AN ENGINEERING GEOLOGICAL INVESTIGATION OF THE URBAN LAND AUTHORITY'S PROPERTY, MELTON

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ABSTRACT

An engineering geological investigation was carried out on land at Melton to determine the viability of subdivision and house construction. The site has two serious limitations - deep expansive soils and active soil subsidence - which will require expensive engineered solutions. A description of the geology and pedology is detailed and the potential development hazards, together with some possible engineering applications are discussed.

KEYWORDS

Engineering Geology, Site investigation, Gilgai, Soils

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1 INTRODUCTION

A request from the Urban Land Authority was received on 16 October 1984 for engineering geology advice on the area known as the "sink-hole plain" at Bimbadeen Estate, Melton. Following subsequent negotiations, the service of the Office of Minerals and Energy (OME) was engaged to carry out an investigation in order to assess the geological constraints on the proposed urban development of the site. Of specific interest are the geological parameters which would affect the subdivision density, domestic housing foundations, sewage effluent disposal and road making. Investigative works commenced in Febuary 1985.

2 SCOPE OF THIS REPORT

This report specifically addresses the engineering geological conditions which are of concern to the urban development of the site. It covers the physical details of the site; relevant site history and previous work in the area; investigative work carried out; the nature, causes and engineering significance of potential hazards; and suggested solutions.

Recommendations are made in respect to the site geological conditions only and do not take into account any other factors (such as the preservation of the environment) which may affect development decisions.

3 SITE DETAILS

3.1 Location

The site is situated approximately 40km W.N.W. of Melbourne in the N.W. corner of the Melton development area (Fig. 1). The area of the site is approximately 50Ha and it is bounded by Harkness Road to the west, farmland to the north and a proposed regional cemetery to the south and east.

3.2 Vegetation

The vegetation on the site comprises mostly eucalypts - grey box and some yellow gum - which vary in size (5 to 50cm diam.; 2 to 20 m high). The larger trees have been removed in the past as indicated by a number of stumps and some coppice regrowth.

Understorey vegetation (mostly boxthorn bushes) is scattered among the trees and along the fences.

3.3 Land use

The area is currently owned by the ULA and until recently was used for grazing.

Discussion with the adjoining property owner, Mr T Minn, revealed that the treed portion of the site had been used for grazing within his memory (over 60 years) and had probably never been ploughed.

An historic air-photo (11/11/1931) confirms this observation and shows the site as being almost unchanged from its present condition.

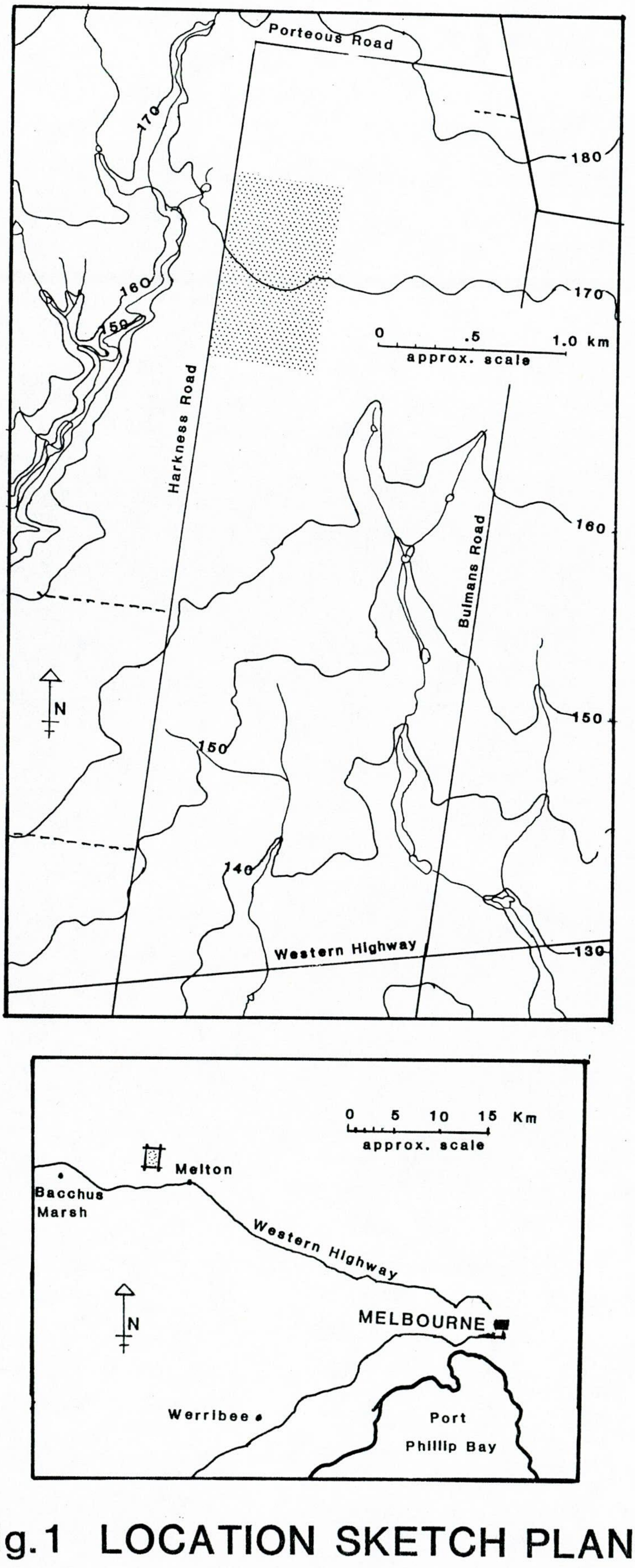


Fig.1 LOCATION SKETCH PLAN

3.4 Topography

The most striking features of the site are the surface undulations. These vary from broad depressions up to 1.5 metres deep to smaller "sinkholes" only one metre wide but one metre deep. Some gentle mounding is obvious, although depressions far out-number the mounds.

The mechanism causing the subsidence is still apparently active since "sinkhole" development has been observed over the past three years. Mr Minn has observed that although the depressions have always been there, they appear to be getting bigger and more numerous.

The undulations are largely confined to the treed area, particularly the recent subsidence, although the immediately surrounding areas contain some broad depressions.

The causes and significance of these depressions are discussed in sections 7.2, 7.3 and 8.2

4 PREVIOUS WORK AND LITERATURE

4.1 Investigations by the Geological Survey

The earliest known investigations in the area were carried out in 1894 when a bore was sunk just to the north of the site as part of a regional investigation for minerals. The stratigraphic sequence was recorded as:

3 ft 2 in surface clay, 100 ft 5 in basaltic rocks, 14 ft 6 in yellow and light clays, 3 ft 11 in gravelly clay and gravel, 4 ft 6 in gravel or fine washdirt; bottomed on sandstone at 126 ft 6 in.

No samples of this bore are recorded at the core store.
In 1958 Kenley mapped the site as being covered by Djerriwarrh High Level Gravels, Pliocene(?) to middle Tertiary in age.

In 1974 VandenBerg mapped the gravels covering the site as being Darley Gravels of Pliestocene age.

In 1983 engineering geological mapping of the Melton proposed development area was commenced by this author. As part of this project shallow bores were drilled along Harkness, Porteous and Bulmans Roads. The soil core recovered from these bores was logged and some samples were tested. Some standpipes were later installed to monitor any shallow groundwater, however none has been recorded.

Following a request by the Health Commission in August 1984 an investigation was carried out on a large tract of land owned by the ULA, to determine its suitability for the establishment of a regional cemetery. The area investigated included the "sinkhole plain" where drilling and backhoe excavations were carried out. The report concluded that a large portion of the area was suitable for cemetery development, however the undulating area was not.

4.2 Other Investigations

4.2.1 The geology and physiography of the region has been previously described by Kitson (1901) who described the area along the lower Werribee valley; Fenner (1918) who wrote a long and detailed account of the physiography of the Werribee River; Condon (1948 & 1950) who carried out a detailed survey of the lower Werribee River; and Forbes (1948) who studied the erosion of the Melton Reservoir catchment .

4.2.2 The Soil Conservation Authority (SCA) reported on "Erosion and its control during urban and drainage development of the Melton area" in 1978. This report dubbed the site the "sinkhole plain" and showed it as a separate land unit. A brief description of the site is included in the report and it is suggested that further investigation be carried out before the land-use is changed.

The SCA report was prepared for the Dandenong Valley Authority (DVA) who completed a "Melton drainage study" of the development area in 1980.

4.2.3 The Melton-Sunbury interim co-ordinating committee published six volumes of planning strategies, produced by consultants in the period 1976-77. The physical structure concept plan of the site is presented in Volume 3 (Clarke Gazzard Planners - 1976); The site is recommended as an area for "infill and redevelopment residential/-commercial", although it is also ranked as an area of natural environmental significance and regarded as having recreation potential.

5 ADDITIONAL SITE INVESTIGATION WORK

5.1 Drilling

Two bores were drilled to depths of 15.5 m and 15.9 m respectively using the OME's Gemco 210B rotrary drilling rig. The soil profile was sampled using hollow augers and thin-walled sampling tubes. Diamond drilling was carried out in the underlying rock and NQ rock core was retreived for examination.

5.2 Geophysics

Geophysical exploration was conducted in order to establish the nature of the soil-rock interface. Two refraction seismic survey lines were run using a 24 channel seismograph, a 3 m geophone spacing and gelignite as an energy source. The results of this survey are presented in Appendix III.

5.3 Site Examination

Site visits were conducted with collegues Messrs A M Cooney and M K Cecil (10/5/1984), and Mr J L Neilson (10/10/84) of the OME; and Mr J Maher, Scientific Officer, from the Department of Agriculture (21/3/85). The on-site discussions were fruitful in the search for a subsidence mechanism.

6 GEOLOGY

6.1 Regional Geology

VandenBerg's 1974 Sunbury sheet (1:63,360) shows the regional geology of the area as being Upper Ordovician sediments overlain by Tertiary (Pliocene) Bullengarook Gravels, Tertiary (Pliocene) Newer Volcanics and Quaternary (Pleistocene) Darley Gravel. More recent work has re-positioned the Djerriwarrh Fault to the west of the site and re-established an ancient eruption point or maar to the north. Roberts (1984) does not accept the name Darley Gravels for the post-Newer Volcanic material, prefering to refer to them as simply alluvial outwash.

The regional geology is summarized in figure 2.

6.2 Site Geology

No rock outcrop occurs on site, hence the geology is interpreted from borehole information, geophysical exploration, surface mapping and regional trends.

6.2.1 Upper Ordovician.

The basement rock of the area is regarded as the sediments of the Upper Ordovician age. These outcrop along Djerriwarrh Creek to the west of the site and were encountered in the boreholes drilled on the site. In outcrop, they typically consist of closely and steeply folded interbedded shales, sandstones and greywacke. In the core retrieved from the bores this horizon is represented by fine to medium grained, yellow-brown sandstone with some quartz veining.

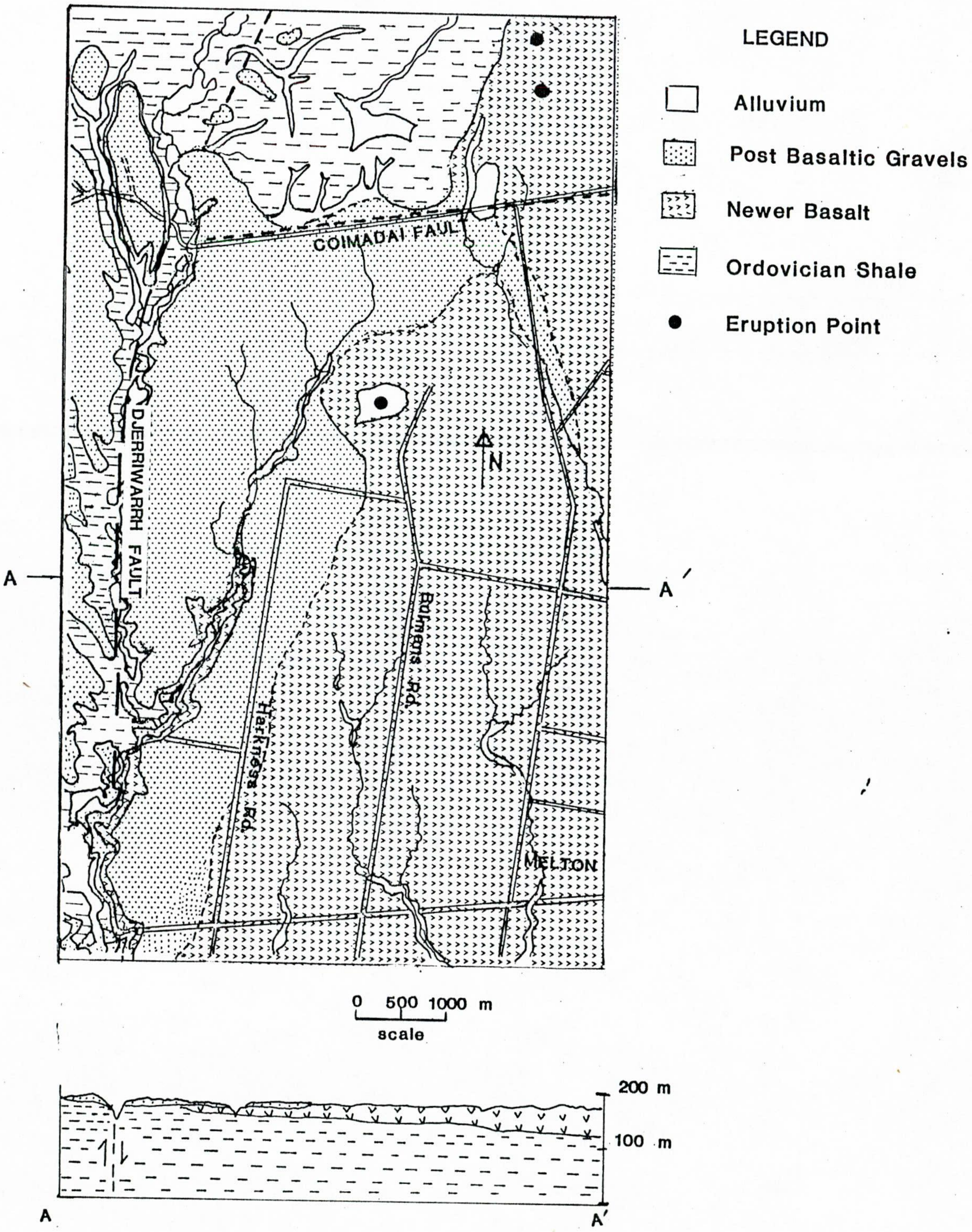


Fig 2 REGIONAL GEOLOGY

6.2.2 Tertiary (Pliocene) Gravels

Unconformably resting on the Upper Ordovician sediments are the Pliocene gravels, sands, silts and clays of the Bullengarook Gravel formation. These are exposed along Djerriwarrh Creek as unconsolidated silty sands and gravels with occassional ferruginous horizons. In the boreholes, core recovery was poor through this section, with the material retreived being mostly clayey sands and gravels. Some carborate-cemented sands were recovered from the lower portion of the section in both bores.

6.2.3 Tertiary (Pliocene) Newer Volcanics.

Disconformably overlying the Bullengarook Gravel are the ancient lava flows which make up the Newer Volcanics. These are exposed on the bank of Djerriwarrh Creek and shown in the boreholes to be olivine basalts, ranging from fresh to completely weathered and dense to vesicular. The thickness of the basalt increases regionally to the east, as shown by the cross-section in figure 2. It appears that only one basalt flow, approximately 4 metres thick, is represented in the bores on site.

The depth of weathering, represented by the soil thickness, is unusually deep for the Newer Volcanics of the Melton area and may reflect that the parent material was of pyroclastic origin. The source for such material could be the eruption point to the north of the site, which has the same dimensions and gravity signature as a maar (L. Thomas pers. comm.).

Scoria is present in bores along Porteous and Harkness Roads to the north and east of the site, although at a depth of only two metres or so. This adds weight to the theory of the eruption point being explosive, although whether it provided the parent material for the deep plastic clays remains academic.

6.2.4 Quaternary (Pleistocene) gravels

Overlying the basaltic clays of the weathered Newer Volcanics is a thin variable layer of silty sands and gravels of Pliestocene age. These have been variously described in previous literature as shoreline deposits (Kitson 1901), alluvial outwash (Fenner 1918), and lake deposits (Condon 1948). VandenBerg (1974) and Roberts (1984) regard these post-basaltic gravels to be alluvial outwash derived from the Ordovician rocks of the Coimadai Fault scarp, 4 kilometres to the north of the site.

