Clare Valley Groundwater Resources
Progress Report 2
Drilling Phase II

REPORT BOOK 98/00014

by

D Morton and A Love

PRIMARY INDUSTRIES AND RESOURCES SA

Clare Valley Groundwater Resources Progress Report 2 Drilling Phase II

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Groundwater

1998 **DME 97/621**

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PRIMARY INDUSTRIES AND RESOURCES
SOUTH AUSTRALIA

REPORT BOOK 98/14

CLARE VALLEY GROUNDWATER RESOURCES PROGRESS REPORT 2 DRILLING PHASE II

D Morton and A Love

Phase II of a drilling program at Clare, South Australia was undertaken in June, 1997. A total of 6 bores were drilled, 4 of these at existing locations established during phase I drilling in January, 1996, and a further 2 bores were drilled open hole at Watervale Oval. It is anticipated that the 2 bores drilled at Watervale Oval will contribute to aquifer storage and recovery (ASR) investigations along with prospective bores to be drilled at the site at a later date. An additional component of the drilling program involved the collection of rock samples through diamond coring of discrete sections of the geological strata in the majority of holes drilled. A number of these samples were submitted for permeability /porosity analysis, and petrological examination. Follow-up work on phase II bores include monitoring and sampling for chemical parameters in addition to down-hole geophysical and sonde profiling.

INTRODUCTION

As part of the Department of Primary Industries and Resources of South Australia's (PIRSA), ongoing assessment of groundwater resources in the Clare Valley, Phase II of a drilling program was implemented at Clare in June, 1997. A total of six (6) bores (Table 1) were drilled using a departmental 'Portadrill' drilling rig utilising rotary hammer technique. In addition, specific sections of rock strata were cored using a diamond drill and core barrel.

The location of the Clare Valley is presented in Figure 1 and the location of the Phase II groundwater bores drilled, is contained in Figure 2.

DRILLING PROGRAM

Four groundwater bores were installed under permit numbers 41496–41499 (Table 1) and drilled adjacent existing bores at monitoring sites established during Phase I drilling in November, 1995 (Morton et. al (1998)).

Table 1: *Phase II - Clare Drilling 1997*

Permit Number	Location	Depth	Diameter	Geological Unit
41496	Neagles Rock Road	130m	8"	Skillogalee Dolomite
41497	Wendouree	40m	10"	Saddleworth Formation
41498	Wendouree	100m	8"	Saddleworth Formation
41499	Pearce Road	100m	8"	Mintaro Shale
41500	Watervale Oval	100m	8"	Mintaro Shale
41501	Watervale Oval	100m	8"	Mintaro Shale

CLARE VALLEY WATER RESOURCES AREA

Mundoora
Brinkworth
Snowtown
Clare
Blyth
Mintaro
Watervale
Lochiel
Auburn
Hanson
Burra
NORTH
MOUNT
LOFTY
RANGES
Robertstown
Manoora
Saddleworth
Halbury
Balaklava
Marrabel
Riverton
Eudunda
Port Wakefield
Port Clinton
Inkerman
Tarlee
Kapunda
Hamley Bridge
Truro
Parham
Mallala
Freeling
Nuriootpa
Angaston
Tanunda
Sedan
Lower Light
Two Wells
Gawler
Lyndoch
Cambrai
Middle Beach
Virginia
Port Gawler
Williamstown
Elizabeth
St Vincent
Gulf
Outer Harbor
Mt Pleasant
Gumeracha
Birdwood
Lobethal
Mt Torrens
Mannum
ADELAIDE
Hahndorf
Mt Barker
Echunga
Murray Bridge
Port Stanvac
Meadows
Maslin Beach
Strathalbyn

138°00'
138°30'
139°00'
34°00'
34°30'
35°00'

0 5 10 15 20 25
KILOMETRES

Figure 1

Clare Valley Water Resources

LOCALITY PLAN

QD6 100396RM DTA 97-1023

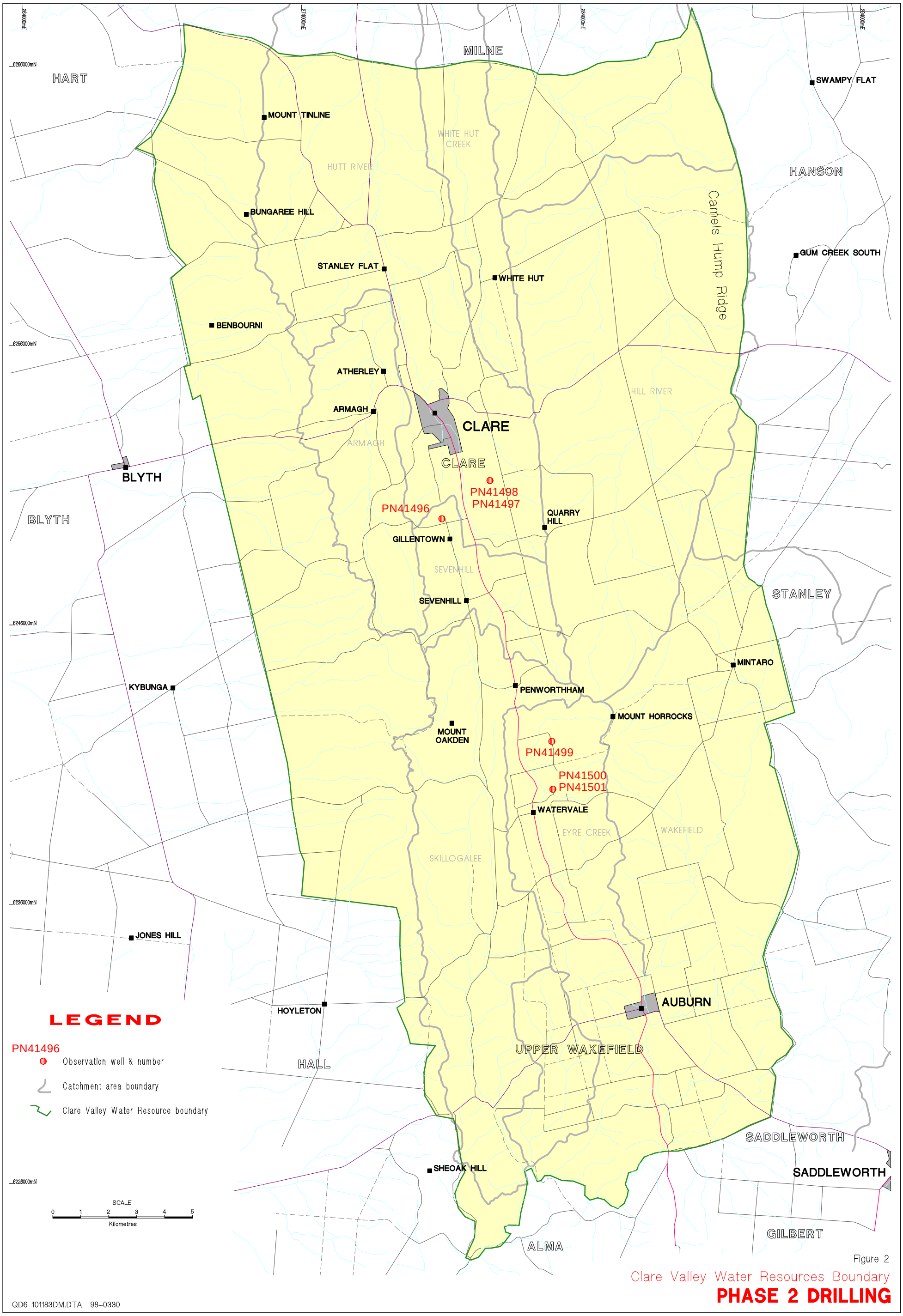


Figure 2

Clare Valley Water Resources Boundary

PHASE 2 DRILLING

QD6 101183DM.DTA 98–0330

A tabulated summary of Phase II drilling is presented in Appendix A and geological logs are contained in Appendix B. All bores drilled were completed open hole with surface casing installed into the soft sediment until hard rock was encountered, generally at a depth between 4 to 9 meters. The aim of the phase II drilling exercise was to provide additional bores to further enhance investigations into the hard rock aquifer properties of Clare (an ongoing joint venture between PIRSA and CSIRO).

Bores drilled at the Neagles Rock Road and Pearce Road sites (PN 41496 & PN 41499) were situated approximately 15–20 meters hydraulically downgradient from established bores (drilled November, 1995). This distance was chosen primarily as a precautionary measure to minimise any possible groundwater impact on the established bores that may have resulted from drilling of the new bores. Each site now contains three monitoring bores.

Phase I bores drilled at the Neagles Rock and Pearce Road sites were completed with nested piezometers in January, 1996. Each of these sites now comprise a deep bore of 8" diameter which contains 4 nested piezometers; a shallower bore of 10" diameter which contains 6 nested piezometers; and a deep open hole bore (recently drilled).

The site at Wendouree, which only contained one bore as a result of Phase I drilling, has had a further two bores installed during Phase II drilling. It is envisaged that the pre-existing 8" and the recently drilled shallow 10" bore installed at the Wendouree site will each be completed with nested piezometers sometime in the near future.

Nested piezometers are a series of separated bore casings (piezometers) of various lengths inserted into a large diameter open bore. Each piezometer is slotted at its base so that groundwater may infiltrate the casing thus providing an isolated sample of groundwater from that particular depth. Between the piezometers and the annulus of the hole a gravel pack is inserted. The slotted sections of the piezometers (including gravel pack) are separated from each other by the use of cement plugs and bentonite, thus prevent mixing of waters from different depths within the wells. The purpose of nested piezometers are to provide discrete samples at specified depths as well as discrete interval aquifer testing for hydraulic parameters. The piezometers will be monitored for temporal variations in salinity and water levels.

A further two wells (PN 41500 & PN 41501), were drilled at Watervale Oval, a site chosen for the purpose of aquifer storage and recovery investigations (ASR - whereby water is injected into the aquifer via the well to be retrieved at a later date). Permit number 41501 was drilled at a distance of 25 metres hydraulically downgradient of the newly installed injection well (PN 41500). It is planned that a further 4–5 wells be installed at this site sometime in the future, subject to budget and time constraints.

DIAMOND CORING

Cored sections of rock strata were obtained at each site with the aid of a diamond drill bit attached to a three metre hollow core barrel. Coring was undertaken at various depths; approximately 1 meter below the water table; approximately 20 meters below the water table; at a depth of approximately 70 meters; and/or at the discretion of the site geologist.

Approximately 3 cored sections measuring 2–3 meters in length were retrieved from each hole. A summary of core samples obtained can be found in Appendix C. Indurated core recovery was in the vicinity of 90–100% from all holes except at Neagles Rock Road (PN 41496), which due to intense fracturing and brecciation of the rock strata, the amount of intact core recovered was much less. Three to four samples of core measuring approximately 25 cm’s in length were chosen from each of the cored sections to make an approximate total of 10 samples obtained per hole. The samples were subsequently wrapped in gladwrap followed by alfoil, and then stored below 4°C in order to prevent any interstitial pore water from escaping. A number of these samples were submitted to CSIRO Petroleum Resources in Melbourne for porosity and permeability analysis.

GEOLOGY

Appendix D contains a geological map of the Clare area. Inspection of drill hole core lengths by Wolfgang Preiss (a departmental expert on the geology of the Adelaide Geosyncline, currently undertaking the geological mapping of the Spalding area, north of Clare) provided confirmation of the geological units ascribed to each site.

Since the Clare region is a meta-sedimentary/metamorphic environment, many of the original rock types were altered through processes of heat and pressure (metamorphosed) to the rocks present today. Rock types at the Neagles Rock Road site, which form part of the Skillogalee Dolomite, originally comprised a carbonate sediment (of chemical origin) which was subsequently metamorphosed (and later weathered) to the present dolomite-marble. Affirmation of this is provided by petrological analysis (undertaken by Mason Geoscience Pty Ltd) of a number of thin sections obtained from the drill core (PN 41496), descriptions of which are contained in Appendix E. The low percentage of intact core recovery obtained from this particular hole can be attributed to fracturing contained within the rock strata, which is thought to result from the drill site being situated on a large Delamerian fault or fracture zone. Minor pyrite observed throughout the drill hole is a relatively young feature, its preservation indicating that it has yet to be subject to intense weathering.

