DEPARTMENT OF MINES AND ENERGY RESOURCES
GEOLOGICAL SURVEY
SOUTH AUSTRALIA

REPORT BOOK 97/14

Aquifer Storage and Recovery MFP Australia - The Levels Progess Report 1

by

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Executive Summary

The MFP Australia, Levels site is underlain by sedimentary deposits which contain two major aquifers of Tertiary age within the Port Willunga Formation. A laterally extensive confining bed (Munno Para Clay) separates the two aquifer systems. The project proposes both aquifers be investigated, and that the best receiving aquifer, based on ground water quality, transmissivity, storage capacity, and current local extraction is to be the recipient of "harvested" stormwater runoff from adjacent housing and wetlands. The other aquifer may be utilised for the storage of treated sewage effluent. It is envisaged that the water stored during winter will be recovered and used by households for non-contact purposes and also for irrigation of gardens, lawns and ovals throughout the village.

This report documents the successful completion of Stages 1(a) and (b) in which production/injection wells were drilled into the confined Tertiary aquifers; step-drawdown pumping tests were carried out to determine preliminary aquifer transmissivity and the parameters of the well equation; chemical analyses of the ambient ground water quality were undertaken; and also the aquifer material was analysed for its physical and chemical properties.

From the evaluation carried out, the deeper of the two confined aquifers targeted has been determined as the aquifer which best meets the project objectives in terms of ambient groundwater quality; aquifer homogeneity; storage; transmissivity; and mechanical displacement efficiency, all of which impact on the amount of water that can be stored and recovered. Based on the above factors, the recovery efficiency of water injected into the deeper of the two targeted aquifers is likely to be an order of magnitude higher than if similar quantities of water were injected into the uppermost Tertiary aquifer.

Some of the disadvantages in selecting the deeper of the two targeted aquifers include:

- higher capital costs incurred during the initial establishment of the ASR scheme because of the greater drilling depth;

- the fine sands encountered in the deeper aquifer may present problems in relation to the stability of the open hole section;

- during the early phase of injection and withdrawal, considerable purging of the well may be required to clear formation fines and;

- recovery of formation fines may also impact on the scheduling of maintenance on pumps, pipelines and valves which are an integral part of the ASR scheme.

It is considered that the recovery of formation fines will occur during the early life of the production/injection well, but after several successive injection / withdrawal cycles will reduce considerably.

Stage 1(a) commenced on 17 June 1996, and involved the drilling of two production wells into the Tertiary aquifer to assess the potential of the two aquifer systems.

Stage 1(b) commenced on 15 November 1996, which involved the drilling of three observation wells into the deeper Tertiary aquifer at a radius of 50 m from the main injection / production well, and one production / observation well at a radius of 150 m from the main well.

From the results of this second phase of drilling it can be inferred that the lithology of this aquifer is reasonably homogeneous across most of the site. It is; therefore, considered that the injection / withdrawal trials (to be carried out under Stage 1(c)) will be applicable across the whole site. The first of the injection trials, using 10 megalitres of mains water, is scheduled to begin in mid January 1997. The results of this injection trial will provide the foundation on which to build the stormwater / groundwater mixing model. Subsequent injections of stormwater from the adjacent Greenfield’s wetlands during the winter of 1997 will enable calibration of the model and development of a recovery schedule under different scenarios of supply and demand.

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Aquifer Storage & Recovery Feasibility Study MFP Australia - The Levels Progress Report. Completion of Stage 1(a) and (b)

Russell R Martin

Mines and Energy South Australia (MESA) was commissioned by MFP Australia to undertake an investigation into the feasibility of establishing an Aquifer Storage and Recovery (ASR) scheme at The Levels site. The programme is being carried out in two stages by MESA, in conjunction with the Centre for Groundwater Studies (CGS) The project proposes that the best receiving aquifer, based on ground water quality, transmissivity, current local extraction and storage capacity is to be the recipient of "harvested" stormwater runoff from adjacent housing and wetlands. The other aquifer may be utilised for the storage of treated sewage effluent. It is envisaged that the water stored during winter will be recovered and used by households for non-contact purposes and also for irrigation of gardens, lawns and ovals throughout the village. This report documents the successful completion of Stage 1(a) and (b) in which production/injection and observation wells were drilled into the confined Tertiary aquifers beneath the Northern Adelaide Plains; step-drawdown pumping tests were carried out to determine preliminary aquifer transmissivity and well equation; chemical analyses of the ambient ground water quality were undertaken; and the aquifer material analysed for its rock chemistry properties. From the analyses carried out, the deeper of the two targeted aquifers has been determined to be the aquifer which best meets the project objectives. Under Stage 1(b) of the programme, drilling of three observation wells and one production/injection well into the deeper Tertiary aquifer has been completed.

1. INTRODUCTION

Mines and Energy Resources South Australia (MESA) was commissioned by MFP Australia to undertake an investigation into the feasibility of establishing an Aquifer Storage and Recovery (ASR) scheme at The Levels site. The programme is to be carried out in two stages by MESA, in conjunction with the Centre for Groundwater Studies (CGS).

Stage I involves;

- the drilling of two wells into the confined Tertiary aquifers to assess their suitability for a sustained aquifer storage and recovery project;
- installation of observation wells;
- assessment of the ambient groundwater quality and;
- the development of an appropriate mixing model to simulate recovery efficiency.

Stage II comprises monitoring of the injected water, refinement of the mixing model and the development of a recovery schedule.

2. INVESTIGATION PROGRAMME

2.1 Stage I

The objectives for Stage I are:-

- Determine which of the upper two confined Tertiary aquifers is the best receiving aquifer for the “harvested” stormwater based on groundwater quality, transmissivity, current local extraction and storage capacity.

- Aquifer characterisation of the selected Tertiary aquifer at the MFP Levels site.

- Assess the feasibility of stormwater harvesting for ASR.

- Develop a stormwater / groundwater mixing model to simulate the movement of the injected stormwater, to assess the potential local and regional impact of ASR on the aquifer and to design a recovery strategy to maximise the value of the recovered water.

In order to facilitate the management of the study, Stage I has been sub-divided into the following parts;

Stage I(a)

Construction of two production / injection wells (one into the T1(b) aquifer and one into the T2 aquifer) to determine aquifer hydraulic parameters and the feasibility of establishing an ASR scheme at the Levels site.

Stage I (b)

Undertake preliminary testing to determine the best receiving aquifer and establish the required observation wells. Location, and spacing of the observation wells will be finalised once preliminary estimates of the aquifer properties have been determined.

Stage I(c)

Determine the ambient groundwater quality and aquifer properties at the site and inject stormwater to ascertain the ability of the aquifer to accept stormwater. Conduct recovery trials to determine the amount of injected water that can be recovered.

Stage I(d)

Develop and test an appropriate mixing model, based on data obtained at Andrews Farm, and at MFP. Use this to predict the quality (notably salinity) of water recovered from the aquifer. The model will also be used to forecast recovery efficiencies for different scenarios of supply and demand. Extend this to preliminary design of ASR facilities to meet projected growth in demand for recovered water. The model would be validated in Stage II, following finalisation of the ASR scheme design.

2.2 Stage II

The major objective of Stage II will be to assess the recovery efficiency of stored stormwater with respect to water quality objectives.

3. REGIONAL GEOLOGY

The site is located approximately 20 km northwest from the Adelaide Central Business District on the Northern Adelaide Plains as shown on the locality plan (Figure 1). The focus of this study is the Tertiary sediments of the Port Willunga Formation of the Adelaide sub-basin which forms part of the much larger St. Vincent Basin.

Beneath the Adelaide Plains, the Port Willunga Formation is characterised by thick subsurface sections (> 100 m) which are laterally extensive across the sub-basin. This unit is hydrostratigraphically divided into an upper sandy limestone facies (T1 aquifer) and a lower, sometimes dense blocky limestone (T2 aquifer) separated by the Munno Para Clay member which forms a laterally extensive aquiclude across the sub-basin.

The water bearing units within the Tertiary sequence also include the Dry Creek / Hallett Cove Sand which lie above the Port Willunga Formation. Because of the existence of a semi-confining bed, the T1 aquifer is further divided into two sub-aquifers. The T1(a) aquifer which comprises the Hallett Cove / Dry Creek Sand and the T1(b) aquifer composed of the sandy limestone facies of the Upper Port Willunga Formation.

4. RESULTS OF STAGE I(a) DRILLING

Drilling of the two investigation wells commenced on 12 June 1996 and was concluded on 30 June 1996. Summary well information for Stage 1(a) is included in Table 1 and geological logs are contained in Appendix I of this report.

The first well (MFP 834) penetrating the T2 aquifer (Unit No. 6628-17760 PN 37834) was drilled to a total depth of 212 m using rotary mud drilling. Cuttings samples were collected at three metre intervals over the entire penetrated depth. Completion of the well was carried out using 203 mm ID Fibre Reinforced Plastic (FRP) casing with the casing shoe set at a depth of 164 m. The casing was then pressure cemented to surface whilst the remaining section of the well (164 m to 212 m which encompasses the entire thickness of the T2 aquifer at this site) was left as an open hole completion.

Figure 2 presents a Hydrogeological cross section of the lithology encountered in the drillholes over the study site. Intervals over which the various lithological units were encountered are:

		Thickness
Hindmarsh Clay	3 - 62 m	59 m
Carisbrooke Sand (Q4)	62 - 98 m	36 m
Dry Creek / Hallett Cove Sand (T1(a))	98 - 111 m	13 m
Upper Port Willunga Formation (T1(b))	111 - 153 m	42 m
Munno Para Clay	153 - 164 m	11 m
Lower Port Willunga Formation (T2)	164 - 203 m	39 m
Ruwarrung Member	>203 m	

Three cores were taken from the following intervals in the Munno Para Clay and T2 aquifer and graphical logs including geological descriptions are included in Appendix II of this report.

Core 1	158.27 - 161.37 m
Core 2	174.95 - 177.95 m
Core 3	193.19 - 195.89 m

After preliminary development by airlifting, a water sample was obtained from the open hole section in the T2 aquifer and the Electrical Conductivity of 2910 µS/cm inferred a Total Dissolved Solids (TDS) content of 1600 mg L^{-1}. The sample was sent for analysis of major ions on 17 July 1996.

After completion the well was developed by airlifting at a rate of 10 to 20 L sec^{-1}. It required up to 10 days before the well stopped producing sand. The well was allowed to recover and a final standing water level (ie. depth to water) of 4.4 m below ground surface was recorded.

The second well MFP 835 (Unit No. 6628-17761 PN 37835) penetrating the T1 aquifer was drilled to a total depth of 155 m using rotary mud drilling. This well was located 15 m to the south of the deeper well MFP 834 (see location map, Figure 1). Cuttings samples were collected at three metre intervals over the entire penetrated depth. The well was completed with 203 mm ID FRP casing at a depth of 126 m and pressure cemented to surface. The well was left open hole from 125 to 155m which extends over the lower section of the T1(b) aquifer at this location. The well was completed in the lower section of the formation to ensure the sand and unconsolidated shelly section T1(b) was cased off.

Intervals over which the various lithological units encountered were:

		Thickness
Hindmarsh Clay	3 - 63 m	60 m
Carisbrooke Sand (Q4)	63 - 92 m	29 m
Dry Creek / Hallett Cove Sand (T1(a))	92 - 116 m	24 m
Upper Port Willunga Formation (T1(b))	116 - 155 m	39 m
Munno Para Clay	>155 m	

Three cores were taken from the following intervals in the T1(b) aquifer:

Core 1	120.00 - 121.60 m
Core 2	130.00 - 132.80 m
Core 3	140.00 - 143.00 m

Graphical logs of the cored intervals are presented in Appendix II of this report.

After limited development by airlifting, a water sample was obtained from the open hole section in the T1(b) aquifer and the Electrical Conductivity (EC) of 3760 µS/cm inferred a TDS content of 2100 mg L^{-1}. The sample was sent for analysis of major ions on 17 July 1996.

After completion the well was developed by airlifting at a rate of 10 to 15 L sec^{-1}. It required 3 days of airlifting before the well stopped producing sand. The well was left to recover and a final standing water level (ie. depth to water) of 14.2 m below ground surface was recorded.

The following suites of Geophysical logs were run over each hole prior to casing:

Gamma, Neutron, Point Resistivity, Caliper, Spontaneous Potential and Density. A composite well log identifying age, formation, completion and lithological profile data is included in Appendix III.

Selected samples from the cored intervals from each aquifer have been dispatched to the appropriate analytical laboratories to undergo the following tests for aquifer characterisation:

Vertical hydraulic conductivity
Porosity
Grain Size analysis
Total Organic Carbon
X-Ray Diffraction
X-Ray Fluorescence
Thin section and optical examination for pyrite
Pore throat size distribution

Table 1

DRILLING SUMMARY

Site No	Permit No	Latitude	Longitude	Depth (m)	Water Cut (m)	Cased To (m)	+Depth To SWL (m)	Thickness (m)	*Yield (L/sec)	TDS (mg/L)	Aquifer monitored
MFP 834	37834	34° 48.742’	138° 36.727’	212	164	164	4.4	48	15	1600	T2
MFP 835	37835	34° 48.750’	138° 36.720’	155	116	126	14.2	29	10	2100	T1(b)

+ SWL measured 2 July 1996
* Yield determined from Airlifting

Open hole completion was selected for both aquifer sections in order to optimise the well efficiency. Given the nature of the very fine sands within the formation (both T1(b) and T2) a screen size of approximately 0.1 mm would be required to prevent 60% of the sand passing the screen. A screen with such a small aperture would significantly affect well performance.

From the results of the drilling carried out during stage I(a) the following inferences are drawn concerning the suitability of the two aquifers for the proposed ASR scheme.

- A 10 metre head difference between the two aquifers at this site indicates there is little or no hydraulic connection between the T1(b) and T2 aquifers. In addition the lower T2 aquifer contains water of better quality than does the T1(b) aquifer which suggests that recharge mechanisms differ between the two aquifer systems.

- Typically, the Port Willunga Formation is characterised as a bryozoal-rich marly limestone. The basal section of the upper confined aquifer (T1(b)) is a well consolidated sandy limestone whilst the lower T2 aquifer consists of a sandy - clayey succession, more appropriately described as a calcarenite. The fine-grained quartz sands with calcareous cementing *(Cooper, 1979)* encountered in the T2 aquifer suggests the Pirramimma Sand Member is the dominant lithology occurring at this site.

- Overall, the lithology of the T2 aquifer is relatively homogeneous which indicates that mixing and storage is likely to occur over the whole aquifer sequence. In addition, the mixing profile vertically across the aquifer will be more uniform. The lower salinity in the T2 aquifer will aid the recovery efficiency of the injected water (ie. more of the injected water can be recovered at an acceptable salinity for its intended use, than for water injected in the more saline T1(b) aquifer.

- Although the quality of water in the T2 aquifer (1600 mg L^{-1}) is better than the T1(b) aquifer (2100 mg L^{-1}) the fine sands encountered in the T2 aquifer may present problems in relation to the stability of the open hole section. In addition, considerable purging of the well may be required after injection and prior to abstraction to clear the well of formation fines. Production of formation fines may also impact on the scheduling of maintenance on pumps, pipelines and valves which will be an integral part of the ASR scheme.

- The factors mentioned in the preceding paragraph may result in higher operating costs with longer redevelopment required after each injection phase if the T2 aquifer is targeted. In addition, because of the greater depth of the T2 aquifer capital costs for initial establishment of the wells is much higher.

- The T1(b) aquifer is heterogeneous and as a result the storage and mixing profile of the injected waters are likely to be non-uniform vertically across the aquifer. The higher salinity of the ambient groundwater implies that recovery efficiency of the injected water from the T1(b) aquifer may not be as great as in the T2 aquifer.

- Within the T1(b) aquifer the lower sandy limestone section is separated from the Hallett Cove / Dry Creek sand by a silty clay and shelly succession. This may require the establishment of additional observation wells to accurately determine the potential for upward leakage into the T1(a) aquifer.

- In addition, the integrity of the semi-confining bed between the T1(a) and T1(b) aquifers is thought to be geotechnically very weak. Increases in hydraulic pressure, as a result of aquifer injection, may result in accelerated upward leakage from the T1(b) aquifer into the T1(a) aquifer. This may also impact on the recovery efficiency of the injected water.

- It should also be noted that because the T1(b) aquifer consists of a consolidated sandy limestone, acidization may be required to enhance injection performance in this aquifer.

5. STEP-DRAWDOWN PUMPING TESTS

In order to determine the well equation and aquifer transmissivity a three stage step-drawdown test of 300 minutes duration was carried out on each of the production wells intersecting the T1(b) and T2 aquifers. The details of the tests are provided in Appendix IV and summary results are presented in Table 2.

The step-drawdown test is a single-well test in which the well is pumped at a slow constant discharge rate until the drawdown within the well stabilises. The pumping rate is then increased to a higher constant discharge rate and the well is pumped until the drawdown stabilises once more *(Kruseman & de Ridder, 1991).* The Eden-Hazel method *(1973)* was applied to determine the well loss parameters and also provide an estimate of the aquifer transmissivity. This method is based on Jacob's approximation of the Theis equation.

Table 2

SUMMARY OF PUMPING TEST RESULTS

Permit Number	Aquifer	Rate 1 (L sec^{-1})	Rate 2 (L sec^{-1})	Rate 3 (L sec^{-1})	Constants			T*
					a	b	c	
37834	T2	3.0	6.0	10.6	3.27	0.89	0.61	310
37835	T1(b)	3.0	6.0	8.7	35.7	4.0	2.35	60

T* = Transmissivity (Jacob Equation)

Results from the pumping test for the T1(b) aquifer indicate a transmissivity of 60 m^2 day^{-1} which translates to an equivalent hydraulic conductivity of 2.0 m day^{-1} based on the aquifer thickness at this location. During the 300 minute test period a 17 m drawdown was observed allowing a reliable estimate of the transmissivity to be calculated using the graphical technique of *Eden-Hazel (1973).* The transmissivity recorded at this site for the T1(b) aquifer is typical of other wells penetrating the same aquifer throughout the Northern Adelaide Plains.

Results from the step-drawdown test carried out on the well penetrating the T2 aquifer indicate a transmissivity of 310 m^2 day^{-1} which translates to an equivalent hydraulic conductivity of 6.5 m day^{-1} based on the aquifer thickness at this location. This could be considered as an upper limit for the transmissivity at this location as other wells which penetrate this same aquifer on the Northern Adelaide Plains have transmissivities of ~200 to 250 m^2 day^{-1}.

It should be noted that recovery efficiency will continue to improve during subsequent injection and recovery cycles. The improvement in recovery efficiency is caused by changes in the zone of dispersion. If withdrawal ends when the withdrawn water exceeds the TDS limits of the injected water, the TDS distribution in the aquifer at that time, which is lower than background, becomes the initial distribution for the next injection phase.

6. ANALYTICAL RESULTS

6.1 Water Chemistry

Chemical analysis for the major cations and anions was carried out on water samples recovered during development of the wells. Results from these analyses are presented in Appendix V.

Comparing the sodium and chloride ratios of groundwater from the T1(b) and T2 aquifers show the waters to be of a similar composition. Although the groundwater from the T2 aquifer has a slightly higher bicarbonate and considerably higher iron content than does the groundwater sample taken from the T1(b) aquifer.

Given the iron content in both water samples: T1(b) 14.1 mg L^{-1}; T2 32.3 mg L^{-1} periodic chlorination during withdrawal operations will be required to control the development of iron bacteria around the well.

The quality of water from either aquifer is suitable for most irrigation purposes; however, the high iron content is likely to cause staining on paths, fences or other structures that it contacts.

6.2 Rock Chemical Properties

6.2.1 Vertical Hydraulic Conductivity

Seven core samples were submitted to the Materials Sciences Centre of the South Australian Water Corporation for determinations of vertical hydraulic conductivity and porosity. Results of these analyses are presented in Tables 4 and 5 in Appendix VI. The samples are representative of the aquifer material as taken during coring. Although a core was taken through a section of the Munno Para Clay a sample of this material was not submitted for analytical testing.

The results from aquifer T1(b) (Table 4 in Appendix VI) show a significant variation in both porosity (0.43 to 0.54) and vertical hydraulic conductivity (0.8 to 9.6 m day^{-1}) indicating that the aquifer is very heterogeneous. The high porosity coupled with a low dry density and high moisture content for sample 96/378 suggests that this sample has a high clay content. Conversely, this sample also displays a reasonably high vertical hydraulic conductivity (5.62 m day^{-1}) which is indicative of either preferential flow paths existing throughout the sample matrix or fracturing as a result of coring this material.

The samples submitted for analysis from the T2 aquifer show a uniform porosity of 0.35 and vertical hydraulic conductivity of between 0.7 and 2.2 m day^{-1}, indicating that the aquifer is relatively homogeneous. Because of the apparent homogeneity of this aquifer material preferential flow of the injected water is likely to be small compared with T1(b).

6.2.2 Geo-Chemistry

Six samples (three from the T1(b) aquifer and three from the T2 aquifer) of the cored aquifer material were submitted to AMDEL Limited for sizing, chemical and mineralogical analyses. Selected samples were taken from the core adjacent to those sections submitted for vertical hydraulic conductivity measurements.

A portion of each sample was pulverised and analysed for major oxides by ICP and for total carbon and organic and elemental carbon by gravimetric methods.

Weighed sub-samples of the -20mm fraction were taken and dispersed in water with the aid of deflocculants and a mechanical shaker, and allowed to sediment to produce a -2mm e.s.d. size fractions by the pipette method. The resulting dispersions were examined by plummet balance to determine their solids contents. The -2mm dispersions were then used to prepare orientated clay preparations on ceramic plates. Two plates were prepared per sample, both being saturated with Mg^{++} ions, and one in addition being treated with glycerol. When air-dry, these were examined in the X-ray diffractometer. A portion of the pulverised head sample used for chemical analysis was analysed by X-ray diffraction to determine the bulk mineralogy.

A riffled portion of the +20mm size fraction from the size analysis was separated centrifugally in a heavy liquid of sp. gr. 2.96 (tetrabromethane). The >2.96 sp. gr. product was examined microscopically in a polished section (PS 57126 - 57131) and loose grain oil mount in order to visually estimate the pyrite content.

A thin section (TS C66713 to C66718) was prepared of each sample and examined microscopically in transmitted light. The samples were unconsolidated and required impregnation prior to thin section preparation. Each section was stained with alizarin red-S dye to distinguish calcite from all other carbonates. Only calcite takes the pink stain. (AMDEL Limited Report G645900G/96)

The chemical analysis results are given in Tables 6 and 7 in Appendix VII and the petrological descriptions are also presented in Appendix VII. *The samples were all unconsolidated, friable, calcareous sands or sandy limestone. Opaques were most abundant in samples 189198 with lesser amounts in 189197 and 189189. Samples 189198 and 189199 contain abundant authigenic dolomite. (AMDEL Limited Report G645900G/96).*

The mineralogies of the bulk sample and the -2μm fraction are given in Table 8 in Appendix VII. *Other minerals in the >2.96 sp. gr. products of all samples are carbonate (dominant) with trace amounts of zircon, tourmaline, sillimanite and amphibole. (AMDEL Limited Report G645900G/96)*

The chemical analysis of the physical rock samples shows the dominant mineral to be calcite with quartz sub-dominant. Reactions which are likely to occur as a result of the injected water having a different chemical composition to the native groundwater are calcite dissolution; and occur equally in both the T1(b) and T2 aquifers.

Most of the calcite dissolution will take place during the early stages of injection, slowing with time, as a new equilibrium between the native groundwater, rock matrix and injected water is approached. The impact of calcite dissolution is that there is likely to be an increase in secondary porosity within the aquifer which may increase porosity and hydraulic conductivity *(Rattray K. et al., 1996).* On the other hand, as calcite is the dominant cementing material between grains, dissolution will result in production of formation fines during the start of withdrawal operations.

This will necessitate a quantity of recovered water being pumped to waste until sand or other formation material is no longer evident in the pumped water. It is expected however, that after several successive cycles of injection and withdrawal, the amount of calcite dissolution will diminish; thus, reducing the amount of formation material mobilised.

Because of the high iron content in the aquifer water there is a significant potential for iron dissolution and re-precipitation. This may require the incorporation of iron removal as a treatment for recovered waters.

6.2.3 Grain Size Analysis

A portion of the sample was taken and submitted for grain size analysis. Samples 189196, 189197 and 189200 contained a considerable proportion of cemented material, and these samples were soaked in water for 1 week before the +4.0 mm cemented material was screened out and excluded from the size analysis. The size analysis consisted of desliming at 20mm and dry-sieving the +20mm fraction.

Weighed sub-samples of the -20mm fraction were taken and dispersed in water with the aid of deflocculants and a mechanical shaker, and allowed to sediment to produce -15, -10, -5 and -2mm e.s.d. size fractions by the pipette method. The resulting dispersions were examined by plummet balance to determine their solids contents.

The size distribution results are given in Appendix VIII. *Note that the proportion of the sample found to separate into the -20mm size fraction is approximate only, and the figures obtained apply only to determination by a plummet balance and to the pre-treatment and dispersion conditions used (AMDEL Limited Report G645900G/96).*

6.2.4 Pore Size Analysis

Flow from or to a well does not occur as a spatially uniform displacement of native water by injected water owing to heterogeneities within the porous media. In all cases, either in sedimentary, karst or fractured rocks, flow occurs through a network of interconnected channels (capillaries) that vary in size and tortuosity. The velocity of flow varies over the cross section of each channel causing the dispersion of the injected water.

One method of characterising the hydraulic properties of the aquifer is to determine the pore size distribution or more correctly the pore throat entry radii distribution. If one considers the interconnected pore spaces within the aquifer to be analogous to a bundle of capillary tubes of differing diameters it requires a certain amount of pressure to overcome the surface tension existing between the fluid and rock before the native fluid can be displaced. By extension, the smaller the tube or pore space, the greater the surface tension between rock and fluid and; therefore, a greater pressure is required to move or displace the native fluid.

In the case of aquifer storage and recovery the required pressure for displacement of the native groundwater is applied during injection via a rise in the hydraulic head at the injection well which is transmitted radially in the aquifer. The displacement of the native groundwater in the first instance is; therefore, considered to be by mechanical displacement.

By characterising the pore throat entry radii an insight can be gained into the displacement efficiency that will occur throughout the aquifer sequence. That is; for a given injection rate or pressure only a certain proportion of fluid can be displaced by mechanical means from those pores in which the surface tension can be overcome.

The remaining pore spaces not flushed by the injection process will retain native groundwater allowing molecular diffusion to occur. Diffusion is the process by which both ionic and molecular species dissolved in water migrate from locations of higher to lower concentration at a rate dependent upon a diffusion coefficient and the concentration gradient between the two fluids *(Merritt M., 1986).*

As molecular diffusion is a relatively slow process the longer the injected water remains in contact with the native groundwater the greater the mixing between the two fluids. The degree to which mechanical displacement of the native water occurs impacts on the recovery efficiency of the injected water.

By optimising the injection rate the maximum amount of displacement of the native groundwater can be obtained by mechanical dispersion. This minimises the amount of injected water lost as a result of molecular diffusion over those areas not flushed by mechanical dispersion.

The pressure curves determined by mercury injection are typically greater than water injection because mercury is normally a non-wetting fluid. By assuming a contact angle of 130 degrees for mercury against the rock surfaces an equivalent water pressure can be determined from the following calculation *(Purcell W. R., 1949)*:

$$\frac{P_{cm}}{P_{cw}} = \frac{\sigma_m \; Cos130°}{\sigma_w \; Cos0°}$$

taking σ_m = surface tension of mercury = 485 dynes/cm
σ_w = surface tension of water = 70 dynes/cm

The above ratio P_{cm}/P_{cw} to correct mercury injection pressure data to an equivalent water pressure is equal to 4.5. The resultant plots in Appendix IX show that displacement by mechanical dispersion with an applied head of 10 m results in between 5 and 75 percent flushing of the native groundwater for aquifer T1(b) and between 70 and 75 percent for aquifer T2.

From these results the T2 aquifer appears to be relatively homogeneous and; therefore, the degree to which preferential fingering of the injected water occurs will be minimised. This is in agreement with the hydraulic conductivity, porosity and particle size results. The implications are that a more uniform radial displacement is likely to occur over the thickness of the T2 aquifer. A greater recovery efficiency (provided withdrawal rates are optimised) is likely to be maintained during withdrawal in comparison to the T1(b) aquifer.

Results of the pore size analysis test data are contained in Appendix IX.

After considering all of the above results it has been concluded that the T2 aquifer is the best receiving aquifer for the ‘harvested’ stormwater based on groundwater salinity, transmissivity, storage capacity and mechanical displacement of native groundwater by injected water.

7. RESULTS OF STAGE I(b) DRILLING

Stage I(b) was commenced with construction of three observation wells and one production/observation well into the T2 aquifer prior to the beginning of injection trials.

Drilling of the four observation wells into the T2 aquifer commenced on 15 November 1996 and was concluded on 10 December 1996. The first suite of three observation wells was positioned at a radius of 50 m from the main T2 aquifer production/injection well (Figure 1). Two of these observation wells were completed as a pair (approximately 10 m apart) for the purposes of monitoring the top and bottom sections of the T2 aquifer.

The paired observation wells were completed with 100 mm ID Class 12 PVC and pressure cemented to surface. One of the pair (MFP 391) was drilled to a total depth of 205 m and has been completed with 12 m of 1 mm slotted casing over the interval 188.5 to 200.5 m to monitor the basal aquifer section. The second well in the pair (MFP 394) was drilled to a total depth of 184 m and completed with a 12 m slotted section over the interval 168 to 180 m to monitor the upper section of the aquifer. The casing was pressure cemented to surface.

A third observation well was drilled at a radius of 50 m from the main T2 aquifer production/injection well and at 90° to the paired observation wells (Figure 1). This well (MFP 395) was drilled to a total depth of 207 m and completed with 100 mm ID Class 12 PVC casing and pressure cemented to surface. Casing was run from surface to a depth of 168 m. Slotted casing with approximately 1 mm slots was positioned over the aquifer interval 168 to 198 m.

A fourth observation/injection/production well (MFP 396)was drilled at a radius of 150 m from the main T2 production/injection well along the same line as well MFP 395 (Figure 1) to a total depth of 212 m. This well was geophysically logged prior to running casing. 152 mm ID FRP casing was run to a total depth of 168 m and pressure cemented to surface. The remaining section of the well from 168 to 212 m was left as an open hole completion.

Summary well information is included in Table 3 and geological logs are contained in Appendix I of this report along with lithological logs for wells MFP 391, MFP 394, MFP 395 and MFP 396. Figure 2 presents a diagrammatic cross section of the lithology encountered over the area of investigation. After limited development by airlifting, a water sample was obtained from each well. The following suite of Geophysical logs were run over well MFP 396 prior to casing: Gamma, Neutron, Point Resistivity, Caliper, Spontaneous Potential and Density.

Table 3

DRILLING SUMMARY T2 Aquifer

Site No	Permit No	Latitude	Longitude	Depth (m)	Cased To (m)	Slotted Section (m)	+Depth To SWL (m)	Thickness (m)	*Yield (L/sec)	TDS (mg/L)	Aquifer monitored
MFP 391	38391			205	188.5	188.5-200.5	3.2	12.0	1.0	1680	T2
MFP 394	38394			184	168.0	168.0-180.0	3.5	12.0	1.0	1630	T2
MFP 395	38395	34°48.71’	138° 36.713’	207	168.0	168.0-198.0	3.5	30.0	1.0	1620	T2
MFP 396	38396	34° 48.65’	138° 36.685’	212	168	OH	3.2	44.0	6.0	1710	T2

+ SWL measured 7 December 1996
* Yield determined from Airlifting, estimate only.

8. PROGRESS AGAINST TIMELINES

Stage I(a) started approximately one week after the scheduled start date however, was completed successfully within the allocated time.

Stage I(b) aquifer characterisation, involving testing of selected core material and preliminary pumping tests has been completed and the results indicate that the T2 aquifer best meets the project objectives in terms of ambient groundwater quality; aquifer homogeneity; storage; transmissivity; and mechanical displacement efficiency.

The second phase of drilling (Stage I(b) installation of the observation wells) began on 15 November 1996, eight weeks behind the proposed schedule because of rig availability coupled with difficulty in site access as a result of heavy rainfall.

The delay in drilling of the observation wells has impacted on the final completion date of the project and also on the proposal to use water from the Greenfield’s wetlands for the preliminary injection trials. The salinity within the Greenfield’s wetlands has increased substantially during the summer, and as at 1 December 1996 was in excess of 2 000 mg L^{-1}, which is higher than the native groundwater in the T2 aquifer. The high salinity in the wetlands at this time precludes the use of this water for injection trials.

9. SUMMARY AND CONCLUSIONS

Stage 1(a) included the construction of two production / injection wells (one into the T1(b) aquifer and one into the T2 aquifer) whilst Stage 1(b) involved; water chemistry analysis; aquifer material analysis and pumping tests to determine aquifer hydraulic parameters; the construction of three observation wells and one production / observation well into the selected aquifer.

All work scheduled to be carried out under Stages 1(a) and 1(b) has now been completed and the following conclusions are drawn:

- The well performance parameters calculated from the step-drawdown test indicate that T2 is the most suitable aquifer to target with respect to ascertaining the feasibility of the ASR project.

- Transmissivity of the T2 aquifer is 310 m^3 day^{-1} m^{-1} (considered to be an upper limit) compared to the transmissivity of the T1(b) aquifer of 60 m^3 day^{-1} m^{-1}.

- The lower salinity in the T2 aquifer will aid the recovery efficiency of the injected water (ie. not as much of the injected water will be lost by mixing with the ambient groundwater).