The thickness of the deposit varies from a centimetre or so, to half a metre in places around the site. The boundary between the gravels and the basaltic clay is indistinct, since intermixing of the units has occurred as a result of both natural pedological processes and land-use practices.

6.2.5 The site geology is illustrated in figure 3.

Located in pocket at rear of report.

6.3 Groundwater

Standpipes installed in bores Djerriwarrh 100 and 105, along Harkness Road, were monitored over a period of 12 months without recording any groundwater in the soil horizons.

In both recent bores (Djerriwarrh 192 and 193) water levels were recorded as detailed in Table 2, below.

BORE NAME AND NUMBER	DATES AND LEVELS			
	17/4/85	23/4/85	2/5/85	18/6/85
Djerriwarrh 192	14.4 m	14.4 m	14.5 m	14.4 m
Djerriwarrh 193	12.6 m	12.6 m	12.5 m	12.5 m

Table Water table levels recorded on site.

The recorded levels are unusually high for the Melton area, although not inconsistent with the geology. Water bores drilled in the region generally encounter the water table either in or just below the basalt. The water quality and quantity are variable and it is only used for stock purposes.

7 PEDOLOGY

7.1 Nature of the Soil

7.1.1 Profile

The soil type varies in the upper profile, but gererally consists of gravelly, sandy and/or clayey silts overlying silty and/or sandy clays. Lower in the profile the soil is predominately highly plastic clay with some sandy horizons and rare gravel layers.

7.1.2 Types of Material

The sands and gravels are typically quartzose, sub-angular to sub-rounded, and well graded. The size of material is generally less than 10mm, although occasional pieces as large as 100mm were noted on the surface.

The clay fraction is largely composed of highly expansive material. X-Ray Diffraction (XRD) analyses of clay material (identical in appearance) sampled from a bore adjacent to the site (Djerriwarrh 93) showed a predominance of montmorillinite in the clay fraction of the sample.

The expansiveness of the clay fraction is displayed by extensive surface cracking in areas where the sands and silts do not overlie the clayey soils (Plate 1). In the profile (as seen from backhoe excavations and core recovered from drilling) the presence of numerous fissures, some filled with sand and others with slickenslided surfaces (Plate 2), testify to the depth of cracking. In all bores drilled on site the fissuring extends the full depth of the soil profile (over 9 metres), with small tree rootlets noted following down the fissure planes.

7.2 Nature of the Surface Undulations

7.2.1 Field Observations

From observations at the site, the shape of the depressions may be divided into three categories:

7.2.1.1 Saucer Shaped Depressions

These depressions are generally 2-5 m wide and up to 10 m long. They have no sharp edges and are from 1-1.5 m deep. Very often they appear to have developed along a line and nearly always have a single crack (15 cm wide and several metres deep) along the bottom. The soil in the depression is darker than the surrounding soil since it is rich in organic matter. (Plates 3 & 4).

7.2.1.2 Saucer Shaped Depression with a Sharp Edge

These depressions are similar to those described above, except that they have a sharp drop at the edge on one side of the depression. The drop is typically 0.5-1.5 m or so, and located above the crack in the bottom of the depression. The depression grows larger by erosion of the sharp edge into the centre crack. (Plates 5 & 6).

7.2.1.3 "Sinkholes"

The "sinkholes" are essentially circular depressions occurring on either flat ground or in the bottom of the saucer shaped depressions. They are generally less than 2 m wide and sharp edged. They have been observed to unpredictably develop within a day or so, particularly during or immediately following rain. The depressions are reasonably deep (1.5 m or so) and often have large cracks in the soil at their base. (Plates 7 & 8).

Over successive years, the "sinkholes" develop (by erosion) into the depressions described in 7.2.1.2 above.

7.2.1.4 Mounds

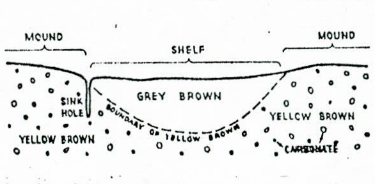
The mounds are gentle rises which generally form the rim if the depressions described in sections 7.2.1.1 & 7.2.1.2. The surface soil appears unchanged from the flat areas. Mounds are not as numerous as the depressions.

7.2.2 Comparisons to Other Areas

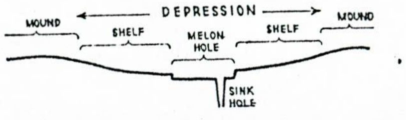
7.2.2.1 Comparisons with "Gilgai" Areas

"Gilgai", taken from an Aboriginal word for a small water hole, is used to describe small-scale undulations on the surface of the land which are particularly widespread in Australia. They were first described in soil literature by Prescott (1931) and subsequently by various other writers (notably Hallsworth, Robertson and Gibbons-1955; Hallsworth and Beckmann-1969; and Knight-1972). The term broadly encompasses a number of different forms and magnitudes of undulations which have the common feature of a more expansive subsoil than surface soil in the depressed area.

Gilgai forms have been classified into six categories (Hallsworth et al. 1955 & 1969) :-i normal or round gilgai, melon-hole gilgai, lattice gilgai, linear or wvy gilgai, tank gilgai and stony gilgai. Of these the normal and melon-hole forms show some resemblance to the observed features at Melton. These are diagramatically represented in Figure 4 and compare well to the depressions described in sections 7.2.1.1 and 7.2.1.2.



Normal gilgai of the Riverina Taken near Leeton, N.S.W.



Melon hole gilgai from Gundarimba, North Coast, (from Hallsworth & Beckmann– 1969)

Fig. 4 Gilgai Terminology

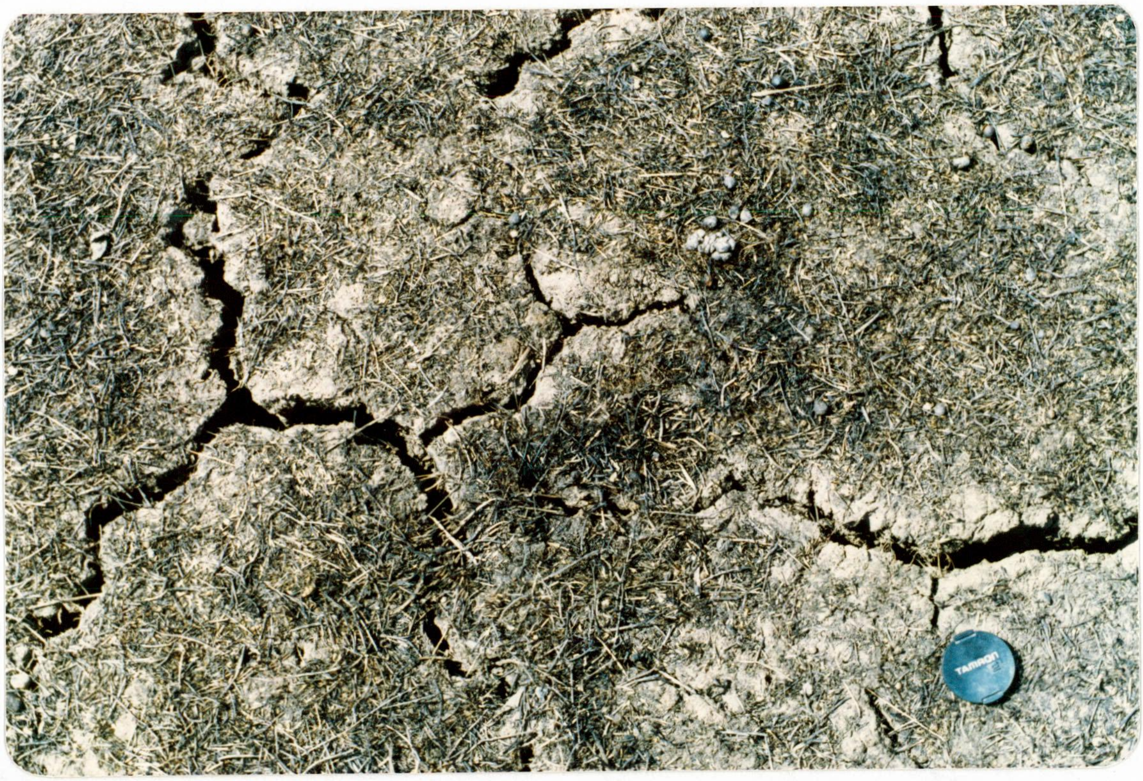


Plate 1 Cracking of clay soils.
(photographed 11/2/'85; scale is 50mm diameter)

Plate 2 Slickensliding of fissure in soil core.

Plate 3 Broad saucer shaped depressions

Plate 4 Broad depression with deep cracking

Plate 5 Sharp edge of depression

Plate 6
Depression with sharp edge
eroding into centre crack

Plate 7 'Sinkhole'
(photographed in road reserve, Spring 1983)

Plate 8 'Sinkhole'
(photographed on-site 30/4/'85)

7.2.2.2 Comparisons with Other "Sinkholes"

The term sinkhole in the geological meaning is normally restricted to a circular depression in a karst area. In recent soil literature however, the term has been used to describe various depressions occurring in the soil surface, which are not normally related to karst features.

In the terminology developed to describe gilgai morphology 'sinkhole' is used in reference to roughly circular holes which occur on the shelf or at the bottom of the depression (Figure 4).

Hallsworth and Beckmann (1969) and Stapledon (1970) described some depressions/sinkholes which occur over large areas of the lower Murray Basin. A sketch section through one of these (Figure 5)in the Tilmy Flat area of South Australia resembles the "sinkholes" described in 7.2.1.3. (Plate 9). Although the resemblance is striking, the geology is quite different, with the clay at Tilmy Flat being underlain by sand.

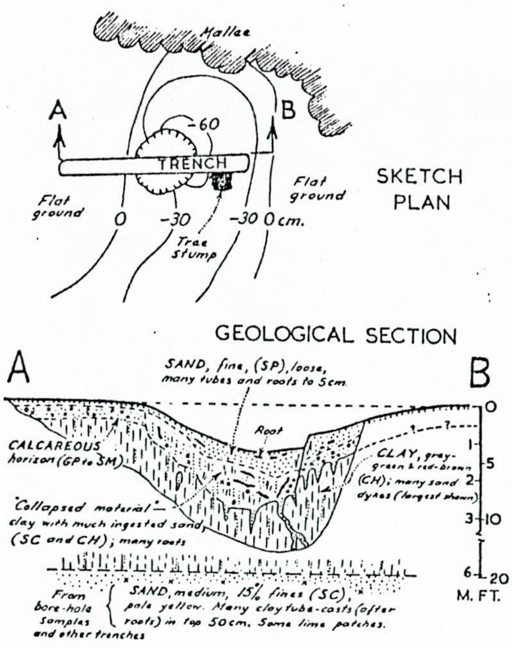
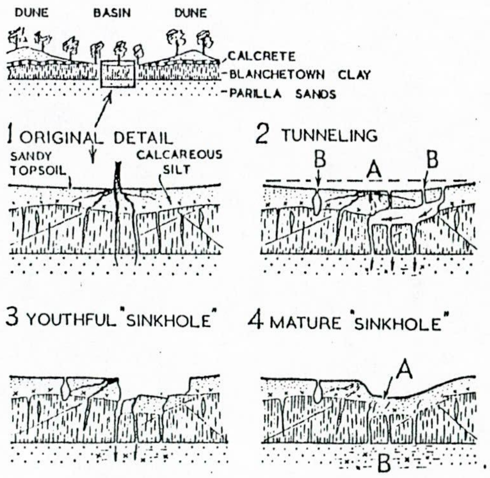


Fig. 5 . Tilmy Flat Area, Sketch Plan and Trench Section through a Large Sinkhole.
(from Stapleton – 1970)



g. 6 . Suggested Origin of Sinkholes in Blanchetown Clay
(from Stapleton – 1970)

Plate 9 Section through 'skinhole'
(excavation pit-Djerriwarrh 176 - 10/5/'84)

7.3 Suggested Origin of the Undulations

From field observation it is apparent that the development of the broad saucer-shaped features begin with a "sinkhole". The material from the edge of the hole is washed into the crack at the base of the hole and eventually the depression becomes a large saucer-shaped feature. The addition of the surface material to the subsoil (ie. the sandy material washed down the crack) begins the development of mounds and depressions as described by the literature on gilgai development.

The initial development of the "sinkhole" is more problematic. For the features described at Tilmy Flat, the suggested origin (Figure 6) relies on the clay being underlain by sand. At this site however, the clay continues to the basalt bedrock, with no obvious highly permeable layers to channel dispersed clay away. This becomes apparent when the "sinkholes" hold water at the end of wet periods (Plate 10).

During on-site discussions with Mr J Maher (Scientific Officer,Dept. of Agriculture) a possible mechanism was formulated which may account for the origin of the "sinkholes". It was noted that the development of the features was largely confined areas where:

- the sand/silt/gravel covered the clay
- the clay was substantially thicker
- there were trees

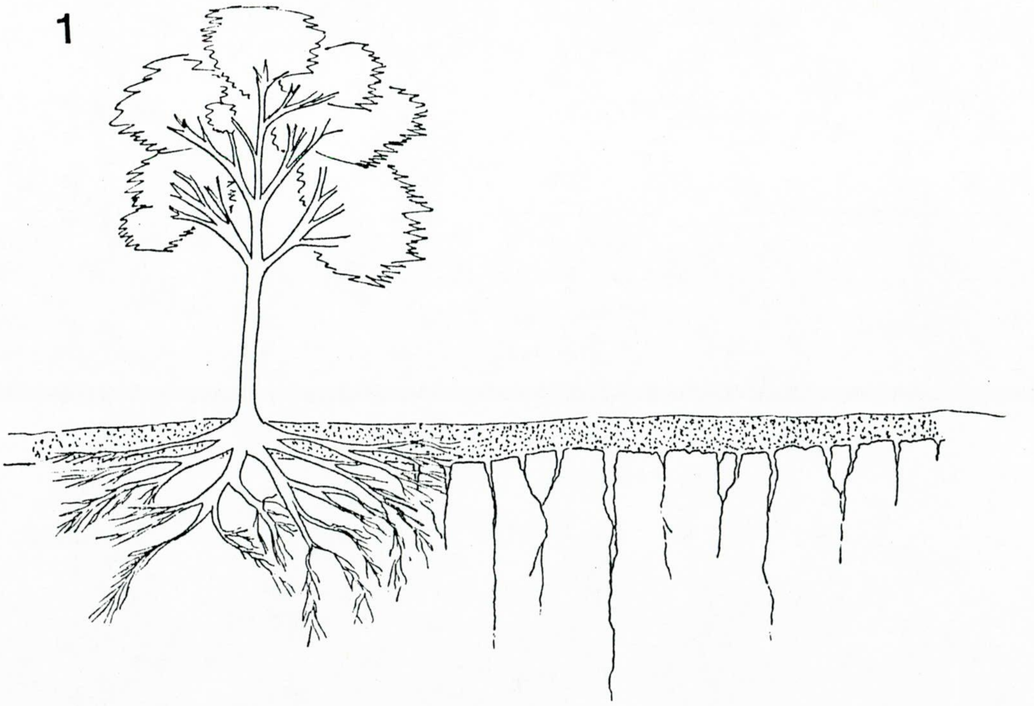
Keeping in mind the expansiveness of the clay, the following suggested origin seems plausible:-

The trees and associated vegetation dessicate the clay substantially, especially in the drier seasons, and form deep cracks and many fissures in the clay. The cracks do not extend to the surface however, since the sand/silt/gravels of the surface are non-plastic and do not shrink on drying. Some of the surface material finds its way into the cracks in the underlying clay, especially during the rainy periods when the relatively high permeability of the surface quickly percolates the rainwater to the near impervious clay layer, where cracks and fissures provide the only drains. The substantial depth of clay provides the space for a reasonable volume of material to be accommodated in the fissures. The erosion of the base of the sand/silt/gravel into the clay fissures creates a void which is not expressed on the surface because the cemented nature of the material. Eventually the void collapses dramatically to create the "sinkhole". The suggested mechanism is shown in Figure 7.

One problem however, remains unsolved. That is the observation by Mr Minn that the "sinkholes" still occur on his property which is outside of the treed area. Although his adjacent paddock is ploughed each year, the subsidence still occurs, although not with the same frequency or extent as in the treed area. The phenomenon of recurring gilgai has been reported by Hallsworth, Robertson and Gibbons (1955) as typical of gilgai areas.