Rock type at the Wendouree site (PN 41497 & PN 41498) comprised a fine grained silty dolomite (of the Saddleworth Formation) which was originally a chemical sediment (carbonate). Rock types found at the Pearce Road site (PN 41499) and Watervale Oval sites (PN 41500 & PN 41502) belong to the Mintaro Shale and are considered to have originally been siltstones which were later altered to dolomitic meta-siltstones.

Generally, rock types obtained from the Phase II drilling are considered to be low in porosity, which is confirmed by petrological analysis of drill core samples (App. E).

GEOPHYSICAL LOGGING

Geophysical logging was undertaking in all newly installed bores following Phase II drilling. The exercise consisted of running a suite of logs which included gamma, neutron, calliper, spontaneous potential, point resistance and density. Logs of this nature are run in attempt to identify areas of high porosity and/or high permeability which may relate to water bearing zones either in the form of large fractures or suitable aquifer material. In fractured rock, locations of potential water bearing fractures are identified mainly from the caliper log in conjunction with the neutron log. Results of the downhole geophysics are presented in Composite Well Logs contained in Appendix F. A blockage of bore PN 41496 (Neagles Rock Road) at approximately 78 metres is evident from the logs and may require removal of the obstruction or re-drilling of the bore at a later date.

CONCLUSION

Follow-up work after the second phase of drilling will be part of the progressive research into the groundwater resources of the Clare Valley and would include:

- Sampling for chemical parameters and isotopes;
- Pump testing of bores to provide information on the hydraulic properties of the hard rock aquifer;
- Obtaining regular and ongoing sonde profiles of holes; and
- Installation of nested piezometers into PN 41498 (Wendouree).

Bores situated at Watervale Oval will eventually constitute part of a trial Aquifer Storage and Recovery (ASR) site. Subsequent bores drilled at this, and other locations are subject to Departmental budget approval.

REFERENCES

Mason, Dr. D.R., 1997. Petrographic Study of Five Drill Core Samples from the Clare Valley. Mason Geoscience Pty. Ltd.,

Morton. D, Love. A, Clarke. D, Martin. R, Cook. P, and M^{c}Ewan. K, (1998). Clare Valley Groundwater Resources, Progress Report I Hydrogeology, Drilling and Groundwater Monitoring. *Department of Primary Industries and Resources, South Australia*, RB98/00015.

APPENDIX A

SUMMARY OF DRILLING

SUMMARY OF DRILLING — CLARE 1997

Permit No	Well No	Obs No	General Location	Latitude	Longitude	Depth (m)	Water Cut (m)	Cased to (m)	Depth to SWL (m)	Yield* (L/sec)	TDS (mg/L)	Rock unit
41496	6630-2792	CLR104	Neagles Rock Road (8")	32°52.146'	138°38.885'	128	21 78 121	11	23	1.5	760	Skillogalee Dolomite
41497	6630-2793	CLR103	Wendouree (10")	33°51.58.5'	138°37.785'	39.9	10 21	2.5	4	3	1289	Auburn Dolomite
41498	6630-2794	CLR105	Wendouree (8")	33°51.58.5'	138°37.785'	116.8	5 15 51	5.5	4	4	1105	Auburn Dolomite
41499	6630-2795	UPW59	Pearce Road (8")	33°56.284'	138°39.071'	100	9 34	7	5	3	628	Mintaro Shale
41500	6630-2796	UPW60	Watervale Oval (8")	33°57.539'	138°38.750'	99.2	4 19 43	9.4	3.1	0.5	894	Mintaro Shale
41501	6630-2797	UPW61	Watervale Oval (8")	33°57.555'	138°38.802'	99.5	51	7.5	5.2	1	683	Mintaro Shale

* Yield determined from airlifting; SWL- Approximate depth to static water level; +++ Obs well no to be assigned

APPENDIX B

GEOLOGICAL LOGS

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41496

LOCATION OR COORDS: Wendouree

UNIT NO: 6630-2792

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

Hundred: CLARE Sec: 111

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:
21		21	26	0.5		AIRLIFT		
78	2.3	78	80	0.5			744	
121	2.0	121	123	0.5			838	

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	0.1		Topsoil	Silty clay, grey, some sand, some organic material.	QUATERNARY		206	0	
0.1	9		Sandy silty CLAY	Pale orange-brown, some cream/off-white calcareous gravel to 2mm, some fine quartz gravel to 2mm, some qtz grains to 1mm, increase in sand content towards base.					
9	15		Weathered Dolomitic Marble	Pink and cream with some dark grey, sub-angular grains, poorly sorted, clay matrix slightly siliceous, weakly calcareous cement, minor quartz.	SKILLOGALEE DOLOMITE (Nms) Burra Group/Torrensian				11
15	21		Weathered Dolomitic Marble	Red, yellow, orange, pink and white, sub-angular, fine-coarse grained, fairly siliceous looking matrix with some clay, weakly calcareous cement in parts, some recrystallised material, rare fine opaques, some Fe rich material with black surface staining, poorly sorted, some friable material, weak schistosity.					

REMARKS:

DRILL TYPE: ROTARY HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 5/6/97

LOGGED BY: D.MORTON

PROJECT:
Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

CONTINUATION SHEET

PERMIT NO: 41496

UNIT NO: 6630-2792

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)
21	27		Dolomite marble	Pale grey/pale pink and white. Fine to coarse grained, moderately sorted, granoblastic texture, minor recrystallised quartz, minor organic material (lignite or graphite), strong mineral lineation in parts with alignment of elongated grains and opaques in a preferred orientation, non-calcareous.	SKILLOGALEE DOLOMITE (Nms) Burra Group/Torrensian	23.1 -24.0			
27	39		Dolomite marble	Weathered in parts. Pale brown with minor white, yellow and pink. Predominantly medium grained, sub-angular, granoblastic texture, minor quartz and opaques, some ?feldspar, minor clay and some minor green discolouration (chloride??).		24.0 -25.6			
39	48		Dolomite marble	Weathered in parts. White, pale grey and pink (mostly white), some brown, sub-rounded grains, granoblastic texture, rare opaques, increase in brown material towards base.		39.8 -40.7			
48	102		Dolomite marble	Pale blue grey and white, fine to medium grained, mostly sutured, sub-rounded to sub-angular, granoblastic texture, rare opaques, weakly calcareous cement, some brown orange fragments <5% (may be fall in) rare fine to medium opaques, some dark grey quartz, some fines, silt and talc.					
102	108		Dolomite marble	As above but with minor pyrite (<1%) occurring as isolated crystals (1mm) occurring as isolated crystals, discrete massive clusters (3-4mm), some fine material (silt and minor talc).					

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

CONTINUATION SHEET

PERMIT NO: 41496

UNIT NO: 6630-2792

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)
108	128		Dolomite marble	Pale blue grey dolomite marble with sugary texture, mostly marble, rest as above but with minor pyrite and massive talc fragments to 15mm, rare opaques. EOH	SKILLOGALEE DOLOMITE (Nms) Burra Group/Torrensian				

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41497

LOCATION OR COORDS: Wendouree

UNIT NO: 6630-2793

EL Surface (m): EL Ref Point (m): Datum:

Hundred: 6630 Sec: 395

AQUIFER	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:
SUMMARY:	10	4	10	12	1		airlift	1317	
	21		21	39	3		airlift	1311	

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	4		CLAY	Brown, plastic, firm to moderately stiff, some angular gravel to 20mm comprising grey and grey/black dolomite, slightly calcareous.	QUATERNARY		263	0	2.5
4	6		SILTY DOLOMITE	Grey and grey/black, sub-fissile fragments and hard massive fragments exhibiting a slightly conchoidal fracture in parts, mostly grey dolomite (80%) lesser grey/black dolomite (20%), calcareous when scratched.	SADDLEWORTH FORMATION (Nbs) Burra Group/Torrensian				
6	9		SILTY DOLOMITE	Grey and grey/black, some massive fragments and some bedded fragments exhibiting micro laminae and a schistosity oblique to bedding observed in some fragments. Mostly grey/black dolomite (55-60%) with lesser grey dolomite, quite silty, some weathered fine grained brown slightly sandy fragments, calcareous when scratched.					
9	18		SILTY DOLOMITE	Grey/black dolomite with minor grey dolomite, sub-fissile, minor laminae with some fragments showing wavy laminae, some soft brown weathered dolomite, very silty, rare hard white irregular calcareous nodules (calcite) up to 2mm, calcareous when scratched.					
19	24		SILTY DOLOMITE	As above but more dark grey/black dolomite and more hard white calcareous clusters up to 10mm, rare white well rounded quartz (5mm in size) increasing in size with depth (up to 10mm), very silty, minor soft grey/brown and grey dolomite (5-10%), calcareous when scratched.					

REMARKS:

DRILL TYPE: ROTARY HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 7/6/97

LOGGED BY: D.MORTON

SHEET 1 of 2

PROJECT:
Clare Valley Groundwater Assessment

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

PERMIT NO: 41497

UNIT NO: 6630-2793

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)
24	27		SILTY DOLOMITE	As above but with minute copper-brown pyrrhotite staining and fine grained weathered pyrite.	SADDLEWORTH FORMATION (Nbs) Burra Group/Torrensian				
27	39		SILTY DOLOMITE	As above but with abundant pyrite (10%) showing cubic crystal habit, mainly fine grained and disseminated throughout or in clusters up to 5mm in width, rare well rounded white quartz grains up to 3mm, rare pyrrhotite coating on cleavage planes at approx 30m. A decrease in amount of pyrite from 33-36m, some white highly calcareous nodules (calcite), minor pale grey dolomite. EOH					

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41498

LOCATION OR COORDS: Wendouree

UNIT NO: 6630-2794

EL Surface (m): EL Ref Point (m): Datum:

Hundred: 6630 Sec:395

AQUIFER	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:
SUMMARY:	5	4.5	5	7	0.5		AIRLIFT		
	15	4	15	17	1			1200	
	51	4	51	52	2			1105	

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	5		CLAY	Brown with minor grey, plastic, soft to slightly firm, quite sandy, fine to medium sub-angular sand grains, sub-angular quartz gravel to 10mm, some calcareous gravel to 20mm.	Quaternary		206	0	
5	9		SILTY DOLOMITE	Grey (50%) and grey/black (50%) dolomite, sub-fissile to massive fragments, grey/black material is better indurated than grey dolomite, occasional hard white grains of calcite (up to 1mm) and nodules (up to 4mm), pale grey clay and silt throughout in minor quantities.	SADDLEWORTH FORMATION (Nbs) Burra Group/Torrensian	7.9 -8.7			5.5
9	12		SILTY DOLOMITE	Grey and grey/black dolomite, mainly sub-fissile, some dark grey laminae 1-2mm every 6mm, abundant clay, minor silt.					
12	21		SILTY DOLOMITE	Grey and grey/black dolomite with minor soft weathered pale brown dolomite, rare white calcareous nodules throughout. Fractures/cleavages appear to be lined with pale grey silt.					
21	27		SILTY DOLOMITE	Grey and grey/black dolomite, mostly grey/black, sub-fissile to fissile some minor laminae and wavy laminae, occasional massive fragments, some soft pale grey weathered cleavage planes, some soft grey-brown dolomite, minor coarse sub-rounded white quartz grains, some disseminated pyrite (<1%) exhibiting cubic crystal structure extremely fine to 1mm, possible fracture surfaces containing brown oxide staining.		24.0 -25.9			

REMARKS:

DRILL TYPE: HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 12/6/97

LOGGED BY: D.MORTON

SHEET 1 of 2

PROJECT:
Clare Valley Groundwater Assessment

WATER WELL LOG

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 41498

UNIT NO: 6630-2794

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	60		SILTY DOLOMITE	Grey and grey/black dolomite, sub-fissile, occasional soft brown weathered dolomite (possible cavings?), rare to occasional pyrite crystal (1mm), occasional sub-rounded white quartz grains to 3mm (non-calcareous), some soft to firm pale grey dolomite and soft weathered brown-grey dolomite. The larger dolomite fragments are dark grey in colour and pale grey along the split or cleavage surface. Increase in brown dolomite to 10% from 48-51 metes.	SADDLEWORTH FORMATION (Nbs) Burra Group/Torrensian				
60	72		SILTY DOLOMITE	Grey and Grey/black dolomite composed mainly of silt and mud held by a calcareous cement. Pale grey laminae defined by a change in colour, increase in pyrite crystals very fine to 1mm at various stages of formation although the majority showing some cubic crystal structure and occurring either concentrated along bedding planes and in short seams up to 10mm long concordant with bedding, or in short seams up to 15mm long cross-cutting bedding, pyrite appears mainly associated with the softer paler grey laminae (which may represent an infilled fracture along a cleavage plane?). Other fractures appear clean or covered in a white calcareous 'crust', some pyrite clusters on some surfaces.		70.0 -71.7			
72	99		SILTY DOLOMITE	As previous but with more pyrite (3-5%) and organic carbon content, rare white calcareous nodule, quite silty throughout.					
99	102		SILTY DOLOMITE	Grey and grey/black dolomite, sub-fissile, minor disseminated pyrite, rare white/grey clay, less silt than previous.					
102	116.8		SILTY DOLOMITE	Grey and grey/black, sub-fissile, increase in grain size of pyrite (to 2mm), minor quartz (mostly associated with pyrite), silt throughout. EOH					

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41499

LOCATION OR COORDS: Pearce Road

UNIT NO: 6630-2795

EL Surface (m): EL Ref Point (m): Datum:

Hundred: 6630 Sec: 26

AQUIFER	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:
SUMMARY:	4 34	9 5	4 34	10.2 37	2 1		AIRLIFT	561	

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		CLAY	Brown, soft, damp, some sand comprising fine to coarse sub-angular grains, some silt, some roots, some angular weakly calcareous gravel to 10mm.	QUATERNARY		206	0	
3	7		Gravelly CLAY	Grey-brown, soft to firm, wet, very sticky, some fine to coarse angular to sub-angular sand, generally non-calcareous, angular to sub-angular gravel to 15mm composed of siltstone weakly calcareous in parts.		7.7 -9.7			7
7	15		DOLOMITIC META-SILTSTONE	Grey laminated siltstone, fissile, weakly calcareous in parts, interbedded with minor grey/black sandstone layers composed of fine to very fine sub-rounded sand grains in a highly calcareous cement. Fractures occur either concordant with bedding and infilled with a soft pale grey silt or stained with a brown oxide, or discordant with bedding and exhibiting brown oxide staining on the fracture surface. Rare white calcareous nodules throughout. Large fracture struck at 10.2 metres.	MINTARO SHALE (Nbi) Burra Group/Torrensian				
15	26		DOLOMITIC META-SILTSTONE	As above but with massive pyrite up to 1mm sometimes in association with white recrystallised quartz, and sometimes showing striated crystal faces (octahedral in shape?), orange oxide staining on fragments from 21-24 metres					
26	36		DOLOMITIC META- SILTSTONE	Grey siltstone, fairly massive, no obvious bedding or laminae although fracturing tends to occur along a preferred plane of orientation, abundant sub-rounded to sub-angular fine to coarse sand grains and silt, the sand and silt are highly calcareous when scratched the siltstone varies from non-calcareous to weakly calcareous. Fracture surfaces are either clean or associated with a white calcareous powder, rare fine pyrite grains up to 2mm in size exhibiting a cubic crystal habit occur in fracture surfaces.		26.0 -28.8			

REMARKS:

DRILL TYPE: HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 15/6/97

LOGGED BY: D.MORTON

PROJECT:
Clare Valley Groundwater Assessment

WATER WELL LOG

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

PERMIT NO: 41499

UNIT NO: 6630-2795

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)
36	54		DOLOMITIC META-SILTSTONE	As above but with abundant clear and white highly calcareous angular carbonate fragments and rare cubic pyrite crystals up to 4mm generally found in association with the calcite (probably vein material) or as massive inclusions up to 4mm, some grey green siltstone.	MINTARO SHALE (Nbi) Burra Group/Torrensian				
54	100		DOLOMITIC META-SILTSTONE	Grey siltstone, laminated in parts with laminae < 0.05mm wide and dark in colour, a preferred orientation of fracturing observed which appears parallel to bedding, some massive pyrite clusters associated with the laminae (parallel to bedding) Soft grey silt layers are possibly infilled zones of weakness along cleavage/fracture planes rather than a sediment layer?. Fractures appear to be coated with a white weakly calcareous material, rare bronzy pyrrhotite coating on some surfaces, some pyrite clusters 2-3mm wide throughout, some small yellow- brown soft to firm silt fragments, rare green siltstone fragments, rare hard yellow clay blobs (possibly derived from large fractures). EOH		70.0 -73.1			

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41500

LOCATION OR COORDS: Watervale Oval

UNIT NO: 6630-2796

EL Surface (m): EL Ref Point (m): Datum:

Hundred: CLARE Sec: 144

AQUIFER	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:
SUMMARY:	4	3	4	5	1		AIRLIFT		
	19	3.1	19	20	0.25			800	
	43	3.1	43	45	0.25			830	

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	4.5		CLAY	Brown, dry, stiff, calcareous, some calcareous gravel to 4mm, minor silt. Water cut at 4.5 m - gravel layer (smooth and fairly well rounded siltstone gravel).	QUATERNARY		206	0	
4.5	6		CLAY & GRAVEL BEDS	Brown, wet, good plastisity, calcareous in parts, some white calcareous gravel to 2mm.					
6	8		GRAVEL & CLAY	Red, yellow, green & white river bed gravel to 30mm, composed of smooth and fairly well rounded fragments of quartz, siltstone, shale, calcareous in parts, some brown, wet, plastic calcareous clay, some grey dolomitic siltstone fragments.					9.4
8	27		DOLOMITIC META-SILTSTONE	Dark grey bedded dolomitic siltstone, fissile to sub-fissile (calcareous in parts), abundant silt some interbedded very fine grained calcareous sandstone containing sub-rounded quartz grains and minor opaques, set in a silt matrix with calcareous cement, rare pyrite grains approx 1mm exhibiting a cubic crystal habit, some fine black laminae <0.5mm thick occurring every 1-2mm over a 10mm thick interval, fracture surfaces are identified by a brown-orange oxide surface coating, abundant silt.	MINTARO SHALE (Nbi) Burra Group/Torrensian				
27	51		DOLOMITIC META-SILTSTONE	Dark grey, thinly bedded dolomitic siltstone, fissile, flaky in appearance, as above but some highly calcareous white angular (calcite?) fragments to 10mm, more bedded than previous, pyrite and lesser pyrrhotite observed along laminae either in clusters or as discrete grains exhibiting 1 to 2 striated crystal faces and increasing in size with depth (up to 6mm), highly fractured zone from 48-51 exhibited by abundant white calcareous vein material in the sample.					

REMARKS:

DRILL TYPE: HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 18/6/97

LOGGED BY: D.MORTON

PROJECT:
Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

CONTINUATION SHEET

PERMIT NO: 41500

UNIT NO: 6630-2796

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)
51	99.2		DOLOMITIC META- SILTSTONE	As previous but with occasional pyrite and rare pyrrhotite, decrease in pyrite and pyrrhotite content with depth. EOH	MINTARO SHALE (Nbi) Burra Group/Torrensian				

PROJECT: Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION

PERMIT NO: 41501

LOCATION OR COORDS: Watervale Oval

UNIT NO: 6630-2797

EL Surface (m): EL Ref Point (m): Datum:

Hundred: CLARE Sec: 144

AQUIFER	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:
SUMMARY:	51	5.2	51	53	1		AIRLIFT	683	

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		CLAY & GRAVEL	Red-brown topsoil composed of a dry, stiff, generally non-calcareous clay, some white calcareous gravel to 3mm, over pale grey dry highly calcareous clay, over grey yellow-orange and white gravel, fine to coarse river gravel composed of grey weathered laminated and non-laminated siltstone, yellow-orange sandstone with a calcareous cement and clay matrix, calcrete, some sub-angular to sub-rounded sand grains.	QUATERNARY		206	0	
3	10		WEATHERED DOLOMITIC SILTSTONE	Pale grey and grey thinly bedded weathered dolomitic siltstone, fissile elongated aggregates, laminated in parts with laminae (~0.5-1mm thick) distinguished by a paler change in colour, some white calcrete nodules 1mm to 5mm, some brown-orange oxide stained fragments, weathered grey/brown dolomitic siltstone constitutes 10-15% of volume.	MINTARO SHALE (Nbi) Burra Group/Torrensian				7.5
10	18		DOLOMITIC META- SILTSTONE	Dark-grey dolomitic siltstone, fissile and hard, fine black laminae in parts, some fine-medium hard white calcareous nodules throughout, occasional brown oxide stained cleavage/bedding plane, dolomitic siltstone composed of silt with a calcareous cement although some very fine sandstone fragments observed, some small whitish blebs observed on some fragments indicating a varying carbonate composition throughout.					
18	48		DOLOMITIC META-SILTSTONE	As above but increase in amount of brown oxide staining on some surfaces in the 18-21 metre interval. some pyrite, occurring either disseminated or in massive lenses either forming along laminae or infilling cleavages, some finely disseminated pyrrhotite.		26.0 -28.4			

REMARKS:

DRILL TYPE: ROTARY HAMMER

CIRCULATION: AIR

DATE: 1/8/97

COMPLETED: 23/6/97

LOGGED BY: D.MORTON

PROJECT:
Clare Valley Groundwater Assessment

DEPARTMENT OF MINES AND ENERGY RESOURCES - SOUTH AUSTRALIA

WATER WELL LOG

GROUNDWATER DIVISION
CONTINUATION SHEET

PERMIT NO: 41501

UNIT NO: 6630-2797

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)
48	57		DOLOMITIC META-SILTSTONE	As previous, slight increase in amount of pyritic surfaces, veins and white carbonate surfaces, increase in size of discrete pyrite grains up to 2mm, showing 1-2 crystal faces and striated surfaces.	MINTARO SHALE (Nbi) Burra Group/Torrensian	49.1 -51.8 53.6 -56.1			
57	100		DOLOMITIC META-SILTSTONE	As previous but less pyrite EOH		75.0 -78.0			

APPENDIX C

LIST OF CORE SAMPLES

CORE SAMPLES

Permit Number	Location	Date	Cored Section	Discrete Samples
41496	Neagles Rock Road	2/6/97	23.1 - 24.0	23.50
			24.0 - 25.6	24.10
				24.40
				25.00*
		3/6/97	39.8 - 40.7	40.30
				40.40*
				40.60*
41497	Wendouree	6/6/97	-	-
41498	Wendouree	7/6/97	7.9 - 8.7	8.20
				8.50*
			24.0 - 25.9	24.10 - 24.62
				25.00 - 25.25
				25.45 - 25.75*
			70.0 - 71.7	70.30 - 70.50
				70.70 - 71.00*
				71.15 - 71.27
41499	Pearce Road	10/6/97	7.7 - 9.7	7.70 - 8.00
				8.20 - 8.45
				8.70 - 8.95*
				9.20 - 9.55
			26.0 - 28.8	26.3 - 26.58*
				26.7 - 27.10
				27.73 - 28.0
			70.0 - 73.10	70.7 - 71.0*
				71.0 - 71.25
				72.1 - 72.35
41500	Watervale Oval	16/6/97	-	-
41501	Watervale Oval	19/6/97	26.3 - 28.4	26.3 - 26.5*
				26.9 - 27.2
				27.45 - 27.8
			49.12 - 51.79	49.5 - 49.7
				50.4 - 50.6
				50.6 - 50.8
				50.8 - 51.04
			53.6 - 56.13	53.7 - 53.8
				55.1 - 55.3*
				55.45 - 55.56
			75.0 - 78.0	75.3 - 75.55
				75.72 - 76.10
				76.62 - 76.92*
				77.25 - 77.65