- The samples submitted for analysis from the T2 aquifer indicate a uniform porosity of 0.35 indicating that the aquifer is relatively homogeneous in comparison to the T1(b) aquifer which lies between 0.40 and 0.53.

- Based on the total dissolved solids (TDS) content groundwater quality is considerably better in the T2 aquifer (1 600 mg L^{-1}) as compared to the groundwater in the T1(b) aquifer (2 100 mg L^{-1}). Comparing the ionic composition of the two groundwaters shows the T2 aquifer to have a slightly higher bicarbonate and iron content than does the groundwater of the T1(b) aquifer.

- Chemical analyses of the aquifer material show the dominant mineral to be calcite with quartz sub-dominant. Reactions which may occur as a result of the injected water having a different chemical composition than the native groundwater are likely to be calcite dissolution and occur equally in both the T1(b) and T2 aquifers. The impact of calcite dissolution is that there is likely to be an increase in secondary porosity as well as an increase in the near wellbore permeability, thereby improving well performance.

- As calcite is the dominant cementing material between grains, dissolution will result in production of formation fines during the start of withdrawal operations. This will require a quantity of recovered water being pumped to waste until sand or other formation material is no longer evident in the pumped water.

- It is considered that production of formation material is likely to be more apparent from the T2 aquifer and that production of such material may impact on maintenance scheduling for wear and replacement of pumps, valves and pipeline infrastructure. It is expected; however, that after several successive cycles of injection and withdrawal, that the amount of calcite dissolution will diminish; thus, reducing the amount of formation material produced.

- Analytical testing of the pore size distribution of the aquifer material indicate the T2 aquifer to be relatively homogeneous in comparison to the T1(b) aquifer. Because of the aquifer homogeneity, mechanical displacement of the native groundwater is greater in the T2 aquifer (75%) given an applied hydraulic head of 10 m, in comparison to the T1(b) aquifer which varies between 5 and 75%.

- The implications of mechanical dispersion efficiency are; with a greater initial displacement of native fluid, less injected fluid is lost as a result of molecular diffusion and consequently recovery efficiencies are higher.

- Because the T2 aquifer is relatively homogeneous, the storage and mixing profile of the injected water are likely to be uniform over the injection zone with minimal preferential fingering of the injected liquid through the formation.

- Although the capital costs of selecting the T2 aquifer are initially greater, because of the depth to drill, these costs should be offset within the first few years of operation because of the larger volumes that can be stored and the anticipated higher recovery efficiencies that may be obtained from the T2 aquifer.

- From the results of this second phase of drilling it can be inferred that the lithology of the T2 aquifer is reasonably homogeneous across most of the site. It is; therefore, considered that the injection / withdrawal trials (to be carried out under Stage 1(c)) will be applicable across the whole site.

10. RECOMMENDATIONS

It is proposed that for the first injection trial, scheduled to begin in mid January, 10 megalitres of mains water be used. The aim of using chlorinated mains water is to avoid the potential of iron dissolution. The costs involved in using mains water at this time are small as there is no requirement to install infrastructure required to pump water from the wetlands.

Results from this injection trial will provide the foundation on which to build the stormwater / groundwater mixing model. Subsequent injections of stormwater from the adjacent Greenfield’s wetlands during the winter of 1997 will enable calibration of the model and development of a recovery schedule under different scenario’s of supply and demand.

It should be noted that additional injection trials using water from the wetlands should be carried out during winter of 1997 in order to calibrate model results.

REFERENCES

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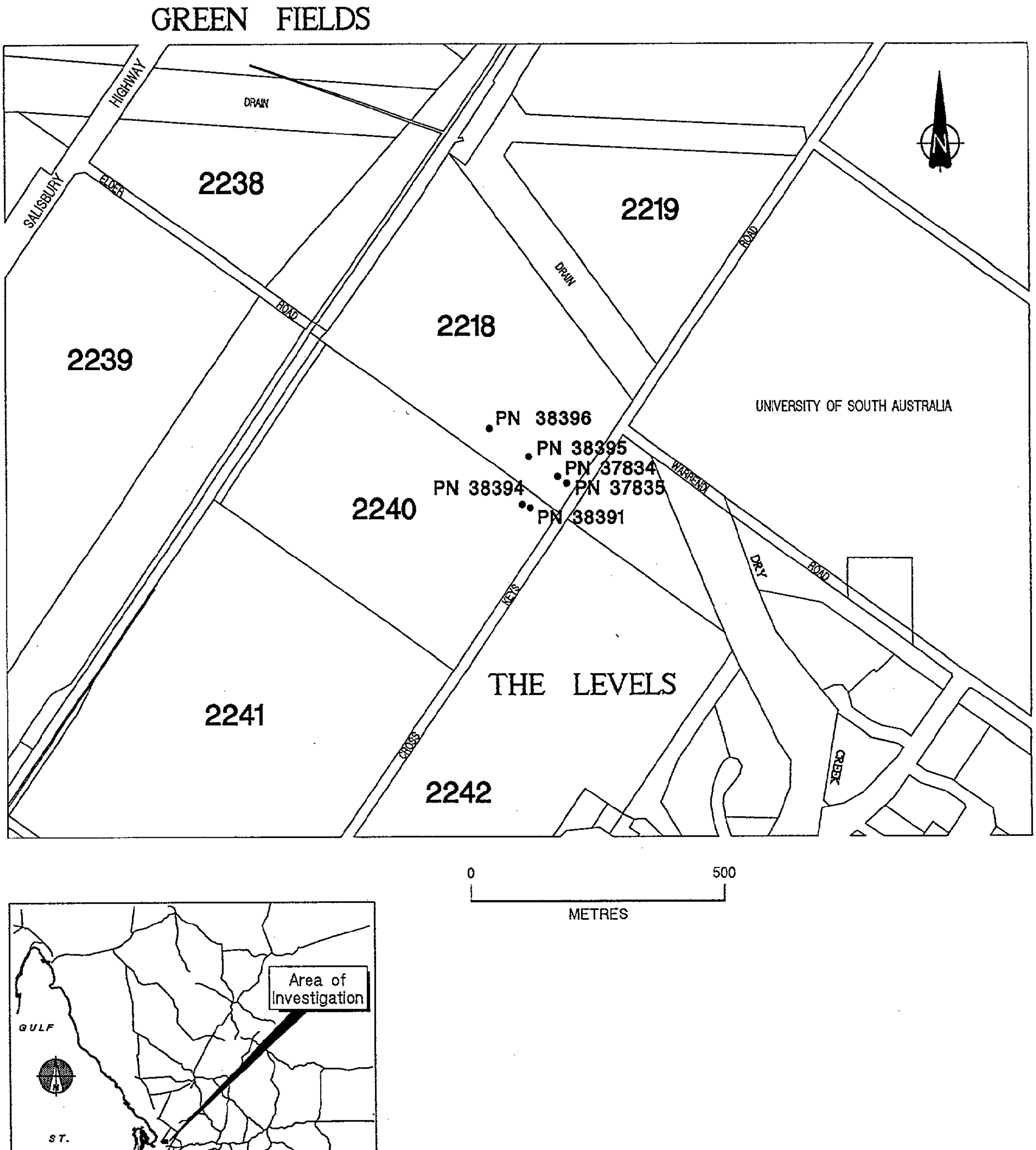


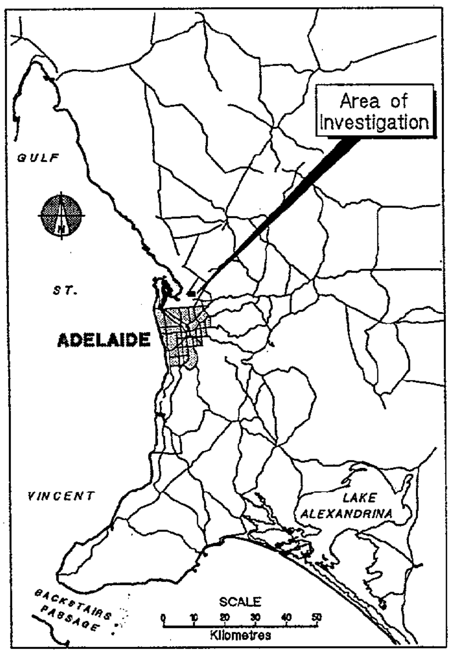


Figure........1

MFP ASR INVESTIGATION – THE LEVELS

WELL LOCATIONS

97-0025 MESA

QD5/100730RM.DTA

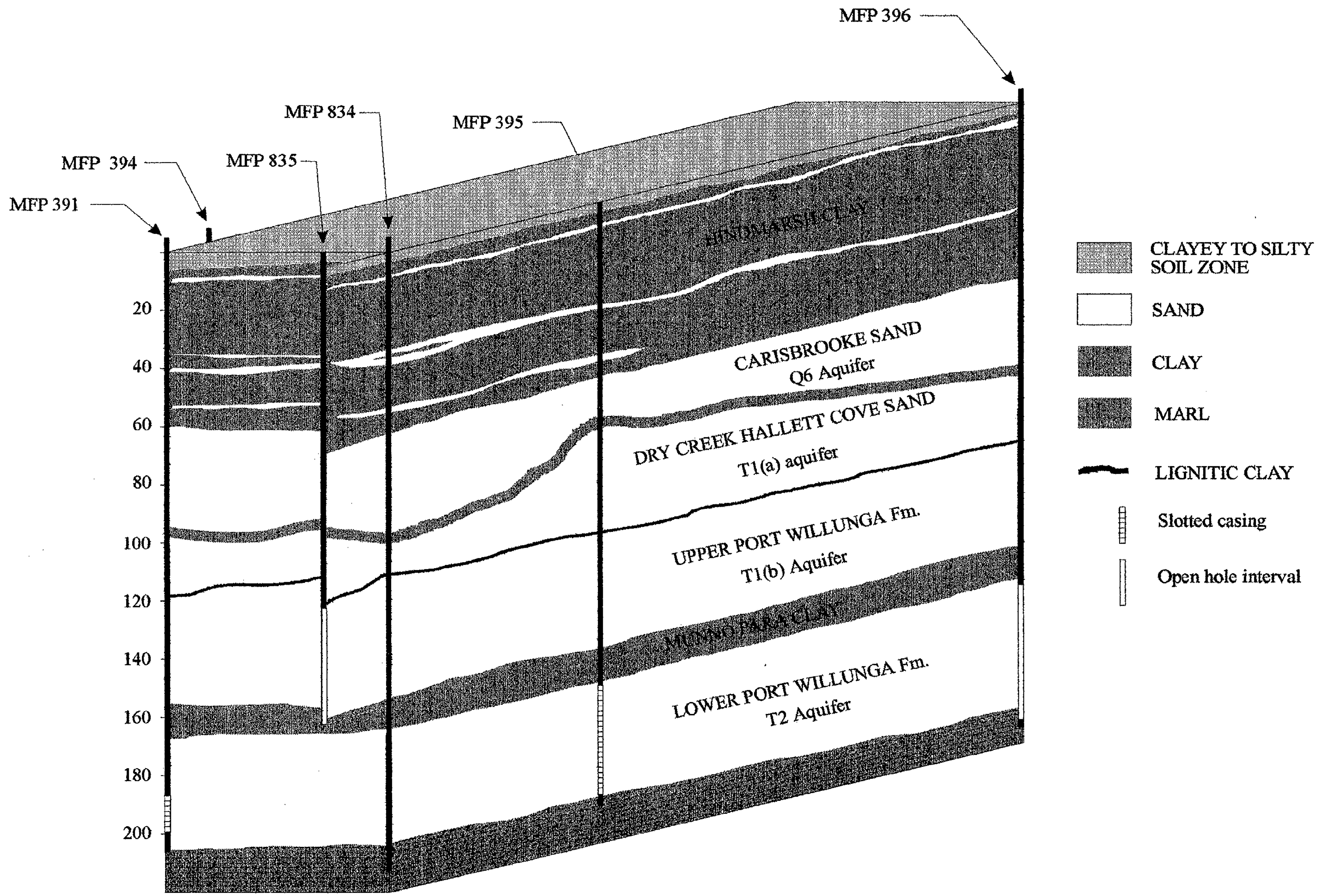


Figure 2. Hydrogeologic section through the ASR feasibility study site at The Levels.

APPENDIX I

WATER WELL LOGS

PROJECT: MFP The Levels ASR

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 37834

UNIT NO: 6628 - 17760

Hundred: YATALA Sec: 2218

LOCATION OR COORDS: Lat 34 deg 48.742'
Long 138 deg 36.727'

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis No:
		4.4	164	212	15 - 20	8 HRS	Airlift	1776	184452

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	3		SANDY LOAM	dark brown/dark grey, loose, fine grained sand, unconsolidated, well sorted, round to sub-angular, non calcareous.	RECENT		203	0	164
3	7		CLAY	brown/red, soft, plastic, sticky, soapy texture, common silt and fine sand through, minor shell fragments through.	HINDMARSH CLAY (Quaternary)				
7	9		CLAY	mottled pale yellow/brown, firm, stiff, high plasticity, abundant very fine to fine grained angular sand through, minor black lignitic? specks through.					
9	18		CLAY	mottled pale yellow/brown/light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.					
18	21		CLAY	mottled reddish brown, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.					

REMARKS: Pressure cemented from surface to 164.0 m. Open hole completion from 164.0 m - 212.0 m monitoring the T2 aquifer.

DRILL TYPE: Rotary

TOTAL DEPTH: 212.0 m

CIRCULATION: Mud

LOGGED BY: R. R. Martin

DATE: 22-06-96

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO: 37834** UNIT NO: 6628 - 17760 **MESA**

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
21	36		CLAY	mottled pale yellow/brown/light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, shell fragments through.					
36	38.5		SAND	yellow/brown, with frosted & opaque grains through, fine to very coarse grained, dominantly medium to coarse grained, poorly sorted, unconsolidated, angular to sub-angular, clay matrix, rare rounded ironstone nodules through, rare shell fragments through & some organic? lignitic debris.					
38.5	51		CLAY	mottled red/yellow & light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.					
51	57		CLAY	mottled red/yellow & light grey, firm to stiff, high plasticity, very silty in part with occasional trace of coarse angular frosted Quartz grains through, rare clear opaque grains through, minor black lignitic? specks through or remnant organic debris, shell fragments through.					
57	62		CLAY	mottled pale yellow/brown & light grey, firm to stiff, high plasticity, soapy texture with minor fine grained Quartz through, silty in part, minor black lignitic? specks through or remnant organic debris, rare shell fragments through.					
62	89.5		SAND	light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine and dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.	CARISBROOKE SAND				

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 37834

UNIT NO: 6628 - 17760

MESA

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
89.5	92		SANDY CLAY	light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine & dominantly sub-rounded, sub-angular to angular where coarse, abundant clay matrix and argillaceous (approx 50%) cement, lignitic? or organic specks & shell fragments through.	HALLETT COVE / DRY CREEK SAND				
92	97		SAND	light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine & dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.					
97	98		LIGNITIC SAND	sands as above with abundant dark brown lignitic? or organic debris through, clay matrix & cement (approx 30%).					
98	103		SAND	light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine, dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.					
103	105		SANDY CLAY	dark grey, soft, sticky, silty, plastic, clear medium grained & opaque Quartz grains through, some iron stained grains, shell fragments through, several specks of soft green clay apparent glauconite?					
105	111		SHELLS	abundant loose shells & shell fragments with minor fine to medium grained loose sand, no cement or matrix.					
111	118		SANDY LIMESTONE	clear, pale yellow/brown, very fine to fine grained, firm, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.	UPPER PORT WILLUNGA (Tertiary)				

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 37834

UNIT NO: 6628 - 17760

MESA

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
118	119		SANDY LIMESTONE	clear, pale yellow/brown, very fine to fine grained, firm to hard, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.					
119	153		SANDY LIMESTONE	light grey, pale yellow, dominantly fine grained with rare loose clear medium quartz grains through, friable to firm, well sorted, strong calcareous yellow/buff cement, sub-round to round, abundant cemented shell debris and spicules through, rare lignitic? specks through.					
153	164		CLAY	dark greyish-blue, soft to firm, sticky when wet, plastic-soapy texture, rare white limestone fragments through with minor shell debris & spicules.	MUNNO PARA CLAY (Tertiary)	Core 1 158.27-161.37			
164	168		SANDY LIMESTONE	light grey, firm to hard, abundant shell & fossil fragments (spicules & sponge fragments) rare medium grained, sub-angular, clear & frosted quartz grains through, minor lignitic specks through.	LOWER PORT WILLUNGA (Tertiary)	Core 2 174.95-177.95			
168	171		SANDY LIMESTONE	as above with occasional clear, angular, loose quartz grains through.					
171	192		SANDY LIMESTONE	tan, yellow/brown, very fine to fine grained, friable to rarely hard in part, well sorted, moderately well cemented, strong calcareous buff cement with abundant argillaceous (30-40%) matrix, minor lignitic specks & small shell fragments through.					
192	203		SANDY LIMESTONE	yellow/brown, with clear & opaque quartz grains, very fine grained, friable to firm, well sorted, moderately well cemented, strong calcareous buff cement with abundant argillaceous (30-40%) matrix, minor lignitic specks & small shell fragments through.		Core 3 193.19-195.89			
203	212		MARL	interbedded light bluish-grey and reddish-brown calcareous clay, soft to firm, sticky, rare firm white limestone nodules through & sandy stringers, rare whole small shells & fossil fragments through.	RUWARRUNG				

PROJECT: MFP The Levels ASR

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 37835

UNIT NO: 6628 - 17761

Hundred: YATALA Sec: 2218

LOCATION OR COORDS: Lat 34 deg 48.750'
Long 138 deg 36.720'

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:

DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis No:
	14.2	126	155	10 - 15	4 HRS	Airlift	2199	189418

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	3		SANDY LOAM	dark brown/dark grey, loose, fine grained sand, unconsolidated, well sorted, round to sub-angular, non calcareous.	RECENT		203	0	126
3	6		CLAY	brown/yellow, soft, plastic, sticky, soapy texture, common silt and fine sand through, minor shell fragments through.	HINDMARSH CLAY (Quaternary)				
6	9		CLAY	mottled light grey, pale yellow/brown, firm, stiff, high plasticity, abundant very fine to fine grained angular sand through, minor white limestone through					
9	12		MARL	mottled light grey & white calcareous clay, firm to stiff, silty in part with trace of coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor shell fragments through.					
12	18		CLAY	mottled light grey, yellow brown, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.					

REMARKS: Pressure cemented from surface to 126.0 m. Open hole completion from 126.0 m - 155.0 m monitoring the T1 aquifer.

DRILL TYPE: Rotary

TOTAL DEPTH: 155.0 m

CIRCULATION: Mud

LOGGED BY: R. R. Martin

DATE: 29-06-96

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 37835

UNIT NO:

MESA

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
18	30		CLAY	mottled light grey, yellow brown, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, shell fragments through.					
30	45		CLAY	mottled red & light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.					
45	51		CLAY	light grey, mottled pinkish/red, firm to stiff, high plasticity, very silty in part with occasional trace of coarse angular frosted Quartz grains through, rare clear opaque grains through, minor black lignitic? specks through or remnant organic debris, shell fragments through.					
51	60		CLAY	light grey mottled reddish/brown, firm to stiff, high plasticity, soapy texture with minor fine grained Quartz through, silty in part, minor black lignitic? specks through or remnant organic debris, rare shell fragments through.					
60	63		SANDY CLAY	light grey, pale yellow, firm with abundant fine grained Quartz through, silty in part, minor black lignitic? specks through or remnant organic debris, rare shell fragments through.					
63	84		SAND	light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine and dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.	CARISBROOKE SAND				

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 37835

UNIT NO: 6628 - 17761

MESA

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
84	86		LIGNITE & SAND	sand as above and dominantly fine to medium grained with abundant black lignite through.					
86	90		SAND	light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine & dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.	HALLETT COVE / DRY CREEK SAND				
90	92		SILTY CLAY	dark grey, soft & sticky, very silty, abundant lignitic specks through sands as above with abundant dark brown lignitic? or organic debris through, clay matrix & cement (approx 30%).					
92	103		SAND	light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine, dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.					
103	106		SILTY CLAY	dark grey, greenish, soft, sticky, silty, plastic, clear medium grained & opaque Quartz grains through, some iron stained grains, shell fragments through, several specks of soft green clay apparent glauconite?					
106	116		SHELLS	abundant loose shells & shell fragments with minor fine to medium grained loose sand, no cement or matrix.					
116	120		SANDY/SHELLY LIMESTONE	clear, pale yellow/brown, very fine to fine grained, firm, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.	UPPER PORT WILLUNGA (Tertiary)	Core 1 120.00-121.60			

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO: 37835** UNIT NO: 6628 - 17761 **MESA**

DEPTH (m)		GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING		
From	To						Dia (mm)	From (m)	To (m)
120	130		SANDY LIMESTONE	clear, pale yellow/brown, very fine to fine grained, firm to hard, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.		Core 2 130.00 - 132.8 Core 3 140.00 - 143.00			
130	155		SANDY LIMESTONE	light grey, pale yellow, dominantly fine grained with rare loose clear medium quartz grains through, friable to firm, well sorted, strong calcareous yellow/buff cement, sub-round to round, abundant cemented shell debris and spicules through, rare lignitic? specks through.					
155			CLAY	dark greyish-blue, soft to firm, sticky when wet, plastic-soapy texture, rare white limestone fragments through with minor shell debris & spicules.	MUNNO PARA CLAY (Tertiary)				

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

PERMIT NO: 38391

UNIT NO:

Hundred: YATALA Sec: 2218

El. Surface (m): X El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m)		SUPPLY			TOTAL DISSOLVED SOLIDS	
			From	To	l/sec	Test length	Method	mg/ltr	Analysis No:
		3.2	188.5	200.5	1.0	4.5	Airlift		

DEPTH (m)		GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING		
From	To						Dia (mm)	From (m)	To (m)
0	6		SANDY LOAM, CLAY	dark brown/red brown, dry			206 101	0 0	5.8 200.5
6	9		CLAY	brown-grey, red-brown mottled, stiff, plastic when wet, sticky, with hard white and grey in colour calcareous grains up to 2mm, silt and fine sand throughout.	HINDMARSH CLAY (quaternary)				
9	18		CLAY	pale grey, brown-grey, mottled red-brown, stiff, firm in part, highly plastic when wet, non-calcareous, sticky, partly sandy, a few quartz grains size up to 1.5mm, some thin lignitic? bar, rare iron stained grains.					
18	21		CLAY	brown-grey, brown mottled, sandy (fine to very fine), sticky, stiff, coarse angular quartz grains throughout, very thin up to 1mm lignitic? bars.					
21	30		CLAY	pale grey, grey, yellow-grey, red-brown mottled in part, hard to stiff, plastic when wet, non-calcareous, occasional coarse quartz grains, some lignitic bars about 1mm thick.					
30	36		CLAY	grey-brown, brown, thin grey bands, sandy, firm to stiff, plastic when wet, with sand bars brown, fine grained, quartz.					
36	45		CLAY	pale grey, grey, slightly sandy, laminated, brown mottled, firm to stiff. From 42.0 more brownish with black lignitic? stains and very thin bars.					

REMARKS: Pressure cemented from surface to 185.0 m. Slotted casing from 188.5 to 200.5 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 205.0

CIRCULATION: Mud

LOGGED BY: A.Sereda

DATE: 20-11-96

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38391

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
45	51		CLAY	red-brown/grey-brown, pale brown, partly grey, firm when dry, plastic when wet, slightly sandy, sand content increasing with depth, a few calcareous granules 0.5 cm in diameter.					
51	57		CLAY	brown-grey, brown mottled, firm to stiff, high plasticity when wet, silty, sandy. From 54.0m - a few black fine to medium size grains.					
57	60		CLAY	pale brownish grey, firm when dry, very sandy, calcareous, a lot of calcareous white granules up to 1cm in diameter.					
60	71		SAND	light grey to greenish brown, clayey, fine to coarse, subrounded to subangular and angular, unconsolidated.	CARISBROOKE SAND				
71	72		SAND	dark grey, gravelly, clayey, quartz, subrounded to angular, gravel grains up to 0.5cm, a few - more 1cm diameter subangular to angular, occasional very firm fine grained grey sandstone fragments (2 cm).					
72	77		SAND	a/a, but some black lignitic? bars stiff, sandy (major sand flowed away by drilling liquid).					
77	94.5		SAND	dark grey, gravelly, slightly clayey, clay content increasing with depth, subrounded to subangular, quartz gravel grain size 2.5-4mm subangular to angular. Some lignitic? bars up to 1.5mm thick. Lignitic content decreasing with depth.					
94.5	96		SANDY CLAY	dark grey, plastic, sands content about 15-20% , fine to coarse grains subrounded to subangular.					
96	98.5		SAND	dark grey, grey, pale grey, medium to gravelly, subrounded to subangular. With lignitic? sand and clay bars, several cm thick.					
98.5	104		SAND	pale grey/yellow, fine to coarse, subrounded to angular (coarse grains), minor clay content.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38391

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
104	107.5		SANDY CLAY	dark grey, soft to plastic, sticky, sand content up to 30% fine to coarse, quartz, rounded to subrounded.					
107.5	118		SHELLS	shells fragments and loose shells, very fine to med sand content.					
118	121.5		SANDY LIMESTONE	greenish grey, well cemented with carbonaceous cement, sand very fine to medium, subrounded, some glauconitic clayey sand bars fine to medium grain size, rare quartzitic or sandstone fragments coarse gravel size. Some black grains present up to 0.2m	UPPER PORT WILLUNGA (Tertiary)				
121.5	126		SANDY LIMESTONE	brownish yellow-grey/yellow-greenish grey, well cemented, with debris of shells. Rare bars of very firm limestone. Yellowish greenish grey sandy clay bars 1-2cm thick. Sand content fine to coarse, subrounded to subangular.					
126	132.5		SANDY LIMESTONE	brownish yellow-grey, well cemented, fossiliferous with yellow clay content.					
132.5	155		SANDY LIMESTONE	light grey, pale grey, greenish yellow to dark grey in colour, well cemented, fossiliferous, shell debris throughout. Dark grey silt, sandy clay and clayey sand bars, some black firm grains up to 0.2mm in size. Sand content - fine to medium grained. Occasional black grains up to 3mm. From 149.0 glauconitic?.					
155	167		CLAY	dark grey, firm to stiff, plastic when wet, sticky, with limestone fragments and shell debris. Limestone bars 161.5 to 162.5, 164 .0(163.5) to 166.0 light grey to grey, firm, well cemented, sandy.	MUNNO PARA CLAY (Tertiary)				
167	172.5		SANDY LIMESTONE	grey, greenish grey, well cemented, fossiliferous. Fine clayey sand bars, subangular to subrounded, few black fine grains throughout. Laminated claystone?, about 3cm thick, hard, dark grey in colour.	LOWER PORT WILLUNGA (Tertiary)				

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38391

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
172.5	177		SANDY CLAY SANDY LIMESTONE	interbedded greenish yellow sandy clay and sandy limestone, some green clay bars, very fine to medium grained sand throughout. Some black fine grains. Shell debris throughout.					
177	194		SANDY LIMESTONE	grey, greenish grey, light grey, sandy, well cemented, from 187.0 to 194.0 firmer. Greenish yellowish grey clayey sand bars fine to coarse grained. At the top of interval some bars of light grey to white clayey sand 10-20 cm thick.					
194	197		SANDY LIMESTONE CLAYEY SAND	interbedded pale green to green grey clayey sand and sandy limestone. Sand very fine to medium, subrounded to subangular. Limestone - well cemented.					
197	203.5		SANDY LIMESTONE	pale grey, firm, fossiliferous, shells debris throughout with clayey sand bars, fine subrounded to rounded.	RUWARRUNG?				
203.5	205		MARL?	light pale grey, grey calcareous clay, sandy, plastic, with limestone fragments.					

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

PERMIT NO: 38394

UNIT NO:

Hundred: YATALA Sec: 2218

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/ltr	TOTAL DISSOLVED SOLIDS Analysis No:
	4.0	3.5	168	180	1.0	3	Airlift		

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	0.5		SOIL	very clayey, dark brown, dry, hard.	RECENT		206 101	0 0	5 180
0.5	3		SANDY LOAM, CLAY	dark brown, brown, reddish brown to light brown, hard when dry, plastic when wet, calcareous, quartz sand , fine to medium grained throughout.					
3	6		CLAY	light brown, brown, pale brown, partly grey, stiff to hard, plastic when wet, sticky, slightly calcareous. Quartz sand, medium grained, subangular throughout.	HINDMARSH CLAY (Quaternary)				
6	9		CLAY	grey, pale grey, brown mottled, stiff to plastic (when wet), slightly calcareous, very sandy in parts (sand medium to coarse, subrounded to angular), with a few bars of white limey sand, and black lignitic? bars up to 1mm thick.					
9	18		CLAY	light grey, grey, brown mottled, hard to stiff, plastic in part, non-calcareous, sand mainly fine to medium, some coarse grains subangular to angular, some lignitic clayey sand bars and specks.					
18	27		CLAY	grey, pale grey, brownish grey, brown mottled, very hard to stiff, quartz sand fine to medium, subrounded to subangular throughout (<10%), some lignitic? clay and sandy clay bars up to 5mm thick (lignitic content decreasing with depth). Rare corse quartz gravel grains.					

REMARKS: Pressure cemented from surface to 165.0 m. Slotted casing from 168.0 to 180.0 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 180.0 m

CIRCULATION: Mud

LOGGED BY: A.Sereda, D.Morton

DATE: 25-11-1996

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO:** 38394 UNIT NO: **DME**

DEPTH (m) From	To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	From (m)	To (m)
27	30		CLAY	pale green-cream with red-brown staining, mainly stiff, some red and orange iron stained, subrounded quartz grains, non-calcareous.					
30	39		SANDY CLAY	mottled red-brown, pale green-cream, mainly red to orange iron stained subangular, medium grained quartz grains, both stiff and soft to plastic clay, non-calcareous. A marked decrease in sand content with depth.					
39	41		SANDY CLAY	mottled pale brown - pale green, cream soft to firm, sand medium grained subangular quartz clear-red in colour.					
41	43		SANDY CLAY	a/a but red brown to pale green in colour some black Fe-rich mineral to 2-5mm.					
43	48		SANDY CLAY	pale brown - cream green mainly firm with some medium grained quartz grains.					
48	51		SANDY CLAY	red brown-cream, soft to firm, medium grained quartz grains, subangular, some fine-very fine black mineral throughout.					
51	57		CLAY	brown to cream, green, soft, sand-medium subangular quartz grains, soft.					
57	60		SANDY CLAY	brown, soft to firm, medium grained quartz grains.					
60	69		SAND	pale brown-cream, fine to medium grained, subrounded-rounded quartz, silty, some clay.	CARISBROOKE SAND				
69	78		GRAVEL, SAND	grey, fine gravel < 5mm, composed mainly of angular to subangular clear to grey quartz. Some larger quartz fragments to 30mm. Decrease in grain size with depth. Angular lignite grains throughout. Increase in lignite content with depth. Increase in fines with depth. (up to 25-30%).					
78	81		SAND	grey, fine, composed of mainly of clear quartz and fine grains of lignite <5%.					

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	PERMIT NO: 38394 UNIT NO: DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
81	87		SAND	grey, coarse grained. Composed mainly of subangular, clear and white quartz grains. Lignite grains to 10mm, angular, decreasing with depth. Some mica (muscovite?) fragments to 6mm, some very fine sand, fines decreasing with depth. Grain size increasing to a fine gravel with depth.					
87	90		SAND	grey, fine-very coarse grained, dominantly subangular - angular, silty, dark grey clay matrix, lignitic in part, very silty, minor mica there.					
90	99		SAND	light grey,dominantly medium to coarse grained, subangular, minor silt, clay matrix, unconsolidated, from 96.0 abundant lignitic.	HALLETT COVE/DRY CREEK SAND				
99	102		?	No returns					
102	105		SILTY CLAY	dark grey/dark green, soft, sticky.					
105	114		SHELLS	shell fragments, loose, minor fine sand content.					
114	120		SANDY LIMESTONE	grey, shell fragment contained in a quartz grained matrix (dominantly fine-medium grained), with calcareous cement. Minor very fine black mineral. Abundant loose shell fragments cave in?. Quartz grains subrounded.	UPPER PORT WILLUNGA (Tertiary)				
120	129		SANDY LIMESTONE	grey-brown, fine to medium grained quartz grains, subrounded, shell fragments, calcareous cement. Dominantly grey limestone, some minor grey-brown clay.					
129	132		SANDY LIMESTONE	grey, fine-medium grained, subrounded quartz grains. shell fragments, calcareous cement. Some very fine heavy black mineral.					
132	145		SANDY LIMESTONE	greenish grey to grey and light grey, very firm, well cemented, dominantly fine grained, fossiliferous, shell debris throughout. Some sand content medium to coarse and gravelly subangular to subrounded. Clay content increase with depth.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38394

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
145	148		SANDY LIMESTONE	dark greenish grey to dark grey, with bars of very sandy greenish grey limestone. Gravelly sand content subangular to angular. Shell fragments throughout.					
148	153		SANDY LIMESTONE	a/a , but brownish grey in colour with some poorly cemented light grey sandy limestone bars.					
153	165		CLAY	dark grey, bluish grey, stiff to plastic when wet, sticky, slightly calcareous. Sandy limestone bars up to 30 cm thick: 163.0, 163.8, 164.0 light grey to grey well cemented, sandy.	MUNNO PARA CLAY (Tertiary)				
165	170.5		SANDY LIMESTONE	grey, bluish grey, poorly to well cemented, very fossiliferous. Sand content fine to coarse grained, subrounded with black firm grains medium to coarse.	LOWER PORT WILLUNGA (Tertiary)				
170.5	184		SANDY LIMESTONE	grey, light grey, greenish grey, brownish grey, pale brown, pale grey well cemented, fossiliferous. Sand fine to medium grained, rounded to subrounded, quartz. Very compacted clay bars, possibly up to 1-2cm thick, non-calcareous, dark grey in colour.					