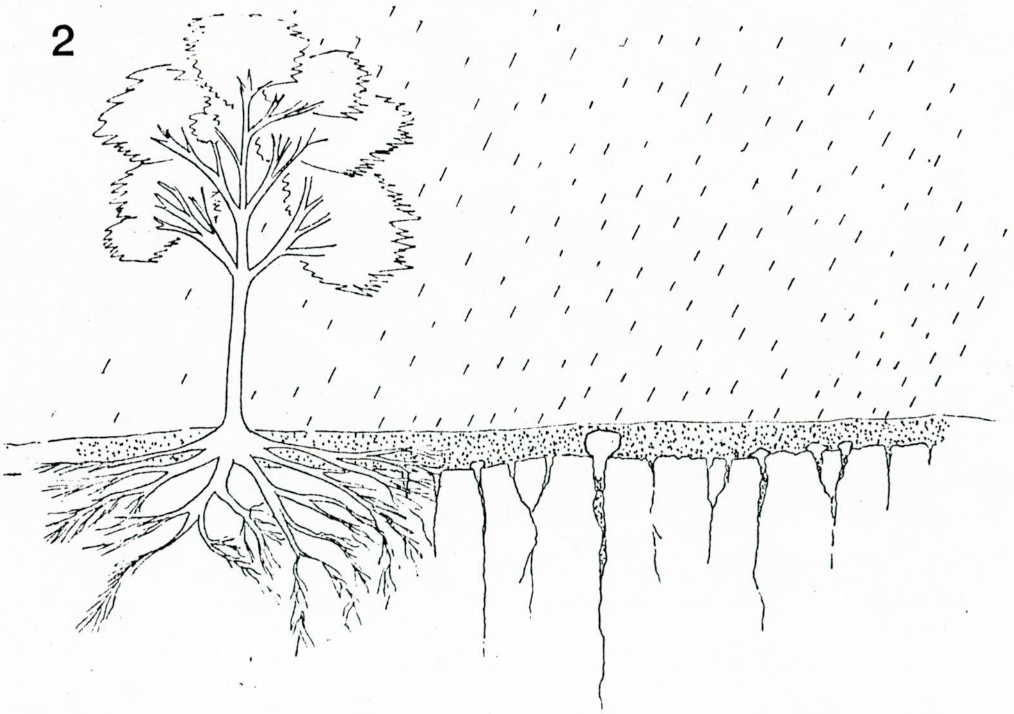
Plate 10 Water filled depressions (Spring 1983)

1

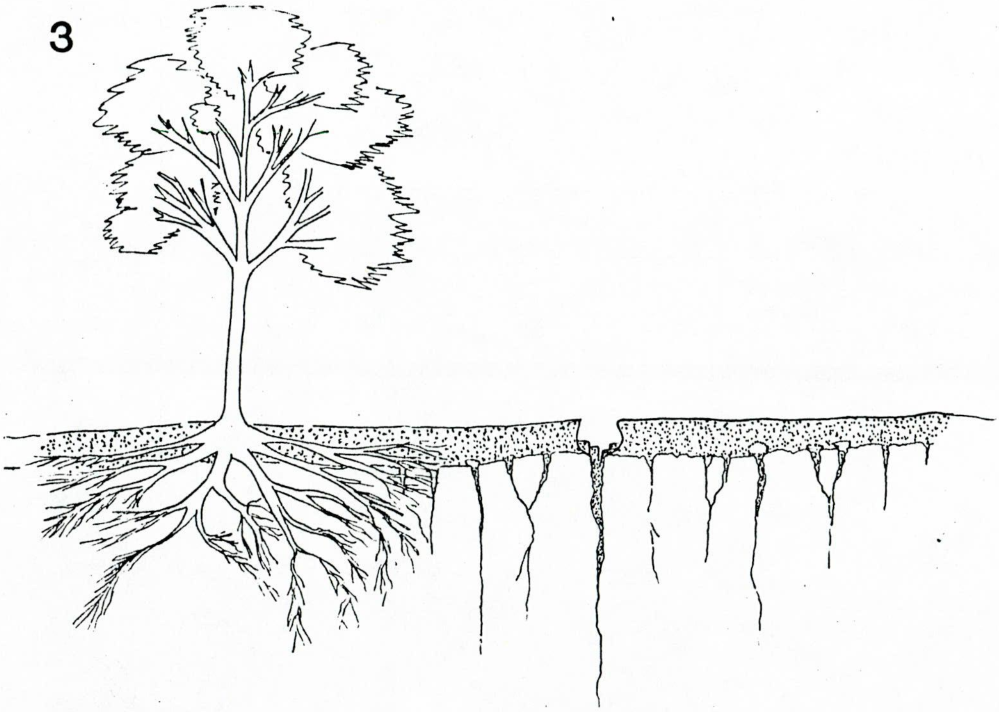


The vegetatation dessicates the soil, causing the highly expansive clay subsoil to shrink and crack deeply, whereas the non-expansive sandy topsoil remains unaffected.

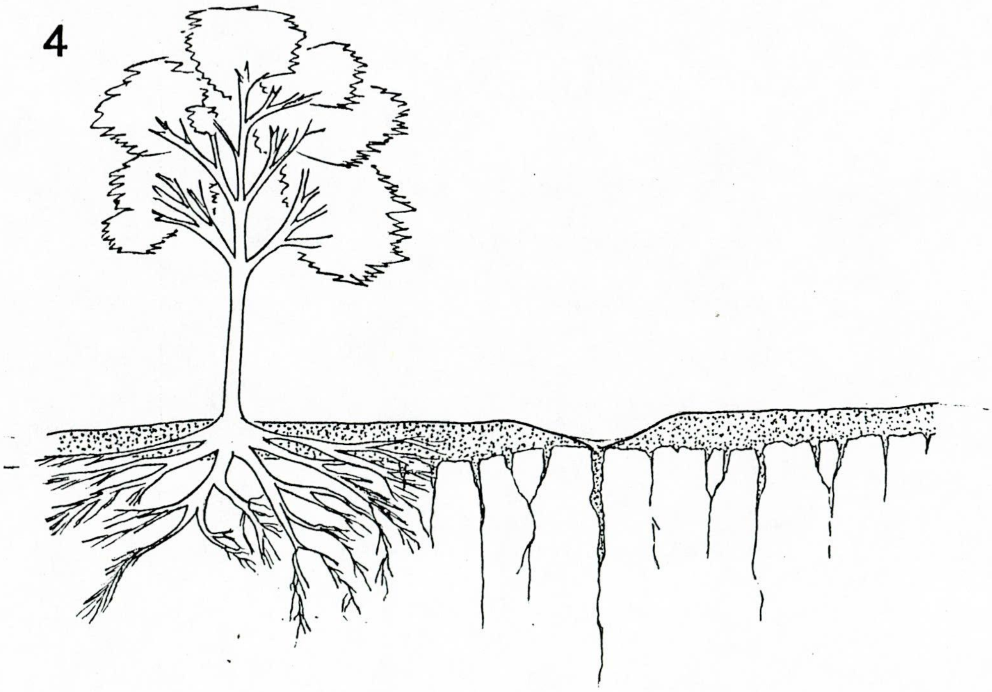
2



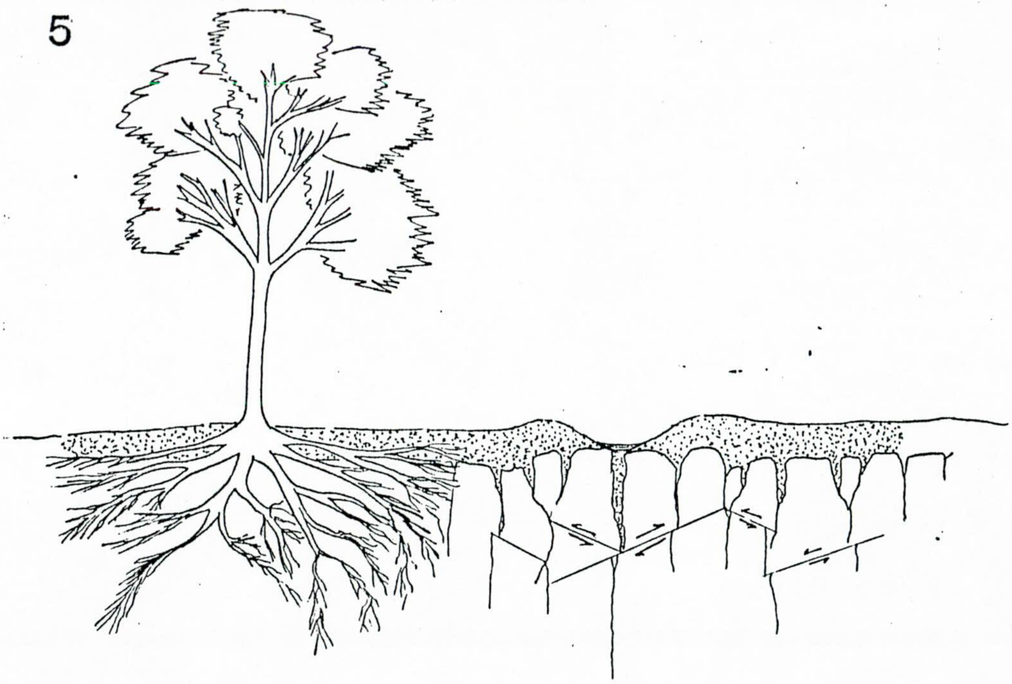
The silty, sandy topsoil falls into the shrinkage cracks in the clay, particularly during rainy periods, when the rainwater easily percolates through the sand and down the cracks in the clay. A void is created in the lightly cemented silty sands above the deeper cracks.



The topsoil eventually collapses into the void creating the "sinkholes" which appear dramatically.



The surrounding soil is eroded into the "sinkhole", smoothing the sides to form a saucer-shaped depression.



The subsequent swelling of the subsoil creates stresses which are relieved by fissuring and slickensliding of the clay, which buckles the surface on the edge of the depression.[1]

Fig 7 SUGGESTED ORIGIN OF SUBSIDENCE FEATURES OF MELTON

8 GEOLOGICAL HAZARDS FOR DEVELOPMENT

8.1 Expansive Clay

The presence of thick expansive clay soil poses a hazard to the development of the site. Buildings, roads and sewerage systems are susceptible to serious damage from the season movements of the soil.

No preferred locations which would avoid the clays can be chosen for building construction. The only viable solution would be to have building foundations engineer-designed to tolerate considerable season movements.

8.2 Subsidence

The most obvious problem for development of the site is the active subsidence. Roads, housing, and sewerage systems would be seriously damaged by sinkhole development. The unpredictability of the sinkholes makes the siting of any structures hazardous. It is likely however, that areas of the site could be found where the potential for subsidence would be lower.

9 POSSIBLE ENGINEERING SOLUTIONS

9.1 Housing

The presence of deep basaltic clay classifies the site as "unstable" for strip and stump footings and "intermediate" for slabs or footing slabs according to the Victoria Building Regulations (VBR's). The regulations set out the minimum dimensions for either type of footing, which are not condidered adequate for this site. The depth of highly expansive clay and the potential for sinkhole development create unusual foundation conditions which require special engineering design for footings.

Buildings founded on expansive soil need careful attention paid to building design and maintenance, in order to mitigate or control structural damage. Properly engineered foundations, segmented interior design, flexible connections to utility lines, and carefully designed lot drainage and landscaping are required for satisfactory building performance.

Selection of building sites in areas where the soil is thinnest and removal of all trees surrounding buildings would lessen the risk of subsidence occurring, although not entirely rule it out. Placement of the footings on the rock (by designing pier and beam footings) would ensure that the building would not subside, even though the soil may. Chen (1975) warns that pier and beam design does not always work in expansive soils, since the swelling and shrinking can produce considerable lateral and frictional forces on the piers.

An alternative solution would be to replace the foundation soils with non-swelling granular soils. Chen (1975) suggests at least 1.5 m under the footings and 3 m beyond the building line (Appendix 3). Soil replacement will lessen the chances of building distress considerably since it would overcome the effects of the expansive soils and cushion the effect of any subsidence. The possibility of subsidence occuring still remains, although the effects would be less dramatic on the surface due to the compensatory movement of the granular soil.

A new approach to site classification has been recommended in the Draft Australian Standard - 'Residential Slabs and Footings' - (August 1985), which would classify this site as both a class E (Extremely reactive) site and a class P (Problem) site. The design of footing systems for these classifications are outlined in sections 4 and 5 of the draft standard, which should be consulted before final footing design is decided upon.

9.2 Roadmaking

The subdivision of the land into more than one lot may necessitate the construction of permanent roads. This is also problematic because of the nature of the soils of the site.

The Road Construction Authority have extensively tested similar soils for the construction of the Western Freeway Melton By-pass and opted for lime stabilization as a suitable soil treatment. The addition of lime (approx. 4%) to the subgrade material greatly improves the roadmaking properties and is recommended for all roads constructed on the site.

The subsidence problem still remains, however. Harkness Road is periodically maintained by the Shire of Melton and any "sinkholes" in the road or road shoulders are filled with crushed rock. The continuous traffic makes the development of the holes less dramatic and if the trees were removed from the roadside reserve the problem would be lessened.

Any paved or compacted surfaces should be provided with adequate drainage to lessen the potential for heaving of the road centreline. Similarly, to lessen the impact of seasonal variations in moisture content, the road edges and shoulders should be well drained and maintained. On no account should trees or shrubs be planted along the road reserves, as they would locally dessicate the soil and almost certainly create "sinkholes".

9.3 Sewage Disposal

Because the site is isolated from the Melton City by a proposed regional cemetery, is was not intended by the ULA to service the site with reticulated sewerage.

Alternative sewage disposal would be limited to above ground methods (e.g. composting, chemical or incinerating toilets, "grey water" irrigation, etc.), since the permeability of the clay is too low to provide adequate effluent absorption. Even in areas where septic system absorption lines could be located in the gravel/sand/silt layer, the localised addition of moisture to the underlying expansive clay would cause excessive swell and distress in the sewerage system. Similarly, sand filters or other in-ground disposal would be ultimately unsatisfactory.

10 RECOMMENDATIONS

10.1 Sub-division Density

The following factors need be considered when planning the sub-division density:-

a construction of building foundations will be costly;
b complete removal of trees surrounding buildings is essential; and
c roads need to be well constructed and maintained.

10.2 Buildings

Buildings should be sited on shallower soils where feasable, and constructed using either pier-and-beam footings or an engineer designed slab over an adequate layer of non-plastic soil.

Trees must be kept well away from buildings and good site drainage is essential.

10.3 Roads

Roads should be constructed by lime stabilisation of the subgrade and well maintained.

10.4 Sewage disposal

Sewage effluent should not be disposed of in-ground if at all possible. Septic tank systems and sand filters would not be acceptable.

11 REFERENCES

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DEPARTMENT OF MINERALS AND ENERGY

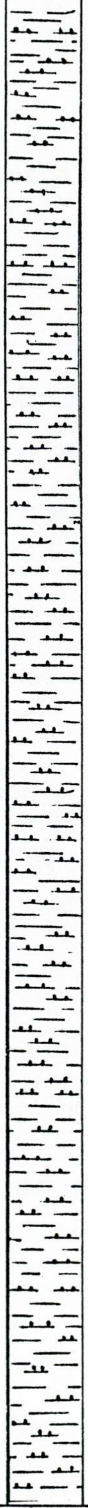
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. DJERRIWARRH 93

LOCATION Harkness Rd. Melton. Vic.