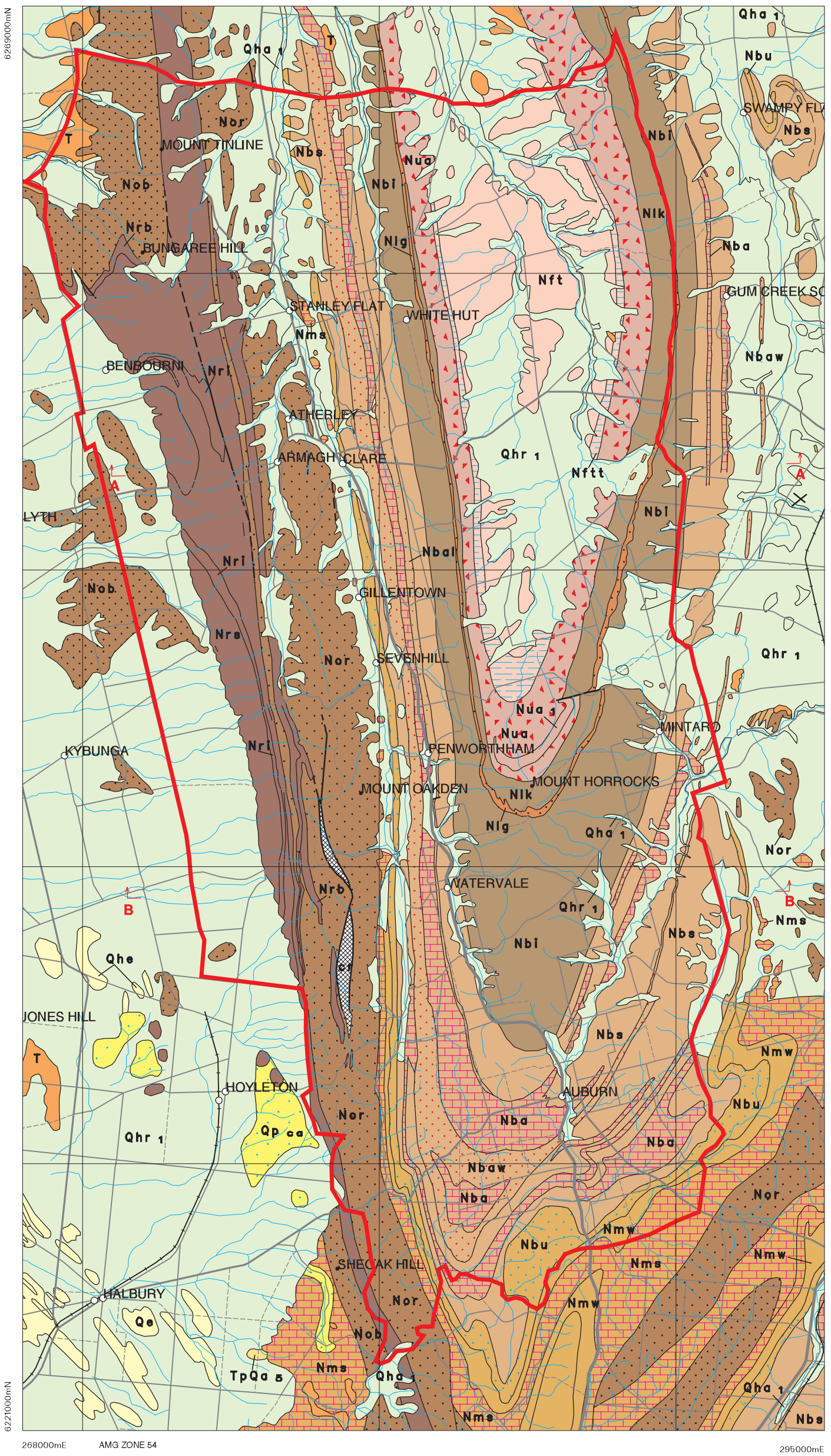
- Samples submitted to CSIRO Petrooleum Resources Melbourne; Results pending

APPENDIX D

GEOLOGY MAP OF THE CLARE REGION

CLARE VALLEY WATER RESOURCES

GEOLOGICAL MAP



REFERENCE

Qha 1	HOLOCENE Present day alluvium	
Qhe	Undifferentiated aeolian sediments	
Qhr 1	Talus and downwash sediments	
Qe	PLEISTOCENE-HOLOCENE Undifferentiated aeolian sediments	
Qp ca	PLEISTOCENE Undifferentiated calcrete	
Qpa	Undifferentiated alluvial/fluvial sediments	
TpQa 5	PLIOCENE-PLEISTOCENE Hindmarsh Clay, Carisbrooke Sand, Ochre Cove Formation, Seaford Formation	
T	TERTIARY Undifferentiated	
Nft	**UMBERATANA GROUP** TAPLEY HILL FORMATION Thinly laminated carbonaceous siltstone	STURTIAN
Nftt	*TINDELPINA SHALE MEMBER*	
Nua	APPILA TILLITE Diamictite, siltstone, sandstone	
	disconformity	
Nlk	**BURRA GROUP** KADLUNGA SLATE Laminated slate	BELAIR SUBGROUP
Nlg	GILBERT RANGE QUARTZITE Coarse feldspathic quartzite	
Nbi	MINTARO SHALE Laminated fine - sandy siltstone	TORRENSIAN
Nbal	SADDLEWORTH FORMATION AUBURN DOLOMITE Dark grey dolomite; chert blebs	
Nbaw	*LEASINGHAM QUARTZITE MEMBER* Fine-grained sandstone	
Nba	*WATERVALE SANDSTONE MEMBER* Cross-bedded sandstone, partly dolomitic	
Nbs	Dolomitic shale and siltstone	
Nbu	UNDALYA QUARTZITE Fine to coarse feldspathic quartzite	
Nmw	WOOLSHED FLAT SHALE Laminated fine - sandy siltstone	MUNDALLIO SUBGROUP
Nms	SKILLOGALEE DOLOMITE Cream dolomite marble; local dark grey dolomite at top with chert and magnesite	
Nob	BUNGAREE QUARTZITE Fine to coarse feldspathic quartzite	
Nrb	BENBOURNIE DOLOMITE Pale grey dolomite; magnesitic siltstone	EMEROO SUBGROUP
Nrs	STRADBROOKE FORMATION Laminated fine - sandy phyllite	
Nri	INGOMAR QUARTZITE Fine-grained quartzite	RIVER WAKEFIELD SUBGROUP
Nrc	BOCONNOC FORMATION Laminated fine - sandy phyllite	
Nry	BLYTH DOLOMITE Grey dolomite marble; dark grey cherty dolomite	
Nor	RHYNIE SANDSTONE Fine to coarse, pebbly, heavy mineral-laminated arkose; minor shale, dolomite. Local altered basalt	

Crush zone ..... Cr

Fault, inferred fault .....

Clare Valley Water Resources boundary .....

Railway .....

River or creek .....

Main road .....

Secondary road .....

Track .....

Cross section ..... A A

SCALE 1:150 000

0 2 4 6 8 10

KILOMETRES

Computer generated from SA_GEOLOGY database.

Cartography by the Mapping Section,
Mapping and Spatial Data Branch.

April 22, 1998

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia

98-0515

J101087

APPENDIX E

PETROLOGICAL DESCRIPTIONS

"Petrological Study of Five Drill Core Samples from the Clare Valley"

Report by

Dr. D.R.Mason
of
Mason Geoscience Ptd Ltd.

Mason Geoscience Pty. Ltd.

ACN 063 539 686

Petrological Services for the
Minerals Exploration and Mining Industry

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e-mail :drmason@interconnect.com.au

REPORT TITLE	**Petrographic Study of Five Drill Core Samples from the Clare Valley**
REPORT #	2399
CLIENT	Mines and Energy South Australia
ORDER NO.	J 4148
CONTACT	Ms Dawn Morton

REPORT BY Dr Douglas R. Mason

SIGNED

for Mason Geoscience Pty. Ltd.

DATE 18 December 1997

Petrographic Study of Five Drill Core Samples from the Clare Valley

SUMMARY

1. Rock Samples

* Five drill core rock samples from the Clare Valley have been studied using petrographic methods.

2. Brief Results

* Rock names and mineralogy are summarised in TABLE 1.

* Porosity

  - Comments on primary and secondary porosity are provided in the individual petrographic descriptions.

  - Primary porosity is considered to have been low in all samples owing to the fine-grained nature of the clastic and chemical sedimentary materials. It may have been slightly higher in some thin silt-rich layers.

  - Secondary porosity in most samples is low, owing to complete occlusion of all primary space during metamorphic recrystallisation. Moderate secondary porosity is evident in sample 41496-2, in which ragged solution cavities from millimetre to centimetre size are sparsely distributed through the rock, especially in association with quartz-rich veins and patches.

TABLE 1: SUMMARY OF ROCK NAMES AND MINERALOGY

SAMPLE	ROCK NAME	MINERALOGY*			
		Primary**	Metamorphic/alteration	Veins	Weathering
41496-1	Weakly weathered dolomitic marble	Qtz,	Dol,mus,opq(?py),chl	Dol	Goe
41496-2	Weakly weathered, quartz-veined talcose dolomitic marble	?Qtz	Dol,tlc,mus	Qtz	Goe
41498	Layered silty carbonaceous dolomite	Qtz,fld,mus	Dol,opq(grp),opq(?py)	-	-
41499	Layered dolomitic meta-siltstone	Qtz,mus,tou	Dol,bio,ser,opq(grp),opq(sulp,sph)	-	-
41501	Layered carbonaceous dolomitic meta-siltstone	Qtz,pla,mus,tou	Dol,bio,ser,opq(grp),opq(sulp,sph),sid	-	-

NOTES:
*: Minerals are listed in each paragenesis according to approximate decreasing abundance.
**: Only primary minerals currently present in the rock are listed. Others may have been present, but are altered.

Mineral abbreviations:
Bio = biotite; chl = chlorite; dol = dolomite; fld = undifferentiated feldspar minerals; goe = goethite; grp = graphitic carbonaceous material; mus = muscovite; opq = undifferentiated opaque minerals; pla = plagioclase; py = pyrite; qtz = quartz; ser = sericite; sid = siderite; sph = sphalerite; sulp = undifferentiated sulphide minerals; tlc = talc; tou = tourmaline; ? = uncertain paragenesis or mineral identification.

1. INTRODUCTION

Five drill core rock samples from the Clare Valley were collected from Ms Dawn Morton (Mines and Energy South Australia, Greenhill Road, Parkside, South Australia) on 8 December 1997.

The samples represent Skillogalee Dolomite and probable Saddleworth/Mintaro Shale. Particular requests were:

i) To prepare a thin section and routine petrographic description (service PETRO 2) for each sample.

ii) To include details of primary and secondary porosity and any mineral replacement.

This report contains the full results of this work.

2. METHODS

The drill core samples were examined in hand specimen and marked for section preparation. In all cases the section plane was oriented normal to bedding. Standard thin sections were obtained from an external commercial laboratory (Pontifex & Associates Pty Ltd, Rose Park, South Australia).

At Mason Geoscience Pty Ltd, conventional transmitted polarised light microscopy was used to prepare the routine petrographic descriptions.

3. PETROGRAPHIC DESCRIPTIONS

The petrographic descriptions are provided in the following pages.

SAMPLE : 41496-1 (24.1-24.19m)

SECTION NO. : 41496-1 (24.1-24.19m)

HAND SPECIMEN : The drill core sample represents a fine- to medium-grained, non-layered, pale grey crystalline rock with pervasive reddish brown tinge. Indistinct white veinlets or fracture fillings cut the rock.

The section offcut fails to react with dilute HCl, suggesting calcite is absent.

ROCK NAME : **Weakly weathered dolomitic marble**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Carbonate (dolomite)	92	Metamorphic / vein filling
Quartz	5	?Relict clastic particles
Muscovite	1	?Metamorphic
Opaques (?pyrite, incl. goethite)	<1	Metamorphic (incl. weathering)
Chlorite	<1	Metamorphic

In thin section, this sample displays a sutured granoblastic metamorphic texture, with possible relict arenaceous clastic texture, slightly modified by selective oxidation in response to weathering.