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

PERMIT NO: 38395

UNIT NO:

Hundred: YATALA Sec: 2218

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/ltr	TOTAL DISSOLVED SOLIDS Analysis No:
		2.5	168	198					

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	36		NO SAMPLES				206 102	0 0	4 198
36	42		CLAY	grey, light reddish brown to pale brown, mottled, stiff to plastic, sticky, quartz fine to medium grained sand throughout, subangular, some coarse quartz grains subangular to very angular, a few iron stained quartz grains, medium, subrounded and some fine to medium sand size black grains.	HINDMARSH CLAY (quaternary)				
42	48		SANDY CLAY	light brownish grey, pale grey, at the end of interval becoming reddish and brownish in colour, stiff to hard, non-calcareous. Sand content mainly fine to medium and some coarse grains, subangular, a few fine gravel quartz grains subangular to angular. A few black grains fine to medium sand size.					
48	54		CLAY	grey, light grey, pale grey, red-brown, orange-brown mottled, stiff to hard, sticky, iron stained up to 1 cm in diameter, non-calcareous. Sand content decreasing with depth from 30% to 10-15%, fine to coarse, subrounded to subangular.					
54	60		CLAY	grey, pale grey, pale brown-grey, iron stained, from plastic to very hard, lignitic bars and specks up to 2-3mm. Sand content less than 10%, fine to medium, a few coarse grains subrounded to subangular. A few shell fragments throughout.					

REMARKS: Pressure cemented from surface to 165.0 m. Slotted casing from 168.0 to 198.0 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 207.0 m

CIRCULATION: Mud

LOGGED BY: A.Sereda

DATE: 01-12-1996

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	PERMIT NO: 38395 UNIT NO: DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
60	66		CLAYEY SAND	interbedded pale grey, yellow-grey, brownish grey, grey, very fine to medium, subangular to rounded, well sorted, silty, clay matrix. Some lignitic bars and specks.	CARISBROOKE SAND				
66	75		CLAYEY SAND	grey, greenish grey, iron sand bars and stains, non-calcareous, fine to medium grained, well sorted, subrounded to rounded. Lignitic content increasing with depth.					
75	102		LIGNITIC SAND	dark grey to black, interbedded loose coarse to gravelly sand and very fine to medium grained quartz sand with clay matrix. Coarse fraction composes milky white to dark grey quartz grains up to 6-8mm in diameter, subangular to angular, (fine grains possibly flow away by drilling liquid), clay matrix, some fines content. Fine fraction composes quartz grains silt and clay matrix, some coarse grains, subangular to subrounded.	HALLETT COVE/DRY CREEK SAND				
102	105		NO SAMPLES						
105	113		SHELLS	(lost circulation), abundant loose shell fragments and whole shells, up to 2 cm in size.					
113	129		SANDY LIMESTONE	light grey, pale grey, brownish grey, well cemented, fossiliferous, shell debris throughout. Sand fine to medium grained rounded to subrounded, a few reddish brown iron grains medium sand size. Some coarse quartz grains throughout.	UPPER PORT WILLUNGA (Tertiary)				
129	143		SANDY LIMESTONE	grey, at the bottom becoming slightly greenish and creamy in colour, interbedded poorly to well cemented bands, some clay filling, grey-cream in colour. Quartz sand fine to coarse grained, rounded to subangular, some very coarse grains, angular to very angular throughout. Shell fragments throughout increasing with the depth.					
143	153.7		SANDY LIMESTONE	light grey, grey, dark grey, at the bottom becoming more brownish, well cemented, a few bars poorly cemented, fossiliferous, shell fragments, Sand content as 129.0-143.0.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38395

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
153.7	165		CLAY	dark bluish grey, plastic to soft when wet, slightly calcareous. Sandy fine to coarse poorly sorted subrounded to angular. Sandy limestone bands up to 30 cm thick, dark to light grey, well to poorly cemented.	MUNNO PARA CLAY (Tertiary)				
165	175		SANDY LIMESTONE	dark grey, grey, pale grey, cream, well cemented, fossiliferous, shell fragments. Quartz sand fine to medium grained, rounded to subrounded.	LOWER PORT WILLUNGA (Tertiary)				
175	180		SANDY LIMESTONE	mainly light brown, yellow-brown well to poorly cemented, fossiliferous, shell debris throughout, yellow clay filling. Sand content a/a.					
180	204		SANDY LIMESTONE	from grey, creamy light grey to grey-brown, pale brown, from 189.0 - some yellowish greenish brown bars, well cemented, some bars poorly cemented, fossiliferous, shell fragments. Sand content a/a. Some bars of compact bluish grey firm clay (claystone?), non calcareous. From 184.0 no clay (claystone?) bars.					
204	207		MARL?	grey, dark grey clay, plastic to stiff and hard, with limestone patches and shell fragments (even whole shells).	RUWARRUNG?				

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 38396

UNIT NO:

Hundred: YATALA Sec: 2218

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/ltr	TOTAL DISSOLVED SOLIDS Analysis No:
		3.2	168	212	6	3 HRS	Airlift		

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	18		NO SAMPLES				236	0	6
18	21		CLAY	brown to grey with brown mottling, hard to stiff, plastic to soft when wet, sticky, lignitic in part, slightly calcareous. Sand content less than 10%, fine to medium grained subangular to subrounded, some angular grains.	HINDMARSH CLAY (Quaternary)		153	0	168
21	30		CLAY	pale grey, grey, brown mottled, hard to stiff, sticky, non calcareous, about 10% sand content, quartz fine to medium grained subangular to angular. Thin lignitic bars and specks increasing with depth.					
30	39		NO SAMPLES	hole blocked up by cuttings.					
39	48		SANDY CLAY	grey, light grey, brown mottled, hard to stiff, plastic when wet, becoming sticky with depth, non calcareous. Sand up to 50%, quartz, fine to coarse, poorly sorted, subangular to angular, some fine gravel quartz grains, a few iron grains.					
48	52.5		CLAY	clay a/a, but more sticky and some iron staining mottled bars. Sand content a/a, but subrounded to angular, some firm fine to medium grains, black in colour.					
52.5	61		NO SAMPLES	hole blocked up by cuttings.					

REMARKS: Pressure cemented from surface to 168.0 m. Open hole completion from 168.0 m. to 212.0 m. Monitoring the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 212.0 m

CIRCULATION: Mud

LOGGED BY: A. Sereda

DATE: 07-12-1996

SHEET 1 of 4

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38396

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
61	66		CLAYEY SAND	grey, yellowish brown iron bars, mainly fine to medium, some coarse grains, quartz, subangular to subrounded.	CARISBROOKE SAND				
66	73		SAND	interbedded grey, slightly bluish grey, yellow-brown, quartz, mainly fine, well sorted, some medium and rare coarse grains, subangular to subrounded. Soft clay matrix.					
73	80		LIGNITIC SAND	dark grey to black, quartz, coarse to gravelly, some grains up to fine gravel in size, subangular to angular. Dark brown to black lignite bars up to 1 cm (or more) thick.					
80	98		LIGNITIC SAND	interbedded dark grey coarse to gravelly sand, subangular to very angular up to fine gravel (a few grains), and black silty clayey fine sand, subrounded to subangular with rare coarse grains. Some black bars of lignite (woody). Lignite content decreasing with depth.	HALLETT COVE/DRY CREEK SAND				
98	102		LIGNITIC SAND	black, slightly greenish black, silty clayey, mainly fine, subrounded to rounded, well sorted, clay matrix, slightly micaceous?, rare coarse quartz grains throughout.					
102	116		SHELLS	loose shell fragments variable size, no matrix, react on HCl.					
116	121		SANDY LIMESTONE	grey, dark grey, pale grey, poorly to well cemented, fossiliferous, shell debris throughout. Some green-brown clayey sand bars mainly fine grained subrounded to rounded, rare coarse quartz grains. A few fine to medium black grains.	UPPER PORT WILLUNGA (Tertiary)				
121	133		SANDY LIMESTONE	grey, dark grey, well cemented. Sand fine to coarse grained, subangular (fine) to angular and very angular (coarse grains). Some green-brown to white in colour sand bars, fine to medium grained, subrounded to subangular.					
133	143.5		SANDY LIMESTONE	pale grey, brownish grey, a few bars grey to dark grey well cemented, some dark grey bars very poorly cemented. Sand content mainly fine to medium grained, some angular coarse quartz grains throughout from milky white to					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38396

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
				off white in colour. More clayey sand bars as above.					
143.5	154		SANDY LIMESTONE	greenish brown, well cemented, shell fragments throughout up to 1cm in size. Sand content as above.					
154	163		CLAY	dark bluish grey, soft to plastic when wet, slightly sandy, slightly calcareous, with limestone bars and bands.	MUNNO PARA CLAY (Tertiary)				
163	166.5		SANDY LIMESTONE	pale grey, grey, well cemented, fossiliferous, shell fragments throughout. Some limestone grains covered by green mineral (possibly glauconite). Sand content mainly fine to very fine grained, quartz, subrounded to rounded some medium to coarse grains, some of them covered by iron oxide. Black grains fine to medium in size throughout.	LOWER PORT WILLUNGA (Tertiary)				
166.5	171		SANDY LIMESTONE	grey, pale grey, some bars bluish grey and greenish grey in colour, well cemented, fossiliferous, shell fragments throughout. Sand content as above. Silty fine grained sand bars, rounded, well sorted.					
171	175.5		SANDY LIMESTONE	a/a but pale brown, grey brown to light grey in colour.					
175.5	189		SANDY LIMESTONE	a/a but mainly grey to dark grey in colour.					
189	193.5		SANDY LIMESTONE	a/a but mainly dark greenish grey in colour.					
193.5	198.5		SANDY LIMESTONE	dark greenish grey, grey, well cemented, fossiliferous. Sand content fine to medium grained, quartz, subangular to rounded .					
198.5	208.5		SANDY LIMESTONE	mainly greenish brown and pale grey, some bluish grey bars, well cemented, fossiliferous, shell fragments throughout. Sand content as above but mainly fine grained.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38396

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
208.5	212		LIMESTONE	greyish brown, sandy, well cemented, very fossiliferous, shell fragments and whole shells throughout. A few black chert nodules up to 0.5cm in diameter. Rare glauconite grains up to 1.5 mm in diameter. A few bars of white sandy siltstone, contained some green grains (possibly glauconite) <1mm in diameter.	RUWARRUNG				

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

El. Surface (m): X El.Ref.Point (m): Datum:

PERMIT NO: 38391

UNIT NO:

Hundred: YATALA Sec: 2218

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/ltr	TOTAL DISSOLVED SOLIDS Analysis No.
		3.2	188.5	200.5	1.0	4.5	Airlift		

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	6		SANDY LOAM, CLAY	dark brown/red brown, dry			206 101	0 0	5.8 200.5
6	9		CLAY	brown-grey, red-brown mottled, stiff, plastic when wet, sticky, with hard white and grey in colour calcareous grains up to 2mm, silt and fine sand throughout.	HINDMARSH CLAY (quaternary)				
9	18		CLAY	pale grey, brown-grey, mottled red-brown, stiff, firm in part, highly plastic when wet, non-calcareous, sticky, partly sandy, a few quartz grains size up to 1.5mm, some thin lignitic? bar, rare iron stained grains.					
18	21		CLAY	brown-grey, brown mottled, sandy (fine to very fine), sticky, stiff, coarse angular quartz grains throughout, very thin up to 1mm lignitic? bars.					
21	30		CLAY	pale grey, grey, yellow-grey, red-brown mottled in part, hard to stiff, plastic when wet, non-calcareous, occasional coarse quartz grains, some lignitic bars about 1mm thick.					
30	36		CLAY	grey-brown, brown, thin grey bands, sandy, firm to stiff, plastic when wet, with sand bars brown, fine grained, quartz.					
36	45		CLAY	pale grey, grey, slightly sandy, laminated, brown mottled, firm to stiff. From 42.0 more brownish with black lignitic? stains and very thin bars.					

REMARKS: Pressure cemented from surface to 185.0 m. Slotted casing from 188.5 to 200.5 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 205.0

CIRCULATION: Mud

LOGGED BY: A.Sereda

DATE: 20-11-96

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38391

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
45	51		CLAY	red-brown/grey-brown, pale brown, partly grey, firm when dry, plastic when wet, slightly sandy, sand content increasing with depth, a few calcareous granules 0.5 cm in diameter.					
51	57		CLAY	brown-grey, brown mottled, firm to stiff, high plasticity when wet, silty, sandy. From 54.0m - a few black fine to medium size grains.					
57	60		CLAY	pale brownish grey, firm when dry, very sandy, calcareous, a lot of calcareous white granules up to 1cm in diameter.					
60	71		SAND	light grey to greenish brown, clayey, fine to coarse, subrounded to subangular and angular, unconsolidated.	CARISBROOKE SAND				
71	72		SAND	dark grey, gravelly, clayey, quartz, subrounded to angular, gravel grains up to 0.5cm, a few - more 1cm diameter subangular to angular, occasional very firm fine grained grey sandstone fragments (2 cm).					
72	77		SAND	a/a, but some black lignitic? bars stiff, sandy (major sand flowed away by drilling liquid).					
77	94.5		SAND	dark grey, gravelly, slightly clayey, clay content increasing with depth, subrounded to subangular, quartz gravel grain size 2.5-4mm subangular to angular. Some lignitic? bars up to 1.5mm thick. Lignitic content decreasing with depth.					
94.5	96		SANDY CLAY	dark grey, plastic, sands content about 15-20% , fine to coarse grains subrounded to subangular.					
96	98.5		SAND	dark grey, grey, pale grey, medium to gravelly, subrounded to subangular. With lignitic? sand and clay bars, several cm thick.					
98.5	104		SAND	pale grey/yellow, fine to coarse, subrounded to angular (coarse grains), minor clay content.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38391

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
104	107.5		SANDY CLAY	dark grey, soft to plastic, sticky, sand content up to 30% fine to coarse, quartz, rounded to subrounded.					
107.5	118		SHELLS	shells fragments and loose shells, very fine to med sand content.					
118	121.5		SANDY LIMESTONE	greenish grey, well cemented with carbonaceous cement, sand very fine to medium, subrounded, some glauconitic clayey sand bars fine to medium grain size, rare quartzitic or sandstone fragments coarse gravel size. Some black grains present up to 0.2m	UPPER PORT WILLUNGA (Tertiary)				
121.5	126		SANDY LIMESTONE	brownish yellow-grey/yellow-greenish grey, well cemented, with debris of shells. Rare bars of very firm limestone. Yellowish greenish grey sandy clay bars 1-2cm thick. Sand content fine to coarse, subrounded to subangular.					
126	132.5		SANDY LIMESTONE	brownish yellow-grey, well cemented, fossiliferous with yellow clay content.					
132.5	155		SANDY LIMESTONE	light grey, pale grey, greenish yellow to dark grey in colour, well cemented, fossiliferous, shell debris throughout. Dark grey silt, sandy clay and clayey sand bars, some black firm grains up to 0.2mm in size. Sand content - fine to medium grained. Occasional black grains up to 3mm. From 149.0 glauconitic?.					
155	167		CLAY	dark grey, firm to stiff, plastic when wet, sticky, with limestone fragments and shell debris. Limestone bars 161.5 to 162.5, 164 .0(163.5) to 166.0 light grey to grey, firm, well cemented, sandy.	MUNNO PARA CLAY (Tertiary)				
167	172.5		SANDY LIMESTONE	grey, greenish grey, well cemented, fossiliferous. Fine clayey sand bars, subangular to subrounded, few black fine grains throughout. Laminated claystone?, about 3cm thick, hard, dark grey in colour.	LOWER PORT WILLUNGA (Tertiary)				

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO:** 38391 UNIT NO: **DME**

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
172.5	177		SANDY CLAY SANDY LIMESTONE	interbedded greenish yellow sandy clay and sandy limestone, some green clay bars, very fine to medium grained sand throughout. Some black fine grains. Shell debris throughout.					
177	194		SANDY LIMESTONE	grey, greenish grey, light grey, sandy, well cemented, from 187.0 to 194.0 firmer. Greenish yellowish grey clayey sand bars fine to coarse grained. At the top of interval some bars of light grey to white clayey sand 10-20 cm thick.					
194	197		SANDY LIMESTONE CLAYEY SAND	interbedded pale green to green grey clayey sand and sandy limestone. Sand very fine to medium, subrounded to subangular. Limestone - well cemented.					
197	203.5		SANDY LIMESTONE	pale grey, firm, fossiliferous, shells debris throughout with clayey sand bars, fine subrounded to rounded.	RUWARRUNG?				
203.5	205		MARL?	light pale grey, grey calcareous clay, sandy, plastic, with limestone fragments.					

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

PERMIT NO: 38394

UNIT NO:

Hundred: YATALA Sec: 2218

El. Surface (m): El.Ref.Point (m): Datum:

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m)		SUPPLY			TOTAL DISSOLVED SOLIDS	
			From	To	l/sec	Test length	Method	mg/ltr	Analysis No.
	4.0	3.5	168	180	1.0	3	Airlift		

DEPTH (m)		GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING		
From	To						Dia (mm)	From (m)	To (m)
0	0.5		SOIL	very clayey, dark brown, dry, hard.	RECENT		206 101	0 0	5 180
0.5	3		SANDY LOAM, CLAY	dark brown, brown, reddish brown to light brown, hard when dry, plastic when wet, calcareous, quartz sand , fine to medium grained throughout.					
3	6		CLAY	light brown, brown, pale brown, partly grey, stiff to hard, plastic when wet, sticky, slightly calcareous. Quartz sand, medium grained, subangular throughout.	HINDMARSH CLAY (Quaternary)				
6	9		CLAY	grey, pale grey, brown mottled, stiff to plastic (when wet), slightly calcareous, very sandy in parts (sand medium to coarse, subrounded to angular), with a few bars of white limey sand, and black lignitic? bars up to 1mm thick.					
9	18		CLAY	light grey, grey, brown mottled, hard to stiff, plastic in part, non-calcareous, sand mainly fine to medium, some coarse grains subangular to angular, some lignitic clayey sand bars and specks.					
18	27		CLAY	grey, pale grey, brownish grey, brown mottled, very hard to stiff, quartz sand fine to medium, subrounded to subangular throughout (<10%), some lignitic? clay and sandy clay bars up to 5mm thick (lignitic content decreasing with depth). Rare corse quartz gravel grains.					

REMARKS: Pressure cemented from surface to 165.0 m. Slotted casing from 168.0 to 180.0 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 180.0 m

CIRCULATION: Mud

LOGGED BY: A.Sereda, D.Morton

DATE: 25-11-1996

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38394

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
27	30		CLAY	pale green-cream with red-brown staining, mainly stiff, some red and orange iron stained, subrounded quartz grains, non-calcareous.					
30	39		SANDY CLAY	mottled red-brown, pale green-cream, mainly red to orange iron stained subangular, medium grained quartz grains, both stiff and soft to plastic clay, non-calcareous. A marked decrease in sand content with depth.					
39	41		SANDY CLAY	mottled pale brown - pale green, cream soft to firm, sand medium grained subangular quartz clear-red in colour.					
41	43		SANDY CLAY	a/a but red brown to pale green in colour some black Fe-rich mineral to 2-5mm.					
43	48		SANDY CLAY	pale brown - cream green mainly firm with some medium grained quartz grains.					
48	51		SANDY CLAY	red brown-cream, soft to firm, medium grained quartz grains, subangular, some fine-very fine black mineral throughout.					
51	57		CLAY	brown to cream, green, soft, sand-medium subangular quartz grains, soft.					
57	60		SANDY CLAY	brown, soft to firm, medium grained quartz grains.					
60	69		SAND	pale brown-cream, fine to medium grained, subrounded-rounded quartz, silty, some clay.	CARISBROOKE SAND				
69	78		GRAVEL, SAND	grey, fine gravel < 5mm, composed mainly of angular to subangular clear to grey quartz. Some larger quartz fragments to 30mm. Decrease in grain size with depth. Angular lignite grains throughout. Increase in lignite content with depth. Increase in fines with depth. (up to 25-30%).					
78	81		SAND	grey, fine, composed of mainly of clear quartz and fine grains of lignite <5%.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38394

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
81	87		SAND	grey, coarse grained. Composed mainly of subangular, clear and white quartz grains. Lignite grains to 10mm, angular, decreasing with depth. Some mica (muscovite?) fragments to 6mm, some very fine sand, fines decreasing with depth. Grain size increasing to a fine gravel with depth.					
87	90		SAND	grey, fine-very coarse grained, dominantly subangular - angular, silty, dark grey clay matrix, lignitic in part, very silty, minor mica there.					
90	99		SAND	light grey,dominantly medium to coarse grained, subangular, minor silt, clay matrix, unconsolidated, from 96.0 abundant lignitic.	HALLETT COVE/DRY CREEK SAND				
99	102		?	No returns					
102	105		SILTY CLAY	dark grey/dark green, soft, sticky.					
105	114		SHELLS	shell fragments, loose, minor fine sand content.					
114	120		SANDY LIMESTONE	grey, shell fragment contained in a quartz grained matrix (dominantly fine-medium grained), with calcareous cement. Minor very fine black mineral. Abundant loose shell fragments cave in?. Quartz grains subrounded.	UPPER PORT WILLUNGA (Tertiary)				
120	129		SANDY LIMESTONE	grey-brown, fine to medium grained quartz grains, subrounded, shell fragments, calcareous cement. Dominantly grey limestone, some minor grey-brown clay.					
129	132		SANDY LIMESTONE	grey, fine-medium grained, subrounded quartz grains. shell fragments, calcareous cement. Some very fine heavy black mineral.					
132	145		SANDY LIMESTONE	greenish grey to grey and light grey, very firm, well cemented, dominantly fine grained, fossiliferous, shell debris throughout. Some sand content medium to coarse and gravelly subangular to subrounded. Clay content increase with depth.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38394

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
145	148		SANDY LIMESTONE	dark greenish grey to dark grey, with bars of very sandy greenish grey limestone. Gravelly sand content subangular to angular. Shell fragments throughout.					
148	153		SANDY LIMESTONE	a/a , but brownish grey in colour with some poorly cemented light grey sandy limestone bárs.					
153	165		CLAY	dark grey, bluish grey, stiff to plastic when wet, sticky, slightly calcareous. Sandy limestone bars up to 30 cm thick: 163.0, 163.8, 164.0 light grey to grey well cemented, sandy.	MUNNO PARA CLAY (Tertiary)				
165	170.5		SANDY LIMESTONE	grey, bluish grey, poorly to well cemented, very fossiliferous. Sand content fine to coarse grained, subrounded with black firm grains medium to coarse.	LOWER PORT WILLUNGA (Tertiary)				
170.5	184		SANDY LIMESTONE	grey, light grey, greenish grey, brownish grey, pale brown, pale grey well cemented, fossiliferous. Sand fine to medium grained, rounded to subrounded, quartz. Very compacted clay bars, possibly up to 1-2cm thick, non-calcareous, dark grey in colour.					

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

El. Surface (m): El.Ref.Point (m): Datum:

PERMIT NO: 38395

UNIT NO:

Hundred: YATALA Sec: 2218

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m)		SUPPLY			TOTAL DISSOLVED SOLIDS	
			From	To	l/sec	Test length	Method	mg/ltr	Analysis No:
		2.5	168	198					

DEPTH (m) From	To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	From (m)	To (m)
0	36		NO SAMPLES				206 102	0 0	4 198
36	42		CLAY	grey, light reddish brown to pale brown, mottled, stiff to plastic, sticky, quartz fine to medium grained sand throughout, subangular, some coarse quartz grains subangular to very angular, a few iron stained quartz grains, medium, subrounded and some fine to medium sand size black grains.	HINDMARSH CLAY (quaternary)				
42	48		SANDY CLAY	light brownish grey, pale grey, at the end of interval becoming reddish and brownish in colour, stiff to hard, non-calcareous. Sand content mainly fine to medium and some coarse grains, subangular, a few fine gravel quartz grains subangular to angular. A few black grains fine to medium sand size.					
48	54		CLAY	grey, light grey, pale grey, red-brown, orange-brown mottled, stiff to hard, sticky, iron stained up to 1 cm in diameter, non-calcareous. Sand content decreasing with depth from 30% to 10-15%, fine to coarse, subrounded to subangular.					
54	60		CLAY	grey, pale grey, pale brown-grey, iron stained, from plastic to very hard, lignitic bars and specks up to 2-3mm. Sand content less than 10%, fine to medium, a few coarse grains subrounded to subangular. A few shell fragments throughout.					

REMARKS: Pressure cemented from surface to 165.0 m. Slotted casing from 168.0 to 198.0 m. Observation the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 207.0 m

CIRCULATION: Mud

LOGGED BY: A.Sereda

DATE: 01-12-1996

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	PERMIT NO: 38395 UNIT NO: DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
60	66		CLAYEY SAND	interbedded pale grey, yellow-grey, brownish grey, grey, very fine to medium, subangular to rounded, well sorted, silty, clay matrix. Some lignitic bars and specks.	CARISBROOKE SAND				
66	75		CLAYEY SAND	grey, greenish grey, iron sand bars and stains, non-calcareous, fine to medium grained, well sorted, subrounded to rounded. Lignitic content increasing with depth.					
75	102		LIGNITIC SAND	dark grey to black, interbedded loose coarse to gravelly sand and very fine to medium grained quartz sand with clay matrix. Coarse fraction composes milky white to dark grey quartz grains up to 6-8mm in diameter, subangular to angular, (fine grains possibly flow away by drilling liquid), clay matrix, some fines content. Fine fraction composes quartz grains silt and clay matrix, some coarse grains, subangular to subrounded.	HALLETT COVE/DRY CREEK SAND				
102	105		NO SAMPLES						
105	113		SHELLS	(lost circulation), abundant loose shell fragments and whole shells, up to 2 cm in size.					
113	129		SANDY LIMESTONE	light grey, pale grey, brownish grey, well cemented, fossiliferous, shell debris throughout. Sand fine to medium grained rounded to subrounded, a few reddish brown iron grains medium sand size. Some coarse quartz grains throughout.	UPPER PORT WILLUNGA (Tertiary)				
129	143		SANDY LIMESTONE	grey, at the bottom becoming slightly greenish and creamy in colour, interbedded poorly to well cemented bands, some clay filling, grey-cream in colour. Quartz sand fine to coarse grained, rounded to subangular, some very coarse grains, angular to very angular throughout. Shell fragments throughout increasing with the depth.					
143	153.7		SANDY LIMESTONE	light grey, grey, dark grey, at the bottom becoming more brownish, well cemented, a few bars poorly cemented, fossiliferous, shell fragments, Sand content as 129.0-143.0.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38395

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
153.7	165		CLAY	dark bluish grey, plastic to soft when wet, slightly calcareous. Sandy fine to coarse poorly sorted subrounded to angular. Sandy limestone bands up to 30 cm thick, dark to light grey, well to poorly cemented.	MUNNO PARA CLAY (Tertiary)				
165	175		SANDY LIMESTONE	dark grey, grey, pale grey, cream, well cemented, fossiliferous, shell fragments. Quartz sand fine to medium grained, rounded to subrounded.	LOWER PORT WILLUNGA (Tertiary)				
175	180		SANDY LIMESTONE	mainly light brown, yellow-brown well to poorly cemented, fossiliferous, shell debris throughout, yellow clay filling. Sand content a/a.					
180	204		SANDY LIMESTONE	from grey, creamy light grey to grey-brown, pale brown, from 189.0 - some yellowish greenish brown bars, well cemented, some bars poorly cemented, fossiliferous, shell fragments. Sand content a/a. Some bars of compact bluish grey firm clay (claystone?), non calcareous. From 184.0 no clay (claystone?) bars.					
204	207		MARL?	grey, dark grey clay, plastic to stiff and hard, with limestone patches and shell fragments (even whole shells).	RUWARRUNG?				

PROJECT: MFP The Levels ASR

LOCATION OR COORDS:

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA
WATER WELL LOG
GROUNDWATER DIVISION

El. Surface (m): El.Ref.Point (m): Datum:

PERMIT NO: 38396

UNIT NO:

Hundred: YATALA Sec: 2218

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL (m) From	INTERVAL (m) To	SUPPLY l/sec	SUPPLY Test length	SUPPLY Method	TOTAL DISSOLVED SOLIDS mg/ltr	TOTAL DISSOLVED SOLIDS Analysis No:
		3.2	168	212	6	3 HRS	Airlift		

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK/SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION/AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	18		NO SAMPLES				236	0	6
18	21		CLAY	brown to grey with brown mottling, hard to stiff, plastic to soft when wet, sticky, lignitic in part, slightly calcareous. Sand content less than 10%, fine to medium grained subangular to subrounded, some angular grains.	HINDMARSH CLAY (Quaternary)		153	0	168
21	30		CLAY	pale grey, grey, brown mottled, hard to stiff, sticky, non calcareous, about 10% sand content, quartz fine to medium grained subangular to angular. Thin lignitic bars and specks increasing with depth.					
30	39		NO SAMPLES	hole blocked up by cuttings.					
39	48		SANDY CLAY	grey, light grey, brown mottled, hard to stiff, plastic when wet, becoming sticky with depth, non calcareous. Sand up to 50%, quartz, fine to coarse, poorly sorted, subangular to angular, some fine gravel quartz grains, a few iron grains.					
48	52.5		CLAY	clay a/a, but more sticky and some iron staining mottled bars. Sand content a/a, but subrounded to angular, some firm fine to medium grains, black in colour.					
52.5	61		NO SAMPLES	hole blocked up by cuttings.					

REMARKS: Pressure cemented from surface to 168.0 m. Open hole completion from 168.0 m. to 212.0 m. Monitoring the T2 aquifer.

DRILL TYPE: Rotary

COMPLETED: 212.0 m

CIRCULATION: Mud

LOGGED BY: A. Sereda

DATE: 07-12-1996

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO:** 38396 UNIT NO: **DME**

DEPTH (m) From	To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	From (m)	To (m)
61	66		CLAYEY SAND	grey, yellowish brown iron bars, mainly fine to medium, some coarse grains, quartz, subangular to subrounded.	CARISBROOKE SAND				
66	73		SAND	interbedded grey, slightly bluish grey, yellow-brown, quartz, mainly fine, well sorted, some medium and rare coarse grains, subangular to subrounded. Soft clay matrix.					
73	80		LIGNITIC SAND	dark grey to black, quartz, coarse to gravelly, some grains up to fine gravel in size, subangular to angular. Dark brown to black lignite bars up to 1 cm (or more) thick.					
80	98		LIGNITIC SAND	interbedded dark grey coarse to gravelly sand, subangular to very angular up to fine gravel (a few grains), and black silty clayey fine sand, subrounded to subangular with rare coarse grains. Some black bars of lignite (woody). Lignite content decreasing with depth.	HALLETT COVE/DRY CREEK SAND				
98	102		LIGNITIC SAND	black, slightly greenish black, silty clayey, mainly fine, subrounded to rounded, well sorted, clay matrix, slightly micaceous?, rare coarse quartz grains throughout.					
102	116		SHELLS	loose shell fragments variable size, no matrix, react on HCl.					
116	121		SANDY LIMESTONE	grey, dark grey, pale grey, poorly to well cemented, fossiliferous, shell debris throughout. Some green-brown clayey sand bars mainly fine grained subrounded to rounded, rare coarse quartz grains. A few fine to medium black grains.	UPPER PORT WILLUNGA (Tertiary)				
121	133		SANDY LIMESTONE	grey, dark grey, well cemented. Sand fine to coarse grained, subangular (fine) to angular and very angular (coarse grains). Some green-brown to white in colour sand bars, fine to medium grained, subrounded to subangular.					
133	143.5		SANDY LIMESTONE	pale grey, brownish grey, a few bars grey to dark grey well cemented, some dark grey bars very poorly cemented. Sand content mainly fine to medium grained, some angular coarse quartz grains throughout from milky white to					

GROUNDWATER DIVISION	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA **WATER WELL LOG** CONTINUATION SHEET	**PERMIT NO:** 38396 UNIT NO: **DME**

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
				off white in colour. More clayey sand bars as above.					
143.5	154		SANDY LIMESTONE	greenish brown, well cemented, shell fragments throughout up to 1cm in size. Sand content as above.					
154	163		CLAY	dark bluish grey, soft to plastic when wet, slightly sandy, slightly calcareous, with limestone bars and bands.	MUNNO PARA CLAY (Tertiary)				
163	166.5		SANDY LIMESTONE	pale grey, grey, well cemented, fossiliferous, shell fragments throughout. Some limestone grains covered by green mineral (possibly glauconite). Sand content mainly fine to very fine grained, quartz, subrounded to rounded some medium to coarse grains, some of them covered by iron oxide. Black grains fine to medium in size throughout.	LOWER PORT WILLUNGA (Tertiary)				
166.5	171		SANDY LIMESTONE	grey, pale grey, some bars bluish grey and greenish grey in colour, well cemented, fossiliferous, shell fragments throughout. Sand content as above. Silty fine grained sand bars, rounded, well sorted.					
171	175.5		SANDY LIMESTONE	a/a but pale brown, grey brown to light grey in colour.					
175.5	189		SANDY LIMESTONE	a/a but mainly grey to dark grey in colour.					
189	193.5		SANDY LIMESTONE	a/a but mainly dark greenish grey in colour.					
193.5	198.5		SANDY LIMESTONE	dark greenish grey, grey, well cemented, fossiliferous. Sand content fine to medium grained, quartz, subangular to rounded .					
198.5	208.5		SANDY LIMESTONE	mainly greenish brown and pale grey, some bluish grey bars, well cemented, fossiliferous, shell fragments throughout. Sand content as above but mainly fine grained.					