R.L. GROUND 166.4 m

AMG REF. 5829801.88
282651.13



DEPTH / R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
0.1	SILTY CLAY, moist, blocky, dark brown.			
0.2				
0.3	SILTY CLAY, moist, very stiff, brown.			
0.4				
0.5				
0.6	SILTY CLAY, sandy moist, very stiff, brown-grey.			
0.7				
0.8				
0.9				
1.0				
1.1				
1.2				
1.3	SILTY CLAY, moist, very stiff, mottled yellow-brown and grey. sandy in parts.			
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Hollow flight auger	DATE	15.6.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10 SHEET 1 OF 3 DRAWING No. M 131/1

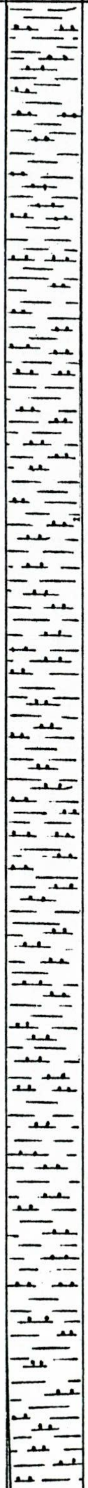
SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 93

LOCATION Harkness Rd. Melton.
R.L. GROUND 166.4 m

AMG REF. 5829801.88
282651.13

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
	SILTY CLAY,			
2.1	moist, very stiff,			
2.2	mottled yellow-brown and grey.			
2.3	sandy in parts.			
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3.0				
3.1				
3.2				
3.3				
3.4				
3.5				
3.6				
3.7				
3.8				
3.9				



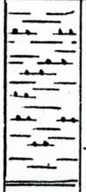
DRILL TYPE	Gemco 210 B	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Hollow flight auger	DATE	15.6.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10 | SHEET 2 OF 3 | DRAWING No. M131/2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 93

LOCATION Harkness Rd. Melton. Vic.
R.L. GROUND 166.4 m
AMG REF. 5829801.88
282651.13

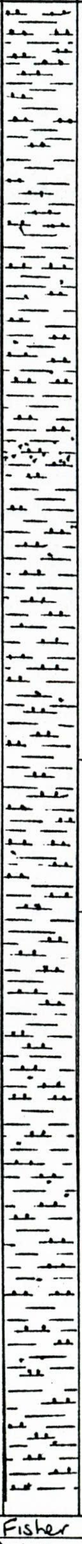
DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
4.1 4.2	SILTY CLAY, sandy moist, very stiff, mottled yellow-brown & grey.			Liquid Limit 65 Free Swell 200 % Sand 18 % Silt & Clay 82 % Linear Shrinkage 14
4.3	End of Hole.			
4.4				
4.5				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	15.6.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10	SHEET 3 OF 3	DRAWING No. M131/3	

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 94

LOCATION Harkness Rd. Melton.
R.L. GROUND 170.8 m
AMG REF. 5830322.26
282726.15



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
	CLAYEY SILT, dry, blocky, brown.			
0.1				
0.2	SILTY CLAY, sandy moist, hard, yellow - brown			
0.3				
0.4				
0.5				
0.6	calcareous sand layer at 0.6 m			
0.7				
0.8				
0.9				
1.0				
1.1	SILTY CLAY, sandy moist, hard, streaky yellow-brown and grey			Liquid Limit 48 Free Swell 170 % Sand 25 % Silt & Clay 75 % Linear Shrinkage 14.5
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				

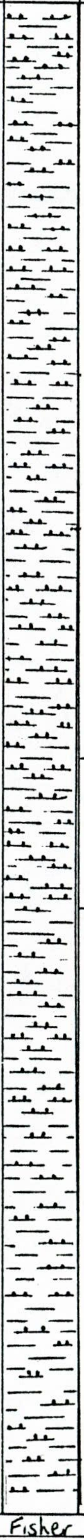
DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow Flight auger	LOGGED	P. Dahlhaus	
		DATE	1.7.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10 SHEET 1 OF 3 DRAWING No. M132/1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 94

LOCATION Harkness Rd. Melton. Vic.
R.L. GROUND 170.8 m
AMG REF. 5830322.26
282726.15



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
2.1	SILTY CLAY, sandy moist, hard, streaky yellow-brown and grey.			
2.2				
2.3	CLAYEY SILT, sandy moist, hard streaky yellow-brown and grey.			
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3.0				Liquid Limit 39 Free Swell 160 % Sand 31 % Silt & Clay 69 %
3.1				
3.2				Linear Shrinkage 11.5
3.3				
3.4				
3.5	SILTY CLAY, sandy Moist, hard, streaky yellow-brown & grey.			
3.6				
3.7				
3.8				
3.9				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow Flight auger	LOGGED	P. Dahlhaus	
		DATE	1.7.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10 SHEET 2 OF 3 DRAWING No. M132/2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 94

LOCATION Harkness Rd. Melton. Vic.

R.L. GROUND 170.8 m

AMG REF. 5830322.26
282726.15

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
	SILTY CLAY, sandy			
4.1	moist, hard,			
	streaky yellow-brown			
4.2	and grey.			
4.3	End of Hole.			
4.4				
4.5				

DRILL TYPE	Gemco 210 B	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Hollow flight auger	DATE	1.7.83	
		CHECKED	R. Wilson	
COMMENCED	6.6.83	APPROVED		
COMPLETED	6.6.83	DRAWN		

VERTICAL SCALE 1:10	SHEET 3 OF 3	DRAWING No. M132/3	

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

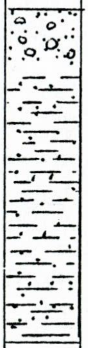
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. DJERRIWARRH 100

LOCATION Harkness Rd. Melton. Vic. Adjacent to Djerriwarrh Bore 93

R.L. GROUND 170 m. approx.

AMG REF. 5829807
282653

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
0.1				Open Standpipe installed 10.11.'83.
0.2				
0.3				
0.4	Not sampled.			
0.5				
0.6				
0.7				
0.8				
0.9				
1.0	Undisturbed Sample 63mm T.W.T.			
1.1	SANDY GRAVEL, clayey. quartz gravel, subrounded			
1.2	SANDY CLAY, moist, very stiff,			
1.3	mottled yellow-brown & grey. Sand is subrounded			
1.4	quartz			
1.5				
1.6				
1.7	Not Sampled.			
1.8				
1.9				

Date	Reading	Comment
10. 11. '83	7.5 m	Dry
17. 11. '83	7.5 m	Dry
8. 12. '83	7.5m	Dry
29. 3. '84	7.5m	Dry
18. 7. '84	7.5m	Dry
16. 8. '84	7.54 m	Dry
19. 9. '84	7.59m	Dry
17. 10. '84	7.57m	Dry
15. 11. '84	7.56 m	Dry

DRILL TYPE	Gemco 210 B	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Solid flight auger	LOGGED	P. Dahlhaus	
		DATE	12.'83	
		CHECKED		
COMMENCED	10.11.'83	APPROVED		
COMPLETED	10. 11. '83	DRAWN		

VERTICAL SCALE 1:10 SHEET 1 OF 4 DRAWING No. M 147/1

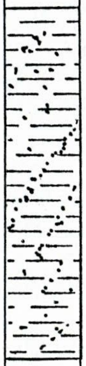
SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. DJERRIWARRH 100

LOCATION Harkness Rd. Melton. Vic. Adjacent to Djerriwarrh Bore 93

R.L. GROUND 170 m. approx.

AMG REF. 5829807
282653

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
2.1				
2.2	Not Sampled			
2.3				
2.4				
2.5	Undisturbed Sample 63mm T.W.T.			
2.6	SANDY CLAY, moist, very stiff, fissured mottled yellow-brown & grey. Sand sized subrounded quartz lines major fissure dipping almost vertically through sample.			
2.7				
2.8				
2.9				
3.0				
3.1				
3.2				
3.3				
3.4				
3.5	Not Sampled.			
3.6				
3.7				
3.8				
3.9				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Solid flight auger	DATE	12.'83.	
		CHECKED		
COMMENCED	10.11.'83	APPROVED		
COMPLETED	10.11.'83	DRAWN		

VERTICAL SCALE 1:10 SHEET 2 OF 4 DRAWING No. M147/2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

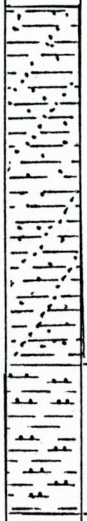
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. DJERRIWARRH 100

LOCATION Harkness Rd, Melton. Vic. Adjacent to Bore Djerriwarrh 93

AMG REF. 5829807
282653

R.L. GROUND 170m. approx.

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
4.1	Not Sampled			
4.2	Undisturbed Sample 63mm T.W.T.			
4.3	SANDY CLAY, moist, very stiff, fissured mottled yellow-brown & grey.			
4.4				
4.5	sand size subrounded quartz lines fissures. some rootlets.			
4.6				
4.7	UD. 63mm T.W.T.			
4.7	SILTY CLAY, moist, very stiff, mottled yellow brown & grey. indistinct layers.			
4.8				
4.9				
5.0				
5.1				
5.2				
5.3				
5.4	Not Sampled.			
5.5				
5.6				
5.7				
5.8				
5.9				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Solid Flight auger	DATE	12.'83	
		CHECKED		
COMMENCED	10.11.83	APPROVED		
COMPLETED	10.11.83	DRAWN		

VERTICAL SCALE 1:10

SHEET 3 OF 4

DRAWING No. M147/3

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY — GEOLOGICAL LOG OF DRILL HOLE — HOLE No. DJERRIWARRH 100

LOCATION Harkness Rd. Melton. Vic. Adjacent to Bore Djerriwarrh 93

AMG REF. 5829807 282653

R.L. GROUND 170 m. approx.

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
6·1				
6·2				
6·3				
6·4				
6·5				
6·6	Not Sampled			
6·7				
6·8				
6·9				
7·0				
7·1				
7·2				
7·3	Undisturbed Sample 63mm T.W.T. SANDY CLAY, mottled yellow-brown & grey. less sand than above sample		▨	
7·4	Black stained BASALT (?) clast at bottom.		▨	
7·5	Refusal - BASALT.			
7·6				
7·7				
7·8				
7·9				

DRILL TYPE	Gemco 210B	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Solid Flight auger	LOGGED	P. Dahlhaus	
		DATE	12.'83	
		CHECKED		
COMMENCED	10.11.'83	APPROVED		
COMPLETED	10.11.'83	DRAWN		

VERTICAL SCALE 1:10 — SHEET 4 OF 4 — DRAWING No. M147/4

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

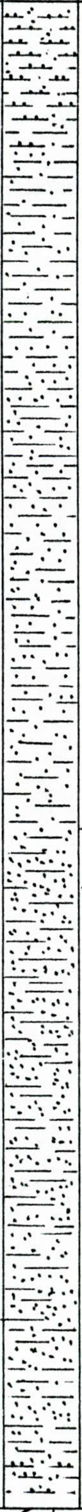
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 192

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170·8 m

AMG REF. 5830198·84
282808·06



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
0·1	SANDY SILT, gravelly dry, friable, pale brown.			quartz gravel and sand; sub-angular to sub-rounded.	Soil core
0·2	SANDY CLAY, silty moist, very stiff to hard, yellow-brown				
0·3				tree root (1 cm ∅) at 0·3 m	
0·4					
0·5					Thin walled tube sample 63·5mm ∅
0·6	CLAY, sandy moist, very stiff to hard, yellow-brown.				
0·7					
0·8					
0·9				small tree root at 0·9m	Soil core
1·0					
1·1	SANDY CLAY, moist, very-stiff to hard, yellow-brown. becomes mottled yellow-brown and grey.			Moisture Content 19·9 % sand fraction is very fine quartz sand.	Thin walled tube sample 63·5mm ∅
1·2					
1·3					
1·4					
1·5					
1·6					Soil core
1·7					
1·8					
1·9	becomes silty.			Moisture Content 17·6%	Thin walled tube 63·5mm ∅

DRILL TYPE	Gemco 210	DRILLER	J. Fisher
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus
		DATE	26·3·'85
		CHECKED	
COMMENCED		APPROVED	
COMPLETED		DRAWN	

NOTES

VERTICAL SCALE 1:10

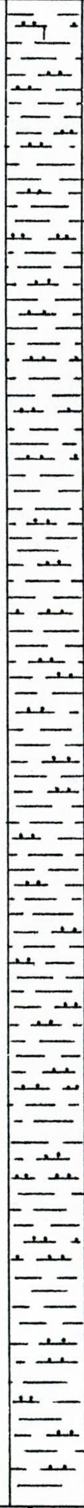
SHEET 1 OF 8

DRAWING No. ULA/1 33·85·1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 192
LOCATION Urban Land Authority Property, Harkness Rd. Melton. R.L. GROUND 170.8 m.		AMG REF. 5830198.84 282808.06

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
2.1	CLAY, silty. moist, very stiff, blocky.			Black staining (not unlike dendrites)	Thin walled tube sample 63.5 mm Ø
2.2	mottled yellow-brown			along fissured joints.	
2.3	and grey.				
2.4					
2.5					Soil Core
2.6					
2.7				sand filled fissure	
2.8				from 2.75m to 2.9m	Soil Core
2.9					
3.0				mottling becomes very distinctive	
3.1					
3.2					
3.3					
3.4					
3.5					
3.6				very fissured undisturbed sample some fine root-hairs down fissures.	Thin walled-tube sample 63.5 mm Ø
3.7				Moisture Content 14.8%	
3.8					
3.9					
					Soil Core



DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	26.3.85	
COMMENCED		CHECKED		
		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 2 OF 8 DRAWING No. ULA/1 33.86.1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

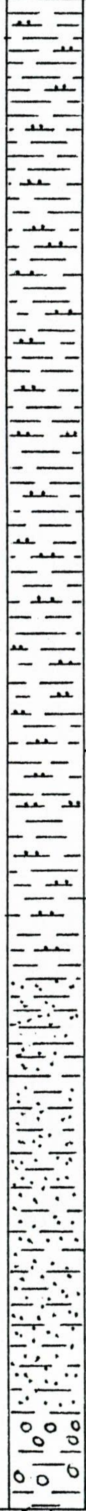
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 192

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170.8 m.

AMG REF. 5830198.84
282808.06



DEPTH / R.L. (m)	SOIL DESCRIPTION: TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION: TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	SOIL: ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS: TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
4.1	CLAY, silty. moist, blocky, very stiff. mottled yellow-brown and grey.			Soil core
4.2				
4.3			Drilling very difficult. Drillers pour water down hole so core run is partly wet.	Soil Core
4.4				
4.5				
4.6				
4.7				
4.8				
4.9	CLAY, silty moist, blocky, very stiff grey.			
5.0			Tree root (3mm ∅) down core	
5.1				
5.2				Soil Core
5.3				
5.4	CLAY, sandy, moist, blocky, very stiff mottled brick-red and grey.			
5.5			some sand along fissures.	
5.6				
5.7				
5.8			Moisture Content 10.8%	Thin walled tube sample 63.5 mm ∅
5.9	GRAVELLY CLAY moist, crumbly.			Soil Core

DRILL TYPE Gemco 210

CORE BARREL TYPE Hollow flight auger

COMMENCED

COMPLETED

DRILLER J. Fisher

LOGGED P. Dahlhaus

DATE 26. 3. '85

CHECKED

APPROVED

DRAWN

NOTES

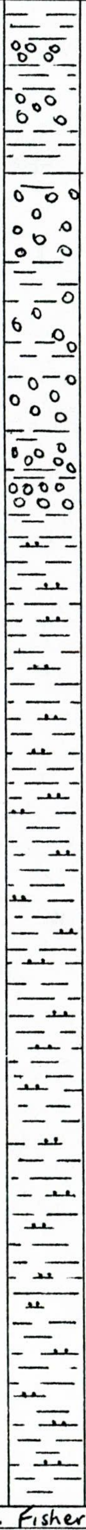
VERTICAL SCALE 1:10

SHEET 3 OF 8

DRAWING No. ULA/1 33.85.1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 192
LOCATION Urban Land Authority Property, Harkness Rd, Melton.		AMG REF. 5830198.84 282808.06
R.L. GROUND 170.8 m		



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
	GRAVELLY CLAY				
6.1	moist, crumbly			sub-angular quartz gravel	
6.2	mottled brick-red and grey			not much sand-sized material	
6.3					Soil Core
6.4					
6.5					
6.6	CLAYEY GRAVEL				
	brown-red				
6.7	SILTY CLAY				
6.8	moist, very stiff, blocky			small root-hairs on fissure surfaces	Soil Core
6.9	grey				
7.0					
7.1				1 mm ∅ root at 7.1 m	
7.2					
7.3					
7.4					
7.5				small root-hairs and roots <1mm ∅	Soil Core
7.6					
7.7					
7.8	becomes mottled				
7.9	brick-red and grey.				

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	26.3.85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 4 OF 8 DRAWING No. ULA/1 33.85.1

SEPT 83

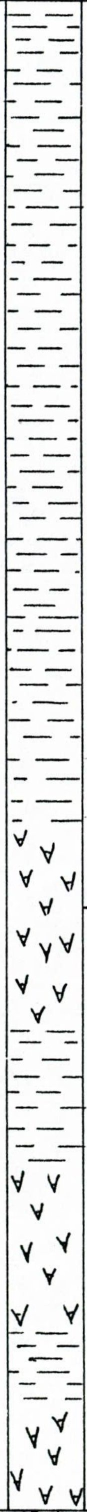
DEPARTMENT OF MINERALS AND ENERGY — GEOLOGICAL LOG OF DRILL HOLE — HOLE No. Djerriwarrh 192

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170·8 m

AMG REF. 5830198·84
282808·06

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	
	SILTY CLAY				Soil core
8·1	moist, very stiff, blocky			some rootlets.	
8·2	red-brown and grey mottling.			black staining on fissure surfaces.	
8·3					
8·4					Soil core
8·5					
8·6					
8·7	CLAY, silty.			Highly weathered vesicular basalt	
8·8	moist, stiff, fissured.			around 8·7 m.	
8·9					
9·0				tree root ≃ 1mm. Ø	Soil core
9·1	BASALT, Highly weathered, vesicular				
9·2	BASALT, Slightly weathered, vesicular			Diamond Drilling Commences.	
9·3					
9·4	CLAY, grey. Some Basalt pieces.				Rock Core
9·5					
9·6	BASALT, Slightly weathered, vesicular				
9·7					
9·8	CLAY, grey.				
9·9	BASALT, Slightly weathered, vesicular.				



DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Hollow auger + Diamond	DATE	26. 3. '85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 — SHEET 5 OF 8 — DRAWING No. ULA/1 33.85.1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 192

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170·8 m

AMG REF. 5830198.84
282808.06

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL
	BASALT,			
10·1	Slightly weathered,			
10·2	vesicular.			
10·3				
	vesicles become smaller			
10·4				
10·5				
10·6	some carbonate lining of vesicles			
10·7				
10·8				
10·9				
11·0	becomes dense			
11·1				
11·2				
11·3				
11·4				
11·5				
11·6				
11·7				
11·8				
11·9	becomes very broken.			

DRILL TYPE	Gemco 210	DRILLER	J. Fisher
		LOGGED	P. Dahlhaus
CORE BARREL TYPE	Diamond	DATE	26·3·'85
		CHECKED	
COMMENCED		APPROVED	
COMPLETED		DRAWN	

NOTES

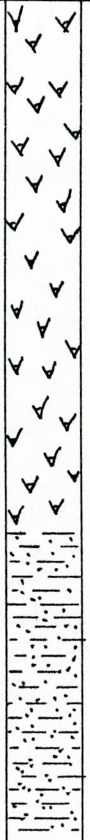
VERTICAL SCALE 1:10

SHEET 6 OF 8

DRAWING No. ULA/1 33·85·1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 192
LOCATION Urban Land Authority Property, Harkness Rd, Melton. Vic. R.L. GROUND 170.8 m		AMG REF. 5830198.84 282808.06

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	
12.1 12.2 12.3 12.4	BASALT, Slightly weathered, very broken.				
12.5 12.6	BASALT, Slightly weathered, vesicular.				
12.7 12.8 12.9 13.0 13.1 13.2 13.3 13.4	SANDY CLAY, grey. to mottled red-brown and grey to red-brown. some buckshot gravel. 57 % recovery.			Core loss attributed to bottom of run as driller's report indicates penetration speed increases with depth.	RECOVERY LOSS
13.5 13.6 13.7 13.8 13.9	90 % core loss			Core loss attributed to top of run on basis of drill penetration.	LOSS

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Diamond	DATE	26.3.'85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10	SHEET 7	OF 8	DRAWING No. ULA/1 33.85.1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 192

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

AMG REF. 5830198.84
282808.06

R.L. GROUND 170.8m

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL		
14.1						LOSS
14.2						
14.3	90 %			Core loss attributed to top of run on basis of drillers evidence. (drill penetration speed)		
14.4	core loss					
14.5						
14.6						
14.7	— ? — ? — ? —					
14.8	SANDSTONE, cemented. mottled red-brown & white some loose quartz gravel.		▨			RECOVERY
14.9	SANDSTONE / QUARTZITE hard, dense, white with red-brown swirls					LOSS
15.0			▨	17 % core loss		RECOVERY
15.1	— — — — — — — —		▨			
15.2	SANDSTONE, pale yellow-brown, some quartz veining.		▨			
15.3			▨			
15.4	83 % recovery.		▨			
15.5			▨			
15.6	End of Hole.					
15.7						
15.8						
15.9						

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Diamond	LOGGED	P. Dahlhaus	
		DATE	26.3.'85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 8 OF 8 DRAWING No. ULA/1 33.85.1

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

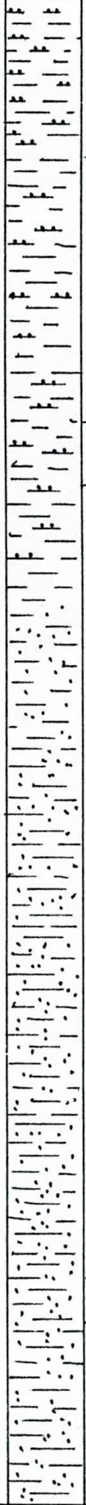
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd, Melton

R.L. GROUND 170 m

AMG REF. 5830150.08
282841.86



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
	SILTY CLAY, sandy			grass roots throughout.	
0.1	moist, blocky			occasional gravel	
0.2	dark grey.				Soil Core
	CLAY, silty				
0.3	moist, stiff,			very plastic "greasy" clay.	
0.4	grey.			some sand and gravel present.	
0.5					Thin walled tube sample
0.6				Moisture content 23.1 %	63.5mm ∅
0.7				1cm ∅ root at 0.7m	
0.8	SANDY CLAY,				
0.9	moist, very stiff			Some calcareous sand around 1 m.	
1.0	brown-grey			very fine quartz sand	
1.1				lining fissures.	Soil Core
1.2					
1.3					
1.4					
1.5	becomes				
1.6	mottled yellow-brown and grey.				
1.7				Moisture Content 18.5 %	Thin-walled tube sample
1.8					
1.9				Sand lining on fissures.	63.5 mm ∅

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Hollow flight auger	DATE	29. 3. '85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 1 OF 8 DRAWING No. ULA/2/ 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

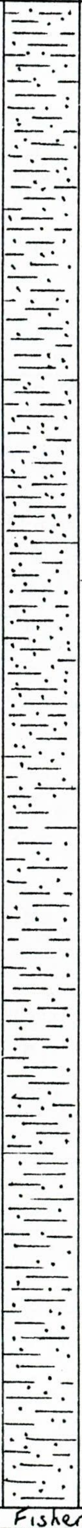
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170m

AMG REF. 5830150.08
282841.86

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S: U.S.C. SYMBOL R: WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
	SANDY CLAY,				
2.1	moist, stiff			appears fissured, with open fissures (but may be just 'discing' on augering)	
2.2	mottled yellow-brown and grey.			fine quartz sand along fissures.	Soil core
2.3				1mm. Ø root at 2.5m.	
2.4					
2.5					
2.6					
2.7				Moisture content 20.7 %	Thin walled tube sample 63.5 mm Ø
2.8					
2.9					
3.0					
3.1	CLAY, sandy				
3.2	moist, very stiff			small root 2mm Ø at 3.7, 3.6 m	
3.3	mottled yellow-brown and grey.			not fissured in appearance.	Soil Core
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					Thin walled tube 63.5mm Ø

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	29.3.'85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10

SHEET 2 OF 8

DRAWING No. ULA/2 / 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

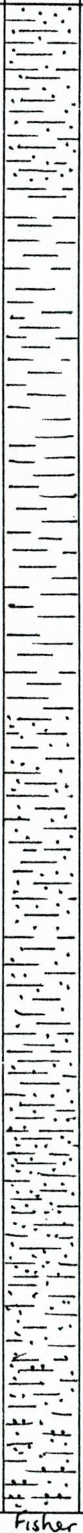
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170 m

AMG REF. 5830150·08
282841·86



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL / R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS / ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE
4·1 4·2	CLAY, sandy moist, very stiff, mottled yellow-brown and grey.				T.W.T 63mm ø
4·3 4·4 4·5 4·6 4·7 4·8 4·9	CLAY, moist, very stiff to hard mottled yellow-brown and grey.			occasional sand grain, some iron (?) staining on fissures. 3mm ø root at 4·3 m slickenslide at 4·7 m	Soil Core
5·0 5·1 5·2 5·3 5·4 5·5	CLAY, sandy moist, stiff, mottled yellow-brown and grey. becomes siltier and sandier			slickenslide at 5·2 m open fissured (discing) very fine quartz sand on fissures.	Soil Core
5·6 5·7 5·8 5·9	SANDY clay, dry to moist, very friable, dessicated, mottled brown & grey. becomes SANDY SILT			dessicated crumbly from 5·8 m. 10 mm. angular quartz piece at 5·9 m 20 mm " " " 6·0 m	Soil Core.

DRILL TYPE	Gemco 210	DRILLER	J. Fisher
		LOGGED	P. Dahlhaus
CORE BARREL TYPE	Hollow Flight auger	DATE	29. 3.'85
		CHECKED	
COMMENCED		APPROVED	
COMPLETED		DRAWN	

NOTES

VERTICAL SCALE 1:10

SHEET 3 OF 8

DRAWING No. ULA/2 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

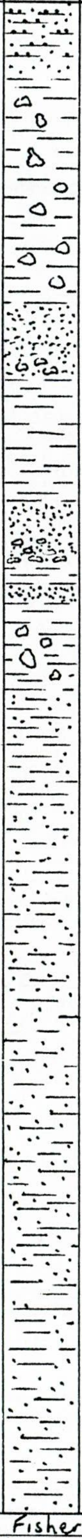
GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd, Melton.

R.L. GROUND 170 m

AMG REF. 5830150.08
282841.86

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN RECOVERY SAMPLE TYPE
	SANDY SILT,				
6.1					
6.2	GRAVELLY CLAY, moist, friable mottled yellow-brown and grey distinct gravel/sand beds.			sub-angular quartz gravel; 2mm - 15mm ø beds at 6.4 - 6.5, 6.66 - 6.75, 6.77 - 6.79 } porous (voidy) graded sand beds. 6.5 - 6.66 grey silty clay.	
6.3					
6.4					Soil Core
6.5					
6.6					
6.7					
6.8					
6.9					Soil Core
7.0	CLAY, sandy moist, hard, mottled yellow-brown and grey.			fissured, desiccated	
7.1					
7.2					
7.3					
7.4					Soil Core
7.5				small roots at 7.5m	
7.6					
7.7					
7.8					
7.9					Soil Core

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	29. 3. '85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

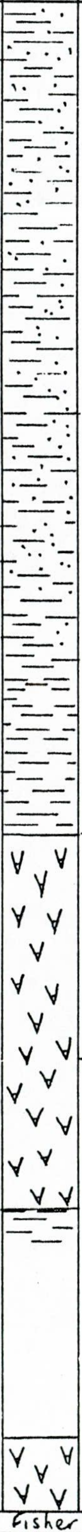
VERTICAL SCALE 1:10 SHEET 4 OF 8 DRAWING No. ULA/2 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd. Melton.
R.L. GROUND 170 m
AMG REF. 5830150.08
282841.86

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SOIL TYPE.
8.1	CLAY, sandy moist, hard, mottled yellow-brown and grey.			dessicated, open fissures, slickenslides.	
8.2					Soil Core
8.3					
8.4				E.W. Basalt piece at 8.4m	
8.5					
8.6				H.W. vesicular basalt pieces at 8.6m to 8.8m.	
8.7					Soil Core
8.8					
8.9	CLAY, moist, very stiff, grey. calcareous nodules throughout			Large calcareous nodule from 8.9 - 9.0m.	
9.0					
9.1	BASALT, medium dense, large vesicles 1-2 cm ø carbonate lined.				
9.2					
9.3					
9.4					
9.5					
9.6	CLAY, grey. 90% core loss.				
9.7					
9.8					
9.9	BASALT				



DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Hollow flight auger	LOGGED	P. Dahlhaus	
		DATE	29. 3. '85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 5 OF 8 DRAWING No. ULA/2 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 193
LOCATION Urban Land Authority Property, Harkness Rd, Melton. R.L. GROUND 170 m		AMG REF. 5830150.08 282841.86

DEPTH — R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE.
10.1	BASALT, medium dense, some alteration.			Rf = 2	Rock core
10.2					
10.3				Rf = 4	
10.4					
10.5					
10.6				Rf = 4	
10.7					Rock core
10.8					
10.9				Rf = 6	
11.0					
11.1					
11.2				Rf = 10	
11.3					
11.4					
11.5					
11.6				Rf = 6	
11.7					
11.8				Rf = 6	
11.9					

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES Rf = fractures per 0.3 m
		LOGGED	P. Dahlhaus	
CORE BARREL TYPE	Diamond	DATE	29.3.'85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 6 OF 8 DRAWING No. ULA/2 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL LOG OF DRILL HOLE

HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd. Melton.

R.L. GROUND 170m

AMG REF. 5830150.08
282841.86

DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL	CORE RUN, RECOVERY, SAMPLE TYPE
12.1	BASALT, medium dence, some alteration.			Rf: 6	Rock core.
12.2					
12.3					
12.4				Rf= 12	Rock core
12.5					
12.6					
12.7				Rf= 20	
12.8					
12.9					
13.0				Rf= 20	
13.1					
13.2					
13.3	GRAVELLY CLAY, grey, becomes red-brown. some buckshot gravel. 27% recovery.			27% core recovery.	recovery Rock Core
13.4					
13.5					
13.6					loss
13.7					
13.8					
13.9					

DRILL TYPE	Gemco 210	DRILLER	J. Fisher
		LOGGED	P. Dahlhaus
CORE BARREL TYPE	Diamond	DATE	29. 3. '85
		CHECKED	
COMMENCED		APPROVED	
COMPLETED		DRAWN	

NOTES

Rf = fractures per 0.3 m

VERTICAL SCALE 1:10

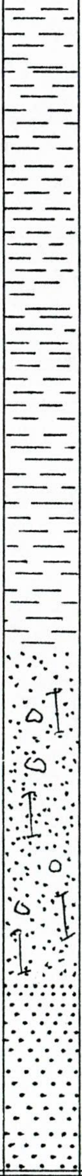
SHEET 7 OF 8

DRAWING No. ULA/2 33.85.2

SEPT 83

DEPARTMENT OF MINERALS AND ENERGY	GEOLOGICAL LOG OF DRILL HOLE	HOLE No. Djerriwarrh 193

LOCATION Urban Land Authority Property, Harkness Rd, Melton.
R.L. GROUND 170m
AMG REF. 5830150·08
282841·86



DEPTH R.L. (m)	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	S. U.S.C. SYMBOL R. WEATHERING	GRAPHIC LOG	SOIL ADDITIONAL OBSERVATIONS, DEFECTS, TEST RESULTS ROCK MASS DEFECTS TYPE, INCLINATION, THICKNESS, ROUGHNESS, COATING/INFILL		
14·1					Loss	Rock Core
14·2						
14·3						
14·4						
14·5	SILTY CLAY,					
14·6	red,-brown with					Rock
	occasional					
14·7	gravel piece.					Core
14·8	becomes					
14·9	SANDY CLAY,					
15.0	mottled white and					
15·1	red-brown					
15·2	- - - -?- - - -?- - - - ?- -					
15·3	CEMENTED SANDS,					
15·4	white with red-brown streaks.					
15·5	Some quartzose gravel.					
15·6						
15·7	SANDSTONE,					
15·8	yellow-brown					
15·9						
	End of Hole.					

DRILL TYPE	Gemco 210	DRILLER	J. Fisher	NOTES
CORE BARREL TYPE	Diamond	LOGGED	P. Dahlhaus	
		DATE	29. 3. '85	
		CHECKED		
COMMENCED		APPROVED		
COMPLETED		DRAWN		

VERTICAL SCALE 1:10 SHEET 8 OF 8 DRAWING No. ULA/2 33·85·2

SEPT 83

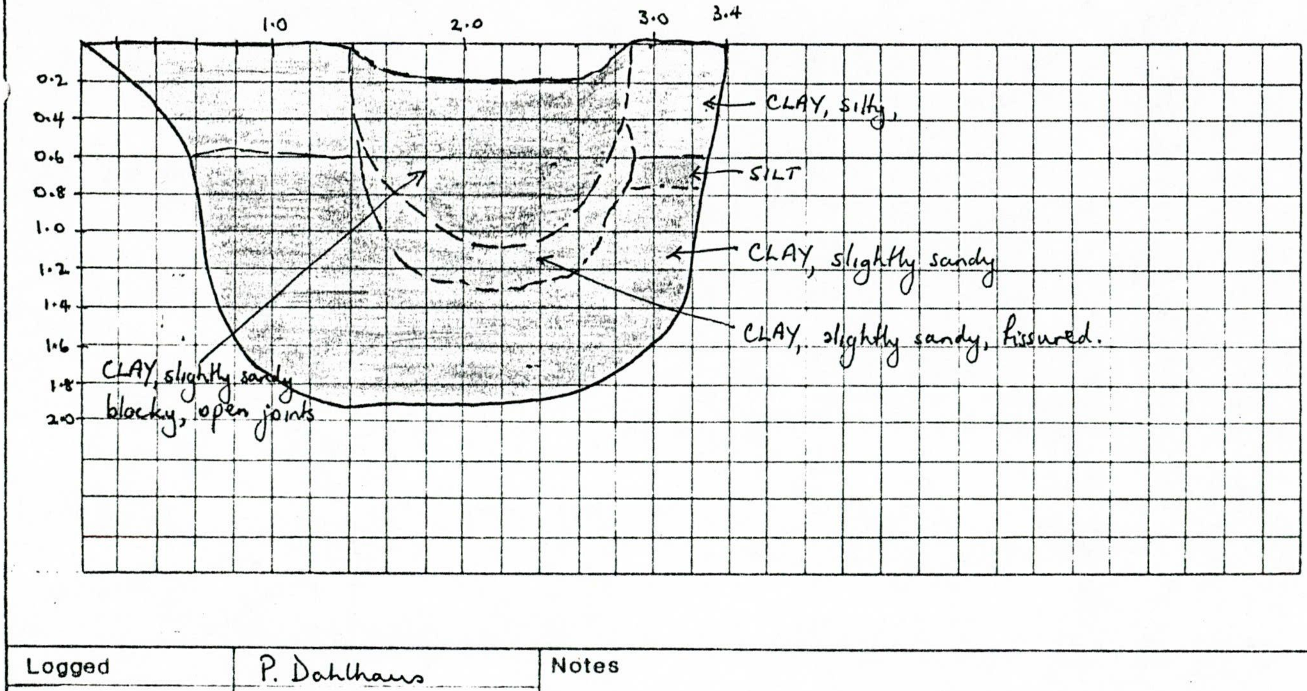
APPENDIX II
EXCAVATION LOGS

DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** DJERRIWARRH 175

PROJECT Proposed Cemetery at Melton Vic. **LOCATION**
R.L. GROUND 169.88
AMG. REF. 5830010.7
282879.3

EQUIPMENT TYPE AND MODEL
EXCAVATION DIMENSIONS m LONG m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL USC SYMBOL ROCK WEATHERING	GRAPHIC LOG		WATER	S HAND PENETROMETER kPa R STRENGTH POINT LOAD
		0.2 0.4	CLAY, silty moist, friable, stiff, fissured brown. many tree roots.			Material in Subsided portion. CLAY, slightly sandy. dry to moist, blocky. brown. open jointed, some 20mm wide, many tree roots.		
		0.6	SILT, clayey fine calcareous material throughout.					
		0.8 1.0 1.2 1.4	CLAY, slightly sandy. moist, stiff. yellow brown. becomes mottled yellow-brown and grey around 1.3m.			CLAY, slightly sandy. fissured. moist, stiff, yellow-brown. very open textured. Some firm to soft areas.		
		1.6 1.8						



Logged	P. Dahlhaus	Notes	
Date	10. 5. '84		
Checked			
Approved			
Vertical Scale	1:20	Sheet no. 1 of 1	Drawing no. Sbs No. 1.

