALE IN METRES

20 0 20 40 60 80 100

Fig..... 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PROPOSED ETSA SUB-STATION, MOUNT GAMBIER
PT. SECS. 390, 391, HD. MINGBOOL

ELEVATION OF TOP OF BRIDGEWATER FORMATION

COMPILED	B.J.T.
DRAWN	R.H.
DATE	June 1987
CHECKED	
C.D.O. DATE	22-9-87
SCALE	
PLAN NUMBER	87-457

4417

10E 30E 50E 70E 90E 110E 130E 150E 170E 190E 210E 230E

Sec. 390

Sec. 391

PONDA ROAD

LEGEND

- L ..... LOW RESISTIVITY ANOMALY
- H ..... HIGH RESISTIVITY ANOMALY
- D ..... DEEP
- NS ..... NEAR SURFACE
- ..... CORRELATION
- 68·5 ..... ELEVATION CONTOUR (mAHD)
- • 25 ..... EXPLORATION HOLE
- 3 ..... THICKNESS OF SAND AND CLAY (m)

SCALE IN METRES

20 0 20 40 60 80 100

Fig..... 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PROPOSED ETSA SUB-STATION , MOUNT GAMBIER
PT. SECS. 390 , 391 , HD. MINGBOOL

THICKNESS OF SAND AND CLAY
ABOVE BRIDGEWATER FORMATION

COMPILED	B.J.T.
DRAWN	R.H.
DATE	June 1987
CHECKED	
C.D.O. DATE	22.9.87
SCALE	1:1000
PLAN NUMBER	87-458

4417