GROUNDWATER DIVISION

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 38396

UNIT NO:

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
208.5	212		LIMESTONE	greyish brown, sandy, well cemented, very fossiliferous, shell fragments and whole shells throughout. A few black chert nodules up to 0.5cm in diameter. Rare glauconite grains up to 1.5 mm in diameter. A few bars of white sandy siltstone, contained some green grains (possibly glauconite) <1mm in diameter.	RUWARRUNG				

APPENDIX II

CORE DESCRIPTION

PROJECT: MFP ASR The Levels

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

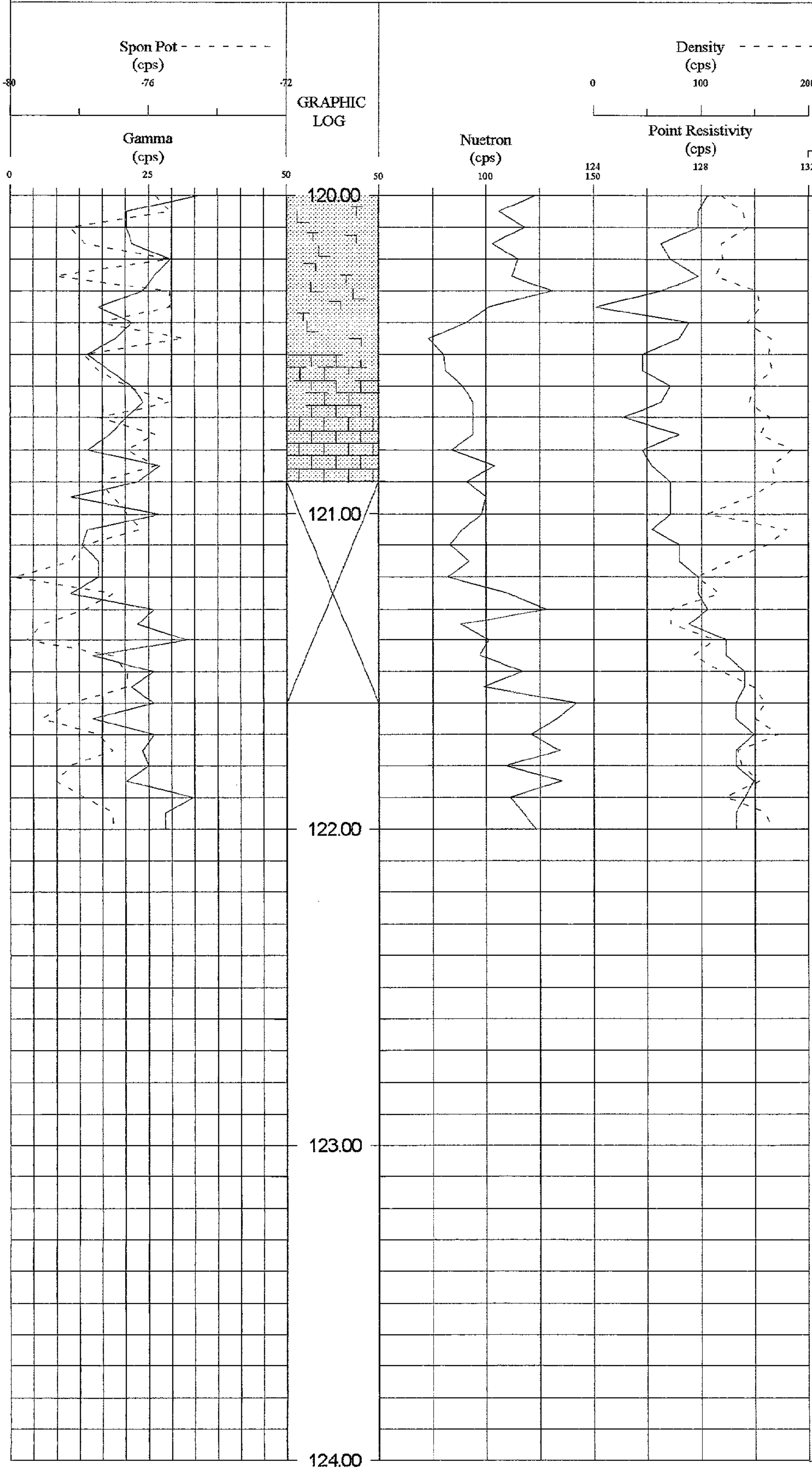
WATER WELL LOG

CORE DESCRIPTION SHEET

LOCATION OR COORDS:

El. Surface (m): El. Ref. Point (m): Datum:

PERMIT NO:	37835
UNIT NO:	6628 - 17761
Hundred: YATALA	Sec: 2218
CORE INTERVAL:	120.00 - 121.60 m
CORE NO:	1
Cut: 1.6 m	Recovered: 0.9 m 56 %



LITHOLOGICAL DESCRIPTION

120.00 - 120.50 SANDY LIMESTONE: mottled yellow/brown, buff, very fine to fine grained, well sorted, soft to friable, rounded to sub-rounded, strong calcareous cement, abundant clay matrix, occassional white limestone nodules through, mottled clay nodules, shell fragments, poor visual porosity, marley at top.

120.50 - 120.90 SANDY LIMESTONE: light grey, white, firm to hard broken limestone, fine to occassional medium, sub-rounded quartz through, generally clear and frosted grains, well sorted, minor clay matrix, abundant shell fragments and spicules, poor visual porosity.

120.90 - 121.60 No recovery

PROJECT: MFP ASR The Levels

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

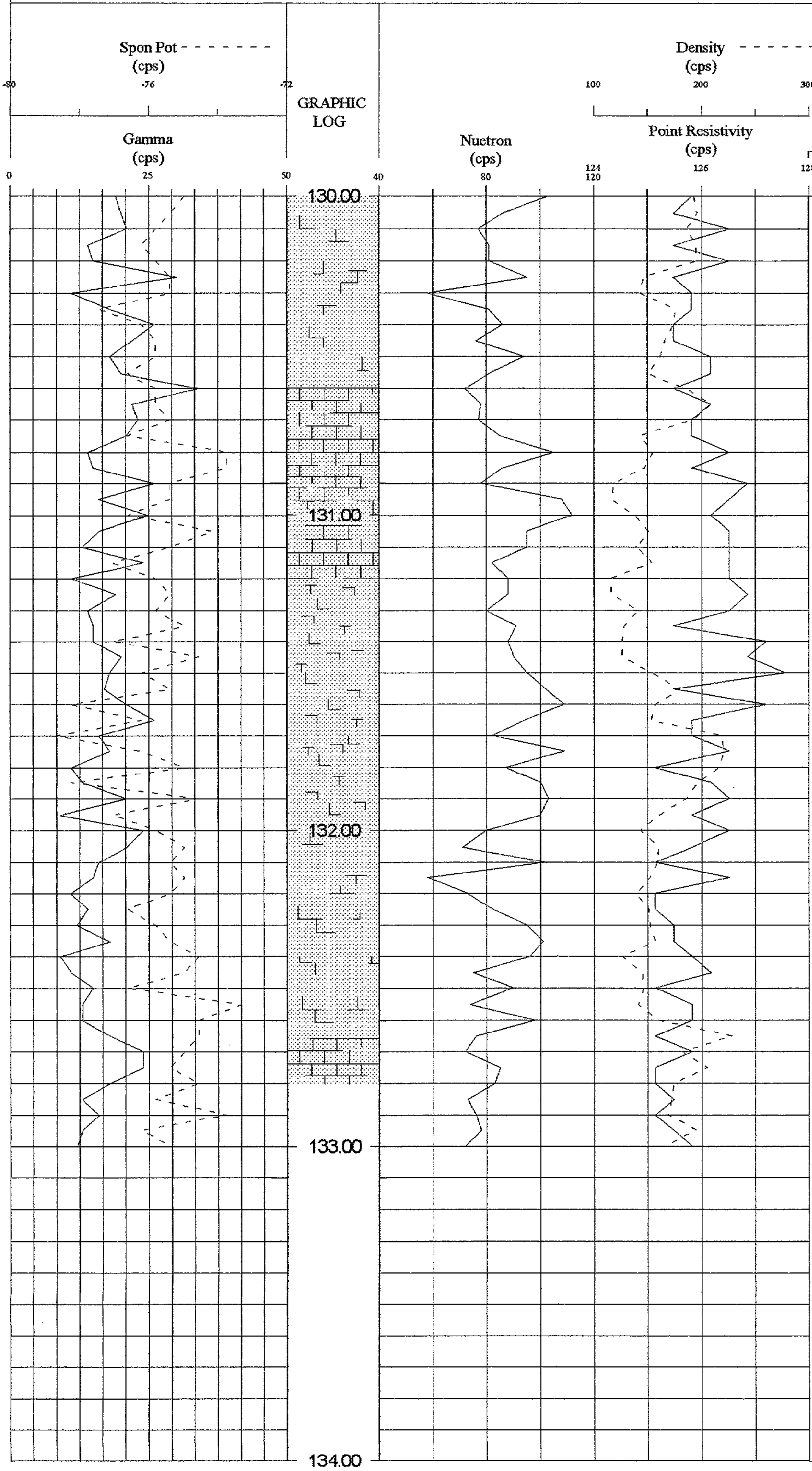
WATER WELL LOG

CORE DESCRIPTION SHEET

LOCATION OR COORDS:

El. Surface (m): El. Ref. Point (m): Datum:

PERMIT NO:	37835
UNIT NO:	6628 - 17761
Hundred: YATALA	Sec: 2218
CORE INTERVAL:	130.00 - 132.80 m
CORE NO:	2
Cut: 2.8 m	Recovered: 2.8 m 100%



LITHOLOGICAL DESCRIPTION

130.00 - 130.58 SANDY LIMESTONE: light grey, yellow/brown, buff, dominantly medium to occassional coarse grained, well sorted, soft to friable, rounded to sub-rounded, strong calcareous cement, abundant clay matrix, occassional grey limestone nodules through, shell fragments, poor visual porosity.

130.58 - 131.40 SANDY LIMESTONE: As Above but well cemented, broken, firm to hard sandy limestone, occassional coarse sand bedding bounded by calcareous layers, poor to rarely good visual porosity, with abundant shell fragments& spicules throughout, minor lignitic specks.

131.40 - 132.65 SANDY LIMESTONE: light grey, yellow/brown, buff, dominantly medium grained with occassional lenses of coarse grains through, well sorted, soft to friable, rounded to sub-rounded and angular where coarse, strong calcareous cement, abundant clay matrix, grey limestone nodules through, shell fragments and minor spicules, rare good visual porosity, mostly poor visual porosity.

132.65 - 132.80 SANDY LIMESTONE: As Above but well cemented, firm to hard.

PROJECT: MFP ASR The Levels

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

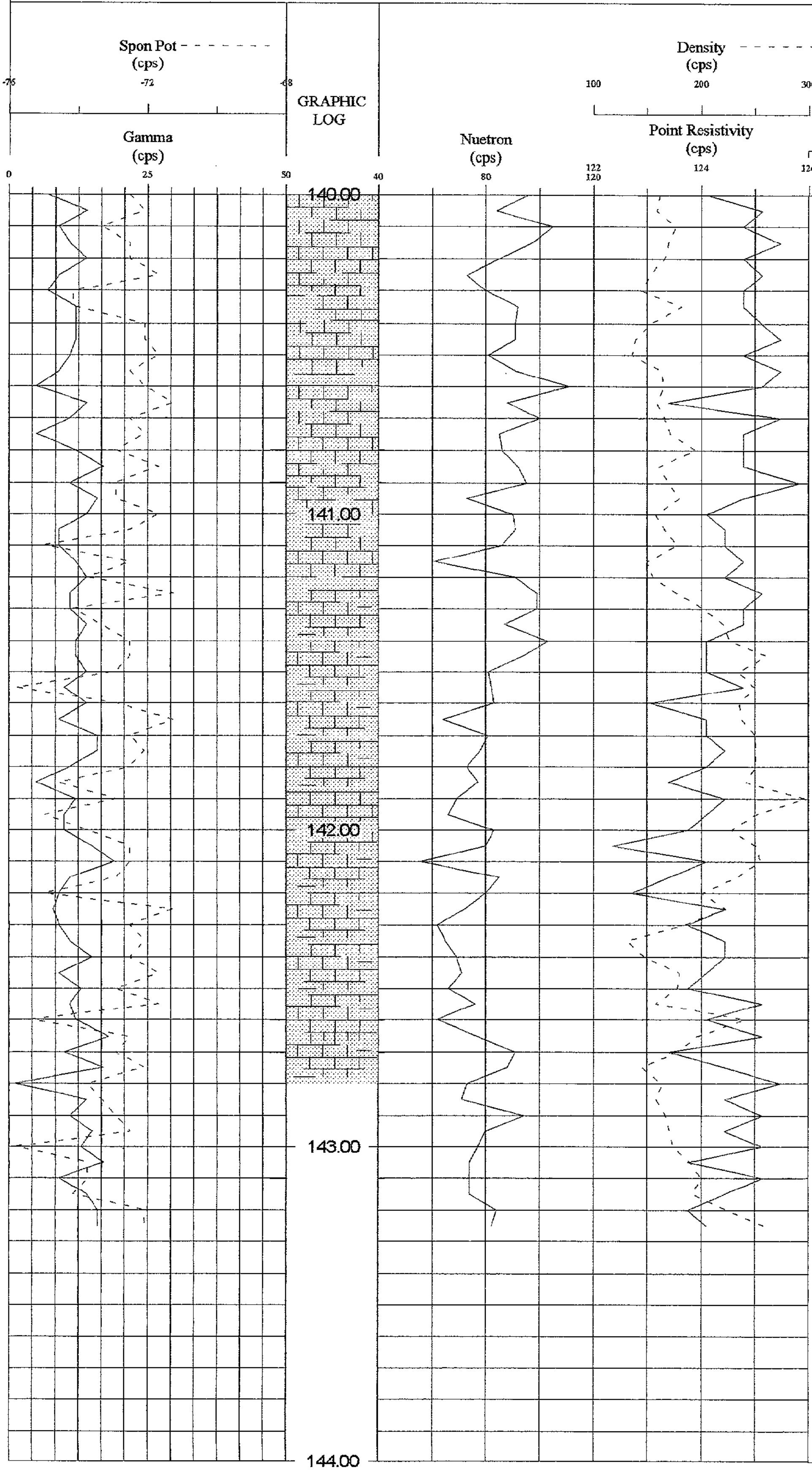
WATER WELL LOG

CORE DESCRIPTION SHEET

LOCATION OR COORDS:

El. Surface (m): El. Ref. Point (m): Datum:

PERMIT NO:	37835
UNIT NO:	6628 - 17761
Hundred: YATALA	Sec: 2218
CORE INTERVAL:	140.00 - 143.00 m
CORE NO:	3
Cut: 3.0 m	Recovered: 3.0 m 100%



LITHOLOGICAL DESCRIPTION

140.00 - 140.50 SANDY LIMESTONE: light grey, white, marley in part, firm to hard, fine to dominantly medium with occassional coarse grained sand, well sorted, rounded to sub-rounded, strong calcareous cement, abundant clay matrix, occassional grey limestone nodules shell fragments, mainly poor to rarely good visual porosity.

140.50 - 141.50 SILTY / MARL and LIMESTONE: dark grey, firm, fine silt throughout, abundant shell fragments, poor visual porosity.

141.50 - 142.26 SANDY LIMESTONE: light grey, white, marley in part, firm to hard, dominantly medium grained, well sorted, rounded to sub-rounded, strong calcareous cement, abundant clay matrix, shell fragments and minor spicules, rare good visual porosity, mostly poor.

142.26 - 143.00 SILTY MARL and LIMESTONE: As for 140.50 - 141.50 dark grey, silty with fine to very fine sand through.

PROJECT: MFP ASR The Levels

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

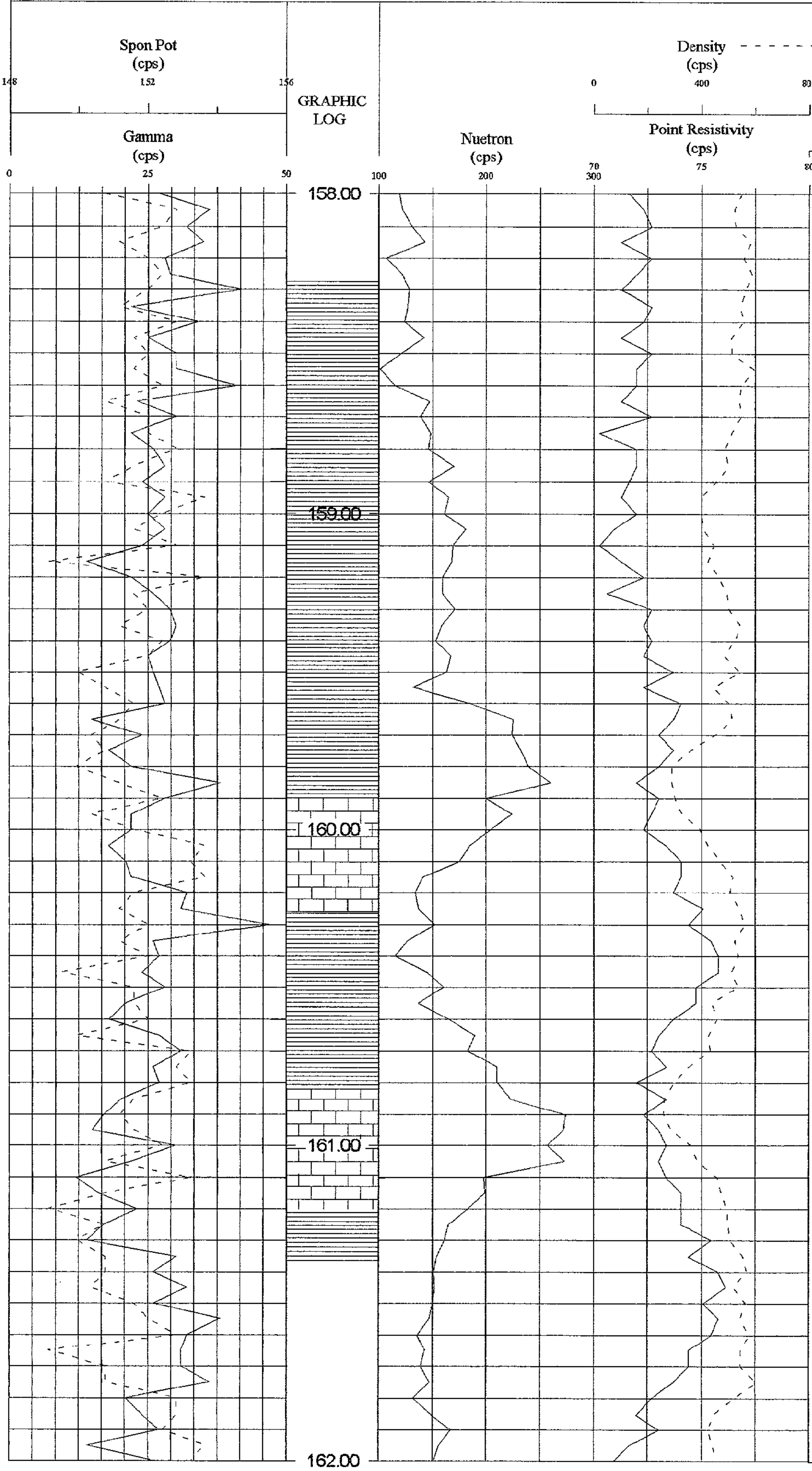
WATER WELL LOG

CORE DESCRIPTION SHEET

LOCATION OR COORDS:

El. Surface (m): El. Ref. Point (m): Datum:

PERMIT NO:	37384
UNIT NO:	6628 - 17760
Hundred: YATALA	Sec: 2218
CORE INTERVAL:	158.27 - 161.37 m
CORE NO:	1
Cut: 3.10 m	Recovered: 3.10 m 100%



LITHOLOGICAL DESCRIPTION

158.27-159.90 CLAY: dark grey/bluish grey, stiff to firm, fine flakey laminae, plastic/soapy texture

159.90 - 160.25 LIMESTONE: white, firm to hard, well indurated, minor shell fragments & lignitic specks through, minor clear medium grained sub-rounded sand through.

160.25 - 160.81 CLAY:dark grey/bluish grey, firm to stiff, fine flakey laminae, plastic/soapy texture.

160.81 - 161.21 LIMESTONE: white, light grey firm to hard, well indurated, shell fragments & lignitic specks through, minor clear medium grained sub-rounded quartz grains through.

161.21 - 161.37 CLAY: dark grey/bluish grey, firm to stiff, fine flakey laminae, plastic soapy texture.

PROJECT: MFP ASR The Levels

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

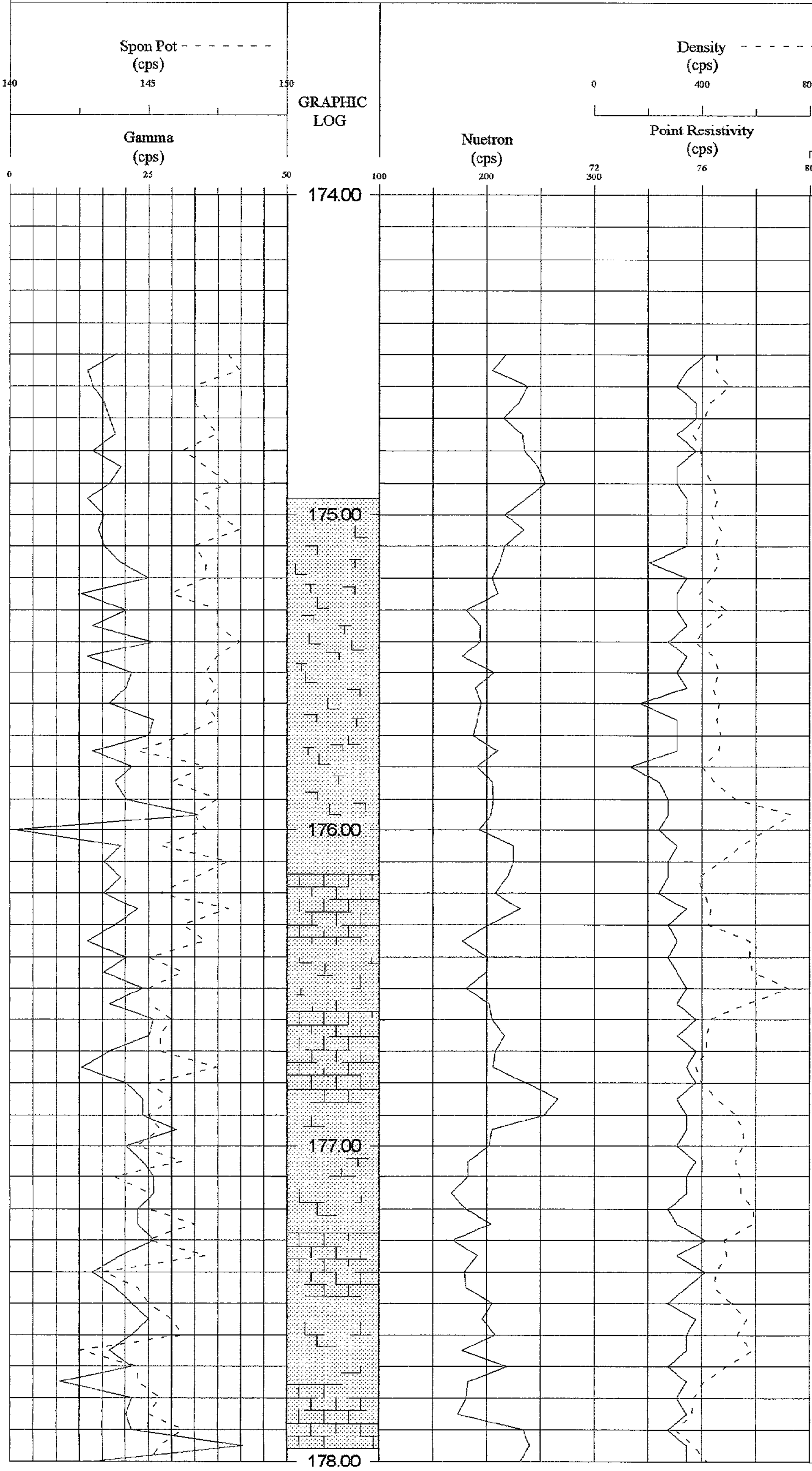
WATER WELL LOG

CORE DESCRIPTION SHEET

LOCATION OR COORDS:

El. Surface (m): El. Ref. Point (m): Datum:

PERMIT NO:	37834
UNIT NO:	6628 - 17760
Hundred: YATALA	Sec: 2218
CORE INTERVAL:	174.95 - 177.95 m
CORE NO:	2
Cut: 3.0 m	Recovered: 3.0 m 100%



LITHOLOGICAL DESCRIPTION

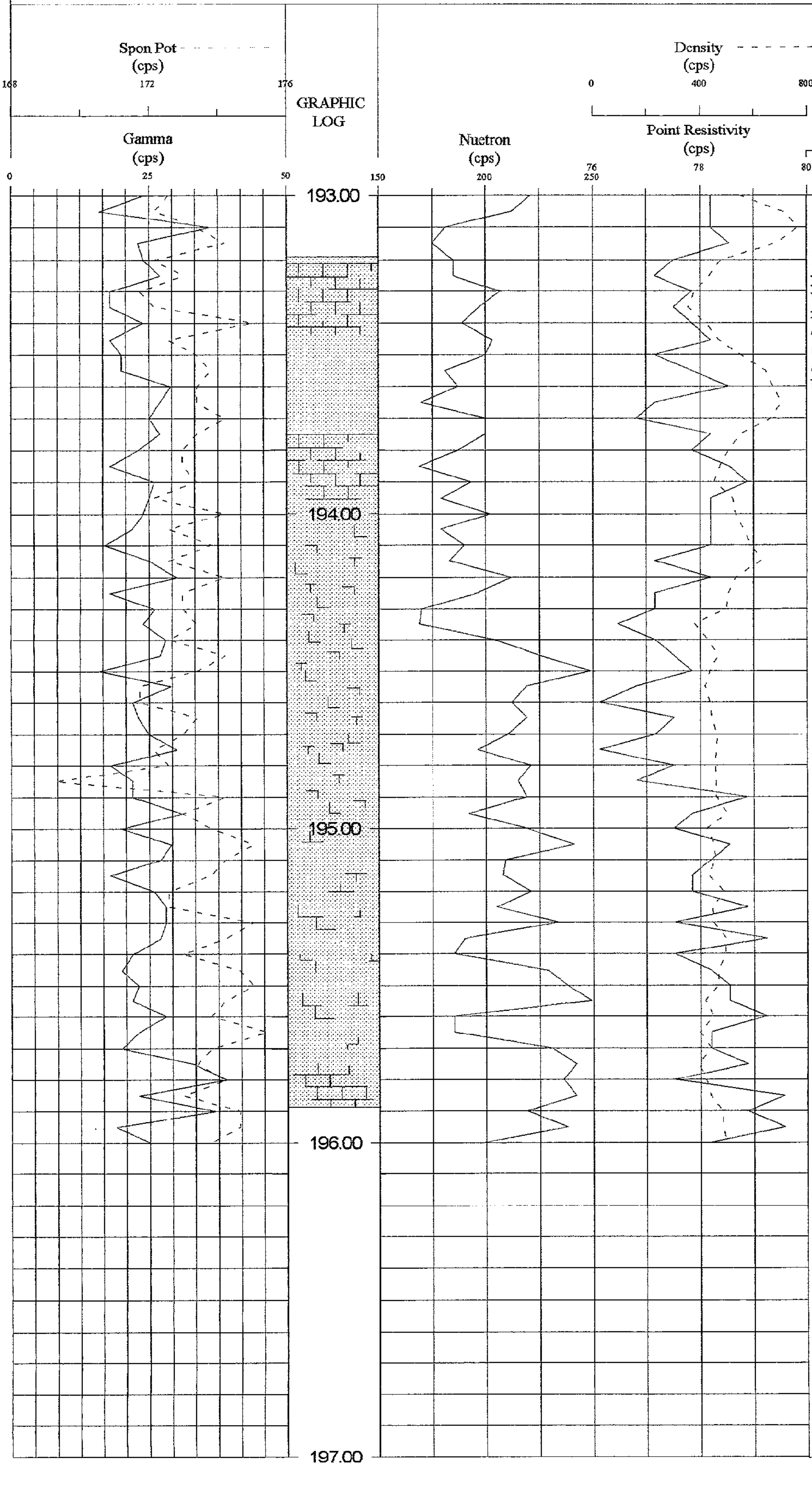
174.95-176.15 SAND: mottled yellow/brown, buff, light grey, very fine to fine grained, well sorted, firm, rounded to sub-rounded, strong calcareous cement, clay matrix, occassional grey limestone nodules through, mottled clay nodules, shell fragments and minor lignitic specks, poor visual porosity.

176.15 - 176.35 SANDY LIMESTONE: buff, yellowish brown, clear, fine to occassioanlly medium grained, well sorted, firm to hard, strong calcareous cement, minor clay matrix, quartz is rounded to sub-rounded, shell fragments and spicules throughout, poor to moderate visual porosity.

176.35 - 176.60 SANDY LIMESTONE: buff, soft to firm, weakly cemented, abundant argillaceous matrix, shell fragments & lignitic specks through, abundant clear, fine to medium grained sub-rounded quartz grains through, poor to nil visual porosity.

176.60 - 177.95 SANDY LIMESTONE: As Above interbeded sequences of soft sandy, poorly cemented limestone with well cemented firm to hard sandy limestone, typically poor visual porosity with abundant shell fragments & spicules throughout, minor lignitic specks.

PROJECT: MFP ASR The Levels	DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA	PERMIT NO: 37834
LOCATION OR COORDS:	**WATER WELL LOG** CORE DESCRIPTION SHEET	UNIT NO: 6628 - 17760
El. Surface (m):	El. Ref. Point (m): Datum:	Hundred: YATALA Sec: 2218
		CORE INTERVAL: 193.19 - 195.89 m
		CORE NO: 3
		Cut: 2.7 m Recovered: 2.7 m 100%



LITHOLOGICAL DESCRIPTION

193.19 - 195.75 SANDY LIMESTONE: mottled yellow/brown, buff, very fine to fine grained, well sorted, soft to friable, rounded to sub-rounded, strong calcareous cement, abundant clay matrix, occassional grey limestone nodules through, mottled clay nodules, shell fragments and minor lignitic specks, poor visual porosity, becomming marley towards base.

195.75 - 195.89 SANDY LIMESTONE: As Above but with well cemented firm to hard sandy limestone, typically poor visual porosity with abundant shell fragments& spicules throughout, minor lignitic specks.

APPENDIX III

COMPOSITE LOGS

Job No. 100730RM.DTA

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENGINEERING SECTION

PLAN No. 97–0026

COMPOSITE WELL LOG – GROUNDWATER

CONSTRUCTION DETAILS

DRILLING METHOD . . ROTARY
CIRCULATION . . . . MUD
MUD RESISTIVITY/TYPE
START . . 1 DEC 1996 . . FINISH . . 7 DEC 1996
TOTAL DEPTH . . 212 . . . m

	mm	From (m)	To (m)
HOLE DIAMETER	300	0	6
	228	6	212
CASING DIAMETER (Cemented)	153	0	168
OPEN HOLE	OH	168	212
SCREEN DETAILS			

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO S.W.L. (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W. No.
	3.2	520	AIRLIFT		

REMARKS

PROJECT . . . . MFP ASR INVESTIGATION – THE LEVELS
FIELD No. . . . . UNIT No. 6628 – . . . . PERMIT No. 38396
LOCATION . . . . LATITUDE 34° 48.650'
LONGITUDE 138° 36.685'
REF. ELEV. . . . . m SURFACE ELEV. . . . . m DATUM . . . .
LOGGED BY . . A. SEREDA . . DATE . . 7 DEC 1996

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUT	CAL	SP	PR	DENS		
DATE OF RUN	5–12–96	5–12–96	5–12–96	5–12–96	5–12–96	5–12–96		
FIRST READING (m)	212.90	212.90	212.90	212.90	212.90	212.90		
LAST READING (m)	0	0	0	0	0	0		
RECORDED BY	D. Freebairn							

WELL SYMBOLS

. . . . Casing seal
. . . . Slotted casing
. . . . Casing shoe
. . . . Cemented interval
. . . . Wire wound screen
. . . . Gravel packed interval

CONSTRUCTION LOG | WATER CUT AND LEVEL | HYDRO DATA | AGE | UNIT | LITHOLOGY DESCRIPTION | LITHO. LOG | DEPTH (m)

AGE: QUATERNARY; TERTIARY

UNIT: HINDMARSH CLAY; CARISBROOKE SAND; HALLETT COVE SANDSTONE / DRY CREEK SAND; UPPER PORT WILLUNGA FORMATION; MUNNO PARA CLAY MEMBER; LOWER PORT WILLUNGA FORMATION; RUWARUNG MEMBER

LITHOLOGY – DESCRIPTION

0 – 3 SANDY LOAM dark brown/dark grey, loose, fine grained sand, unconsolidated, well sorted, round to sub-angular, non-calcareous.

3 – 21 CLAY brown to grey with brown mottling, hard to stiff, plastic to soft when wet, sticky, lignitic in part, slightly calcareous. Sand content less than 10%, fine to medium grained sub-angular to subrounded, some angular grains.

21 – 39 CLAY pale grey, grey, brown mottled, hard to stiff, sticky, non-calcareous, about 10% sand content, quartz fine to medium grained sub-angular to angular. Thin lignitic bars and specks increasing with depth.

39 – 48 SANDY CLAY grey, light grey, brown mottled, hard to stiff, plastic when wet, becoming sticky with depth, non-calcareous. Sand up to 50%, quartz, fine to coarse, poorly sorted, sub-angular to angular, some fine gravel quartz grains, a few iron grains.