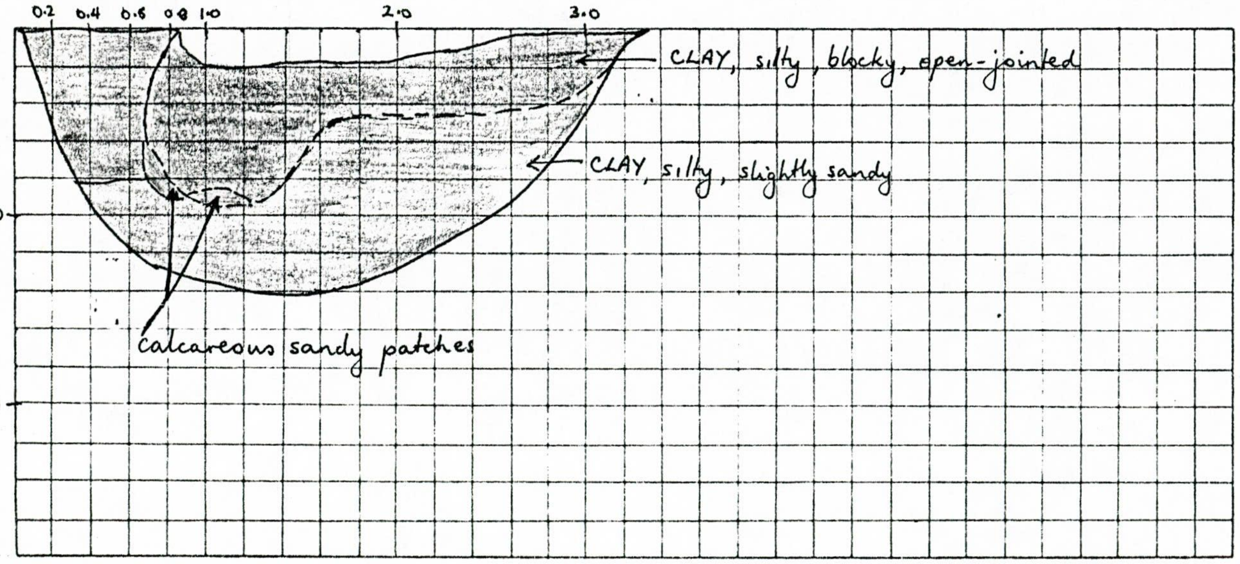
DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** Djerriwarrh 176

PROJECT Proposed Cemetery at Melton Vic. **LOCATION** **R.L. GROUND** 169.88 **AMG. REF.** 5830010.7 282879.3

EQUIPMENT TYPE AND MODEL

EXCAVATION DIMENSIONS m LONG m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL U.S.C. SYMBOL ROCK WEATHERING	GRAPHIC LOG.		WATER	S HAND PENETRO-METER kPa R STRENGTH POINT LOAD
BACKHOE		0.2 0.4 0.6 0.8	CLAY, silty. moist, stiff, friable. dark yellow-brown.			Material in Subsided patch. CLAY, silty. moist (near dry) very stiff, blocky. brown. open jointed. some calcareous patches (sandy) at the base.		
		1.0 1.2 1.4	CLAY, silty, moist, stiff, greenish-yellow brown. slightly sandy.					
		1.6 1.8						



Logged	P. Dahlhaus
Date	10.5.'84
Checked	
Approved	

Notes

Vertical Scale 1:20

Sheet no. 1 of 1

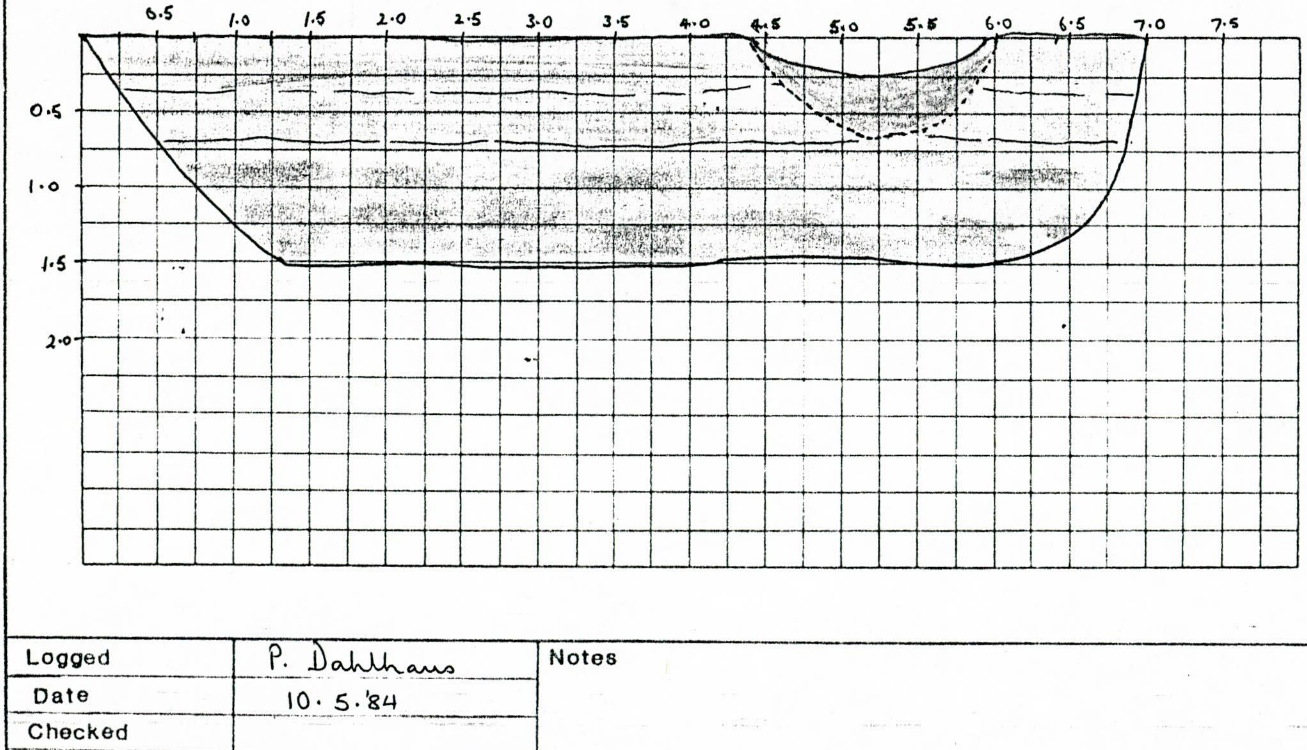
Drawing no. Subs. No. 2

DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** DJERRIWARRH 177

PROJECT Proposed Cemetery at Melton Vic.
LOCATION
R.L. GROUND 169.48
AMG. REF. 5829978.8 282828.8

EQUIPMENT TYPE AND MODEL
EXCAVATION DIMENSIONS m LONG m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE MINOR COMPONENTS	SOIL U.S.C. SYMBOL ROCK WEATHERING	GRAPHIC LOG.		WATER	S HAND PENETRO-METER kPa R STRENGTH POINT LOAD
BACKHOE		0.2	SILTY CLAY, sandy, gravelly. moist, very stiff, friable, fissured yellow-brown.			Material in Subsided section. CLAY, silty, sandy. Dry, blocky, open jointed peds. dark yellow-brown. some organic material.		
		0.4 0.6	CLAY, silty. moist, stiff, yellow-brown					
		0.8 1.0 1.2	CLAY, silty, moist, stiff, mottled yellow-brown & grey. slightly sandy.					
		1.4						
		1.6 1.8						



Logged	P. Dahlhaus
Date	10.5.84
Checked	
Approved	

Notes

Vertical Scale 1:20 Sheet no. 1 of 1 Drawing no. Sbs No. 3

DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** Djerriwarrh 178

PROJECT Proposed Cemetery at Melton Vic.

LOCATION

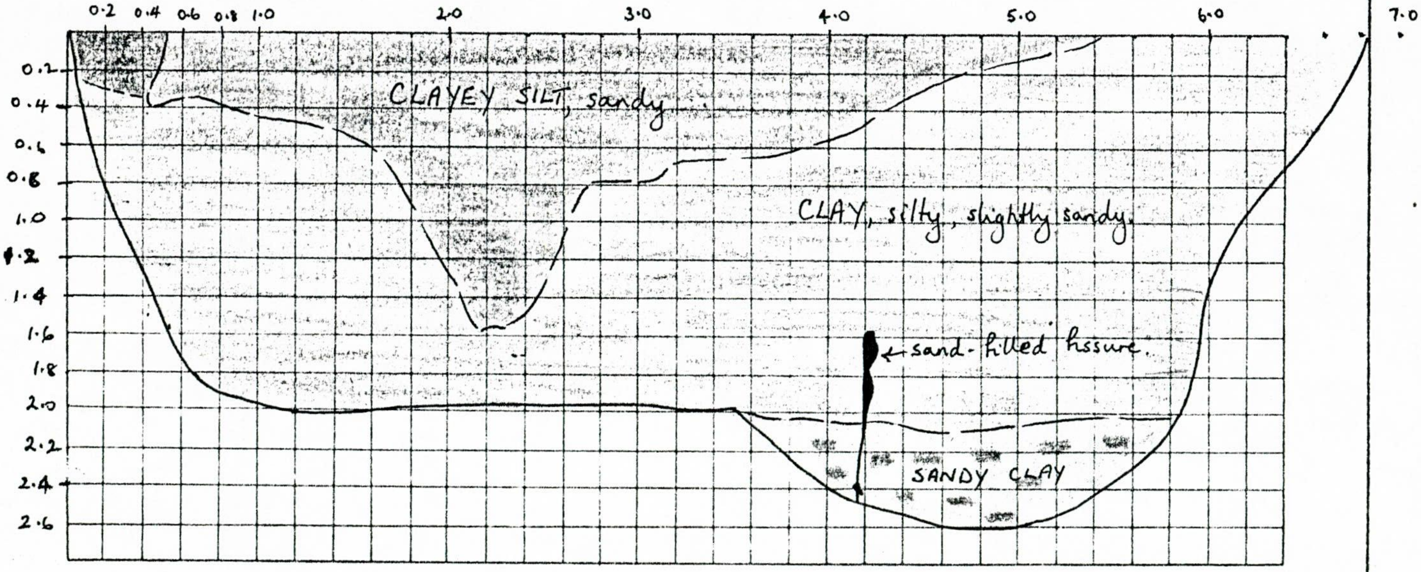
R.L. GROUND 168.95

AMG. REF. 5829972.0 / 282839.3

EQUIPMENT TYPE AND MODEL

EXCAVATION DIMENSIONS m LONG m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL U.S.C. SYMBOL ROCK WEATHERING	GRAPHIC LOG.		WATER	S HAND PENETROMETER kPa R STRENGTH POINT LOAD
BACKHOE	PATCHY - 1 to 3.	0 – 0.5	CLAYEY SILT, sandy. fissured in parts moist friable darkgrey. DEPTH VARIES			siltier near top. Quartz gravel pieces to 1.5m in centre trough.		
		0.5 – 2.0	CLAY, silty. moist, stiff, fissured greenish-brown. slightly sandy.			Some mottled patches. Sand pockets (fine quartz sand) throughout. One large sand-filled fissure (60mm to 2mm fissure width)		
		2.0 – 2.5	SANDY CLAY, moist, very stiff, mottled brick-red and grey.			Sand filled fissure continues to 2.6m, although barely visible.		
		3.0						



Logged	P. Dahlhaus	Notes
Date	10. 5. '84	
Checked		
Approved		

Vertical Scale 1:50

Sheet no. 1 of 1

Drawing no. Subs. No. 4

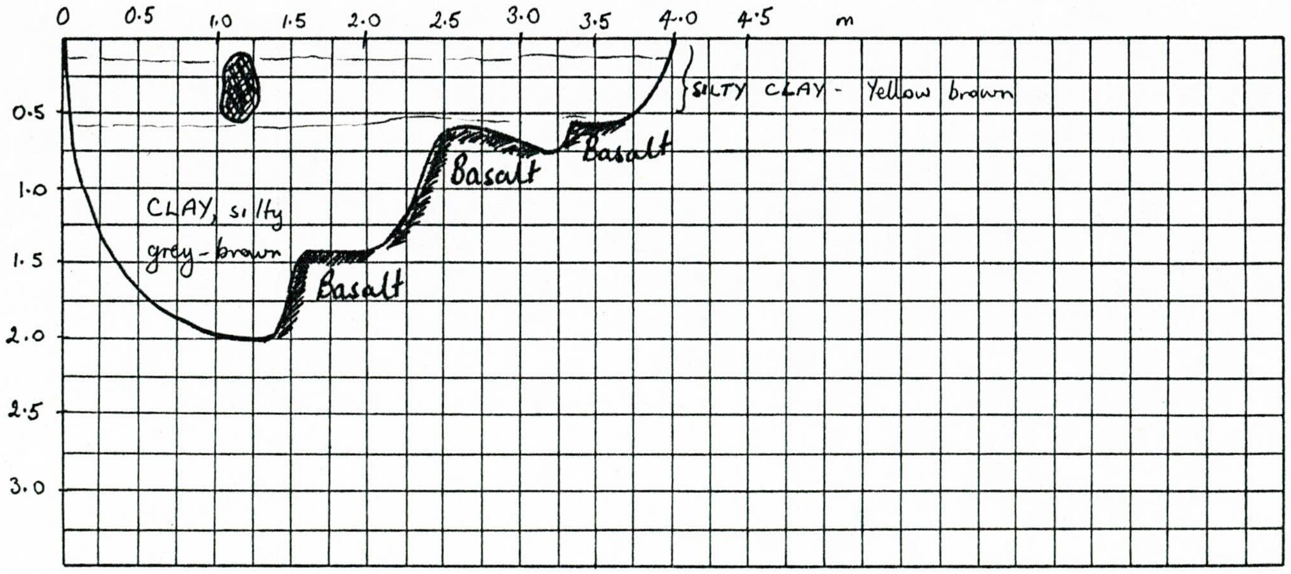
DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** Djerriwarrh 179

PROJECT Proposed Cemetery at Melton. **LOCATION** **R.L. GROUND** 173.98 **AMG. REF.** 5830203.2 283421.7