Carbonate (dolomite) dominates the rock, and occurs in two forms:

i) Most occurs as anhedral grains ~0.1-0.2 mm in size that form a sutured granoblastic mosaic throughout the rock. Slightly larger grains up to ~0.4 mm in size occur locally. Many grains are equant in shape, but there is a tendency for slightly elongate grains to display a preferred orientation subparallel to aligned muscovite and quartz grains (presumably sedimentary layering).

ii) A small amount of carbonate occurs as larger anhedral grains ~0.4 mm in size that fill uncommon, indistinct veins cutting the rock discordant to layering.

Quartz occurs in minor amount as subangular to subrounded grains ~0.2-0.4 mm in size. They are sparsely distributed throughout the rock. Their margins are sutured with adjacent dolomite, and some are slightly elongated in the trace of layering.

Muscovite occurs in minor amount as small flakes ~0.1-0.2 mm long, sparsely and irregularly distributed through the rock.

Opaques (probably pyrite) occur as tiny equant crystals with cubic morphologies, sparsely disseminated through the rock. Many display partial to complete replacement by cryptocrystalline dense dark reddish brown to opaque iron oxides (probably mainly goethite).

Chlorite is present in minor amount as very fine-grained small patches, sparsely distributed through the rock.

INTERPRETATION:

This sample represents a carbonate sediment. It is thought to have been composed originally of abundant carbonate accompanied by minor clastic particles (mainly quartz, but possibly with minor muscovite). Weak layering was defined by alignment of muscovite and some of the quartz grains.

Subsequent low-grade regional metamorphism (greenschist facies) resulted in recrystallisation of the carbonate to sutured granoblastic dolomite, accompanied by accessory small sulphide crystals (?pyrite) and small chloritic aggregates. The quartz grains and muscovite grains, of inferred clastic sedimentary origin, survived the event with only slight modification of the quartz grain shapes. It should be noted that there remains some uncertainty as to the origin of the muscovite: it is possible that it belongs to the metamorphic event rather than being of clastic origin.

Client query: Comment on primary and secondary porosity.

Response: Metamorphic recrystallisation was quite thorough, resulting in tightly sutured granoblastic textures and consequent low secondary porosity. The nature of any primary porosity has therefore been completely obscured, but it is considered to have been low or very low, as appropriate for a fine-grained chemical sediment.

SAMPLE : 41496-2 (40.3-40.37m)

SECTION NO. : 41496-2 (40.3-40.37m)

HAND SPECIMEN : The drill core sample represents a massive medium-grained crystalline rock of pale orange-cream colour, with ragged translucent grey quartz-rich veins that are characteristically harder than the enclosing host rock. Small to large ragged solution cavities are distributed throughout the rock; most are very small (mm-sized), but uncommon larger ones up to cm size are present within and near the quartz-rich veins.

The section offcut effervesces in reaction with dilute HCl, but only in or near small cavities. This suggests a small amount of calcite is present.

ROCK NAME : **Weakly weathered, quartz-veined talcose dolomitic marble**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Carbonate (dolomite, minor ?calcite)	81	Metamorphic
Talc	3	Metamorphic
Muscovite	1	?Metamorphic
Quartz	1	?Clastic particles / ?metamorphic
Quartz	8	Vein filling
Goethite	<1	Weathering
Voids	5	Solution cavities

In thin section, this sample displays a sutured granoblastic metamorphic texture, weakly modified by a weathering overprint.

Carbonate is abundant, occurring as equant anhedral grains ~0.2-1.0 mm in size (mostly ~0.6-1.0 mm). They form a massive medium-grained sutured granoblastic mosaic through the rock. Most of the carbonate is inferred to be dolomite from the lack of reaction in hand specimen; no calcite has been specifically identified optically, but a small amount of calcite is inferred to be present from local reaction in hand specimen.

Quartz occurs in two forms:

i) Most occurs as small equant anhedral grains that fill large patches or veins.

ii) A small amount occurs as equant anhedral grains ~0.4 mm in size, sparsely and irregularly distributed through the rock. These may represent relict sand-sized clastic particles, but this interpretation remains uncertain owing to grain shape modification.

Talc occurs in significant amount as very fine-grained dense mats concentrated in elongate patches or thin tortuous laminae. They are readily distinguished from muscovite (see below) by their fine grain size, higher birefringence, and tendency to be concentrated in the patches/laminae.

Muscovite occurs in trace amount as small well-crystallised flakes sparsely scattered through the rock. They appear to be in textural equilibrium with the carbonate grains, and therefore may be of metamorphic origin.

Goethite occurs in trace amount as small cryptocrystalline dense orange-brown patches, scattered sparsely and irregularly through the rock.

Voids of variable size and ragged shape are scattered through the rock. The lack of stain in the mounting medium makes them somewhat difficult to detect.

INTERPRETATION:

This sample is interpreted to represent a carbonate sediment, originally composed of abundant carbonate of chemical sedimentary origin, accompanied by minor clastic materials (mainly quartz and minor clays). Low-grade regional metamorphism affected the rock in particular ways:

i) Most of the rock recrystallised to abundant dolomite, accompanied by minor talc and muscovite.

ii) Quartz-rich veins developed locally in the rock.

Subsequent near-surface oxidation generated a trace amount of goethite as small patches scattered through the rock.

Client query: Comment on the primary and secondary porosity.

Response: Secondary porosity is moderate, as indicated by the small to large solution cavities scattered through the rock. Largest ones are associated with the quartz-rich veins and patches, but small ones occur throughout the rock. Primary porosity is inferred to have been low to very low, owing to the fine-grained nature of the primary carbonate chemical sediment.

SAMPLE : 41498 (71.15-71.33m)

SECTION NO. : 41498 (71.15-71.33m)

HAND SPECIMEN : The drill core sample represents a very dark grey rock in which thin lamination is evident.

The section offcut fails to react with dilute HCl, suggesting calcite is absent.

ROCK NAME : **Layered silty carbonaceous dolomite**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	3	Clastic particles
Feldspar	2	Clastic particles
Muscovite	2	Clastic particles
Tourmaline	Tr	Clastic particles
Carbonate (dolomite)	78	Recrystallised sedimentary matrix
Opaques (carbonaceous materials)	15	Recrystallised sedimentary matrix
Opaques (?pyrite)	Tr	Metamorphic

In thin section, this sample displays a fine-grained clastic sedimentary texture with particle layering, modified by low-grade metamorphic recrystallisation.

Clastic particles occur in minor amount, and vary in abundance from layer to layer. Small angular particles of quartz, feldspar and muscovite are distinguished. Rare small pleochroic green tourmaline grains also are observed.

The matrix is dominated by carbonate (dolomite), which occurs as tiny ragged grains of micron size (~2-20 m) which form a dense mosaic throughout the rock. Submicron-sized opaque material is diffusely distributed throughout the dolomitic matrix, and is inferred to be of carbonaceous origin. Sparsely disseminated through the matrix are tiny equant to ovoid opaque grains (probably pyrite): the presence of some ovoid shapes suggest they may be framboidal in nature.

INTERPRETATION:

This sample represents a fine-grained silty carbonate sedimentary rock, originally composed of abundant fine chemical sedimentary materials (mainly carbonate, with minor carbonaceous and possibly sulphidic components) and minor silty clastic crystal particles (quartz, feldspar, muscovite, tourmaline). Low-grade regional metamorphism, possibly in the lower greenschist facies, resulted in incipient recrystallisation of the matrix to carbonate (dolomite) + carbonaceous material + opaques (?pyrite). The clastic particles remained unaffected.

Client query: Comment on primary and secondary porosity.
Response: The secondary porosity is low, owing to the finely recrystallised texture of the matrix and the lack of effect on the silty particles. The primary porosity most likely also was low, consistent with the very fine-grained nature of the primary silty chemical sediment.

AMPLE : 41499 (71.0-71.25m)

SECTION NO. : 41499 (71.0-71.25m)

HAND SPECIMEN : The drill core sample represents a thinly layered sedimentary rock, in which layers are alternately dark brownish grey and paler greenish grey. Small lustrous sulphide aggregates are sparsely scattered through the rock, and tend to be oriented in the plane of layering.

The section offcut fails to react with dilute HCl, suggesting calcite is absent.

ROCK NAME : **Layered dolomitic meta-siltstone**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	30	Clastic particles
Muscovite	Tr	Clastic particles
Tourmaline	Tr	Clastic particles
Carbonate (dolomite)	36	Metamorphic matrix
Biotite	20	Metamorphic matrix
Sericite	10	Metamorphic matrix
Opaques (carbonaceous material)	2	Metamorphic matrix
Opaques (sulphides, incl. sphalerite)	<1	Metamorphic matrix

In thin section, this sample displays a fine-grained clastic sedimentary texture, with layering defined by abundance of clastic particles, and modified by low-grade metamorphic recrystallisation of the matrix.

Clastic particles are moderately abundant. Quartz occurs as small angular crystals fragments that range in size ~0.05-0.2 mm. Most lie in the range ~0.05-0.1 mm, and the larger particles ~0.2 mm are concentrated in thin laminae. Muscovite flakes range up to ~0.3 mm, and are aligned in the trace of layering. Tourmaline is rare, forming small crystal fragments pleochroic in drab greens.

Carbonate (dolomite) is moderately abundant, occurring as tiny ragged grains that are more abundant in the layers richer in silty crystal fragments.

Biotite occurs as small ragged flakes ~0.05-0.1 mm in size, pleochroic from tan brown to very pale yellow. They are randomly oriented, and therefore may have formed in the absence of a directed stress field. It is distributed throughout the rock, but is more abundant in the layers richer in silty fragments.

Sericite occurs as tiny flecks distributed through most of the rock, but more abundantly in those layers poorer in silty crystal fragments. The sericite is distinguishable by its small size from the larger clastic muscovite particles.

Opaques occur in two forms:

i) Some occurs as submicron-sized materials sparsely distributed through the rock, and is more abundant in the particle-poor layers. It appears to be of carbonaceous origin.

ii) Some occurs as tiny disseminated ragged grains, and larger crystalline aggregates elongated in the trace of layering. These opaques represent the lustrous sulphide aggregates observed in hand specimen, and may be mainly pyrrhotite or pyrite. A trace of sphalerite has been identified (deep red-brown colour, isotropic) as small ragged grains marginal to some opaque aggregates.

INTERPRETATION:

This sample represents a layered silty sedimentary rock. Layers were originally composed of variable proportions of crystal fragments (quartz, muscovite, tourmaline) in a fine matrix composed of clays, carbonate materials, and carbonaceous materials.

Recrystallisation of the matrix under low-grade regional metamorphic conditions in the middle greenschist facies (biotite-stable) generated the new assemblage of carbonate (dolomite) + biotite + sericite + carbonaceous material + opaques (sulphides, including sphalerite). The components of the sulphides (viz. S, Fe, Zn) are considered to have been derived locally from the sediment, and therefore formed part of the primary sedimentary layered materials.

Client query: Comment on the primary and secondary porosity.

Response: The secondary porosity is low, owing to the fine-grained nature of the recrystallised matrix. The primary porosity is also considered to have been low, according to the fine-grained nature of the primary clastic and chemical sedimentary components.

SAMPLE : 41501 (75.3-75.55m)

SECTION NO. : 41501 (75.3-75.55m)

HAND SPECIMEN : The drill core sample represents a layered sedimentary rock, in which thicker medium grey-green layers alternate with thin dark green-black laminae.

The section offcut fails to effervesce in reaction with dilute HCl, suggesting calcite is absent.

ROCK NAME : **Layered carbonaceous dolomitic meta-siltstone**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	20	Clastic particles
Plagioclase	Tr	Clastic particles
Muscovite	Tr	Clastic particles
Tourmaline	Tr	Clastic particles
Carbonate (dolomite)	47	Metamorphic (recrystallised matrix)
Carbonate (?siderite)	Tr	Metamorphic
Biotite	12	Metamorphic (recrystallised matrix)
Sericite	15	Metamorphic (recrystallised matrix)
Opaques (carbonaceous material)	5	Metamorphic (recrystallised matrix)
Opaques (?sulphides, incl. sphalerite)	<1	Metamorphic

In thin section, this sample displays a fine-grained clastic sedimentary texture with layering, modified by metamorphic recrystallisation.