48 – 55 CLAY a/a, but more sticky and some iron staining mottled bars. Sand content a/a, but sub-rounded to angular, some fine to medium grains, black in colour.

55 – 60 CLAYEY SAND grey, yellowish brown iron bars, mainly fine to medium, some coarse grains, quartz, sub-angular to sub-rounded.

60 – 73 SAND interbedded grey, slightly bluish grey, yellow-brown, quartz, mainly fine, well sorted, some medium and rare coarse grains, subangular to subrounded. Soft clay matrix.

73 – 89 LIGNITIC SAND interbedded dark grey coarse to gravelly sand, sub-angular to very angular up to fine gravel (a few grains), and black silty clayey fine sand, subrounded to subangular with rare coarse grains. Some black bars of lignite (woody). Lignite content decreasing with depth.

89 – 92 LIGNITIC SAND sands as above with abundant dark brown lignitic? or organic debris through, clay matrix and cement (approx. 30%).

92 – 101 LIGNITIC SAND interbedded dark grey coarse to gravelly sand, sub-angular to very angular up to fine gravel (a few grains), and black silty clayey fine sand, subrounded to subangular with rare coarse grains. Some black bars of lignite (woody). Lignite content decreasing with depth.

101 – 104 LIGNITIC SAND black, slightly greenish black, silty clayey, mainly fine, subrounded to rounded, well sorted, clay matrix, slightly micaceous? rare coarse quartz grains throughout.

104 – 116 SHELLS loose shell fragments variable size, no matrix, react on HCl.

116 – 133 SANDY LIMESTONE grey, dark grey, well cemented. Sand fine to coarse grained, sub-angular (fine) to angular and very angular (coarse grains). Some green-brown to white in colour sand bars, fine to medium grained, sub-rounded to sub-angular.

133 – 143.5 SANDY LIMESTONE pale grey, brownish grey, a few bars grey to dark grey, well cemented, some dark grey bars very poorly cemented. Sand content mainly fine to medium grained, some angular coarse quartz grains throughout from milky white to off white in colour. More clayey sand bars as above.

143.5 – 152 SANDY LIMESTONE greenish brown, well cemented, shell fragments throughout, up to 1cm in size. Sand content as above.

152 – 163 CLAY dark bluish grey, soft to plastic when wet, slightly sandy, slightly calcareous, with limestone bars and bands.

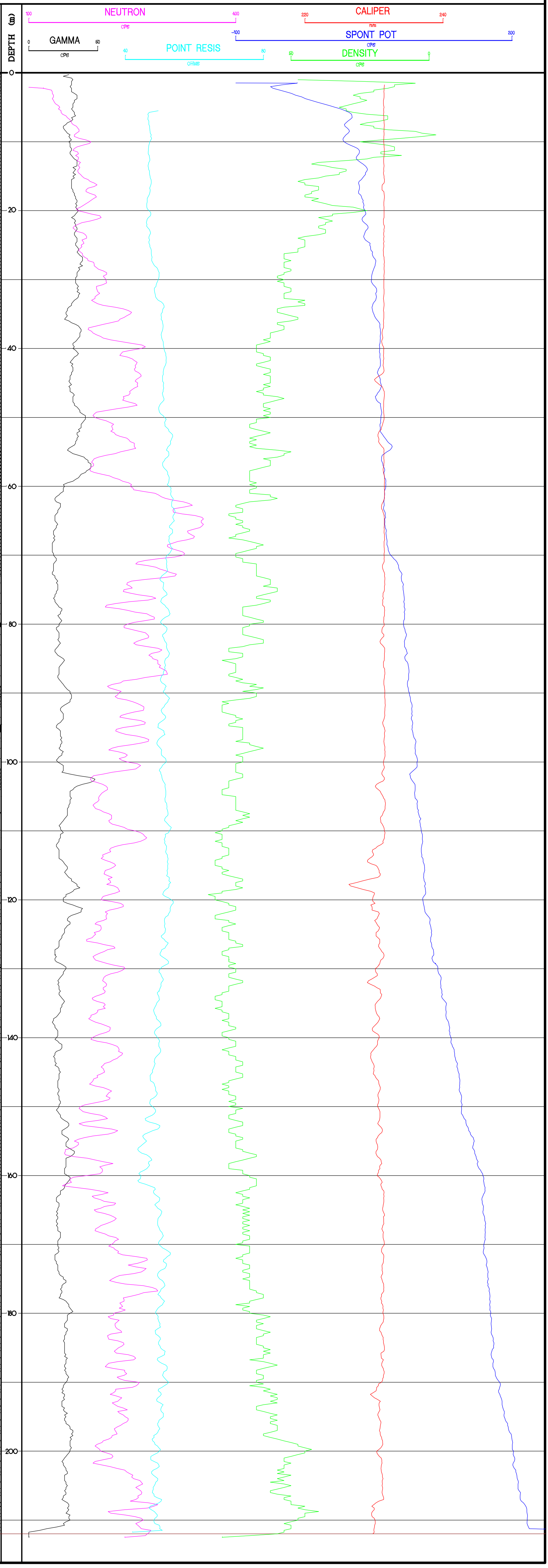
163 – 171 SANDY LIMESTONE pale grey, grey, well cemented, fossiliferous, shell fragments throughout. Some limestone grains covered by green mineral (possibly glauconite). Sand content mainly fine to very fine grained, quartz, sub-rounded to rounded some medium to coarse grains, some of them covered by iron oxide. Black grains fine to medium in size throughout.

171 – 193.5 SANDY LIMESTONE grey, pale grey, some bars bluish grey and greenish grey in colour, well cemented, fossiliferous, shell fragments throughout. Sand content as above. Silty fine grained sand bars, rounded, well sorted.

193.5 – 208 SANDY LIMESTONE dark greenish grey, grey, well cemented, fossiliferous. Sand content fine to medium grained, quartz, sub-angular to rounded.

208–212 LIMESTONE/MARL greyish brown, sandy, well cemented, very fossiliferous, shell fragments and whole shells throughout. A few black chert nodules up to 0.5cm in diameter. Rare glauconite grains up to 1.5 mm in diameter. A few bars of white sandy siltstone, contained some green grains (possibly glauconite) <1mm in diameter.

EOH



Job No. 100478RM.DTA

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENGINEERING SECTION

PLAN No. 96–0237.

COMPOSITE WELL LOG – GROUNDWATER

CONSTRUCTION DETAILS

DRILLING METHOD . . ROTARY. . . . .
CIRCULATION . . . . MUD. . . . .
MUD RESISTIVITY/TYPE . . . .
START . 12 JUNE 1996 . . FINISH . . 22 JUNE 1996 .
TOTAL DEPTH . . 212 . . . m

	mm	From (m)	To (m)
HOLE DIAMETER	254	0	6
	203	0	212
CASING DIAMETER (Cemented)	203	0	164
OPEN HOLE	203	164	212
SCREEN DETAILS			

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO S.W.L. (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W. No.
	4.4	1300	AIRLIFT	1776	184452

REMARKS

PROJECT . . . . MFP ASR INVESTIGATION – THE LEVELS . . . .
FIELD No. . . . . UNIT No. 6628 – 17760 . . . . PERMIT No. 37834 . . . .
LOCATION . . . LATITUDE 34° 48.742' . . . .
. . . . LONGITUDE 138° 36.727' . . . .
REF. ELEV. . . . . m SURFACE ELEV. . . . . m DATUM . . . .
LOGGED BY . . R. MARTIN . . DATE . . 22 JUNE 1996

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUT	CAL	SP	PR	DENS		
DATE OF RUN	17–6–96	17–6–96	17–6–96	17–6–96	17–6–96	17–6–96		
FIRST READING (m)	212.35	212.35	212.35	212.6	212.6	212.35		
LAST READING (m)	0	0	0	0	0	0		
RECORDED BY	A. FROLOV							

WELL SYMBOLS

. . . Casing seal
. . . Slotted casing
. . . Casing shoe
. . . Cemented interval
. . . Wire wound screen
. . . Gravel packed interval

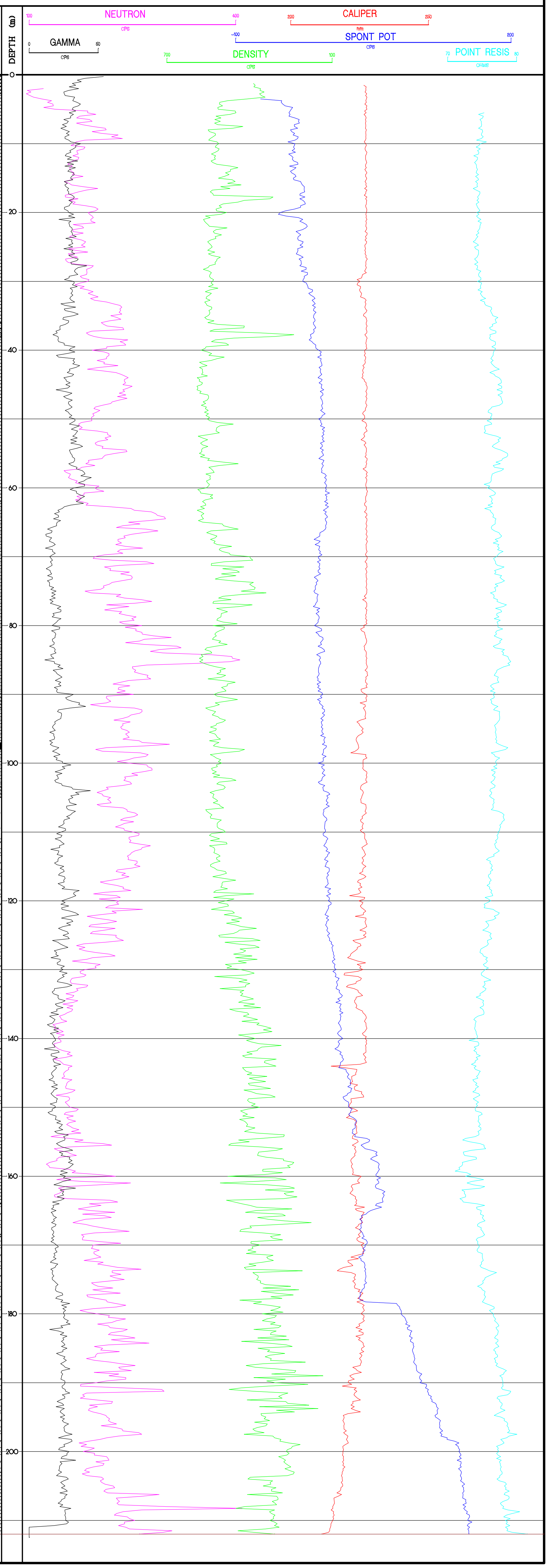
CONSTRUCTION LOG | WATER CUT AND LEVEL | HYDRO DATA

LITHOLOGY

AGE	UNIT	DESCRIPTION
QUATERNARY	HINDMARSH CLAY	0 – 3 SANDY LOAM dark brown/dark grey, loose, fine grained sand, unconsolidated, well sorted, round to sub-angular, non calcareous.
QUATERNARY	HINDMARSH CLAY	3 – 7 CLAY brown/red, soft, plastic, sticky, soapy texture, common silt and fine sand through, minor shell fragments through.
QUATERNARY	HINDMARSH CLAY	7 – 18 CLAY mottled pale yellow/brown/light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.
QUATERNARY	HINDMARSH CLAY	18 – 21 CLAY mottled reddish brown, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.
QUATERNARY	HINDMARSH CLAY	21 – 36 CLAY mottled pale yellow/brown/light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, shell fragments through.
QUATERNARY	HINDMARSH CLAY	36 – 38.5 SAND yellow/brown, with frosted & opaque grains through, fine to very coarse grained, dominantly medium to coarse grained, poorly sorted, unconsolidated, angular to sub-angular, clay matrix, rare rounded ironstone nodules through, rare shell fragments through & some organic? lignitic debris.
QUATERNARY	HINDMARSH CLAY	38.5 – 57 CLAY mottled red/yellow & light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.
QUATERNARY	HINDMARSH CLAY	57 – 62 CLAY mottled pale yellow/brown & light grey, firm to stiff, high plasticity, soapy texture with minor fine grained Quartz through, silty in part, minor black lignitic? specks through or remnant organic debris, rare shell fragments through.
QUATERNARY	CARISBROOKE SAND	62 – 89.5 SAND light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine and dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.
QUATERNARY	CARISBROOKE SAND	89.5 – 92 SANDY CLAY light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine & dominantly sub-rounded, sub-angular to angular where coarse, abundant clay matrix and argillaceous (approx 20%) cement, lignitic? or organic specks & shell fragments through.
QUATERNARY	CARISBROOKE SAND	92 – 97 SAND AS ABOVE
QUATERNARY	CARISBROOKE SAND	97 – 98 LIGNITIC SAND sands as above with abundant dark brown lignitic? or organic debris through, clay matrix & cement (approx 30%).
QUATERNARY	HALLETT COVE SANDSTONE / DRY CREEK SAND	98 – 103 SAND light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine, dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.
QUATERNARY	HALLETT COVE SANDSTONE / DRY CREEK SAND	103 – 105 SANDY CLAY dark grey, soft, sticky, silty, plastic, clear medium grained & opaque Quartz grains through, some iron stained grains, shell fragments through, several specks of soft green clay apparent glauconite?
QUATERNARY	HALLETT COVE SANDSTONE / DRY CREEK SAND	105 – 111 SHELLS abundant loose shells & shell fragments with minor fine to medium grained loose sand, no cement or matrix.
TERTIARY	UPPER PORT WILLUNGA FORMATION	111 – 118 SANDY LIMESTONE clear, pale yellow/brown, very fine to fine grained, firm, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.
TERTIARY	UPPER PORT WILLUNGA FORMATION	118 – 153 SANDY LIMESTONE clear, pale yellow/brown,light grey, very fine to fine grained, firm to hard, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules plus, rare organic? or lignitic specks through.
TERTIARY	MUNNO PARA CLAY MEMBER	153 – 164 CLAY dark greyish-blue, soft to firm, sticky when wet, plastic-soapy texture, rare white limestone fragments through with minor shell debris & spicules.
TERTIARY	LOWER PORT WILLUNGA FORMATION	164 – 171 SANDY LIMESTONE light grey, firm to hard, abundant shell & fossil fragments (spicules & sponge fragments) rare medium grained, sub-angular, clear & frosted quartz grains through, minor lignitic specks through.
TERTIARY	LOWER PORT WILLUNGA FORMATION	171 – 192 SANDY LIMESTONE tan, yellow/brown, very fine to fine grained, friable to rarely hard in part, well sorted, moderately well cemented, strong calcareous buff cement with abundant argillaceous (30–40%) matrix, minor lignitic specks & small shell fragments through.
TERTIARY	LOWER PORT WILLUNGA FORMATION	192 –203 SANDY LIMESTONE yellow/brown, with clear & opaque quartz grains, very fine grained, friable to firm, well sorted, moderately well cemented, strong calcareous buff cement with abundant argillaceous (30–40%) matrix, minor lignitic specks & small shell fragments through.
TERTIARY	RUWARUNG MEMBER	203 – 211.5 MARL interbedded light bluish-grey and reddish-brown calcareous clay, soft to firm, sticky, rare firm white limestone nodules through & sandy stringers, rare whole small shells & fossil fragments through.
		End of Hole

EOH

LITHO. LOG



Job no. 100478RM.DTA

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENGINEERING SECTION

PLAN No. 1996–238

COMPOSITE WELL LOG – GROUNDWATER

CONSTRUCTION DETAILS

DRILLING METHOD . . ROTARY
CIRCULATION . . . . MUD
MUD RESISTIVITY/TYPE . . .
START . 24. June 1996 . . FINISH . 30. June 1996
TOTAL DEPTH . . . . . 155 m

	mm	From (m)	To (m)
HOLE DIAMETER	254	0	6
	203	0	155
CASING DIAMETER (Cemented)	203	0	126
OPEN HOLE	203	126	155
SCREEN DETAILS			

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO S.W.L. (m)	YIELD		TOTAL DISSOLVED SOLIDS	
		m³/day	Method of Test	mg/litre	Analysis W. No.
	14.2	864	AIRLIFT	2199	189418

REMARKS

GEOPHYSICS

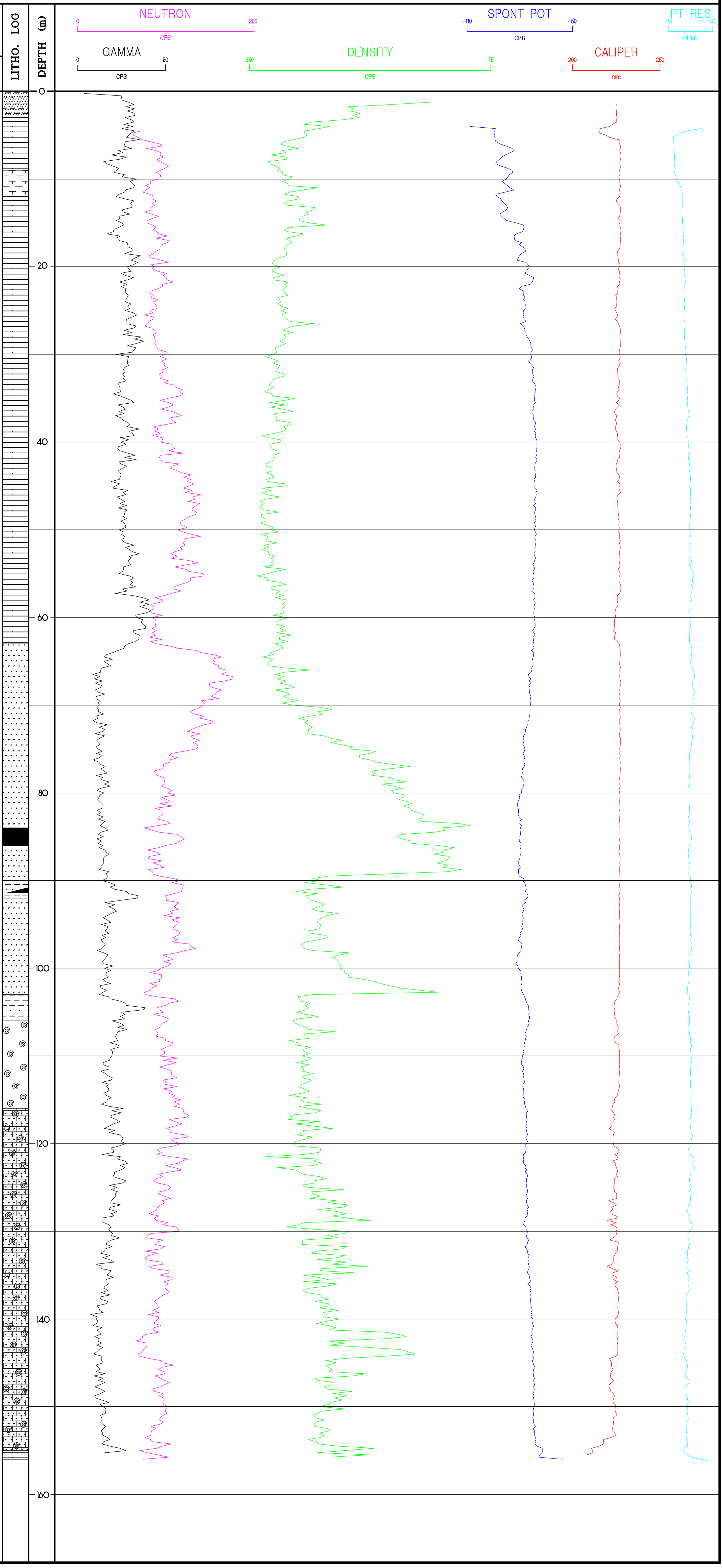
TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON. POTENT.	POINT RESIST.	DENSITY		
DATE OF RUN	27–06–96	27–06–96	27–06–96	27–06–96	27–06–96	27–06–96		
FIRST READING (m)	156.40	156.40	156.40	156.40	156.40	156.40		
LAST READING (m)	0	0	0	0	0	0		
RECORDED BY	A FROLOV	A FROLOV	A FROLOV	A FROLOV	A FROLOV	A FROLOV		

PROJECT . . . . . MFP ASR INVESTIGATION – THE LEVELS . . .
FIELD No. . . . . **UNIT No.** 6628–17761 . . . . . . **PERMIT No.** 37835
LOCATION . . . . LATITUDE 34° 48.750'
. . . . LONGITUDE 138° 36.720'
REF. ELEV. . . . . **m** **SURFACE ELEV.** . . . . **m** **DATUM** . . . .
LOGGED BY . . R. MARTIN . . **DATE** . . 30 JUNE 1996

WELL SYMBOLS

. . . Casing seal
. . . Slotted casng
. . . Casing shoe
. . . Cemented interval
. . . Wire wound screen
. . . Gravel packed interval

CONSTRUCTION LOG	WATER CUT AND LEVEL	HYDRO DATA	AGE	UNIT	LITHOLOGY – DESCRIPTION
			QUATERNARY		0 – 3 SANDY LOAM dark brown/dark grey, loose, fine grained sand, unconsolidated, well sorted, round to sub-angular, non calcareous.
			QUATERNARY	HINDMARSH CLAY	3 – 9 CLAY mottled brown/yellow and light grey, firm to stiff , plastic, sticky, soapy texture, common silt and fine sand through, minor shell fragments through, non calcareous.
					9 – 12 MARL mottled light grey & white calcareous clay, firm to stiff, silty in part with trace of coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor shell fragments through.
					12 – 30 CLAY mottled light grey, yellow brown, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through, non calcareous.
					30 – 45 CLAY mottled red & light grey, firm to stiff, high plasticity, silty in part with occasional trace of very coarse angular frosted Quartz grains through, occasional clear opaque grains and rare iron stained grains, minor black lignitic? specks through or remnant organic debris, minor shell fragments through.
					45 – 60 CLAY light grey, mottled pinkish/reddish brown, firm to stiff, high plasticity, very silty in part with occasional trace of coarse angular frosted Quartz grains through, rare clear opaque grains through, minor black lignitic? specks through or remnant organic debris, shell fragments through.
					60 – 63 SANDY CLAY light grey, pale yellow, firm with abundant fine grained Quartz through, silty in part, minor black lignitic? specks through or remnant organic debris, rare shell fragments through.
				CARISBROOKE SAND	63 – 84 SAND light grey/pale yellow/buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine and dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.
					84 – 86 LIGNITIC SAND as above and dominantly fine to medium grained with abundant black lignite through.
					86 – 90 SAND light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine & dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.
					90 – 92 SILTY CLAY dark grey, soft & sticky, very silty, abundant lignitic specks through sands as above with abundant dark brown lignitic? or organic debris through, clay matrix & cement (approx 30%).
				HALLETT COVE SANDSTONE / DRY CREEK SAND	92 – 103 SAND light grey/pale yellow, buff, interbedded sequences of very fine to very coarse grained sands with abundant clear & frosted grains through, well sorted where fine, dominantly sub-rounded, sub-angular to angular where coarse, unconsolidated with minor clay matrix and argillaceous (approx 10%) cement, lignitic? or organic specks & shell fragments through.
					103 – 106 SILTY CLAY dark grey, greenish, soft, sticky, silty, plastic, clear medium grained & opaque Quartz grains through, some iron stained grains, shell fragments through, several specks of soft green clay apparent glauconite?
					106 –116 SHELLS abundant loose shells & shell fragments with minor fine to medium grained loose sand, no cement or matrix.
			TERTIARY	UPPER PORT WILLUNGA FORMATION	116 – 120 SANDY/SHELLY LIMESTONE clear, pale yellow/brown, very fine to fine grained, firm, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.
					120 – 130 SANDY LIMESTONE clear, pale yellow/brown, very fine to fine grained, firm to hard, well sorted, well cemented, sub-round to round, strong calcareous pale yellow/buff cement and minor argillaceous matrix, abundant cemented shell debris and spicules through, rare organic? or lignitic specks through.
					130 – 155 SANDY LIMESTONE light grey, pale yellow, dominantly fine grained with rare loose clear medium quartz grains through, friable to firm, well sorted, strong calcareous yellow/buff cement, sub-round to round, abundant cemented shell debris and spicules through, rare lignitic? specks through.
End of hole				MUNNO PARA CLAY MEMBER	155 CLAY dark greyish-blue, soft to firm, sticky when wet, plastic-soapy texture, rare white limestone fragments through with minor shell debris & spicules.



APPENDIX IV

STEP DRAWDOWN TEST RESULTS

PUMPING TEST RESULTS

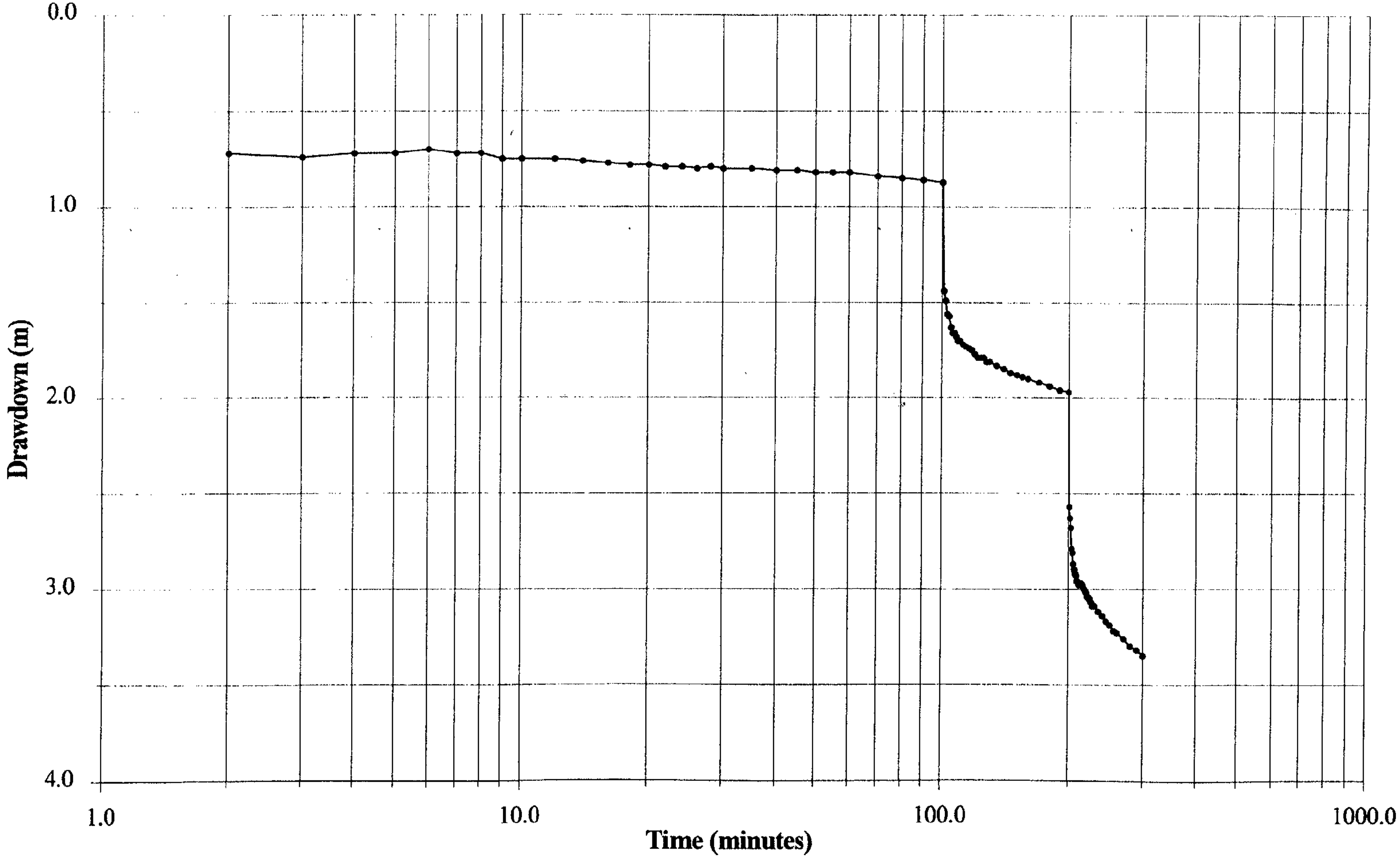
PERMIT NUMBER: 37834 AQUIFER: T2
UNIT NUMBER:6628-17760

Table 1

Time (min)	Drawdown (m)	Rate (m^3/day)	Time (min)	Drawdown (m)	Rate (m^3/day
1	0	0	122	1.79	518
2	0.72	259	124	1.79	518
3	0.74	259	126	1.79	518
4	0.72	259	128	1.81	518
5	0.72	259	130	1.81	518
6	0.70	259	135	1.83	518
7	0.72	259	140	1.85	518
8	0.72	259	145	1.87	518
9	0.75	259	150	1.88	518
10	0.75	259	155	1.89	518
12	0.75	259	160	1.90	518
14	0.76	259	170	1.92	518
16	0.77	259	180	1.94	518
18	0.78	259	190	1.96	518
20	0.78	259	200	1.97	518
22	0.79	259	201	2.57	916
24	0.79	259	202	2.63	916
26	0.80	259	203	2.68	916
28	0.79	259	204	2.79	916
30	0.80	259	205	2.81	916
35	0.80	259	206	2.87	916
40	0.81	259	207	2.90	916
45	0.81	259	208	2.92	916
50	0.82	259	209	2.93	916
55	0.82	259	210	2.96	916
60	0.82	259	212	2.98	916
70	0.84	259	214	2.97	916
80	0.85	259	216	2.98	916
90	0.86	259	218	3.00	916
100	0.87	259	220	3.02	916
101	1.44	518	222	3.04	916
102	1.49	518	224	3.05	916
103	1.56	518	226	3.07	916
104	1.57	518	228	3.09	916
105	1.63	518	230	3.09	916
106	1.66	518	235	3.12	916
107	1.66	518	240	3.14	916
108	1.68	518	245	3.17	916
109	1.70	518	250	3.19	916
110	1.70	518	255	3.22	916
112	1.72	518	260	3.23	916
114	1.73	518	270	3.26	916
116	1.74	518	280	3.30	916
118	1.75	518	290	3.32	916
120	1.77	518	300	3.35	916

STEP DRAWDOWN TEST DATA
T2 Aquifer

Permit No: 37834
Unit No: 6628-17760

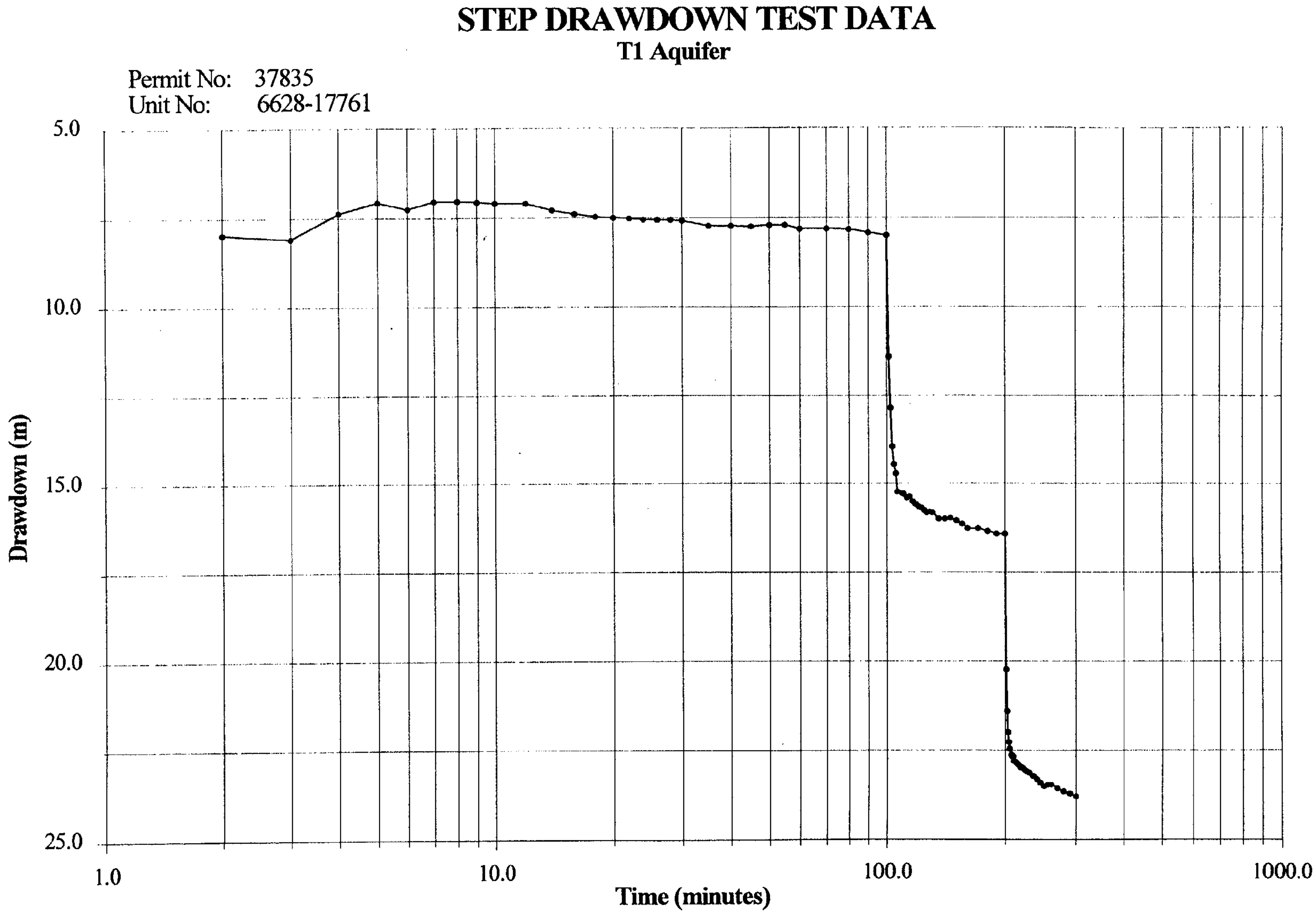


PUMPING TEST RESULTS

PERMIT NUMBER: 37835 AQUIFER: T1
UNIT NUMBER:6628-17761

Table 2

Time (min)	Drawdown (m)	Rate (m^3/day)	Time (min)	Drawdown (m)	Rate (m^3/day)
0	0	0	122	15.68	518
2	7.97	605	124	15.75	518
3	8.09	432	126	15.82	518
4	7.37	259	128	15.80	518
5	7.07	259	130	15.81	518
6	7.26	259	135	15.99	518
7	7.04	259	140	15.99	518
8	7.03	259	145	15.97	518
9	7.06	259	150	16.04	518
10	7.10	259	155	16.14	518
12	7.10	259	160	16.27	518
14	7.29	259	170	16.27	518
16	7.39	259	180	16.34	518
18	7.47	259	190	16.41	518
20	7.50	259	200	16.41	518
22	7.52	259	201	20.23	743
24	7.55	259	202	21.41	743
26	7.56	259	203	21.99	743
28	7.56	259	204	22.27	743
30	7.58	259	205	22.46	743
35	7.72	259	207	22.64	743
40	7.72	259	208	22.68	743
45	7.74	259	209	22.68	743
50	7.71	259	210	22.81	743
55	7.70	259	212	22.84	743
60	7.82	259	214	22.88	743
70	7.81	259	216	22.93	743
80	7.83	259	218	22.99	743
90	7.92	259	220	22.99	743
100	7.99	259	222	23.01	743
101	11.41	518	224	23.06	743
102	12.85	518	228	23.11	743
103	13.95	518	230	23.14	743
104	14.45	518	235	23.23	743
105	14.71	518	240	23.32	743
106	15.23	518	245	23.42	743
109	15.27	518	250	23.51	743
110	15.28	518	255	23.47	743
112	15.40	518	260	23.47	743
114	15.36	518	270	23.57	743
116	15.50	518	280	23.66	743
118	15.58	518	290	23.72	743
120	15.64	518	300	23.80	743