EQUIPMENT TYPE AND MODEL Case 580C ; 600mm Bucket

EXCAVATION DIMENSIONS 4.0 m LONG 0.65 m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL / ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL U.S.C. SYMBOL / ROCK WEATHERING	GRAPHIC LOG.		WATER	S. HAND PENETROMETER kPa / R. STRENGTH POINT LOAD
BACK HOE	1 2 3		SILTY CLAY, moist, stiff, red-brown	CL				
		0.5	SILTY CLAY, moist, stiff, yellow brown Sandy and gravelly ('buckshot')			- one Basalt 'floater' (400mm x 300mm) excavated.		
		1.0 1.5	CLAY, silty, moist, stiff, grey-brown some 'buckshot.' large basalt 'floaters.'	CH				
		2.0 2.5 3.0	Difficult Excavation due to 'floaters'					



Logged	Peter Dahlhaus
Date	12. 7. '84
Checked	
Approved	
Vertical Scale	1:50

Notes Not Suitable for Burial because of Basalt 'floaters'

Sheet no. 1 **of** 1 **Drawing no.** MCPS - 1

DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** DJERRIWARRH 180

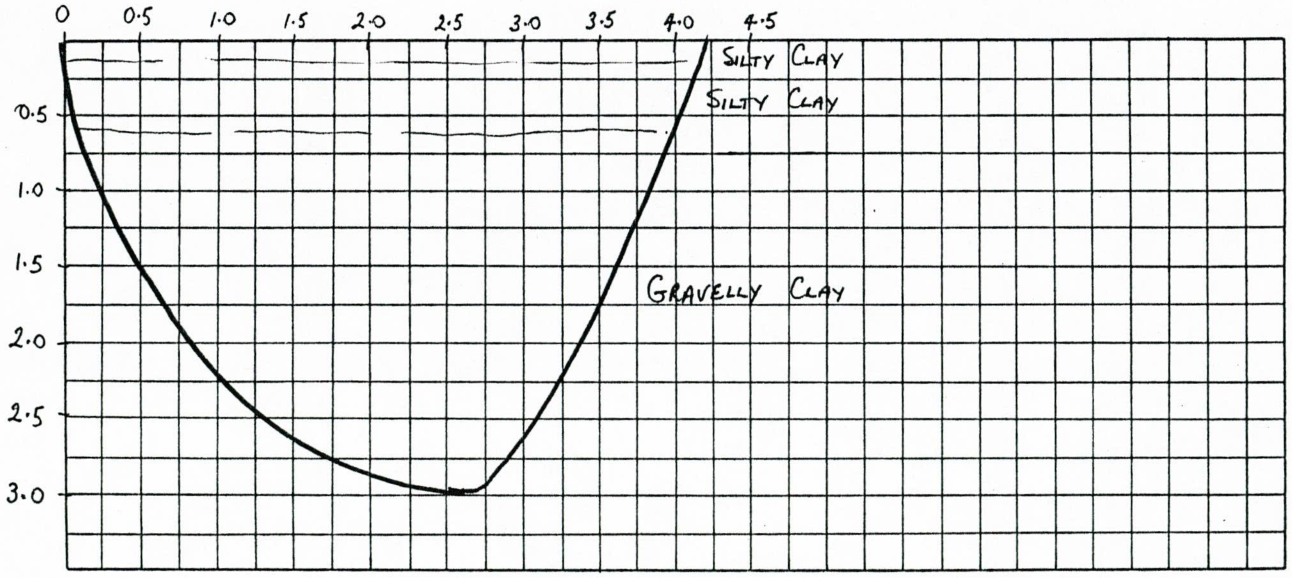
PROJECT Proposed Cemetery at Melton. Vic. **LOCATION**

R.L. GROUND 171·67 **AMG. REF.** 5829955·1 283380·9

EQUIPMENT TYPE AND MODEL Case 580 C; 600 mm Bucket

EXCAVATION DIMENSIONS 4·2 m LONG 0·65 m WIDE

METHOD	EASE OF EXCAVATION	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL U.S.C. SYMBOL ROCK WEATHERING	GRAPHIC LOG.		WATER	S HAND PENETRO-METER kPa R STRENGTH POINT LOAD
BACKHOE			SILTY CLAY, moist, friable, dark grey.	CL				
			SILTY CLAY, moist, stiff, red-brown	CH				
		1·0 2·0 3·0	GRAVELLY CLAY, sandy moist, stiff, fissured, grey. Calcareous nodules at 0.7m	GC		gravel is mostly "ironstone" (not solid Fe) varieties. Some quartz. Sand is a mixture of 'buckshot' and quartz. Some fine quartz along fissures.		
			End of Excavation.					



Logged	Peter Dahlhaus
Date	12. 7. '84
Checked	
Approved	

Notes

Vertical Scale 1:50 Sheet no. 1 of 1 Drawing no. MCPS-2

DEPARTMENT OF MINERALS AND ENERGY **EXCAVATION LOG.** **PIT No.** DJERRIWARRH 181

PROJECT Proposed Cemetery at Melton.

LOCATION

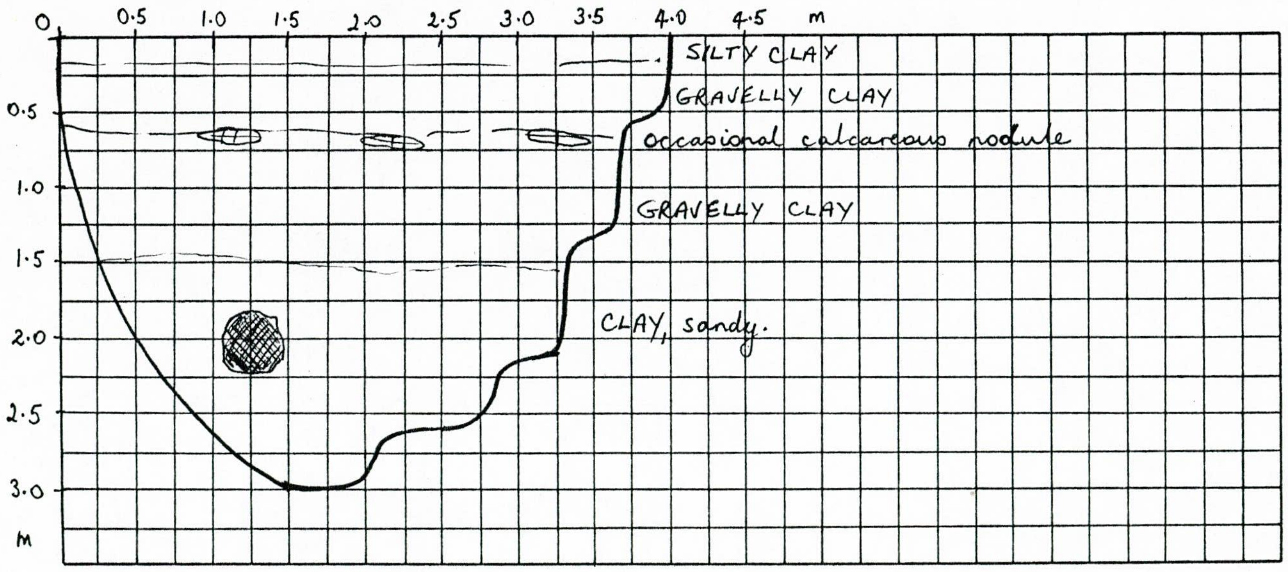
R.L. GROUND 169.52

AMG. REF. 5829773.6 283344.7

EQUIPMENT TYPE AND MODEL Case 580C; 600mm Bucket

EXCAVATION DIMENSIONS 4 m LONG 0.63 m WIDE

METHOD	EASE OF EXCAVATION 1 2 3	DEPTH m	SOIL DESCRIPTION TYPE, PLASTICITY, PARTICLE CHARACTERISTICS, COLOUR, ACCESSORY MATERIAL ROCK DESCRIPTION TYPE, TEXTURE, COLOUR, PRIMARY STRUCTURE, MINOR COMPONENTS	SOIL U.S.C. SYMBOL ROCK WEATHERING	GRAPHIC LOG.		WATER	S HAND PENETROMETER kPa R STRENGTH POINT LOAD
BACKHOE			SILTY CLAY, dry, blocky, dark brown	CL				
			GRAVELLY CLAY, moist, stiff, red-brown some 'buckshot' sands.	GC		- three or four calcareous nodules at 0.6m		
		1.0	GRAVELLY CLAY, moist, stiff, fissured, grey. occasional Basalt cobble.			- gravel is mostly 'ironstone' types. some quartz.		
		2.0	CLAY, sandy. moist, stiff, fissured. mottled yellow-brown & grey. some 'buckshot' and quartz gravel some roots and remnant roots. some sand lenses.	CH		- one Basalt cobble (400mm x 400mm) at 2.0m		
		3.0	End of Excavation.					



Logged	Peter Dahlhaus	Notes	
Date	12. 7. '84		
Checked			
Approved			
Vertical Scale	1:50	Sheet no. 1 of 1	Drawing no. MCPS - 3

APPENDIX III

GEOPHYSICAL REPORT

EXTRACT FROM UNPUBLISHED REPORT 1985/59

BY W L KILLEY

METHOD AND EQUIPMENT

1 Equipment

A Geometrics 24 channel signal enhancement seismograph model ES-2415F was used to record the signals from an array of 8 hertz Geospace GSC-11D geophones.

Two seismic energy sources were tested in the area including a Betsy Seisgun surface source and Anzite explosives fired in shallow boreholes. The surface source performed poorly because of its low energy and the high attenuation of seismic energy found at this site. Explosives produced a more energetic impulse and were used for most of the survey.

The explosives were electrically fired and the seismograph triggered by an Electro-Tech BC8A blaster box.

2 Field Method

The seismic refraction method was employed in this investigation. A 480m east-west traverse consisting of 7 spreads, and a 620m north-south traverse consisting of 9 spreads were surveyed (see Figure 3A).

Each spread was 69m long with a geophone spacing of 3m.

Five explosive shots were fired for each spread; a centre shot located between geophones 12 and 13, two off end shots offset by 1m and two long shots offset from the ends of the spread by 70m. The sizes of charge used at the centre, off-end and longshots were 150, 250 and 500 grams respectively.

Shot holes of about 1m depth were drilled by a Minute Man motorised auger.

3 Interpretation Method and Record Quality

The Hawkins' (1961) intercept time method was used to compute depths to refractors at shot point locations. Minimum depths were calculated where usable data was sparse.

Record quality was generally fair to good.

Some of the data was irregular in nature and could not be computed by the Hawkin's (1961) technique. This data was attributable to irregular interfaces between refractors combined with the shallowness of the depth of investigation (Redpath, 1973).

RESULTS

1 East-west Traverse

A surficial layer exists along the traverse and is characterised by seismic velocities 200 to 430 m/sec. At the western part of this profile, the layer varies in thickness from 7.1m at chainage 35m to 2.6m at chainage 310m, and ranges in velocity from 330 to 430 m/sec. This layer thins to less than 0.9m at chainages 380 to 520m, and has predominantly lower velocities (200 to 260 m/sec). The layer thickens to 4m over chainages 550 to 580m and the velocity increases to 390 m/sec. This layer is interpreted to consist of unconsolidated clays, silts and sands.

The surficial layer overlies a layer which has seismic velocities in the 500 to 1880 m/sec range. Lateral velocity changes are apparent.

Two velocity zones exist within this layer :

1) a low velocity zone (500 to 760 m/sec) between chainages 375 and 570m, with a maximum thickness of 9.4m at chainage 450m, and
2) a high velocity zone (1020 to 1880 m/sec) at chainages 35 to 240m, 275 to 415m and 520 to 575m, which has a maximum thickness of 6.8m at chainage 375m.

The low velocity zone overlies the high velocity zone at chainages 375 to 415m and 520 to 575m. An anomalous velocity of 840 m/sec was detected at chainages 335 to 370m.

Drillhole information from Djerriwarrh 159, 161 and 192 was used to interpret this layer to consist of clay, silt and highly weathered basalt. The lack of borehole data in the area prevented further subdivision of lithology within this layer.

The deepest refractor detected has seismic velocities between 1960 and 3090 m/sec. This refractor directly underlies the surficial layer at chainages 240 to 275m and 575 to 600m, and was interpreted to consist of weathered to fresh basalt. Depths to this layer vary from 3.6m at chainage 275m, to 9.8m at chainage 450m. Fresher basalt interpreted to have the highest velocities (2600 to 3090 m/sec), was detected at chainages 35, 370, 410 and 550m. Depths could not be calculated because of the lack of usable data.

2 North-south traverse

A surficial layer characterised by seismic velocities 240 to 480 m/sec exists along the profile. It ranges in thickness from 2.0m at chainage 105m to 4.4m at chainage 415m. Lateral velocity variations occur in the layer.

Data from boreholes Djerriwarrh 161, 159 and 192 at chainages 8, 235 and 475m respectively correlated with this layer which is interpreted to consist of unconsolidated clays and silts and sands.

The surficial layer directly overlies a layer characterised by velocities in the 880 to 1570 m/sec range at chainages 45 to 170m, 210 to 335m and 425 to 450m. This underlying layer has a maximum thickness of 7.9m at chainage 275m and exhibits lateral variations in velocity along the profile. The layer is interpreted to consist of clay, silt and weathered basalt.

For the rest of the traverse, the surficial layer directly overlies the deepest refractor which is characterised by velocities between 2330 and 2900 m/sec. The depth to this layer varies from a minimum of 2.8m at chainage 380m, to a maximum of 10.2m at chainage 275m, and is interpreted to consist of weathered to fresh basalt. The interpreted depth to this layer agrees with data from borehole Djerriwarrh 159.

Lateral velocity variations occur along all layers in both profiles. This could be due to changes in weathering, lithology or a combination of these two factors. However, specific causes are not known because of insufficient borehole information. Further drilling has been recommended (see Fig. 3B).

3 Accuracy of Interpretation

Analysis of the uncertainties involved in the calculation of refractor depths was not possible because of the lack of coincident borehole and seismic refraction data.

The Hawkins' (1961) method used to interpret this data assumes planar, shallow dipping layers. The refractor interfaces in this area are irregular and are therefore difficult to accurately delineate with Hawkins' (1961) technique. Consequently further drilling is recommended to confirm the interpretations presented in this report.

Refractor depths could not be calculated at Djerriwarrh 161 and 192. However the following observations were made :

1) the two interpreted profiles show an increase in depth to basalt towards Djerriwarrh 192, which is supported by the borehole data, and

2) borehole data from Djerriwarrh 161 on the north-south traverse shows a surficial layer which is 3.1m thick and directly overlies basalt. This agrees with the trend of the interpretation near this borehole.

The two traverses intersect at borehole Djerriwarrh 192 (see Figure 3B). Agreement of the two profiles at the intersection point is difficult to determine because of the sparseness of the data in this area. A general deepening of the basalt on both traverses was observed. However the velocities detected on each traverse could not be correlated.

5 CONCLUSIONS

1) The Hawkins' (1961) interpretation method was not strictly applicable to this data because of the irregular nature and shallowness of the refractor interfaces. Consequently, more borehole information is required to confirm the interpretation.

2) The thickness of material overlying the higher velocity basalt ranges from 3.6 to 9.8m along the east-west traverse, and from 2.0 to 10.2m along the north-south traverse.

6 RECOMMENDATIONS

Four boreholes drilled to basalt are recommended (see Figure 3B) to confirm the interpretations presented in this report.

East-west traverse : Two boreholes are recommended for drilling at chainages 35 and 450m. Data from these holes will;

1) reveal the precise nature and extent of refractors which have velocities that could not be correlated absolutely with existing borehole data (i.e. 1880 and 760 m/sec at chainages 35 and 450m respectively),
2) confirm refractor depths where minimum depths were calculated, and
3) confirm refractor depths calculated where seismic refraction data coverage was regular and complete (i.e. at chainage 450m).

North-south traverse : two boreholes are recommended for drilling at chainages 105 and 310m. Data from these holes would;

1) identify the nature and thickness of the refractors with velocities 1260 and 920 m/sec, and
2) confirm interpreted refractor depths where data coverage was good (i.e. chainage 310m).

REFERENCES

Dahlhaus, P G, 1985 : An engineering geological investigation of the Urban Land Authority's property, Melton. Department of Industry, Technology and Resources, Geological Survey Division, Unpublished Report 1985/57.

Hawkins, L V, 1961 : The reciprocal method of routine shallow seismic refraction investigations. Geophysics 26(6), 806-19.

Redpath, B B, 1973 : Seismic refraction exploration for engineering site investigations. Department of Lands, Surveys and Mining, Geological Survey of Papua New Guinea, Technical Report E-73-4.