Clastic particles occur in significant amount. Quartz forms small angular crystal fragments ~0.1 mm in size abundantly in coarser silty layers, and ~0.05 mm in size in minor amount in thicker dolomitic argillite layers. Plagioclase occurs as small angular crystal fragments with characteristic polysynthetic twinning, associated with abundant quartz in the particle-rich coarser silty layers. Muscovite flakes ~0.1 mm long are uncommon, and pleochroic green tourmaline grains are rare.

Carbonates of different types are identified:

i) Most occurs as tiny ragged grains of dolomite that form a sutured microgranular mosaic in the thicker dolomitic argillite layers. Larger anhedral dolomite grains occur in the coarser silty layers.

ii) Larger anhedral dolomite grains are concentrated in uncommon ovoid patches that lie in the trace of the layering. These patches may contain finer-grained aggregates of higher-relief carbonate which has the appearance of an Fe-carbonate (siderite).

Biotite is moderately abundant, occurring as small ragged flakes pleochroic in orange-yellow colours. The flakes are randomly oriented, suggesting crystallisation in the absence of a directed stress field.

The biotite is most abundant in the coarser silty layers, and occurs in only minor amount in the thicker dolomitic argillite layers.

Sericite occurs as tiny flecks distributed through most layers, but most abundant in the dolomitic argillite layers.

Opaques occur in different forms:

i) Some occurs as submicron-sized materials, concentrated in thin laminae and to a lesser extent in the thicker dolomitic argillite layers. This opaque material is likely to be of carbonaceous nature.

ii) Some opaques occur as tiny grains disseminated through the rock, as fine-grained granular aggregates concentrated in feathery concordant to slightly discordant discontinuous veinlets, and as granular aggregates in uncommon coarser-grained lenses with dolomite. Most of these opaques are considered to be sulphide (pyrite or pyrrhotite), but some grains of reddish brown sphalerite occur in the coarser lenses.

INTERPRETATION:

This sample represents a layered silty sedimentary rock, originally composed of small clastic particles (quartz, plagioclase, muscovite, tourmaline) in a very fine matrix of carbonate, clays, carbonaceous material and sulphidic components. Particle size layering defined silt-rich and silt-poor (dolomitic argillite) sedimentary layers. Thin carbonaceous laminae contributed to the primary sedimentary layering.

Low-grade regional metamorphism in the middle greenschist facies caused recrystallisation of the matrix materials, generating the new assemblage of dolomite + biotite + sericite + carbonaceous material + opaques (sulphides including sphalerite).

Client query: Comment on primary and secondary porosity.

Response: The primary porosity is considered to have been low, owing to the fine-grained nature of the clastic sedimentary materials. However, some of the coarser silt-rich layers may have had a higher porosity defined by open interparticle pores. The secondary porosity of the rock is low in all layers, owing to complete occlusion of all space during metamorphic recrystallisation of matrix components.

APPENDIX F

COMPOSITE WELL LOGS

Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1406

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Rotary Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 2nd June 1997 FINISH 5th June 1997
TOTAL DEPTH 128 m

	mm	From (m)	To (m)
HOLE DIAMETER	251	0	11
	202	11	128.1
CASING DIAMETER (Cemented)			
CASING DIAMETER (Uncemented)	206	0	11
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
21		43.2	Airlift		
78	23	43.2		744	
121	2	43.2		838	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	DENSITY
DATE OF RUN	15/10/97	15/10/97	15/10/97	15/10/97	15/10/97	15/10/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	79.0	79.0	79.0	79.0	79.0	79.0
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. ..... UNIT No. 6630–2792 PERMIT No. 4149 6
LOCATION Neagles Rock Road
Lat. 33°52.078' Long. 138°36.748'
REF. ELEV. ..... m SURFACE ELEV. ..... m DATUM .....
LOGGED BY D. Morton DATE 5th June 1997

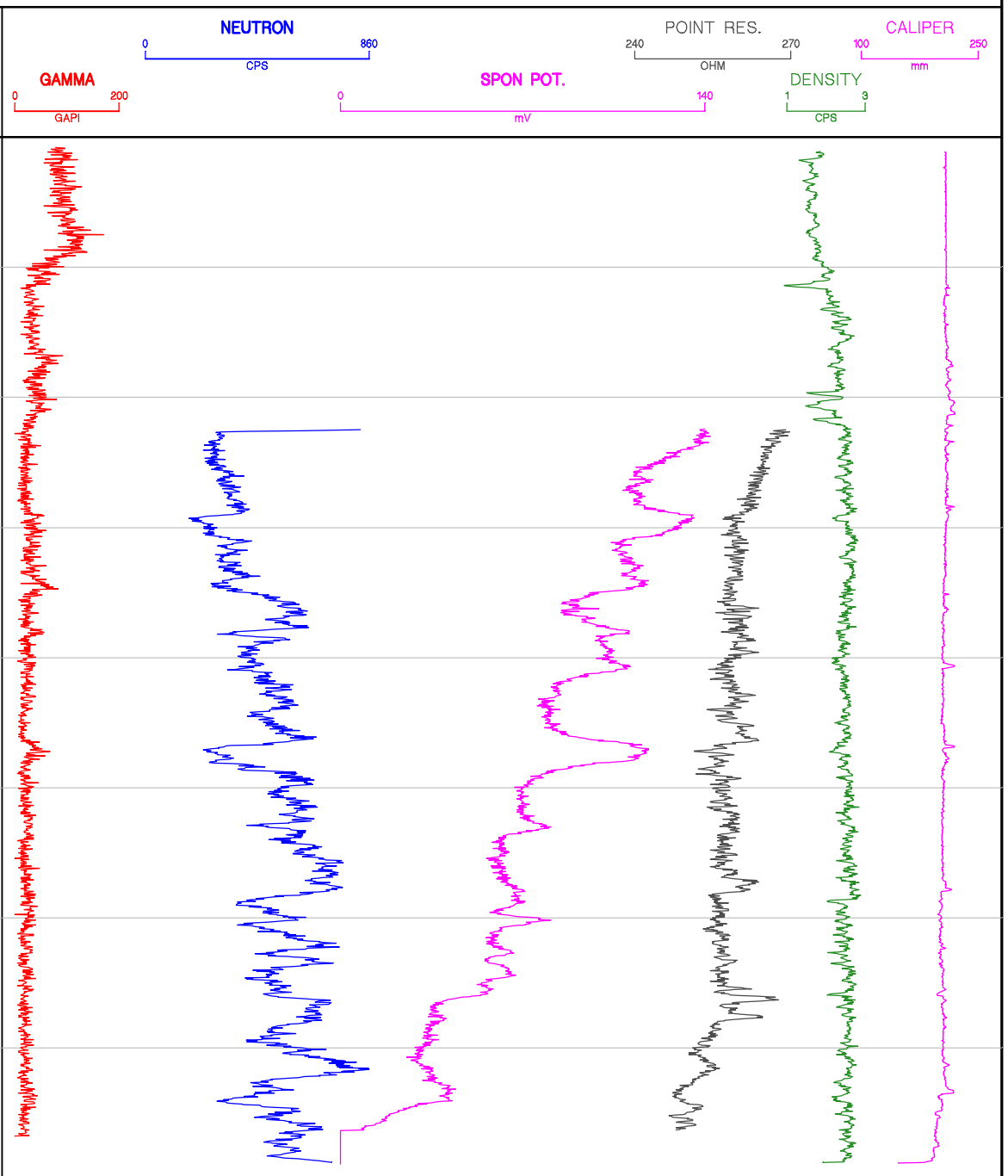
WELL SYMBOLS

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

DEPTH (m)	AGE	UNIT	LITHOLOGY DESCRIPTION
0	CAINOZOIC		0–0.1m Topsoil. Silty clay, grey, some sand, some organic material. 0.1–9m Sandy silty clay. Pale orange–brown, some cream calcareous gravel and qtz gravel to 2mm, some qtz grains to 1mm, increase in sand content towards base.
20	PROTEROZOIC	SKILLOGALEE DOLOMITE	9–15m Weathered Dolomitic Marble. Pink, cream, some dark grey, sub–angular grains, clayey matrix, slightly siliceous, weakly calcareous cement, minor quartz. 15 –21m Weathered Dolomitic Marble. Red, yellow, orange, pink and white, sub–angular, fairly silceous looking matrix with some clay, weakly calcareous cement in parts, some recrystallised material, rare fine opaques, some Fe rich material with black surface staining, some friable material, weak schistosity. 21–27m Dolomite Marble. Pale grey/pale pink & white. Fine to coarse grained, granoblastic texture, minor recrystallised quartz, minor organic material, strong mineral lineation in parts, non–calcareous. 27–39m Dolomite Marble. Weathered in parts. Pale brown with minor white, yellow and pink. Medium grained, sub–angular, granoblastic texture, minor quartz and opaques, some ?feldspar, minor clay and some minor green discolouration (chloride??). 39–48m Dolomite Marble. Weathered in parts. White, pale grey and some pink, some brown, sub–rounded grains, granoblastic texture, rare opaques, increase in brown material towards base. 48–102m Dolomite Marble. Pale blue grey and white, fine to medium grained, mostly sutured, sub–rounded to sub–angular, granoblastic texture, rare opaques, weakly calcareous cement, some brown orange fragments <5% (may be fall in) rare fine to medium opaques, some dark grey quartz, some fines, silt and talc.
40			
60			
80			
100			102–108m Dolomite Marble. As above but with minor pyrite (<1%) occurring as isolated crystals (1mm) occurring as isolated crystals, discrete massive clusters (3–4mm), some fine material (silt and minor talc). 108–128m Dolomite Marble. Pale blue grey dolomite marble with sugary texture, mostly marble, rest as above but with minor pyrite and massive talc fragments to 15mm, rare opaques.
120			TD 128m

CONSTRUCTION and LITHO. LOG

HYDRO DATA



Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1407

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Rotary Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 6th June 1997 FINISH 7th June 1997
TOTAL DEPTH 39.9 m

	mm	From (m)	To (m)
HOLE DIAMETER	304	0	3
	251	3	37.4
CASING DIAMETER (Cemented)	263	0	2.5
CASING DIAMETER (Uncemented)			
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD		TOTAL DISSOLVED SOLIDS	
		m³/day	Method of Test	mg/litre	Analysis W No.
10	4	86.4	Airlift	1317	
21		259.2	Airlift	1311	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	BULK DENSITY
DATE OF RUN	23/7/97	23/7/97	23/7/97	23/7/97	23/7/97	23/7/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	39.35	39.35	39.35	39.35	39.35	39.35
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. UNIT No. 6630–2793 PERMIT No. 41497
LOCATION Wendouree
Lat. 33°51.529' Long. 138°37.684'
REF. ELEV. m SURFACE ELEV. m DATUM
LOGGED BY D. Morton DATE 7th June 1997

WELL SYMBOLS

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

DEPTH (m)	AGE	UNIT	LITHOLOGY DESCRIPTION
0	CAINOZOIC		0–4 m CLAY. Brown, plastic, firm to moderately stiff, some angular gravel to 20 mm comprising grey and grey/black dolomite, slightly calcareous.
	PROTEROZOIC	SADDLEWORTH FORMATION	4–6 m SILTY DOLOMITE. Grey and grey/black, sub–fissile fragments and hard massive fragments exhibiting a slightly conchoidal fracture in parts, mostly grey dolomite (80%) lesser grey/black dolomite (20%), calcareous when scratched.
			6–24 m SILTY DOLOMITE. Grey and grey/black, mostly bedded fragments exhibiting micro laminae, some wavy laminae, and occasional schistosity oblique to bedding observed in some fragments. Mostly grey/black dolomite with lesser grey dolomite quite silty, some weathered fine grained brown slightly sandy fragments, rare hard white irregular calcareous nodules (calcite) up to 2 mm, rare white well rounded quartz (5 mm in size) increasing in size with depth (up to 10 mm).
20			24–27 m SILTY DOLOMITE. As above but with minute copper–brown pyrrhotite staining and fine grained weathered pyrite.
			27–39 m SILTY DOLOMITE. As above but with abundant pyrite (10%) showing cubic crystal habit, mainly fine grained and disseminated throughout or in clusters up to 5 mm in width, rare well rounded white quartz grains up to 3 mm, rare pyrrhotite coating on cleavage planes at approx 30 m. A decrease in amount of pyrite from 33–36 m, some white highly calcareous nodules (calcite), minor pale grey dolomite.
40			TD 39.9m
60			
80			
100			
120			