STEP DRAWDOWN TEST DATA
T1 Aquifer
Permit No: 37835
Unit No: 6628-17761
5.0
10.0
15.0
20.0
25.0
Drawdown (m)
1.0
10.0
100.0
1000.0
Time (minutes)

APPENDIX V

WATER CHEMISTRY

WATER CHEMISTRY - ANALYSIS RESULTS

Table 3

ELEMENTS	PN 37835 T1 Aquifer	PN 37834 T2 Aquifer
GENERAL DATA		
pH	7.9	7.8
Conductivity (µs/cm)	3760	2910
Total Dissolved Solids (by EC)	2100	1600
Dissolved Solids (by calculation)	2390	1860
CATIONS		
Calcium (Ca) mg/L	131	87.7
Magnesium (Mg) mg/L	73.2	52.6
Sodium (Na) mg/L	612	498
Potassium (K) mg/L	11.3	18.5
ANIONS		
Bicarbonate (HCO_3) mg/L	449	551
Sulphate (SO_4) mg/L	476	294
Chloride (Cl) mg/L	840	615
Fluoride (F) mg/L	0.32	0.50
NUTRIENTS		
Nitrate + Nitrite as N mg/L	0.010	<0.010
Silica - Reactive	24	21
METALS		
Iron - Total (Fe) mg/L	14.1	32.3
DERIVED DATA - Hardness		
Total Hardness as $CACO_3$	628	436
Carbonate Hardness as $CACO_3$	368	436
Non-carbonate Hardness as $CACO_3$	260	0
Calcium Hardness as $CACO_3$	326	219
Magnesium Hardness as $CACO_3$	301	217
DERIVED DATA - Other		
Alkalinity as Calcium Carbonate mg/L	368	452
Free Carbon Dioxide mg/L	9	14
Langelier Index	0.97	0.80
Sodium Adsorption Ratio	10.6	10.4
Total Chlorides as NaCl mg/L	1380	1010
Sodium/Total Cations Ratio %	67.5	70.2
Ion Balance %	-1.91	-2.67

Sample Collected 22/06/96
Analysis by: Australian Water Quality Centre
ref: AWQC 187

APPENDIX VI

VERTICAL HYDRAULIC CONDUCTIVITY

VERTICAL HYDRAULIC CONDUCTIVITY

Permit Number: 37835
Unit Number: 6628-17761
Aquifer: T1(b)

Table 4

Sample Number	Depth (m)	Vertical Permeability (m day^{-1})	Porosity (fraction)	Voids Ratio	M.C. (%)	Specific Gravity (g /cm^3)	Dry Density insitu (t/m^3)
96/377	131.18 - 131.40	0.83	0.428	0.749	27.0	2.73	1.56
96/378	140.85 - 141.05	5.62	0.535	1.149	41.3	2.70	1.26
96/379	142.00 - 142.17	9.59	0.447	0.808	29.8	2.70	1.49

Permit Number: 37834
Unit Number: 6628-17760
Aquifer: T2

Table 5

Sample Number	Depth (m)	Vertical Permeability (m day^{-1})	Porosity (fraction)	Voids Ratio	M.C. (%)	Specific Gravity (g /cm^3)	Dry Density insitu (t/m^3)
96/373	176.50 - 176.75	2.23	0.357	0.555	24.8	2.68	1.72
96/374	176.90 - 177.13	0.76	0.357	0.555	19.8	2.69	1.73
96/375	193.39 - 193.52	1.74	0.357	0.554	19.4	2.74	1.76
96/376	194.06 - 194.26	2.02	0.350	0.539	20.4	2.69	1.75

Analysis by: South Australian Water Corporation, *Soils & Concrete Laboratory*
Materials Sciences Centre
275 Grand Junction Rd
Ottoway S.A. 5013

APPENDIX VII

ROCK MINERALOGY

PHYSICAL ROCK PROPERTIES - ANALYSIS RESULTS

Permit Number: 37835
Unit Number: 6628-17761
Aquifer: T1(b)

Table 6

Sample ID	Depth (m)	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LOI	TC	TOEC	*Pyrite Est wt%
189198	120.00-120.20	2.43	14.6	4.40	0.99	1.50	0.01	0.24	0.08	60.0	0.19	13.8	3.74	0.25	0.06
189199	132.00-132.22	0.69	37.5	2.00	0.14	7.26	0.01	0.14	0.05	14.7	0.03	37.0	9.76	0.10	0.10
189200	140.30-140.46	0.28	48.9	0.53	0.09	1.65	0.02	0.09	0.03	8.62	0.02	40.0	10.1	<0.05	0.0005
Units		%	%	%	%	%	%	%	%	%	%	%	%	%	
Det.Lim.		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.05	
Method		IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	Grav7	Grav4E	Grav4B	Optical Exam

Al_2O_3 = Aluminium tri-oxide
CaO = Calcium oxide
Fe_2O_3 = Iron oxide (haematite)
K_2O = Potassium oxide
MgO = Magnesium oxide
MnO = Manganese oxide
Na_2O = Sodium oxide
P_2O_5 = Phosphorous pent-oxide
SiO_2 = Silicon di-oxide
TiO_2 = Titanium di-oxide
LOI = Loss on Ignition
TC = Total Carbon
TOEC = Total Organic & Elemental Carbon

* Pyrite content estimated by optical examination of clay fraction with a specific gravity >2.96 gm /cm^3.

PHYSICAL ROCK PROPERTIES - ANALYSIS RESULTS

Permit Number: 37834
Unit Number: 6628-17760
Aquifer: T2

Table 7

Sample ID	Depth (m)	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LOI	TC	TOEC	*Pyrite Est wt%
189195	175.24-175.50	1.01	31.5	2.00	0.32	0.96	0.03	0.18	0.05	39.6	0.06	24.5	6.34	0.05	0.005
189196	176.75-176.90	0.85	39.6	1.04	0.23	1.06	0.03	0.15	0.03	26.2	0.05	31.4	8.24	0.05	0.003
189197	195.13-195.26	2.63	25.3	10.0	0.46	1.50	0.09	0.18	0.11	35.6	0.11	24.0	5.86	0.10	-
Units		%	%	%	%	%	%	%	%	%	%	%	%	%	
Det.Lim.		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.05	
Method		IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	Grav7	Grav4E	Grav4B	Optical Exam

Al_2O_3 = Aluminium tri-oxide
CaO = Calcium oxide
Fe_2O_3 = Iron oxide (haematite)
K_2O = Potassium oxide
MgO = Magnesium oxide
MnO = Manganese oxide
Na_2O = Sodium oxide
P_2O_5 = Phosphorous pent-oxide
SiO_2 = Silicon di-oxide
TiO_2 = Titanium di-oxide
LOI = Loss on Ignition
TC = Total Carbon
TOEC = Total Organic & Elemental Carbon

* Pyrite content estimated by optical examination of clay fraction with a specific gravity >2.96 gm /cm^3.

BULK & -2µm MINERALOGIES OF LIMESTONE SAMPLES

Permit Number: 37834
Unit Number: 6628-17760
Aquifer: T2

Table 8

Mineral	189195		189196		189197	
	Bulk	-2µm	Bulk	-2µm	Bulk	-2µm
Calcite	D	D	D	D	D	SD
Dolomite	Tr		Tr		Tr-A	
Siderite						
Aragonite						
Quartz	SD	Tr	SD	Tr	SD	Tr
Plagioclase						
K-feldspar	Tr		Tr		Tr	
Kaolinite		Tr		Tr		Tr
Smectite						
Illite						
Goethite		Tr-A		Tr-A	A	D
Pyrite						
Halite	Tr				Tr	

Table 9

Permit Number: 37835
Unit Number: 6628-17761
Aquifer: T1(b)

Mineral	189198		189199		189200	
	Bulk	-2µm	Bulk	-2µm	Bulk	-2µm
Calcite	SD	CD	D	D	D	D
Dolomite	Tr-A		SD	A	Tr	Tr
Siderite	Tr					
Aragonite	Tr	CD				
Quartz	D	Tr	A	Tr	A	Tr
Plagioclase	Tr					
K-feldspar	Tr-A					
Kaolinite		A		Tr		Tr
Smectite		Tr				Tr
Illite		A				
Goethite	Tr-A	Tr-A		A		
Pyrite			Tr			
Halite			Tr			

Semi-quantitative abbreviations

D	=	Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
CD	=	Co-dominant. Used for two (or more) predominating components, both or all of which are judged to be present in roughly equal amounts.
SD	=	Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A	=	Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr	=	Trace. Components judged to be below about 5%.

SAMPLE: 189195 : TSC 66713

ROCK NAME: Sandy limestone

HAND SPECIMEN:

This is a fine grained, unconsolidated, friable, buff coloured calcareous sand. It contains abundant fine white particles up to 1mm in size, some of which appear to be fossil fragments.

THIN SECTION:

The sample consists of angular to subrounded detrital quartz and planktonic fossil tests, minor potash feldspar, trace plagioclase and lithic fragments and rare tourmaline. Typical grainsize is 0.1 to 0.3mm but some fossil fragments are up to 1mm in longest dimension. Microcline twinning is observable in some feldspar grains. Many fossil tests appear complete.

Staining with alizarin red-S shows the fossils to be constructed of calcite. Some authigenic recrystallisation has occurred and some authigenic outgrowths are welded to adjacent silicate grains; however, the rock pore spaces are mostly void. Truly opaque grains are rare and less than 0.1mm in grainsize. They occur as inclusions in other grains as well as free detrital grains. Some of the fossil fragments are locally stained with pale to yellow to deep brown oxides and/or organic material. Trace yellow brown clay fills some fossil chambers.

SAMPLE: 189196 : TSC 66714

ROCK NAME: Sandy limestone

HAND SPECIMEN:

This is an unconsolidated, crumbly, buff coloured calcareous sand flecked with white fossil fragments up to 1mm in longest dimension.

THIN SECTION

This sample consists of angular to subangular detrital quartz and planktonic fossil tests, minor potash feldspar (including microcline) and rare possible plagioclase, tourmaline and lithic fragments partly cemented by a calcite matrix. Typical grainsize is 0.07 to 0.3mm but many of the fossil fragments are up to 1mm. Many fossil tests appear complete and the largest is over 2mm across.

Alizarin red-S staining shows the fossils to be constructed of calcite. Much authigenic recrystallisation has occurred and some tests are just shadows outlined in a single large calcite grain. Authigenic calcite cement is more abundant than in 189195 but the sample consists mainly of loosely packed detritus with no cement between the particles.

Rare opaques form 0.01 to 0.1mm sized grains scattered throughout the matrix of the sample. Some fossil fragments are stained with brownish-yellow to deep reddish-brown by oxides and/or organic material. Many test chambers are filled with yellow-brown clay.

SAMPLE: 189197 : TSC 66715

ROCK NAME: Calcareous sand

HAND SPECIMEN:

This is a fine grained, unconsolidated, friable, buff coloured sand. It contains fine white sand-sized particles up to 3mm in longest dimension, some of which appear to be fossil fragments. The sample is intact and shows centimetre sized patches of orange oxide staining.

THIN SECTION:

This sample consists of angular to subrounded detrital quartz, subordinate potash feldspar including microcline, planktonic fossil tests, traces of lithic fragments and some muscovite. Typical grainsize is 0.5 to 0.3mm, but some fossil fragments are over 2mm long. A few fossil tests appear to be complete. The sample has a loosely packed intact fabric.

Alizarin red-S staining shows the fossils to be constructed of calcite. Much authigenic recrystallisation has occurred and some tests have been pseudomorphed by single skeletal calcite crystals. Some spiky authigenic outgrowths are welded to adjacent silicate grains, but there is virtually only void space between the detrital grains in this sample.

Truly opaque grains are rare and <0.1mm in diameter. About 3% of the detrital grains have a deep red brown colour and are probably iron oxide. Many feldspar grain show cleavage-controlled iron oxide staining. More than 50% of the calcareous tests are stained yellow to near opaque deep reddish-brown or yellow brown, possibly due to iron oxides and/or organic material. Some test chambers are filled with green to yellow green clay ((?) glauconite).

SAMPLE: 189198 : TSC 66716

ROCK NAME: Calcareous sand

HAND SPECIMEN:

This is a fine grained, unconsolidated, friable, grey-buff coloured sand. It contains fine white sand-sized particles up to 1mm in diameter.

THIN SECTION

This sample consists of angular to subrounded detrital quartz, subordinate to minor planktonic fossil tests, minor potash feldspar including microcline, minor to trace yellow to pinkish-yellow tourmaline and green and yellow to dark yellow-brown clay pellets, and rare lithic fragments. Some clay pellets tend to be subspherical and rounded. Typical detrital grainsize is 0.05 to 0.2mm, but some fossil tests are over 2.5mm in length. Many tests appear complete. The detrital grains are relatively well packed with an intact fabric and with mostly no matrix cement between the grains. However, there are abundant irregular patches up to 3mm across where the interstitial void spaces have been crammed with minute (?)dolomite rhombohedra. These are commonly cemented with green clay sieved with relatively abundant <0.02mm sized opaques. Two or three aggregates of aragonite between 1 and 1.5mm across form compact masses of randomly orientated acicular crystals.

Many fossil tests as well as some of the dolomite-clay cement are stained with yellow to red-brown oxides and/or organic material. Some authigenic recrystallisation of the tests has occurred and most contain fine opaques within their chambers.

SAMPLE: 189199 : TSC 66717

ROCK NAME: Sandy limestone

HAND SPECIMEN:

This is a fine grained, unconsolidated, friable, slightly greyish-buff coloured sand. It contains fine sand sized particles up to 1mm in longest dimension.

THIN SECTION

This sample consists of detrital planktonic fossil test fragments, minor angular to subrounded detrital quartz, trace potash feldspar including microcline, and rare tourmaline and (?)leucoxene. Typical grainsize is 0.05 to 0.2mm, but the planktonic tests are commonly up to 0.5mm and some are as large as 1mm. Only a few tests appear to be complete. The detrital grains are loosely packed and the silicates are generally non-intact.

Alizarin red-S staining shows the fossil tests to be constructed of calcite. Many appear to have undergone authigenic recrystallisation to single crystal pseudomorphs, commonly with loss of detail. Most have developed some dolomitic authigenic outgrowths, many of which have rhombohedral faces. Firm dolomite rhombs, mostly <0.05mm in size are abundantly scattered through the pore spaces between the detrital grains. This authigenic dolomite weakly cements the detrital grains together, but most space between the grains is void. The dolomite is not stained by the alizarin red-S solution making it distinguishable from calcite.

Some fossil tests are stained yellow to dark yellow-brown, locally with red and orange tones. This is probably due to iron oxides and/or organic material. Opaques are rare and less than 0.05mm in grainsize. They are mostly scattered through the interstices and are commonly locked in authigenic (?)dolomite. One or two test chambers are filled with yellow-orange clay.

SAMPLE: 189200 : TSC 66719

ROCK NAME: Sandy limestone

HAND SPECIMEN:

This is a fine grained, unconsolidated, friable, cream coloured sand.

THIN SECTION

This sample consists of planktonic fossil tests, minor angular to subrounded quartz and rare leucoxene, microcline and green clay pellets. Typical grainsize is 0.05 to 0.2mm for the silicates, but some fossil fragments are up to 0.5mm long. A few tests are complete. The test fragments form an intact framework sprinkled with relatively sparse detrital silicate.

Alizarin red-S staining shows the fossils to be constructed entirely of calcite. Almost all tests have suffered authigenic recrystallisation with resultant loss of detail and considerable welding together of the tests. Void space is in excess of 15% of the rock volume, however.

There are a few fine dusty opaques <0.005mm in diameter scattered through the calcite and a few <0.02mm sized interstitial grains, but these are rare.

A few tests are stained with yellow to yellow-brown iron oxides and/or organic material, but this is also comparatively rare. A few rare tests are filled with olive-green clay.

APPENDIX VIII

GRAIN SIZE ANALYSIS

GRAIN SIZE ANALYSIS

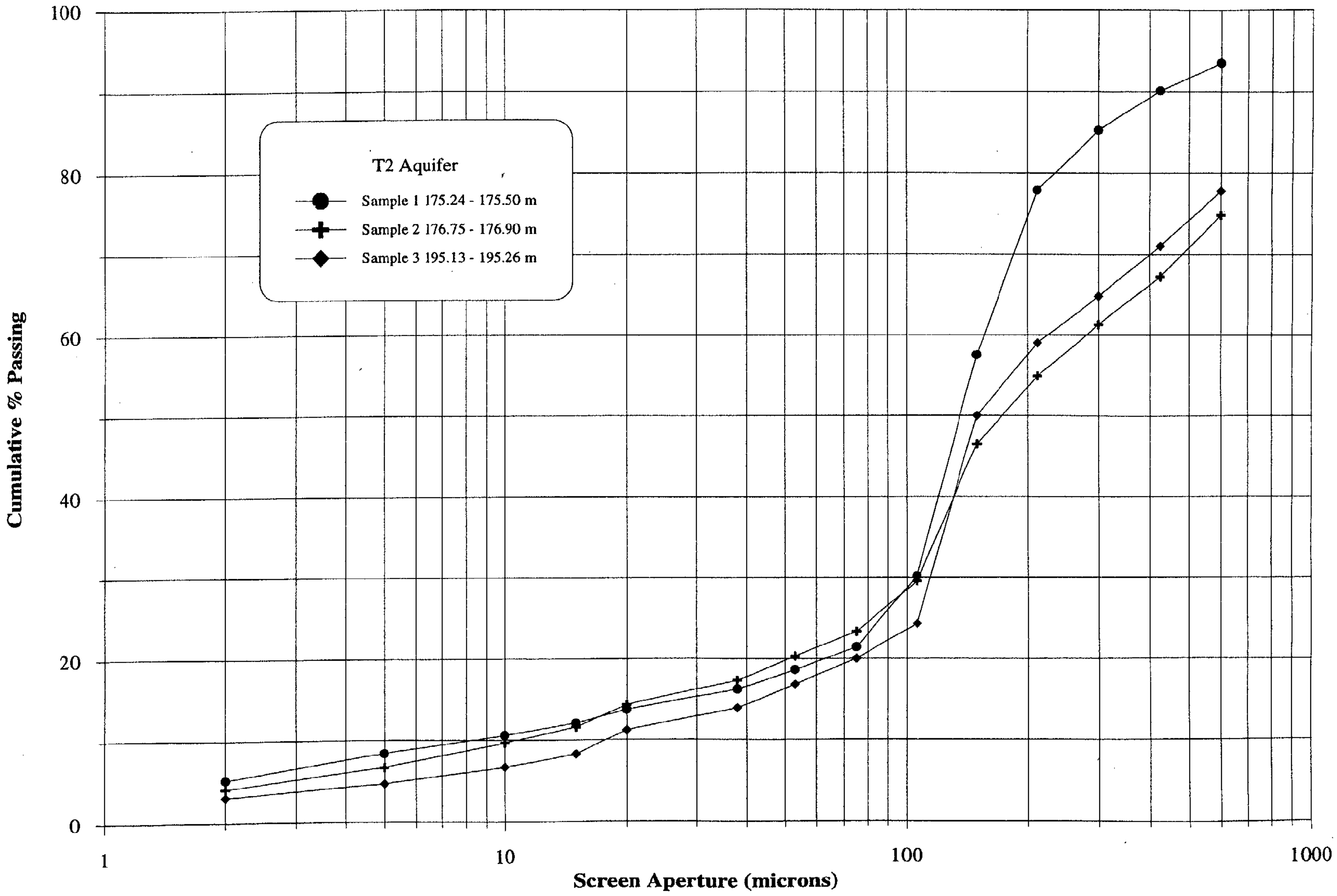
Permit Number: 37834
Unit Number: 6628-17760
Aquifer: T2

Table 10

Screen Aperture (mm)	Sample # 189195 (175.24 - 175.50 m)				Sample # 189196 (176.75 - 176.90 m)				Sample # 189197 (195.13 - 195.26 m)			
	Weight Retained		**Cumulative Weight**		**Weight Retained**		**Cumulative Weight**		**Weight Retained**		**Cumulative Weight**	
	g	**%**	**% Ret.**	**% Pass**	**g**	**%**	**% Ret.**	**% Pass**	**g**	**%**	**% Ret.**	**% Pass**
0.600	28.75	6.5	6.5	93.5	78.22	25.2	25.2	74.8	74.18	22.2	22.2	77.8
0.425	14.69	3.3	9.9	90.1	23.81	7.7	32.8	67.2	22.71	6.8	29.0	71.0
0.300	21.21	4.8	14.7	85.3	18.37	5.9	38.7	61.3	20.4	6.1	35.2	64.8
0.212	32.46	7.4	22.1	77.9	19.67	6.3	45.1	54.9	19.34	5.8	41.0	59.0
0.150	89.79	20.4	42.5	57.5	26.08	8.4	53.5	46.5	30.25	9.1	50.0	50.0
0.106	120.09	27.3	69.8	30.2	53.01	17.1	70.5	29.5	85.66	25.7	75.7	24.3
0.075	38.79	8.8	78.6	21.4	19.22	6.2	76.7	23.3	14.50	4.3	80.0	20.0
0.053	11.89	2.7	81.4	18.7	9.48	3.1	79.7	20.3	10.48	3.1	83.2	16.8
0.038	10.49	2.5	83.8	16.2	9.09	2.9	82.7	17.3	9.84	2.9	86.1	13.9
0.020	10.69	2.4	86.3	13.7	9.45	3.0	85.7	14.3	9.02	2.7	88.8	11.2
0.015	7.03	1.6	87.9	12.1	8.39	2.7	88.4	11.6	9.68	2.9	91.7	8.3
0.010	6.59	1.5	89.4	10.6	5.91	1.9	90.3	9.7	5.34	1.6	93.3	6.7
0.005	9.67	2.2	91.6	8.4	9.32	3.0	93.3	6.7	6.67	2.0	95.3	4.7
0.002	14.07	3.2	94.8	5.2	8.08	2.6	95.9	4.1	5.34	1.6	96.9	3.1
<0.002	22.86	5.2	100.0	0.0	12.74	4.1	100.0	0.0	10.34	3.1	100.0	0.0
Total	439.65	100.0			310.81				333.65			
Wt. Loss	0.00				0.00				0.00			

Note: Sieve sub-size fraction less than 0.020 mm determined by pipette method and examined by plummet balance to determine solids content.

SIZE DISTRIBUTION
T2 Aquifer



GRAIN SIZE ANALYSIS

Permit Number: 37835
Unit Number: 6628-17761
Aquifer: T1(b)

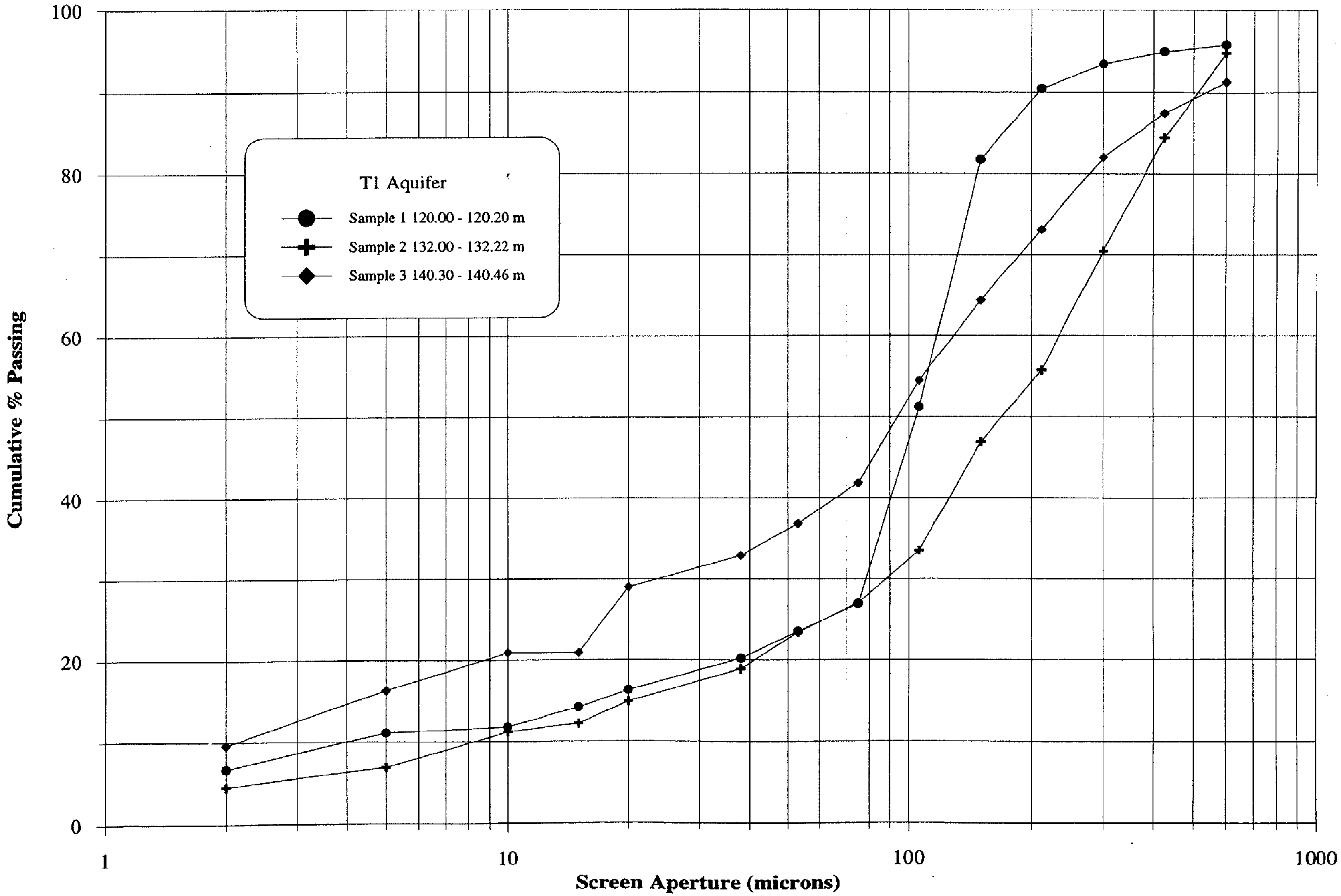
Table 11

Screen Aperture (mm)	Sample # 189198 (120.00 - 120.20 m)				Sample # 189199 (132.00 - 132.22 m)				Sample # 189200 (140.30 - 140.46 m)			
	Weight Retained		Cumulative Weight		Weight Retained		Cumulative Weight		Weight Retained		Cumulative Weight	
	g	%	% Ret.	% Pass	g	%	% Ret.	% Pass	g	%	% Ret.	% Pass
0.600	22.88	4.2	4.2	95.8	31.28	5.2	5.2	94.8	9.3	8.7	8.7	91.3
0.425	5.12	0.9	5.1	94.9	62.12	10.4	15.6	84.4	4.19	3.9	12.6	87.4
0.300	8.09	1.5	6.6	93.4	83.32	13.9	29.6	70.5	5.88	5.5	18.0	82.0
0.212	16.48	3.0	9.6	90.4	87.74	14.7	44.2	55.8	9.51	8.9	26.9	73.1
0.150	47.15	8.6	18.3	81.7	52.95	8.9	53.1	46.9	9.29	8.7	35.6	64.4
0.106	166.81	30.6	48.8	51.2	80.20	13.4	66.5	33.5	10.68	9.9	45.5	54.5
0.075	132.58	24.3	73.1	26.9	39.10	6.5	73.0	27.0	13.6	12.7	58.2	41.8
0.053	18.25	3.3	76.5	23.5	21.36	3.6	76.6	23.4	5.34	5.0	63.2	36.8
0.038	18.35	3.4	79.8	20.2	26.98	4.5	81.1	18.9	4.25	4.0	67.1	32.9
0.020	21.08	3.9	83.7	16.3	24.00	4.0	85.1	14.9	4.12	3.8	71.0	29.0
0.015	11.46	2.1	85.8	14.2	16.15	2.7	87.8	12.2	8.69	8.1	79.0	21.0
0.010	13.10	2.4	88.2	11.8	5.98	1.0	88.8	11.2	0.00	0.0	79.0	21.0
0.005	3.82	0.7	88.9	11.1	25.73	4.3	93.1	6.9	4.94	4.6	83.7	16.3
0.002	24.02	4.4	93.3	6.7	14.36	2.4	95.5	4.5	7.19	6.7	90.3	9.7
<0.002	36.57	6.7	100.0	0.0	26.92	4.5	100.0	0.0	10.3	9.6	99.9	0.1
Total	545.86				598.29				107.34			
Wt. Loss	0.00				0.00				0.11			

Note: Sieve sub-size fraction less than 0.020 mm determined by pipette method and examined by plummet balance to determine solids content.