APPENDIX IV

SOIL REPLACEMENT METHOD

(FROM CHEN 1975)

SOIL REPLACEMENT

A simple and easy solution for slabs and footings founded on expansive soils is to replace the foundation soil with nonswelling soils. Experience indicates that if the subsoil consists of more than about 5 feet of granular soils (SC-SP), underlain by highly expansive soils, there is no danger of foundation movement when the structure is placed on the granular soils. The mechanics and the path of surface water seeping through the upper granular soils and into the expansive soils is not clear. It is concluded that either seepage water has never reached the expansive soils, or the heaving of the lower expansive soils is so uniform that structural movement is not noticeable.

This is not true in the case of man-made fill. For economic reasons, the extent of the selected fill must be limited to a maximum of 10 feet beyond the building line. Therefore, the possibility of edge wetting exists. A guideline has not been established as to the thickness requirement for the selected fill. A minimum of 3 feet should always be insisted upon, although 5 feet is preferred. This thickness refers to thickness of selected fill beneath the bottom of the footings or bottom of floor slabs.

The pertinent requirements concerning soil replacement are the type of replacement material, the depth of replacement, and the extent of replacement.

Type of material

Obviously, the first requirement for the replacement soil is that it be nonexpansive. All granular soils ranging from GW to SC in the Unified Soil Classification System may fulfill the nonexpansive soil requirement. However, for clean, granular soils such as GW and SP, surface water can travel freely through the soil and cause wetting of the lower swelling soils. In the other extreme, SC material with a high percentage of plastic clay sometimes will exhibit swelling potential. The following criteria have been used with a certain degree of success:

Liquid limit, percent	Percent minus No. 200 sieve
Greater than 50	15 – 30
30 – 50	10 – 40
Less than 30	5 – 50

It is becoming increasingly difficult to locate materials, fulfilling the above requirements, in expansive soil areas such as Metropolitan Denver. If necessary, the requirement for imperviousness can be forfeited. Any selected fill will be satisfactory provided the material is nonexpansive. Also, swell tests are the only positive method of determining the expansiveness of the material. When in doubt, such tests should be conducted rather than relying on plasticity tests.

A great deal of emphasis has been given to the possibility of blending granular soil with the on-site swelling soils, thus reducing the amount of imported fill required. Theoretically, such a method is reasonable; but in practice it is difficult to incorporate granular soil with stiff, dry expansive clays. Disc harrows and plows will be required to break the clay into reasonably sized clods. Such an undertaking will probably be as expensive as using the lime stabilization method.

Depth of replacement

The depth of influence is a most complicated question that must be answered when dealing with soil treatment beneath the slabs or footings. To what depth should the natural soil be recompacted? How many feet of overexcavation will be required? How many cubic yards of nonexpansive soil will have to be imported? These questions cannot be intelligently answered until the amount of movement that will occur beneath the slabs or footings can be assessed.

Theoretically, the amount of uplift can be evaluated from the data derived from swell tests and pressure distribution methods. Gizienski and Lee [70] evaluated the theoretically computed uplift derived from laboratory test data and the actual measurement taken from a small scale field test. They found that the actual heave in the field was only one-third of that estimated from the results of laboratory tests.

The Colorado Highway Department established curves which show the relationship between total swell and the depth below the surface of the subgrade [71]. Studies have shown that the swelling can take place down to a depth of as much as 50 feet. Also, 60 percent of the swell in many of the Colorado subgrade clays can occur down to a 20-foot depth.

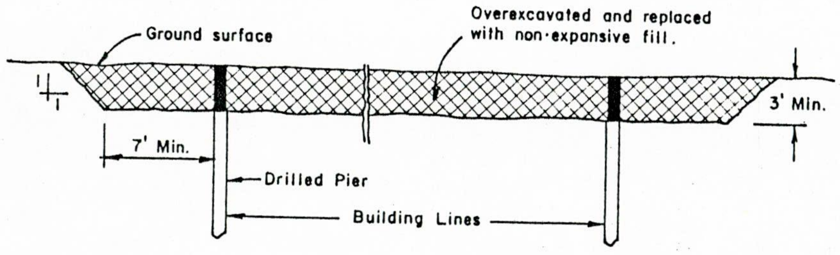
While both the theoretical approach and actual measurement concerning depth of influence are urgently needed, the following should be pointed out:

1. The potential vertical rise of a soil mass, say 10-by 10-by 3-feet, (such as that used in Gizienski's experiment) under uniform saturation conditions, can be less than that of the same mass subject to local wetting only. Uniform wetting tends to equalize heaving.
2. There is a definite gain in placing the structure on a nonexpansive soil cushion. Even if the deep seated soils swell, the movement will be more uniform, and consequently, more tolerable.
3. The depth of selected fill should never be less than 36 inches and preferably 48 inches. The swelling potential of the soil beneath the fill is very important as density and moisture conditions change at various locations. It should be noted that with 4 feet of fill plus the weight of concrete, a uniform pressure of about 600 psf is applied to the surface of expansive soils. For moderately swelling soil, such surcharge load can be important in preventing potential heave.
4. The failure of the soil replacement method generally occurs during construction. If the subgrade or open excavation becomes wetted excessively before the placement of the fill, the trapped water will cause heaving. In such case, detrimental heaving will occur regardless of thickness of the selected fill. The soils engineer should have the opportunity of supervising the placement of fill, or such a scheme should not be adopted.
5. The thickness of the imported fill can be reduced if a combination of the soil recompaction and soil replacement methods is used. The natural soil is scarified and recompacted as described under "Compaction Control" for a thickness of about 2 feet, then another 2 feet of selected compacted fill placed. The combined thickness of 4 feet should be adequate to control heaving.
6. The degree of compaction of the selected fill depends upon the type of supporting structure. For supporting slabs, 90 percent of standard Proctor density should be adequate. For supporting footings, a degree of compaction of 95 to 100 percent should be achieved.

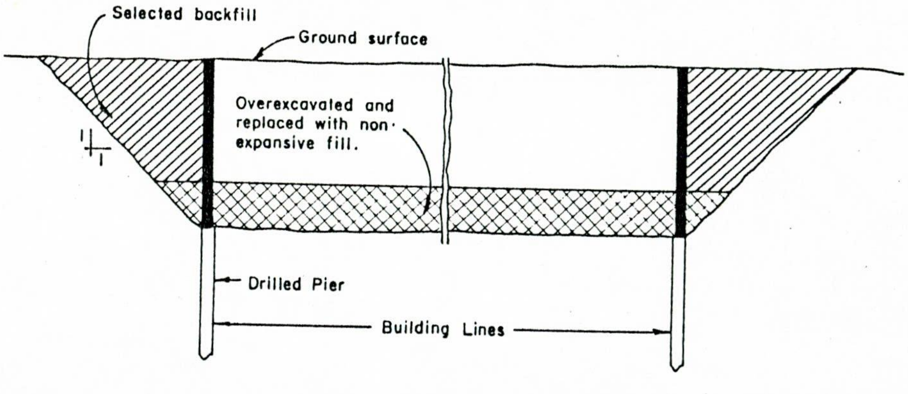
Extent of replacement

The main reason that an artificially selected fill cushion is less effective than a natural granular soil blanket is that in natural conditions, the blanket extends over a large area, much larger than in the artificial condition. In an artificial fill situation, it is always possible for surface water to seep into the deep-seated expansive soil at the perimeter of the fill. Therefore, the larger the area of replacement, the more effective the fill.

Figure 108 shows the suggested extent of replacement for both basement and nonbasement conditions. With this arrangement, the possibility of surface water entering the foundation soil is greatly reduced. The type of material used for backfill should be the same as used for the underslab selected fill.



NON · BASEMENT CONDITION



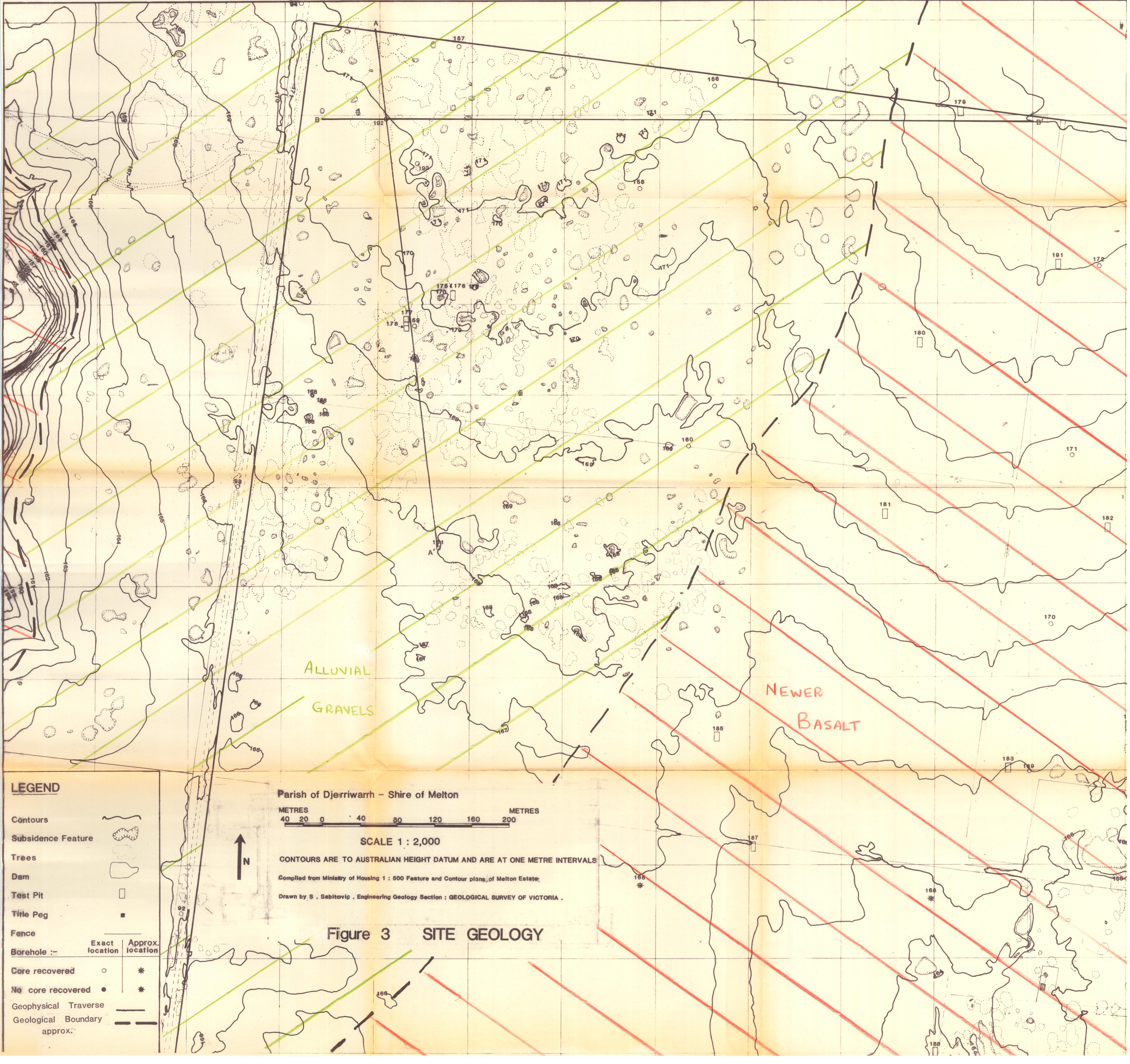
DEEP BASEMENT CONDITION

Figure 108. Suggested extent of fill replacement.

Evaluation

With present technology on expansive soils, soil replacement is the best method to use in obtaining a stabilized foundation soil. The following are the evaluations of soil replacement method:

1. It is possible to compact the replaced nonexpansive soil to a high degree of compaction, thus enabling the material to support either heavily loaded slabs or footings. Such capability cannot be obtained by the prewetting method. Also, with the compaction control method, a high degree of compaction on expansive soils is not desirable, and, consequently, the load carrying capacity is limited.
2. The cost of soil replacement is relatively inexpensive when compared to chemically treating the soil. No special construction equipment, such as disc harrow, spreader, or mixer will be required. The construction can be carried out without delay as is encountered in the prewetting method.
3. The granular soil cushion also serves as an effective barrier against the rise of ground water or perched water.
4. With the exception of a structural floor slab (suspended floor), soil replacement provides the safest approach to slab-on-ground construction.
5. To guard against unexpected conditions which might cause heaving, it is strongly suggested that floating slab construction be used. Slip joints must be provided for all slab-bearing partition walls so there is no chance of slab movement disturbing the structure.
6. Surface drainage around the building must be properly maintained so there is no opportunity for water to enter the expansive soils beneath the selected fill.



Parish of Djerriwarrh – Shire of Melton

SCALE 1 : 2,000

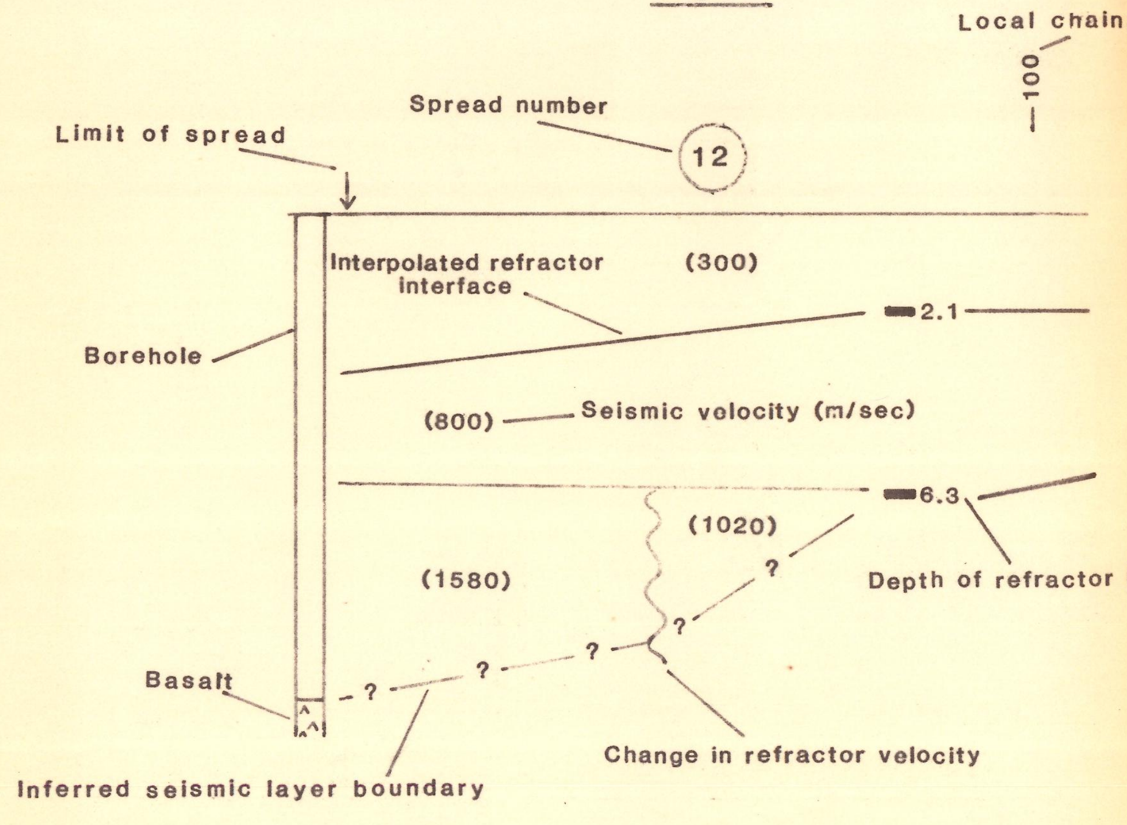
CONTOURS ARE TO AUSTRALIAN HEIGHT DATUM AND ARE AT ONE METRE INTERVALS

Compiled from Ministry of Housing 1 : 500 Feature and Contour plans of Melton Estate

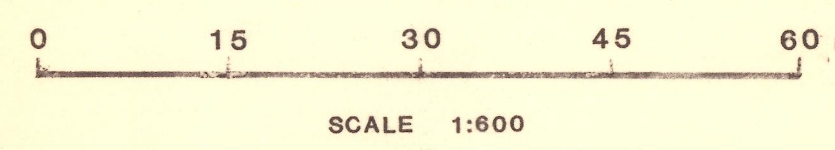
Drawn by S . Sabitovic . Engineering Geology Section : GEOLOGICAL SURVEY OF VICTORIA .

Figure 3 SITE GEOLOGY

The information displayed on this drawing was determined as accurately as possible but cannot be guaranteed because of the nature of the refractors and the limitations of the seismic method at this site.


Legend

V/H= 0.63



SCALE 1:600

OFFICE OF MINERALS AND ENERGY

GEOLOGICAL SURVEY OF VICTORIA
GEOPHYSICS SECTION

Melton seismic refraction investigation.

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Figure No. 3B
Drawing No. UR/1985/59/2
Scale 1:600