CONSTRUCTION and LITHO. LOG

HYDRO DATA

NEUTRON 0 700 CPS
GAMMA 0 150 GAPI
SPON POT. 30 130 mV
POINT RES. 100 120 OHM
CALIPER 200 400 mm
BULK DENSITY 500 1100 CPS

Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1408

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Rotary Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 7th June 1997 FINISH 12th June 1997
TOTAL DEPTH 116.8 m

	mm	From (m)	To (m)
HOLE DIAMETER	250	0	5.5
	202	5.5	116.8
CASING DIAMETER (Cemented)	206	0	5.5
CASING DIAMETER (Uncemented)			
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
5	4	43.2	Airlift		
15		86.4	Airlift	1200	
51		172.8	Airlift	1105	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	DENSITY
DATE OF RUN	23/7/97	23/7/97	23/7/97	23/7/97	23/7/97	23/7/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	117.9	117.9	117.9	117.9	117.9	117.9
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. ..... UNIT No. 6630–2794 PERMIT No. 4149B
LOCATION Wendouree
Lat. 33°51.543' Long. 138°37.666'
REF. ELEV. ..... m SURFACE ELEV. ..... m DATUM .....
LOGGED BY D. Morton DATE 10th June 1997

WELL SYMBOLS

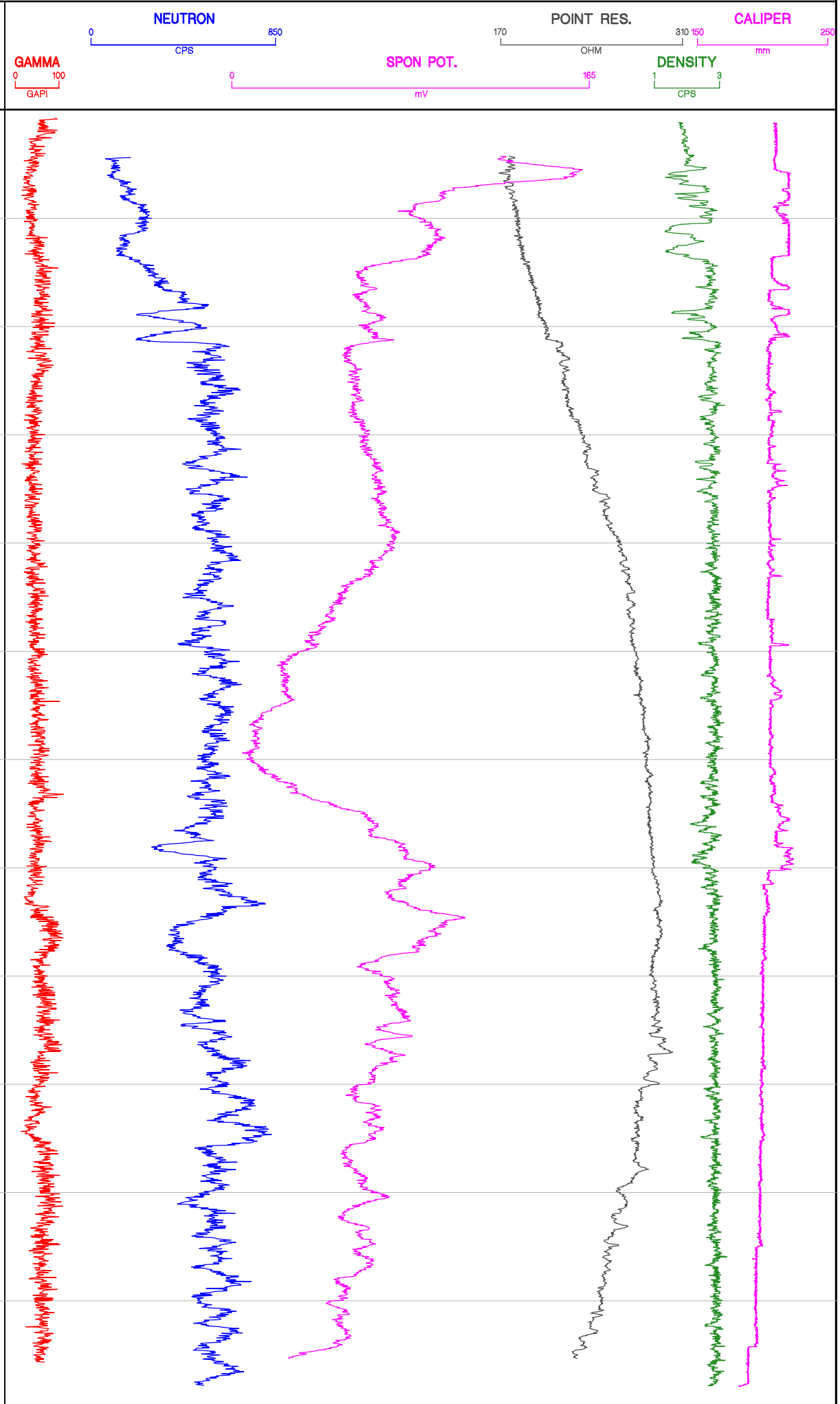
Casing seal — Slotted casing
Casing shoe — Cemented interval
Wire wound screen — Gravel packed Interval

LITHOLOGY

DEPTH (m)	AGE	UNIT	DESCRIPTION
0	CAINOZOIC		0–5 m CLAY. Brown with minor grey, plastic, soft to slightly firm, quite sandy, fine to medium sub–angular sand grains, sub–angular quartz gravel to 10mm, some calcareous gravel to 20mm.
			5–21 m SILTY DOLOMITE. Grey and grey/black dolomite with minor soft weathered pale brown dolomite, mainly sub–fissile, some dark grey laminae 1–2mm every 6mm, rare white calcareous nodules throughout. Fractures/cleavages appear to be lined with pale grey silt.
20			21–60 m SILTY DOLOMITE. Grey and grey/black dolomite, mostly grey/black, sub–fissile to fissile some minor laminae and wavy laminae, occasional massive fragments, some soft pale grey weathered cleavage planes, some soft grey–brown dolomite, minor coarse sub–rounded white quartz grains, some disseminated pyrite (<1%) exhibiting cubic crystal structure extremely fine to 1mm, possible fracture surfaces containing brown oxide staining. Larger dolomite fragments are dark grey in colour and weathered to a pale grey along the split or cleavage surface. Increase in soft grey–brown dolomite to 10% from 48–51 metes.
40			
	PROTEROZOIC	SADDLEWORTH FORMATION	
60			60–69 m SILTY DOLOMITE. Grey and Grey/black dolomite composed mainly of silt and mud held by a calcareous cement. Pale grey laminae defined by a change in colour, increase in pyrite crystals very fine to 1mm at various stages of formation although the majority showing some cubic crystal structure and occurring either concentrated along bedding planes and in short seams up to 10mm long concordant with bedding, or in short seams up to 15mm long cross–cutting bedding, pyrite appears mainly associated with the softer paler grey laminae (which may represent an infilled fracture along a cleavage plane?). Other fractures appear clean or covered in a white calcareous 'crust', some pyrite clusters on some surfaces.
80			72–99 m SILTY DOLOMITE As previous but with more pyrite (3–5%) and organic carbon content, rare white calcareous nodule, quite silty throughout.
100			99–102 m SILTY DOLOMITE. Grey and grey/black dolomite, sub–fissile, minor disseminated pyrite, rare white/grey clay, less silt than previous.
			102–116.8 m SILTY DOLOMITE. Grey and grey/black, sub–fissile, increase in grain size of pyrite (to 2mm), minor quartz (mostly associated with pyrite), silt throughout.
			TD 116.8m
120			

CONSTRUCTION and LITHO. LOG

HYDRO DATA



Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1409

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 13th June 1997 FINISH 15th June 1997
TOTAL DEPTH 100 m

	mm	From (m)	To (m)
HOLE DIAMETER	250	0	7
	202	7	100
CASING DIAMETER (Cemented)	206	0	7
CASING DIAMETER (Uncemented)			
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
4	9	172.8	Airlift		
34	5	86.4	Airlift	561	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	DENSITY
DATE OF RUN	15/7/97	15/7/97	15/7/97	15/7/97	15/7/97	15/7/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	105.0	105.0	105.0	105.0	105.0	105.0
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. UNIT No. 6630–2795 PERMIT No. 4149
LOCATION Pearce Road
Lat. 33°56.318' Long. 138°39.053'
REF. ELEV. m SURFACE ELEV. m DATUM
LOGGED BY D. Morton DATE 13th June 1997