SIZE DISTRIBUTION

T1 Aquifer



APPENDIX IX

PORE SIZE ANALYSIS

Pore Size Analysis Micromeritics 9305

Permit Number:	37834	Sample Weight (g):	2.5269	Stem Length (cm) 23		Mercury Surface Tension:	485 dynes cm^{-1}
Unit Number:	6628-17760	Max. Head Pressure:	4.45	Stem Diameter (cm) 0.15		Contact Angle:	130 degrees
Aquifer:	T2	Penetrometer Con:	0.01079	Stem Volume (cc) 0.366			
Sample #	1 (Core 2 176.75 m)						

Table 12

Pressure psia	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.5	0.5	360	39.99	0	0	0	0	0	0
0.8	0.7	257	39.83	0.16	0.0017264	0.0017264	0.000683209	0.000683209	0.47
1	1	180	39.63	0.2	0.002158	0.0038844	0.000854011	0.00153722	1.06
1.3	1.5	120	38.71	0.92	0.0099268	0.0138112	0.00392845	0.00546567	3.78
1.7	1.8	100	38.03	0.68	0.0073372	0.0211484	0.002903637	0.008369307	5.79
2	2	90	37.61	0.42	0.0045318	0.0256802	0.001793423	0.01016273	7.03
2.6	2.5	72	36.88	0.73	0.0078767	0.0335569	0.00311714	0.01327987	9.19
3.1	3	60	36.23	0.65	0.0070135	0.0405704	0.002775535	0.016055405	11.11
3.6	3.5	51	35.24	0.99	0.0106821	0.0512525	0.004227354	0.020282759	14.03
4	4	45	34.34	0.9	0.009711	0.0609635	0.003843049	0.024125808	16.69
4.6	4.5	40	33.36	1.88	0.0202852	0.0715377	0.008027702	0.028310459	19.59
5	5	36	32.58	0.78	0.0084162	0.0799539	0.003330642	0.031641101	21.89
5.5	5.5	33	31.78	0.8	0.008632	0.0885859	0.003416043	0.035057145	24.25
6.2	6	30	30.75	1.83	0.0197457	0.0996996	0.007814199	0.039455301	27.3
6.5	6.5	28	29.88	1.9	0.020501	0.1090869	0.008113103	0.043170248	29.87
7	7.2	25	28.69	2.06	0.0222274	0.121927	0.008796312	0.048251613	33.38
8	8	23	27.67	1.02	0.0110058	0.1329328	0.004355455	0.052607068	36.4
10	10	18	25.67	2	0.02158	0.1545128	0.008540108	0.061147176	42.3
12	12	15	24.2	1.47	0.0158613	0.1703741	0.00627698	0.067424156	46.65
14	14	13	22.92	1.28	0.0138112	0.1841853	0.005465669	0.072889825	50.43
17	17	11	21.48	1.44	0.0155376	0.1997229	0.006148878	0.079038704	54.68
20	20	9	20.27	1.21	0.0130559	0.2127788	0.005166766	0.084205469	58.26
23	23	7.83	19.37	0.9	0.009711	0.2224898	0.003843049	0.088048518	60.92

Table 12 Continued

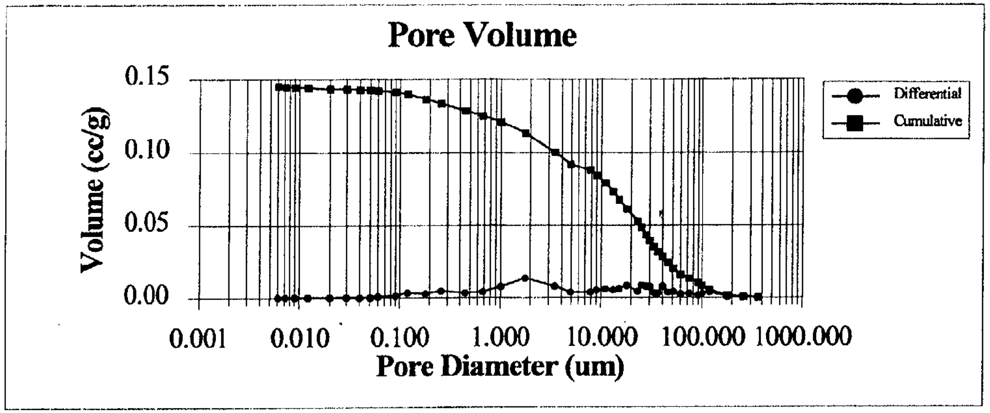
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
35	36.62679	4.91	19.13	0.9	0.009711	0.2322008	0.003843049	0.091891567	63.57
51	52.38409	3.44	17.28	1.85	0.0199615	0.2521623	0.0078996	0.099791167	69.04
100	100.9748	1.78	14.16	3.12	0.0336648	0.2858271	0.013322569	0.113113736	78.26
180	180.7386	1	12.36	1.8	0.019422	0.3052491	0.007686098	0.120799834	83.57
270	270.614	0.67	11.41	0.95	0.0102505	0.3154996	0.004056552	0.124856385	86.38
400	400.5025	0.45	10.56	0.85	0.0091715	0.3246711	0.003629546	0.128485931	88.89
700	700.3569	0.26	9.45	1.11	0.0119769	0.336648	0.00473976	0.133225692	92.17
1000	1000.266	0.18	8.76	0.69	0.0074451	0.3440931	0.002946337	0.136172029	94.21
1500	1500.157	0.12	7.93	0.83	0.0089557	0.3530488	0.003544145	0.139716174	96.66
2000	2000.115	0.09	7.61	0.32	0.0034528	0.3565016	0.001366417	0.141082591	97.61
3000	3000.085	0.06	7.38	0.23	0.0024817	0.3589833	0.000982112	0.142064704	98.29
4000	4000	0.05	7.3	0.08	0.0008632	0.3598465	0.000341604	0.142406308	98.52
5000	5000	0.04	7.25	0.05	0.0005395	0.360386	0.000213503	0.142619811	98.67
7000	7000	0.03	7.17	0.08	0.0008632	0.3612492	0.000341604	0.142961415	98.91
10000	10000	0.02	7.09	0.08	0.0008632	0.3621124	0.000341604	0.14330302	99.14
15000	15000	0.012	6.98	0.11	0.0011869	0.3632993	0.000469706	0.143772726	99.47
20000	20000	0.009	6.89	0.09	0.0009711	0.3642704	0.000384305	0.144157031	99.73
25000	25000	0.0072	6.8	0.09	0.0009711	0.3652415	0.000384305	0.144541336	100
30000	30000	0.006	6.72	0.08	0.0008632	0.3661047	0.000341604	0.14488294	100
					Total PV =	0.14488294	**cc/g**		

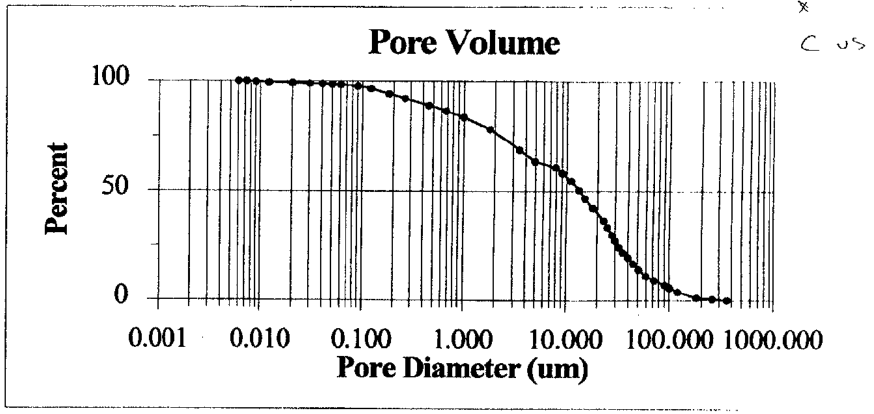
Pore Size Analysis

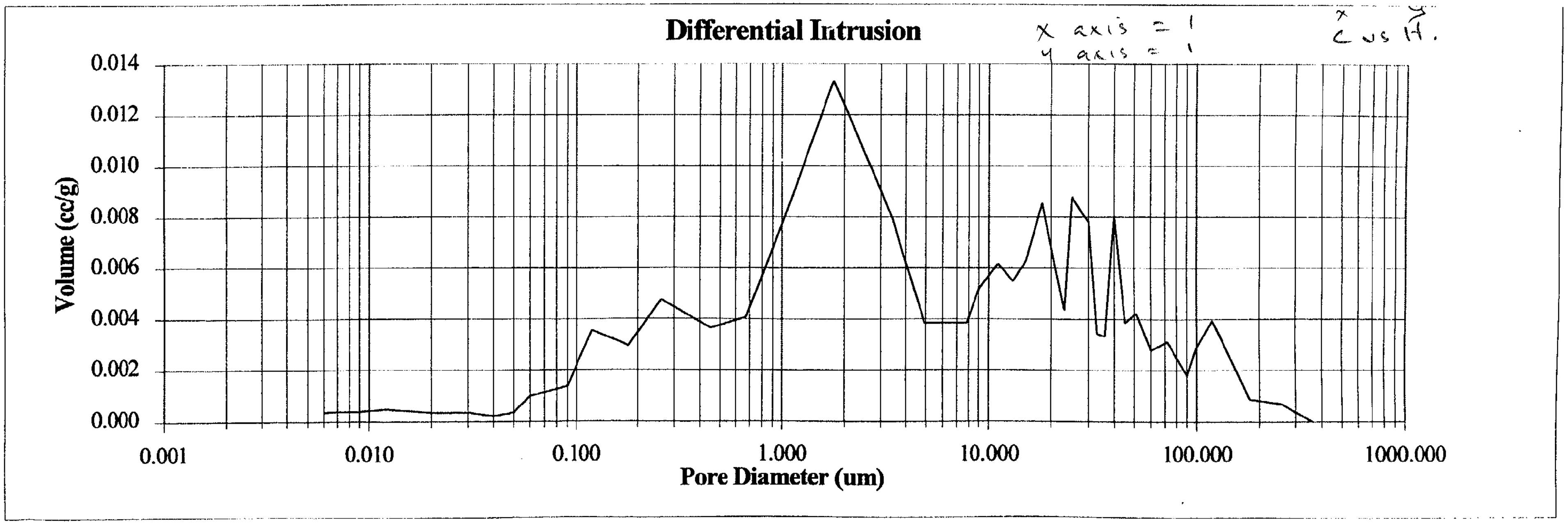
Sample # 1 (Core 2 176.75 m)
T2 Aquifer

y axis = 3
x axis = 3.

curve 4.
x y
C vs D.







x axis = 1
y axis = 1

x y
C vs H.

Pore Size Analysis Micromeritics 9305

Permit Number:	37834	Sample Weight (g):	0.9917	Stem Length (cm) 23		Mercury Surface Tension:	485 dynes cm^{-1}
Unit Number:	6628-17760	Max. Head Pressure:	4.45	Stem Diameter (cm) 0.15		Contact Angle:	130 degrees
Aquifer:	T2	Penetrometer Con:	0.01079	Stem Volume (cc) 0.366			
Sample #	2 (Core 2 177.13 m)						

Table 13

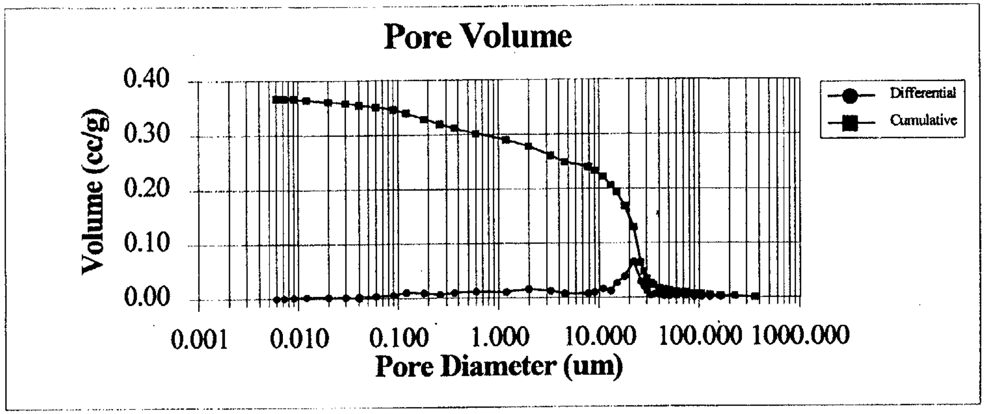
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.5	0.5	360	39.96	0	0	0	0	0	0
0.8	0.8	225	39.8	0.16	0.0017264	0.0017264	0.001740849	0.001740849	0.47
1	1.1	164	39.7	0.1	0.001079	0.0028054	0.001088031	0.00282888	0.77
1.3	1.4	129	39.58	0.12	0.0012948	0.0041002	0.001305637	0.004134516	1.13
1.7	1.7	106	39.46	0.12	0.0012948	0.005395	0.001305637	0.005440153	1.48
2	2	90	39.35	0.11	0.0011869	0.0065819	0.001196834	0.006636987	1.81
2.5	2.5	72	39.17	0.18	0.0019422	0.0085241	0.001958455	0.008595442	2.34
3	3	60	38.99	0.18	0.0019422	0.0104663	0.001958455	0.010553897	2.88
3.5	3.5	51	38.82	0.17	0.0018343	0.0123006	0.001849652	0.012403549	3.38
4	4	45	38.64	0.18	0.0019422	0.0142428	0.001958455	0.014362005	3.91
4.5	4.5	40	38.37	0.45	0.0048555	0.0171561	0.004896138	0.017299687	4.72
5.1	5.1	35	37.88	0.49	0.0052871	0.0224432	0.00533135	0.022631038	6.17
5.5	5.5	33	37.52	0.36	0.0038844	0.0263276	0.00391691	0.026547948	7.24
6	6.1	30	36.74	1.14	0.0123006	0.0347438	0.012403549	0.035034587	9.55
6.5	6.5	28	35.61	1.91	0.0206089	0.0469365	0.020781385	0.047329333	12.9
7	7	26	34.09	2.65	0.0285935	0.0633373	0.028832812	0.063867399	17.41
8.3	8.3	22	28.11	5.98	0.0645242	0.1278615	0.065064233	0.128931633	35.14
10	10.1	18	24.55	3.56	0.0384124	0.1662739	0.038733891	0.167665524	45.7
12.2	12.2	15	22.11	2.44	0.0263276	0.1926015	0.026547948	0.194213472	52.94
14	14	13	21	1.11	0.0119769	0.2045784	0.01207714	0.206290612	56.23
17.1	17.1	11	19.48	1.52	0.0164008	0.2209792	0.016538066	0.222828678	60.74
20	20	9	18.55	0.93	0.0100347	0.2310139	0.010118685	0.232947363	63.49
23	23	7.83	17.81	0.74	0.0079846	0.2389985	0.008051427	0.24099879	65.69

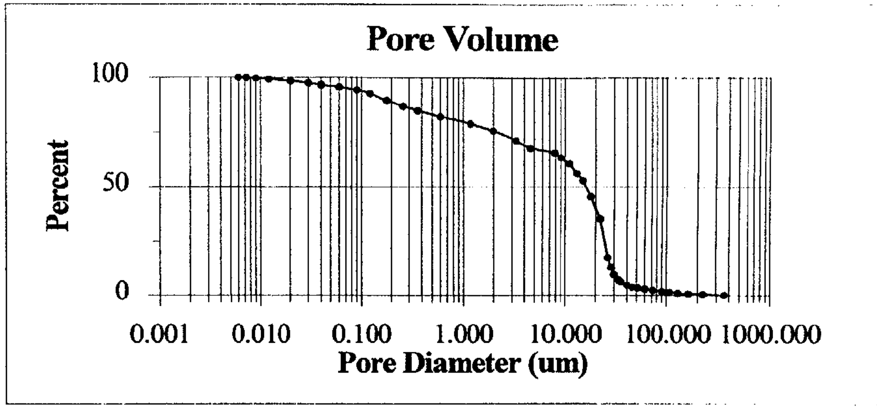
Table 13 Continued

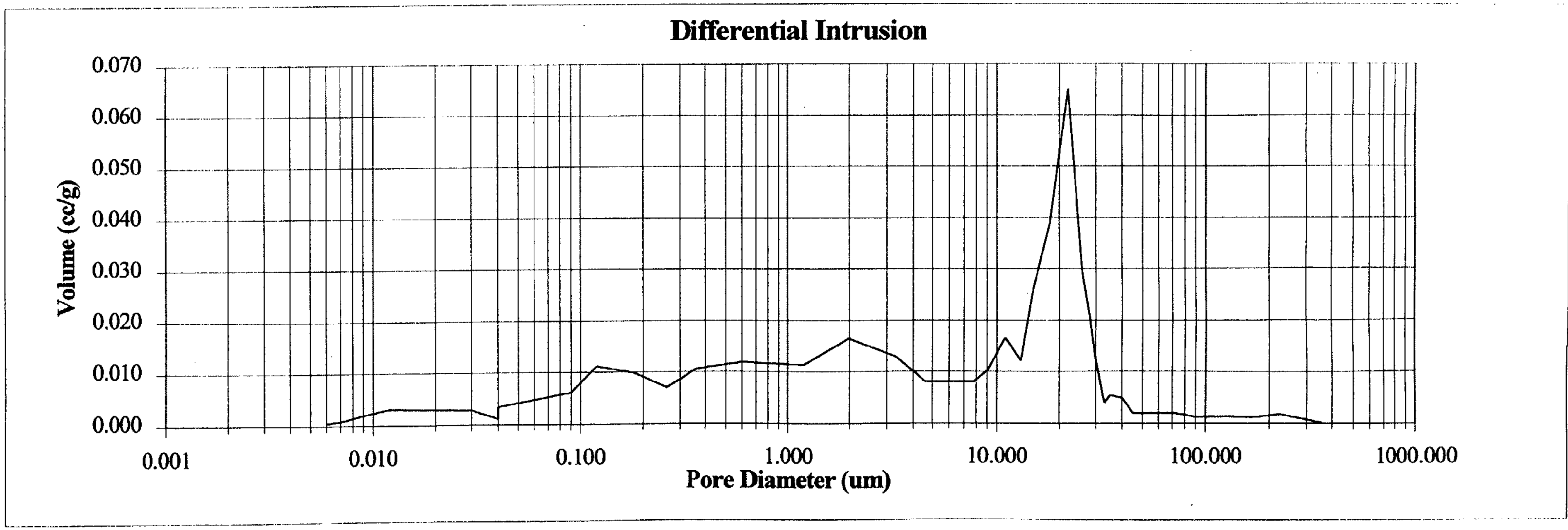
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
38	39.44706	4.56	18.04	0.74	0.0079846	0.2469831	0.008051427	0.249050217	67.88
53	54.29226	3.32	16.86	1.18	0.0127322	0.2597153	0.012838762	0.261888979	71.38
90	91.09416	1.98	15.35	1.51	0.0162929	0.2760082	0.016429263	0.278318241	75.86
150	150.9577	1.19	14.31	1.04	0.0112216	0.2872298	0.011315519	0.28963376	78.94
300	300.8147	0.6	13.22	1.09	0.0117611	0.2989909	0.011859534	0.301493294	82.18
500	500.6875	0.36	12.25	0.97	0.0104663	0.3094572	0.010553897	0.312047192	85.05
700	700.6035	0.26	11.61	0.64	0.0069056	0.3163628	0.006963396	0.319010588	86.95
1000	1000.484	0.18	10.7	0.91	0.0098189	0.3261817	0.009901079	0.328911667	89.65
1500	1500.35	0.12	9.68	1.02	0.0110058	0.3371875	0.011097913	0.34000958	92.67
2000	2000.277	0.09	9.12	0.56	0.0060424	0.3432299	0.006092972	0.346102551	94.34
3000	3000.22	0.06	8.69	0.43	0.0046397	0.3478696	0.004678532	0.350781083	95.61
4300	4300	0.04	8.38	0.31	0.0033449	0.3512145	0.003372895	0.354153978	96.53
5000	5000	0.04	8.28	0.1	0.001079	0.3522935	0.001088031	0.355242009	96.83
7000	7000	0.03	8.02	0.26	0.0028054	0.3550989	0.00282888	0.358070888	97.6
10000	10000	0.02	7.75	0.27	0.0029133	0.3580122	0.002937683	0.361008571	98.4
15000	15000	0.012	7.47	0.28	0.0030212	0.3610334	0.003046486	0.364055057	99.23
20000	20000	0.009	7.29	0.18	0.0019422	0.3629756	0.001958455	0.366013512	99.76
25000	25000	0.0072	7.21	0.08	0.0008632	0.3638388	0.000870425	0.366883937	100
30000	30000	0.006	7.17	0.04	0.0004316	0.3642704	0.000435212	0.367319149	100
					Total PV =	0.367319149	**cc/g**		

Pore Size Analysis

Sample # 2 (Core 2 177.13 m)
T2 Aquifer







Pore Size Analysis Micromeritics 9305

Permit Number: 37834
Unit Number: 6628-17760
Aquifer: T2
Sample # 3 (Core 3 195.50 m)

Sample Weight (g): 1.1847
Max. Head Pressure: 4.45
Penetrometer Con: 0.01079

Stem Length (cm) 23
Stem Diameter (cm) 0.15
Stem Volume (cc) 0.366

Mercury Surface Tension: 485 dynes cm^{-1}
Contact Angle: 130 degrees

Table 14

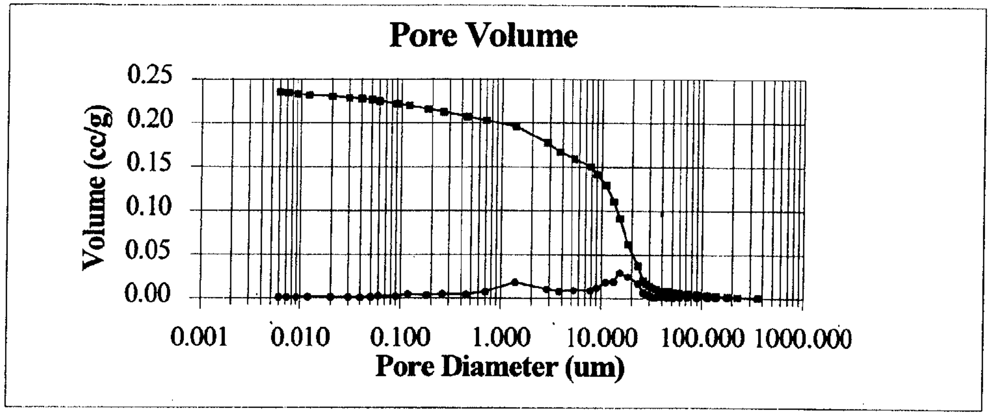
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.5	0.5	360	39.89	0	0	0	0	0	0
0.8	0.8	225	39.79	0.1	0.001079	0.001079	0.000910779	0.000910779	0.39
1	1	180	39.69	0.1	0.001079	0.002158	0.000910779	0.001821558	0.78
1.3	1.3	138	39.6	0.09	0.0009711	0.0031291	0.000819701	0.002641259	1.13
1.6	1.6	113	39.52	0.08	0.0008632	0.0039923	0.000728623	0.003369883	1.44
2	2	90	39.45	0.07	0.0007553	0.0047476	0.000637545	0.004007428	1.71
2.5	2.5	72	39.33	0.12	0.0012948	0.0060424	0.001092935	0.005100363	2.18
3	3	60	39.22	0.11	0.0011869	0.0072293	0.001001857	0.00610222	2.61
3.5	3.5	51	39.13	0.09	0.0009711	0.0082004	0.000819701	0.006921921	2.96
4	4	45	39.02	0.11	0.0011869	0.0093873	0.001001857	0.007923778	3.39
4.5	4.5	40	39.92	0.21	0.0022659	0.0104663	0.001912636	0.008834557	3.78
5.1	5.1	35	38.72	0.2	0.002158	0.0126243	0.001821558	0.010656115	4.55
5.6	5.6	32	38.57	0.15	0.0016185	0.0142428	0.001366169	0.012022284	5.14
6	6	30	38.38	0.34	0.0036686	0.0162929	0.003096649	0.013752764	5.88
6.5	6.5	28	38.07	0.5	0.005395	0.0196378	0.004553896	0.01657618	7.08
7	7	26	37.68	0.7	0.007553	0.0238459	0.006375454	0.020128218	8.6
8	8	23	35.8	1.88	0.0202852	0.0441311	0.017122647	0.037250865	15.92
10	10	18	33.07	2.73	0.0294567	0.0735878	0.024864269	0.062115135	26.55
12	12	15	29.87	3.2	0.034528	0.1081158	0.029144931	0.091260066	39
14	14	13	27.74	2.13	0.0229827	0.1310985	0.019399595	0.110659661	47.29
17	17	11	25.69	2.05	0.0221195	0.153218	0.018670972	0.129330633	55.27
20	20	9	24.37	1.32	0.0142428	0.1674608	0.012022284	0.141352917	60.41
23	23	7.83	23.39	0.98	0.0105742	0.178035	0.008925635	0.150278552	64.23

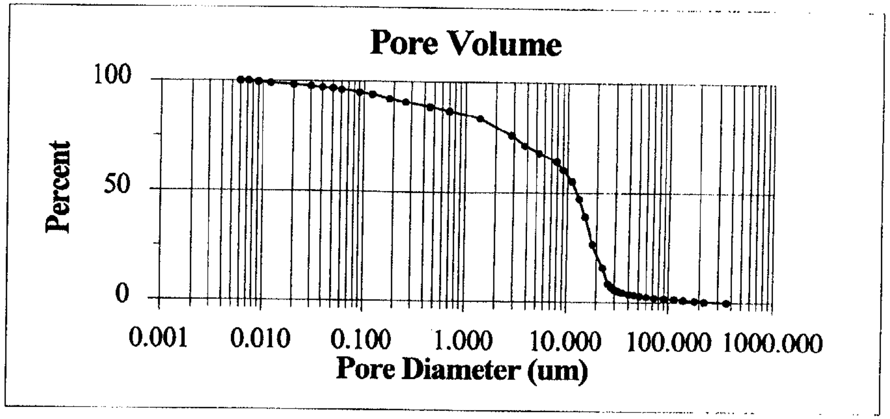
Table 14 Continued

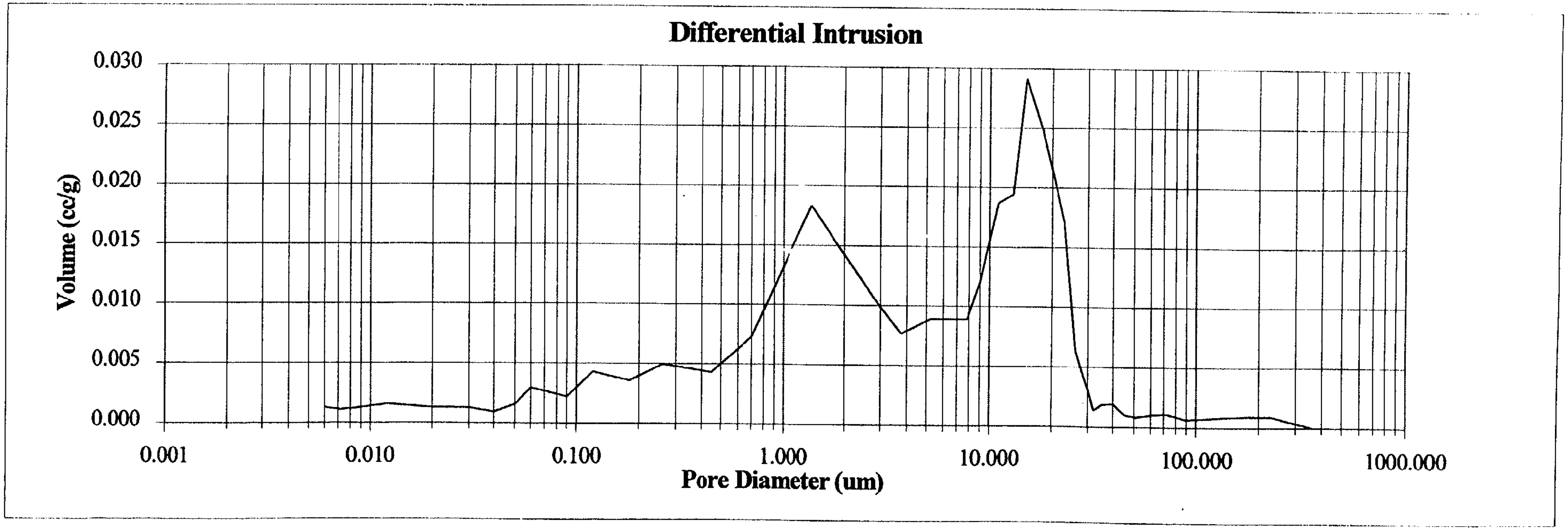
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
32	34.1568	5.27	23	0.98	0.0105742	0.1886092	0.008925635	0.159204187	68.04
46	48.0466	3.75	22.16	0.84	0.0090636	0.1976728	0.007650544	0.166854731	71.31
62	63.89573	2.82	21.01	1.15	0.0124085	0.2100813	0.01047396	0.177328691	75.79
130	131.632	1.37	19	2.01	0.0216879	0.2317692	0.01830666	0.195635351	83.61
255	256.5271	0.7	18.2	0.8	0.008632	0.2404012	0.007286233	0.202921584	86.73
400	401.4654	0.45	17.73	0.47	0.0050713	0.2454725	0.004280662	0.207202246	88.56
700	701.3946	0.26	17.19	0.54	0.0058266	0.2512991	0.004918207	0.212120453	90.66
1000	1001.343	0.18	16.8	0.39	0.0042081	0.2555072	0.003552038	0.215672491	92.18
1560	1561.282	0.12	16.33	0.47	0.0050713	0.2605785	0.004280662	0.219953153	94.01
2050	2051.25	0.09	16.09	0.24	0.0025896	0.2631681	0.00218587	0.222139023	94.94
3100	3101.208	0.06	15.77	0.32	0.0034528	0.2666209	0.002914493	0.225053516	96.19
4000	4000	0.05	15.6	0.17	0.0018343	0.2684552	0.001548324	0.22660184	96.85
5000	5000	0.04	15.5	0.1	0.001079	0.2695342	0.000910779	0.227512619	97.24
7000	7000	0.03	15.36	0.14	0.0015106	0.2710448	0.001275091	0.22878771	97.78
10000	10000	0.02	15.22	0.14	0.0015106	0.2725554	0.001275091	0.230062801	98.33
15000	15000	0.012	15.05	0.17	0.0018343	0.2743897	0.001548324	0.231611125	98.99
20000	20000	0.009	14.91	0.14	0.0015106	0.2759003	0.001275091	0.232886216	99.53
25000	25000	0.0072	14.79	0.12	0.0012948	0.2771951	0.001092935	0.233979151	100
30000	30000	0.006	14.65	0.14	0.0015106	0.2787057	0.001275091	0.235254242	100
					Total PV =	0.235254242	**cc/g**		

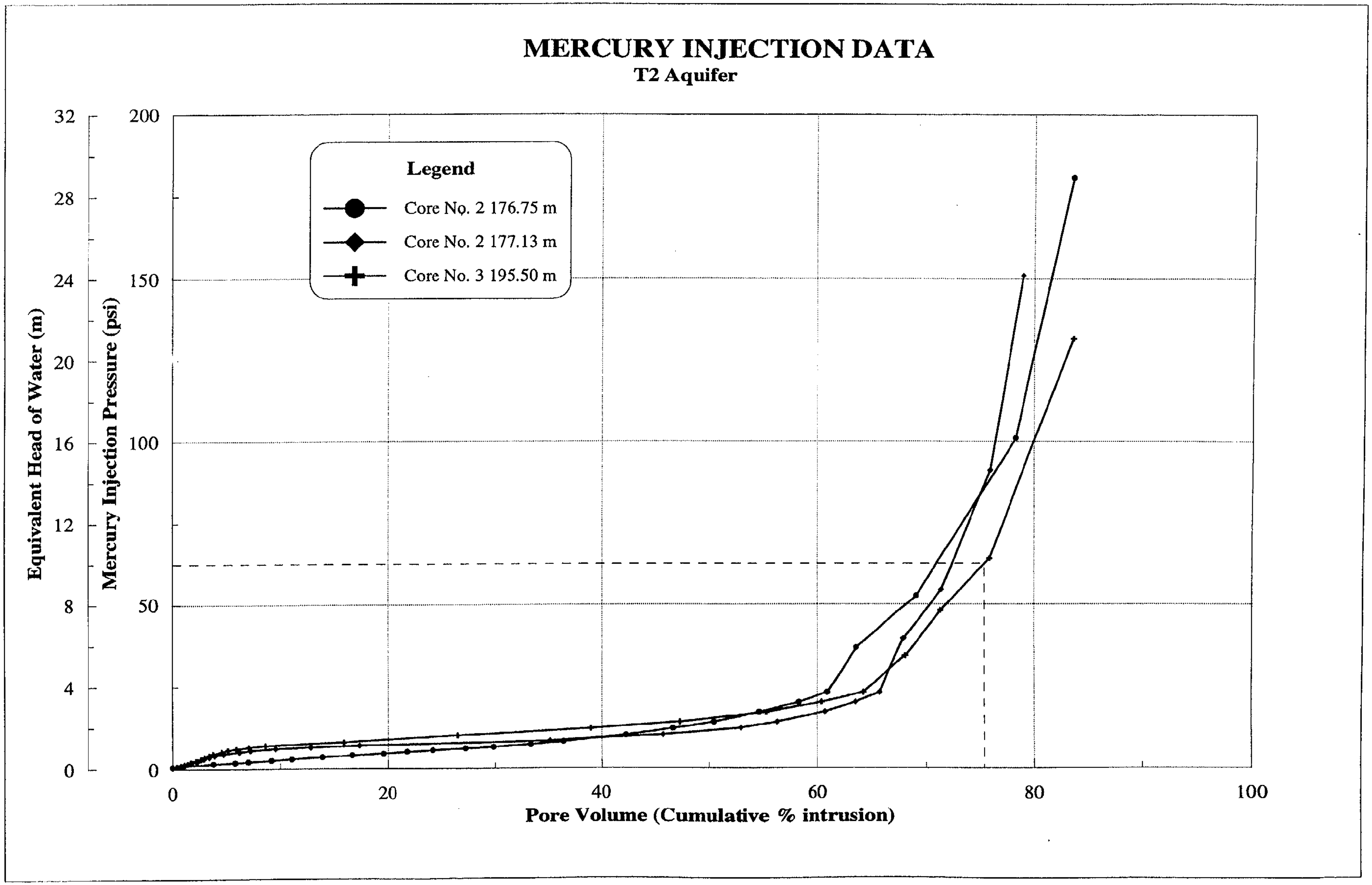
Pore Size Analysis

Sample # 3 (Core 3 195.50 m)
T2 Aquifer








MERCURY INJECTION DATA
T2 Aquifer
Legend
Core No. 2 176.75 m
Core No. 2 177.13 m
Core No. 3 195.50 m
Equivalent Head of Water (m)
Mercury Injection Pressure (psi)
Pore Volume (Cumulative % intrusion)
0
4
8
12
16
20
24
28
32
0
50
100
150
200
20
40
60
80
100

Pore Size Analysis Micromeritics 9305

Permit Number:	37835	Sample Weight (g):	2.8107	Stem Length (cm)	23	Mercury Surface Tension:	485 dynes cm^{-1}
Unit Number:	6628-17761	Max. Head Pressure:	4.45	Stem Diameter (cm)	0.15	Contact Angle:	130 degrees
Aquifer:	T1(b)	Penetrometer Con:	0.01079	Stem Volume (cc)	0.366		
Sample #	4 (Core 1 120.90 m)						