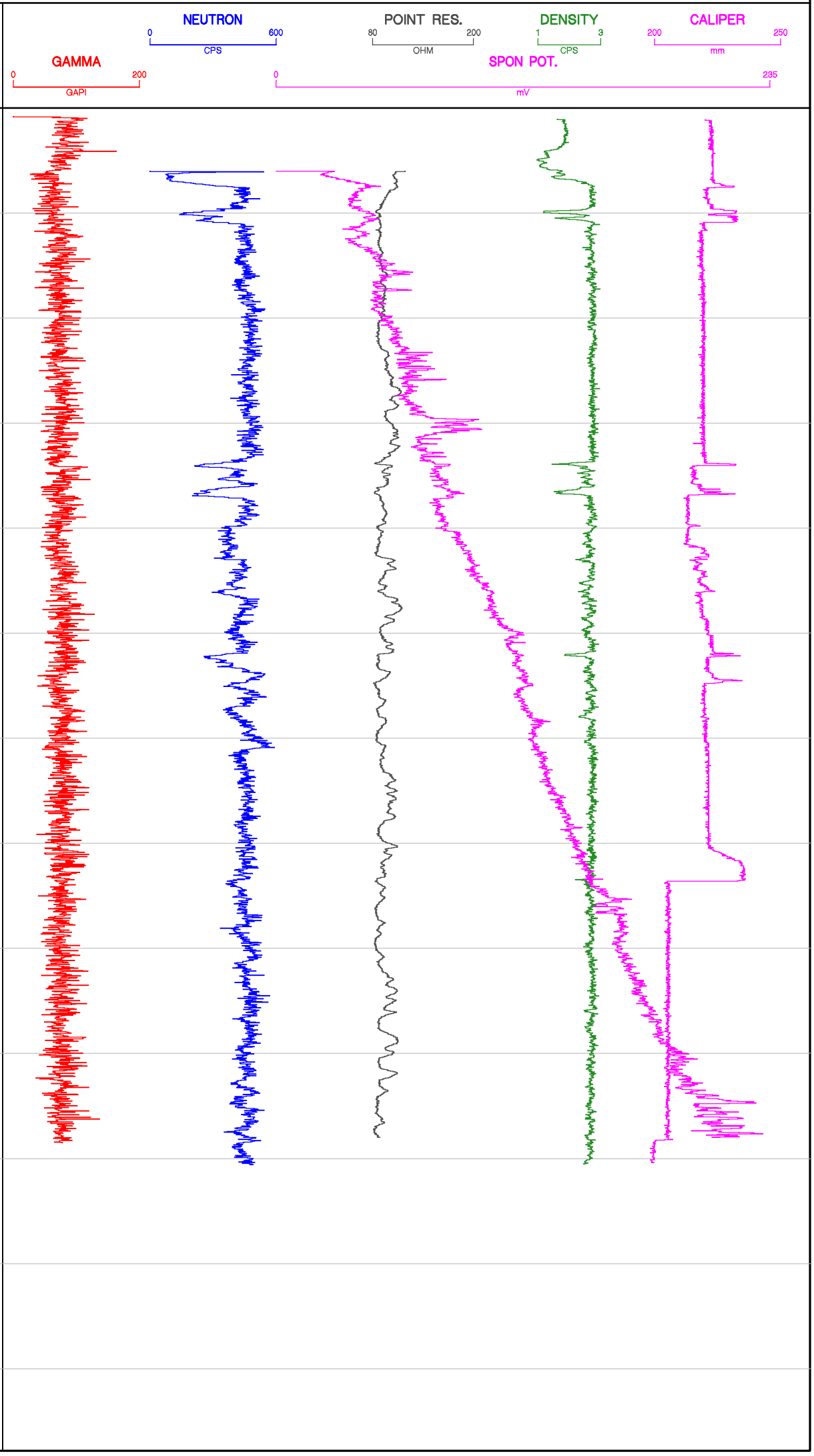
WELL SYMBOLS

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

DEPTH (m)	AGE	UNIT	DESCRIPTION
0	CAINOZOIC		0–3m CLAY Brown, soft, damp, some sand, silt and gravel. 3–7m Gravelly CLAY Grey–brown, soft to firm, wet, very sticky.
			7–15m DOLOMITIC META–SILTSTONE Grey laminated siltstone, fissile, weakly calcareous in parts interbedded with minor fine grained calcareous sandstone. Fractures concordant or discordant to SO & infilled with a soft pale grey silt or stained with a brown oxide. Rare white calcareous nodules throughout. Large fracture struck at 10.2 metres.
20			15–26m DOLOMITIC META–SILTSTONE As above but with massive pyrite up to 1mm sometimes in association with white recrystalized quartz, orange oxide staining on fragments from 21–24 metres.
			26–36m DOLOMITIC META–SILTSTONE Grey siltstone, fairly massive, fracturing tends to occur along a preferred plane of orientation. Fracture surfaces are either clean or associated with a white calcareous powder, rare fine pyrite grains up to 2mm in size exhibiting a cubic crystal habit occur in the fracture surface.
40	PROTEROZOIC	MINTARO SHALE	36–54m DOLOMITIC META–SILTSTONE As above but with abundant clear and white highly calcareous angular carbonate fragments and rare cubic pyrite crystals up to 4mm generally found in association with the calcite (probably vein material) or as massive inclusions up to 4mm, some grey green siltstone.
60			54–100m DOLOMITIC META–SILTSTONE Grey siltstone, laminated in parts a preferred orientation of fracturing observed, some massive pyrite clusters associated with the laminae which are parallel to the dominant fracture surface. Fractures appear to be coated with a white weakly calcareous material, rare bronzy pyrrhotite coating on some surface, some pyrite clusters 2–3mm wide throughout.
80			
100			TD 100m
120			

CONSTRUCTION and LITHO. LOG

HYDRO DATA



Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1410

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Rotary Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 16th June 1997 FINISH 18th June 1997
TOTAL DEPTH 99.2 m

	mm	From (m)	To (m)
HOLE DIAMETER	300	0	1.3
	250	1.3	12
	202	12	99.2
CASING DIAMETER (Cemented)	251	0	1.3
	206	0	9.4
CASING DIAMETER (Uncemented)			
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
4	3	86.4	Airlift		
19	3.1	21.6	Airlift	800	
43	3.1	21.6	Airlift	830	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	DENSITY
DATE OF RUN	14/10/97	14/10/97	14/10/97	14/10/97	14/10/97	14/10/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	99.7	99.7	99.7	99.7	99.7	99.7
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. UNIT No. 6630–2796 PERMIT No. 4150
LOCATION Watervale Oval
Lat. 33°57.539' Long. 138°38.750'
REF. ELEV. m SURFACE ELEV. m DATUM
LOGGED BY D. Morton DATE 16th June 1997

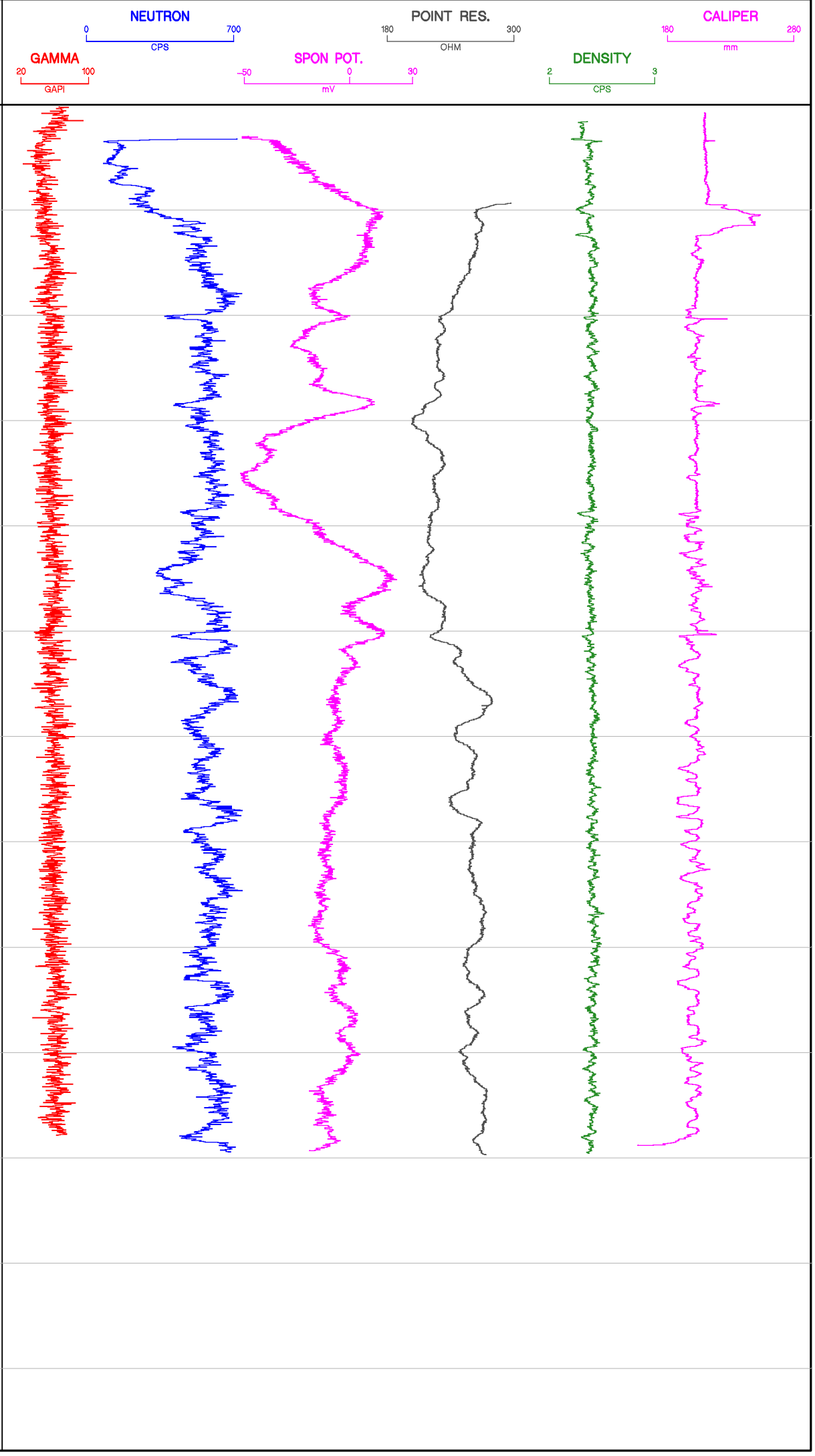
WELL SYMBOLS

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

DEPTH (m)	AGE	UNIT	DESCRIPTION
0	CAINOZOIC		0–4.5m CLAY Brown, dry, stiff, calcareous, some gravel, minor silt. 4.5–6m CLAY & GRAVEL BEDS Brown, wet, good plasticity (PL), calcareous in parts some white gravel. 6–8m GRAVEL & CLAY River bed gravel to 30mm some brown, wet, plastic calcareous clay, some grey calcareous siltstone fragments.
	PROTEROZOIC	MINTARO SHALE	8–27m DOLOMITIC META–SILTSTONE Dark grey bedded siltstone, fissile to sub–fissile (calcareous in parts), abundant silt some interbedded very fine grained calcareous sandstone containing sub–rounded quartz grains and minor opaques, set in a silt matrix with calcareous cement, rare pyrite grains approx 1mm exhibiting a cubic crystal habit, some fine black laminae <0.5mm thick occurring every 1–2mm over a 10mm thick interval, fracture surfaces are identified by a brown–orange oxide surface coating, abundant silt.
20			27–51m DOLOMITIC META–SILTSTONE Dark grey, thinly bedded siltstone, fissile, flakey in appearance, as above but some highly calcareous white angular (calcite?) fragments to 10mm, more bedded than previous, pyrite and lesser pyrrhotite observed along laminae either in clusters or as discrete grains exhibiting 1 to 2 striated crystal faces and increasing in size with depth (up to 6mm), highly fractured zone from 48–51 exhibited by abundant white calcareous vein material in the sample.
40			
60			51–99.2m DOLOMITIC META–SILTSTONE As previous but with occasional pyrite and rare pyrrhotite, decrease in pyrite and pyrrhotite content with depth.
80			
100			TD 99.2m
120			

CONSTRUCTION and LITHO. LOG

HYDRO DATA



Job No. QD6 101044DM.DTA

MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENVIRONMENTAL SERVICES

PLAN No. 97–1411

COMPOSITE WELL LOG

CONSTRUCTION DETAILS

DRILLING METHOD Rotary Hammer
CIRCULATION Air
MUD RESISTIVITY/TYPE
START 19th June 1997 FINISH 23rd June 1997
TOTAL DEPTH 99.5 m

	mm	From (m)	To (m)
HOLE DIAMETER	250	0	7.5
	202	7.5	99.5
CASING DIAMETER (Cemented)	206	0	7.5
CASING DIAMETER (Uncemented)			
SCREEN DETAILS	OH		

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO SWL (m)	YIELD m³/day	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
51	5.2	86.4	Airlift	683	

REMARKS

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	CALIPER	SPON POT	PT RES	DENSITY
DATE OF RUN	22/7/97	22/7/97	22/7/97	22/7/97	22/7/97	22/7/97
FIRST READING (m)	0	0	0	0	0	0
LAST READING (m)	99.85	99.85	99.85	99.85	99.85	99.85
RECORDED BY	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor	B. Taylor

PROJECT Clare Valley Groundwater Assessment
FIELD No. UNIT No. 6630–2797 PERMIT No. 41501
LOCATION Watervale Oval
Lat. 33°57.555' Long. 138°38.802'
REF. ELEV. m SURFACE ELEV. m DATUM
LOGGED BY D. Morton DATE 19th June 1997

WELL SYMBOLS

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

DEPTH (m)	AGE	UNIT	LITHOLOGY DESCRIPTION
0	CAINOZOIC		0–3m CLAY & GRAVEL Red–brown dry, stiff, clay, over pale grey dry, highly calcareous clay, over grey, yellow–orange and white river gravel. 3–10m WEATHERED DOLOMITIC META–SILTSTONE Pale grey and grey thinly bedded weathered siltstone, fissile enlongated agregates, laminated in parts, some white calcrete nodules 1mm to 5mm, some oxide stained fragments, weathered grey/brown siltstone constitutes 10–15% of volume. 10–18m DOLOMITIC META–SILTSTONE Dark–grey siltstone, fissile and hard, fine black laminae in parts, some fine–medium hard white calcareous nodules throughout, occassional brown oxide stained cleavage/bedding plane, some very fine sandstone fragments observed, some small whitish blebs observed on some fragments indicating a varying carbonate compostion throughout. 18–48m DOLOMITIC META–SILTSTONE As above but increase in amount of brown oxide staining on some surfaces in the 18–21 metre interval. Some pyrite, occurring either disseminated or in massive lenses either forming along laminae or infilling cleavages, some finely disseminated pyrrhotite.
40	PROTEROZOIC	MINTARO SHALE	48–57m DOLOMITIC META–SILTSTONE As previous, slight increase in amount of pyritic surfaces and veins and white carbonate surfaces and veins, increse in size of discrete pyrite grains up to 2mm, showing 1–2 crystal faces and striated surfaces. 57–99.5m DOLOMITIC META–SILTSTONE As previous but less pyrite.
100			TD 99.5 m

CONSTRUCTION and LITHO. LOG

HYDRO DATA