Table 15

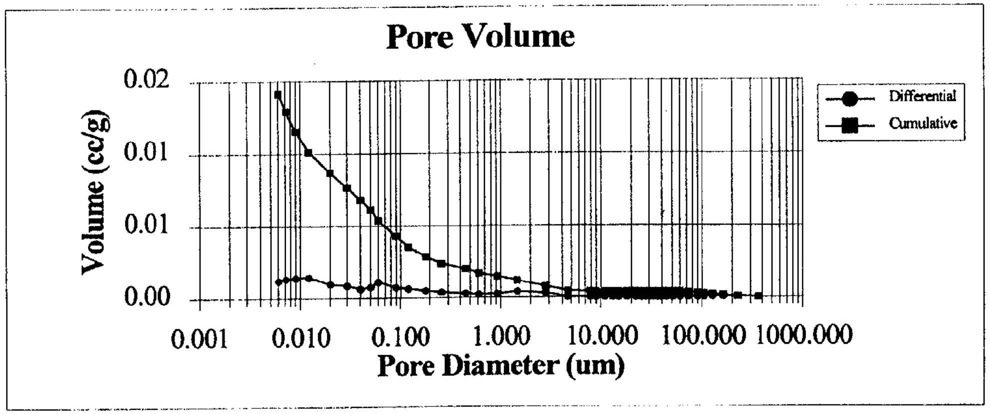
Pressure (psia)	Corrected Pressure	Pore Dia µm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.5	0.5	360	39.7	0	0	0	0	0	0
0.8	0.8	225	39.68	0.02	0.0002158	0.0002158	0.000076778	0.000076778	0.6
1	1.1	164	39.66	0.02	0.0002158	0.0004316	0.000076778	0.000153556	1.19
1.4	1.4	129	39.64	0.02	0.0002158	0.0006474	0.000076778	0.000230334	1.79
1.7	1.7	106	39.63	0.01	0.0001079	0.0007553	0.000038389	0.000268723	2.08
2	2	90	39.62	0.01	0.0001079	0.0008632	0.000038389	0.000307112	2.38
2.5	2.5	72	39.61	0.01	0.0001079	0.0009711	0.000038389	0.000345501	2.68
3	3	60	39.6	0.01	0.0001079	0.001079	0.000038389	0.00038389	2.98
3.6	3.5	51	39.6	0	0	0.001079	0	0.00038389	2.98
4.1	4.1	44	39.6	0	0	0.001079	0	0.00038389	2.98
4.6	4.6	39	39.6	0	0	0.001079	0	0.00038389	2.98
5	5	36	39.6	0	0	0.001079	0	0.00038389	2.98
5.5	5.5	33	39.6	0	0	0.001079	0	0.00038389	2.98
6	6.1	30	39.6	0	0	0.001079	0	0.00038389	2.98
6.5	6.5	28	39.6	0	0	0.001079	0	0.00038389	2.98
7.1	7.1	25	39.6	0	0	0.001079	0	0.00038389	2.98
8.1	8.1	22	39.6	0	0	0.001079	0	0.00038389	2.98
10	10.1	18	39.6	0	0	0.001079	0	0.00038389	2.98
12	12	15	39.6	0	0	0.001079	0	0.00038389	2.98
14	14	13	39.6	0	0	0.001079	0	0.00038389	2.98
17	17	11	39.6	0	0	0.001079	0	0.00038389	2.98
20	20	9	39.6	0	0	0.001079	0	0.00038389	2.98
23	23	7.83	39.59	0.01	0.0001079	0.0011869	0.000038389	0.000422279	3.27

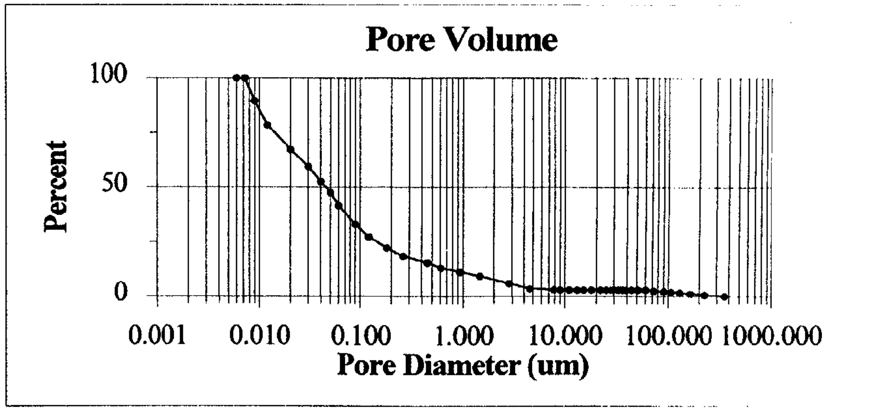
Table 15 Continued

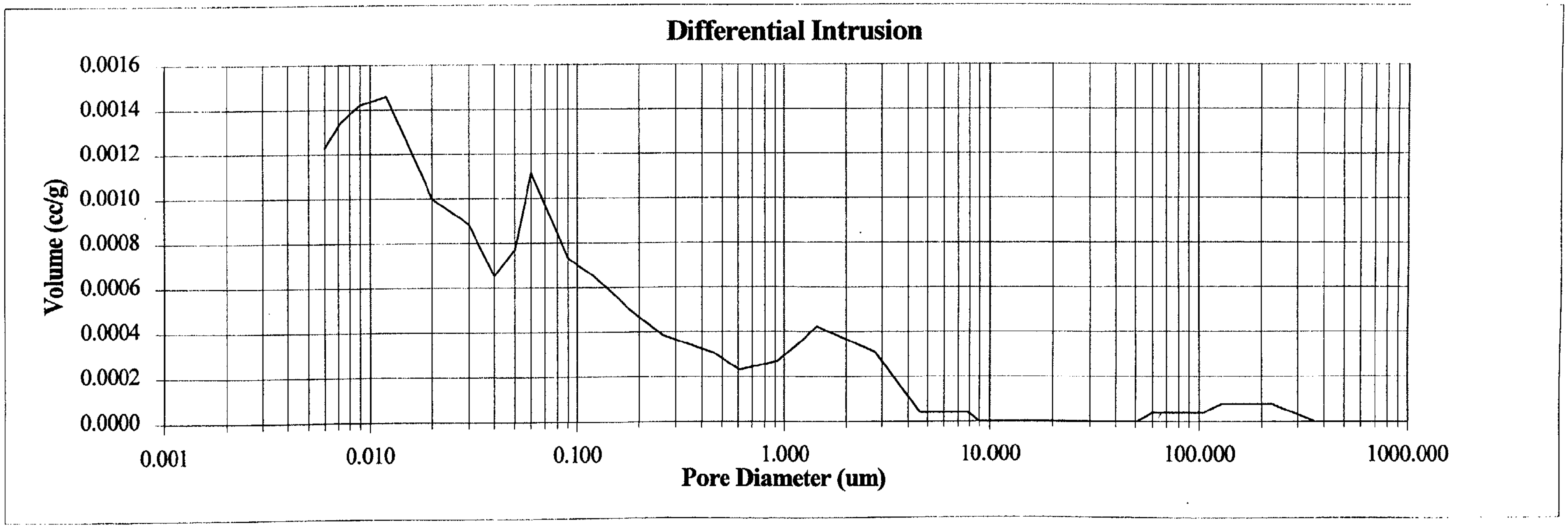
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
35	39.43426	4.56	40.55	0.01	0.0001079	0.0012948	0.000038389	0.000460668	3.57
60	64.42376	2.79	40.47	0.08	0.0008632	0.002158	0.000307112	0.00076778	5.95
120	124.4093	1.45	40.36	0.11	0.0011869	0.0033449	0.000422279	0.001190059	9.23
190	194.4001	0.93	40.29	0.07	0.0007553	0.0041002	0.000268723	0.001458783	11.31
290	294.3923	0.61	40.23	0.06	0.0006474	0.0047476	0.000230334	0.001689117	13.1
400	404.3818	0.45	40.15	0.08	0.0008632	0.0056108	0.000307112	0.001996229	15.48
700	704.3687	0.26	40.05	0.1	0.001079	0.0066898	0.00038389	0.002380119	18.45
1000	1004.352	0.18	39.92	0.13	0.0014027	0.0080925	0.000499057	0.002879176	22.32
1500	1504.329	0.12	39.75	0.17	0.0018343	0.0099268	0.000652613	0.003531789	27.38
2000	2004.304	0.09	39.56	0.19	0.0020501	0.0119769	0.000729391	0.00426118	33.04
3000	3004.266	0.06	39.27	0.29	0.0031291	0.015106	0.001113281	0.005374462	41.67
4000	4000	0.05	39.07	0.2	0.002158	0.017264	0.00076778	0.006142242	47.62
5000	5000	0.04	38.9	0.17	0.0018343	0.0190983	0.000652613	0.006794855	52.68
7000	7000	0.03	38.67	0.23	0.0024817	0.02158	0.000882947	0.007677803	59.52
10000	10000	0.02	38.41	0.26	0.0028054	0.0243854	0.000998114	0.008675917	67.26
15000	15000	0.012	38.03	0.38	0.0041002	0.0284856	0.001458783	0.0101347	78.57
20000	20000	0.009	37.66	0.37	0.0039923	0.0324779	0.001420393	0.011555093	89.58
25000	25000	0.0072	37.31	0.35	0.0037765	0.0362544	0.001343615	0.012898709	100
30000	30000	0.006	36.99	0.32	0.0034528	0.0397072	0.001228448	0.014127157	100
					Total PV =	0.014127157	**cc/g**		

Pore Size Analysis

Sample # 4 (Core 1 120.90 m)
T1(b) Aquifer







Pore Size Analysis Micromeritics 9305

Permit Number:	37835	Sample Weight (g):	0.9686	Stem Length (cm)	23	Mercury Surface Tension:	485 dynes cm^{-1}
Unit Number:	6628-17761	Max. Head Pressure:	4.45	Stem Diameter (cm)	0.15	Contact Angle:	130 degrees
Aquifer:	T1(b)	Penetrometer Con:	0.01079	Stem Volume (cc)	0.366		
Sample #	5 (Core 2 132.00 m)						

Table 16

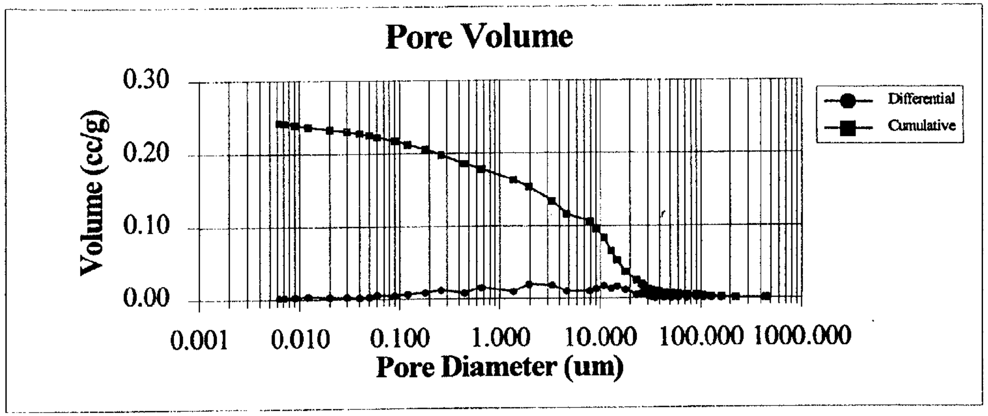
Pressure (psia)	Corrected Pressure	Pore Dia µm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.4	0.4	450	39.81	0	0	0	0	0	0
0.8	0.8	225	39.78	0.03	0.0003237	0.0003237	0.000334194	0.000334194	0.14
1.1	1.1	164	39.7	0.08	0.0008632	0.0011869	0.000891183	0.001225377	0.51
1.4	1.4	129	39.62	0.08	0.0008632	0.0020501	0.000891183	0.00211656	0.88
1.7	1.7	106	39.54	0.08	0.0008632	0.0029133	0.000891183	0.003007743	1.25
2	2	90	39.45	0.09	0.0009711	0.0038844	0.001002581	0.004010324	1.66
2.5	2.5	72	39.38	0.07	0.0007553	0.0046397	0.000779785	0.004790109	1.98
3	3	60	39.28	0.1	0.001079	0.0057187	0.001113979	0.005904088	2.44
3.5	3.5	51	39.2	0.08	0.0008632	0.0065819	0.000891183	0.006795272	2.81
4	4.1	44	39.11	0.09	0.0009711	0.007553	0.001002581	0.007797853	3.23
4.6	4.6	39	38.97	0.23	0.0024817	0.0090636	0.002562152	0.009357423	3.87
5	5	36	38.9	0.07	0.0007553	0.0098189	0.000779785	0.010137208	4.2
5.5	5.5	33	38.77	0.13	0.0014027	0.0112216	0.001448173	0.011585381	4.8
6	6.1	30	38.61	0.29	0.0031291	0.012948	0.003230539	0.013367747	5.54
6.6	6.6	27	38.28	0.49	0.0052871	0.0165087	0.005458497	0.017043878	7.06
7	7	26	38.04	0.57	0.0061503	0.0190983	0.00634968	0.019717427	8.16
8	8	23	37.64	0.4	0.004316	0.0234143	0.004455916	0.024173343	10.01
10	10.1	18	36.58	1.06	0.0114374	0.0348517	0.011808177	0.03598152	14.9
12	12	15	35.11	1.47	0.0158613	0.050713	0.01637549	0.05235701	21.68
14	14	13	33.92	1.19	0.0128401	0.0635531	0.013256349	0.065613359	27.17
17	17	11	32.35	1.57	0.0169403	0.0804934	0.017489469	0.083102829	34.41
20	20	9	31.18	1.17	0.0126243	0.0931177	0.013033554	0.096136383	39.81
23	23	7.83	30.28	0.9	0.009711	0.1028287	0.01002581	0.106162193	43.96

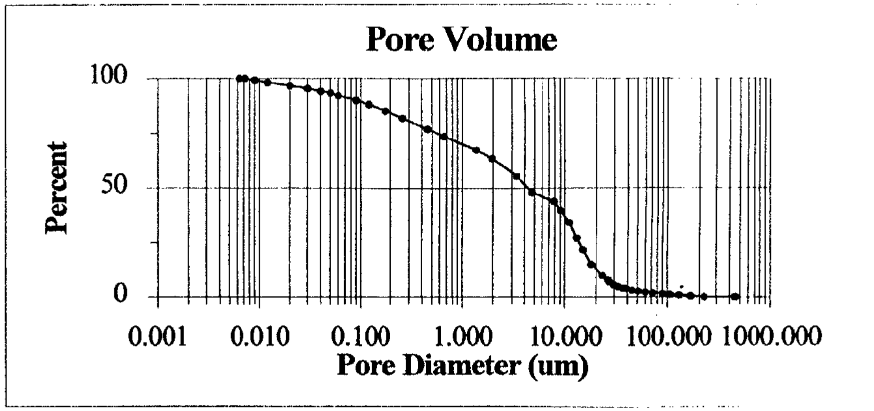
Table 16 Continued

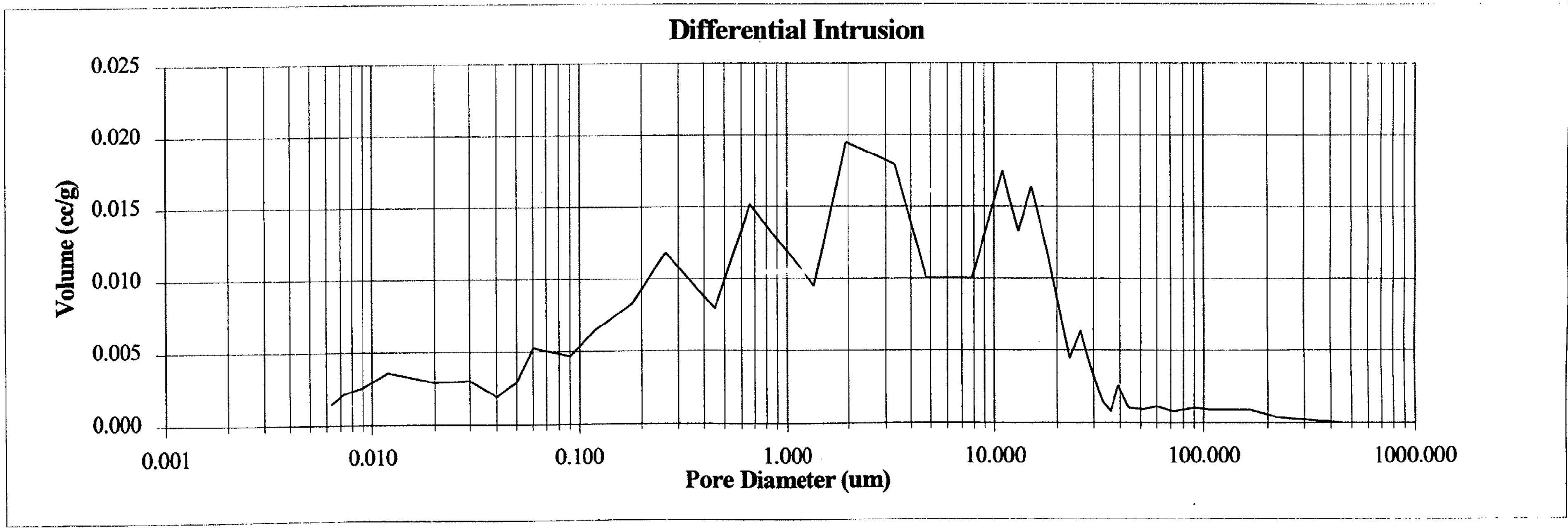
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
35	38.08169	4.73	29.73	0.9	0.009711	0.1125397	0.01002581	0.116188003	48.11
51	53.87047	3.34	28.12	1.61	0.0173719	0.1299116	0.017935061	0.134123064	55.54
90	92.64089	1.94	26.37	1.75	0.0188825	0.1487941	0.019494631	0.153617695	63.61
130	132.5294	1.36	25.52	0.85	0.0091715	0.1579656	0.009468821	0.163086516	67.53
270	272.351	0.66	24.16	1.36	0.0146744	0.17264	0.015150114	0.17823663	73.8
400	402.2578	0.45	23.45	0.71	0.0076609	0.1803009	0.00790925	0.18614588	77.08
700	702.1188	0.26	22.39	1.06	0.0114374	0.1917383	0.011808177	0.197954057	81.96
1000	1002.022	0.18	21.65	0.74	0.0079846	0.1997229	0.008243444	0.206197501	85.38
1500	1501.946	0.12	21.07	0.58	0.0062582	0.2059811	0.006461078	0.212658579	88.05
2000	2001.89	0.09	20.65	0.42	0.0045318	0.2105129	0.004678712	0.217337291	89.99
3000	3001.829	0.06	20.18	0.47	0.0050713	0.2155842	0.005235701	0.222572992	92.16
4000	4000	0.05	19.92	0.26	0.0028054	0.2183896	0.002896345	0.225469337	93.36
5000	5000	0.04	19.75	0.17	0.0018343	0.2202239	0.001893764	0.227363101	94.14
7000	7000	0.03	19.48	0.27	0.0029133	0.2231372	0.003007743	0.230370844	95.39
10000	10000	0.02	19.22	0.26	0.0028054	0.2259426	0.002896345	0.233267189	96.59
15000	15000	0.012	18.9	0.32	0.0034528	0.2293954	0.003564733	0.236831922	98.06
20000	20000	0.009	18.67	0.23	0.0024817	0.2318771	0.002562152	0.239394074	99.12
25000	25000	0.0072	18.48	0.19	0.0020501	0.2339272	0.00211656	0.241510634	100
28500	28500	0.00631579	18.35	0.13	0.0014027	0.2353299	0.001448173	0.242958807	100
					Total PV =	0.242958807	**cc/g**		

Pore Size Analysis

Sample # 5 (Core 2 132.00 m)
T1(b) Aquifer







Pore Size Analysis Micromeritics 9305

Permit Number:	37835	Sample Weight (g):	0.6664	Stem Length (cm)	23	Mercury Surface Tension:	485 dynes cm^{-1}
Unit Number:	6628-17761	Max. Head Pressure:	4.45	Stem Diameter (cm)	0.15	Contact Angle:	130 degrees
Aquifer:	T1(b)	Penetrometer Con:	0.01079	Stem Volume (cc)	0.366		
Sample #	4 (Core 3 140.46 m)						

Table 17

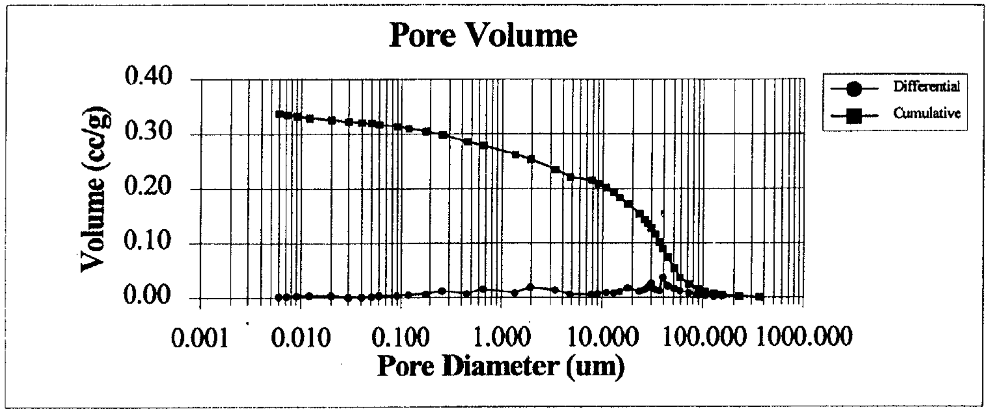
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
0.5	0.5	360	39.31	0	0	0	0	0	0
0.8	0.8	225	39.19	0.12	0.0012948	0.0012948	0.001942977	0.001942977	0.58
1	1.1	154	39	0.19	0.0020501	0.0033449	0.003076381	0.005019358	1.5
1.3	1.4	129	38.83	0.17	0.0018343	0.0051792	0.002752551	0.007771909	2.32
1.7	1.7	106	38.61	0.22	0.0023738	0.007553	0.003562125	0.011334034	3.38
2	2	90	38.36	0.25	0.0026975	0.0102505	0.004047869	0.015381903	4.59
2.6	2.5	72	37.83	0.53	0.0057187	0.0159692	0.008581483	0.023963386	7.15
3.1	3.1	58	37.07	0.76	0.0082004	0.0241696	0.012305522	0.036268908	10.82
3.6	3.5	51	36.07	1	0.01079	0.0349596	0.016191477	0.052460384	15.65
4	4.1	44	34.75	1.32	0.0142428	0.0492024	0.021372749	0.073833133	22.03
4.6	4.6	39	33.79	2.28	0.0246012	0.0595608	0.036916567	0.089376951	26.67
5	5	36	33	0.79	0.0085241	0.0680849	0.012791267	0.102168217	30.48
5.5	5.5	33	32.1	0.9	0.009711	0.0777959	0.014572329	0.116740546	34.83
6.2	6.1	30	31.43	1.57	0.0169403	0.0850252	0.025420618	0.127588836	38.07
6.5	6.5	28	30.94	1.16	0.0125164	0.0903123	0.018782113	0.135522659	40.43
7	7	26	30.52	0.91	0.0098189	0.0948441	0.014734244	0.142323079	42.46
8	8	23	29.81	0.71	0.0076609	0.102505	0.011495948	0.153819027	45.89
10	10.1	18	28.69	1.12	0.0120848	0.1145898	0.018134454	0.171953481	51.3
12	12	15	28.01	0.68	0.0073372	0.121927	0.011010204	0.182963685	54.59
14	14	13	27.45	0.56	0.0060424	0.1279694	0.009067227	0.192030912	57.29
17	17	11	26.86	0.59	0.0063661	0.1343355	0.009552971	0.201583883	60.14
20	20	9	26.39	0.47	0.0050713	0.1394068	0.007609994	0.209193877	62.42
23	23	7.83	26.03	0.36	0.0038844	0.1432912	0.005828932	0.215022809	64.15

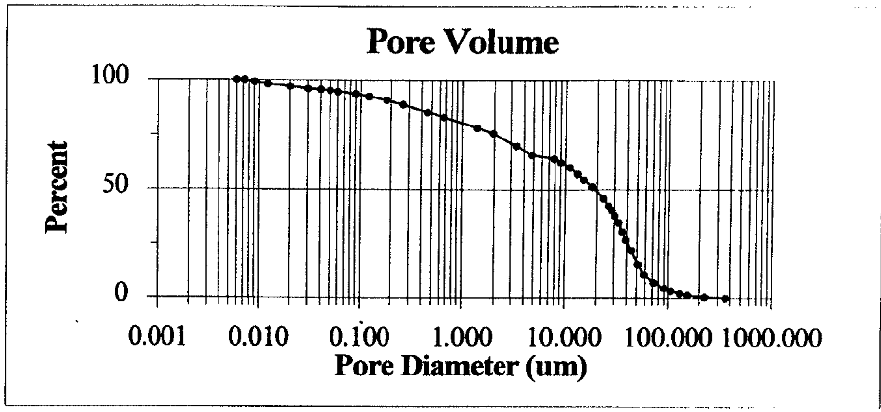
Table 17 Continued

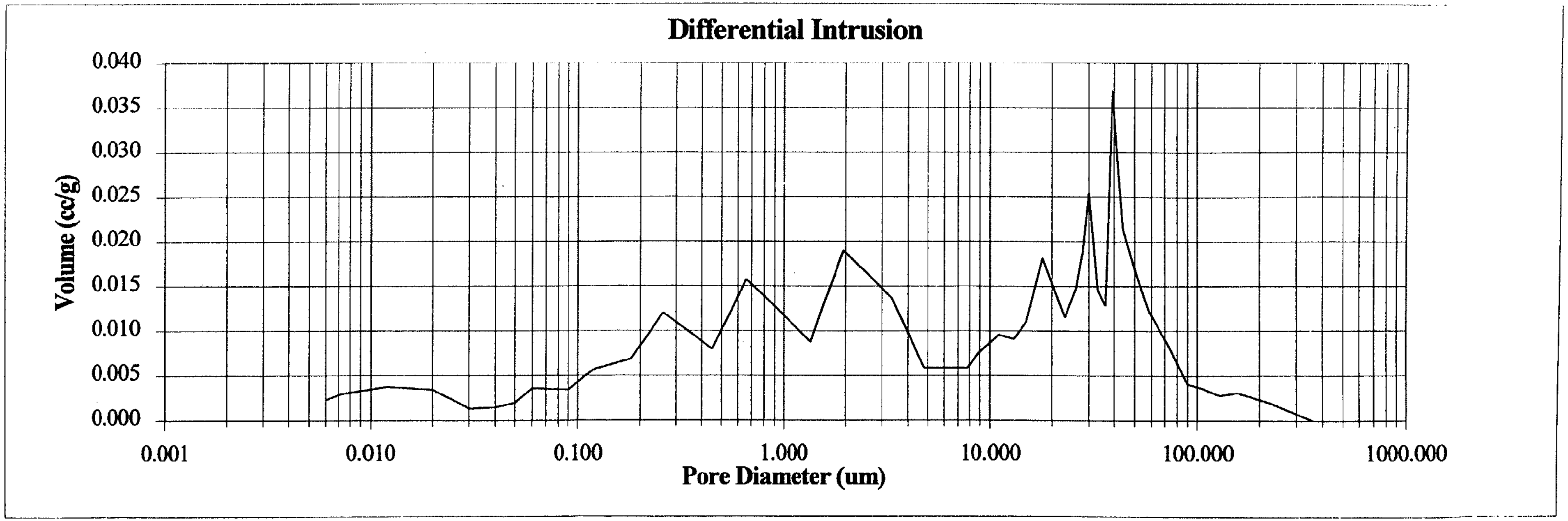
Pressure (psia)	Corrected Pressure	Pore Dia μm	Intrusion Reading	Differential Intrusion	Diferential Pore Vol. cc	Cumulative Pore Vol. cc	Differential Pore Vol. cc/g	Cumulative Pore Vol. cc/g	Cum Percent Pore Vol.
35	37.66057	4.78	27.34	0.36	0.0038844	0.1471756	0.005828932	0.220851741	65.89
51	53.55037	3.36	26.5	0.84	0.0090636	0.1562392	0.01360084	0.234452581	69.95
90	92.39688	1.95	25.33	1.17	0.0126243	0.1688635	0.018944028	0.253396609	75.6
130	132.326	1.36	24.79	0.54	0.0058266	0.1746901	0.008743397	0.262140006	78.21
270	272.1988	0.66	23.82	0.97	0.0104663	0.1851564	0.015705732	0.277845738	82.9
400	402.1345	0.45	23.33	0.49	0.0052871	0.1984281	0.007933824	0.285779562	85.27
700	702.0374	0.26	22.59	0.74	0.0079846	0.2029599	0.011981693	0.297761255	88.84
1000	1001.982	0.18	22.17	0.42	0.0045318	0.2067364	0.00680042	0.304561675	90.87
1500	1501.936	0.12	21.82	0.35	0.0037765	0.2090023	0.005667017	0.310228691	92.56
2000	2001.909	0.09	21.61	0.21	0.0022659	0.2113761	0.00340021	0.313628902	93.57
3000	3001.88	0.06	21.39	0.22	0.0023738	0.2126709	0.003562125	0.317191027	94.64
4000	4000	0.05	21.27	0.12	0.0012948	0.213642	0.001942977	0.319134004	95.22
5000	5000	0.04	21.18	0.09	0.0009711	0.2145052	0.001457233	0.320591237	95.65
7000	7000	0.03	21.1	0.08	0.0008632	0.2167711	0.001295318	0.321886555	96.04
10000	10000	0.02	20.89	0.21	0.0022659	0.2192528	0.00340021	0.325286765	97.05
15000	15000	0.012	20.66	0.23	0.0024817	0.2214108	0.00372404	0.329010805	98.16
20000	20000	0.009	20.46	0.2	0.002158	0.223353	0.003238295	0.3322491	99.13
25000	25000	0.0072	20.28	0.18	0.0019422	0.223353	0.002914466	0.335163565	100
30000	30000	0.006	20.14	0.14	0.0015106	0.2248636	0.002266807	0.337430372	100
					Total PV =	0.337430372	**cc/g**		

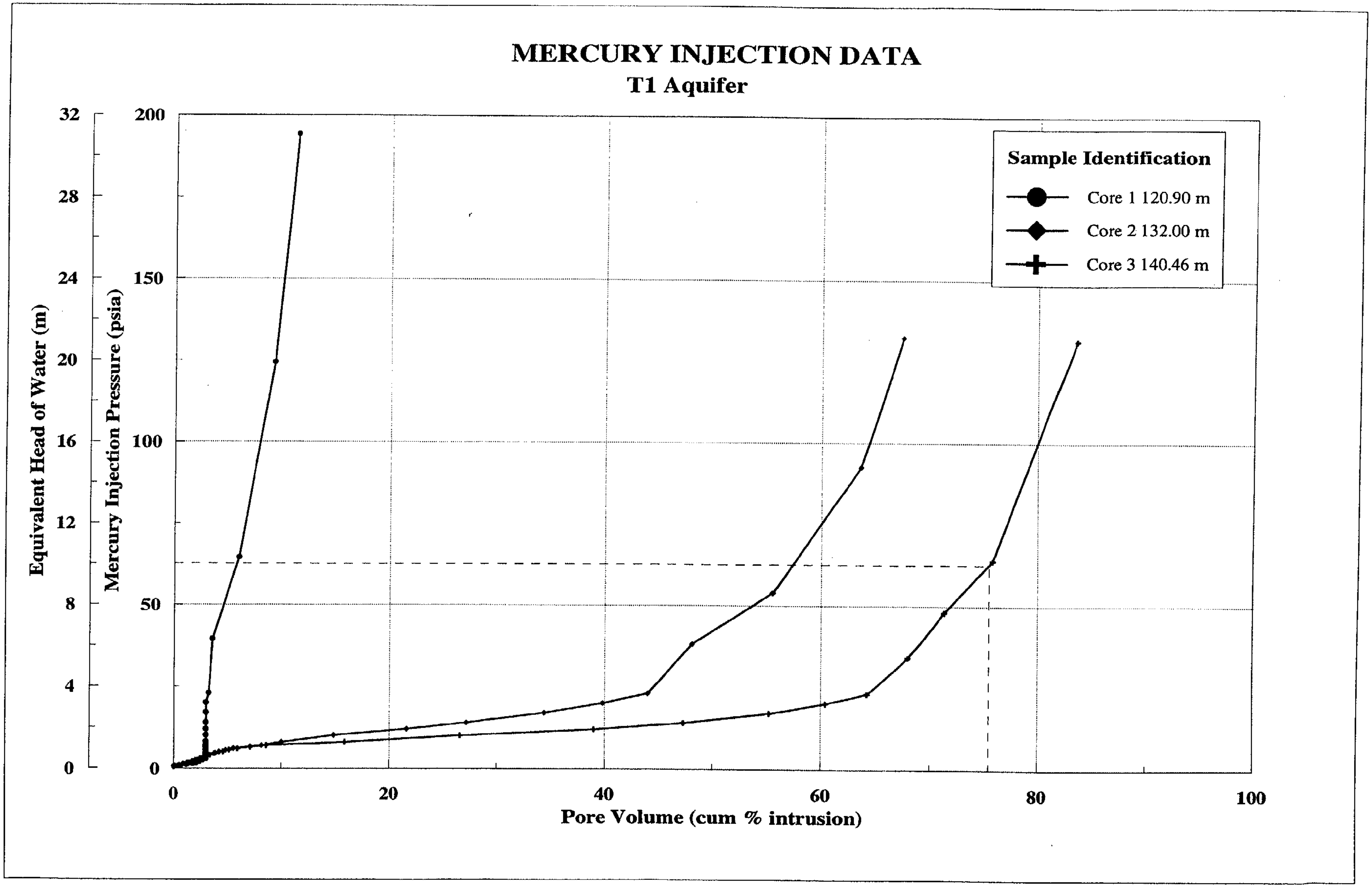
Pore Size Analysis

Sample # 6 (Core 3 140.46 m)
T1(b) Aquifer








MERCURY INJECTION DATA
T1 Aquifer
Sample Identification
Core 1 120.90 m
Core 2 132.00 m
Core 3 140.46 m
Equivalent Head of Water (m)
Mercury Injection Pressure (psia)
Pore Volume (cum % intrusion)
0
4
8
12
16
20
24
28
32
50
100
150
200
20
40
60
80
100