

Appendices

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Note: A copy of all Appendices are available on the Project CD

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Appendix 1

EM Operation

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(Adapted from report by J Lucas, Terrabyte Services, Wagga Wagga).

The EM 31 instrument does not come into direct physical contact with the soil. It uses induced electromagnetic fields to collect information about the soil.

These electromagnetic fields are induced as a result of electromagnetic fields that are generated by the EM 31. The EM 31 instrument generates a primary magnetic field (**Figure A1**). This field induces an electric current to flow through the soil. The current produced in the soil as a result of the EM 31 primary field creates secondary magnetic field. The intensity of the secondary field is proportional to the strength of the induced soil current. Because the primary field is of constant intensity the strength of the induced current will fluctuate only as a result of varying conductivity of the soil profile.

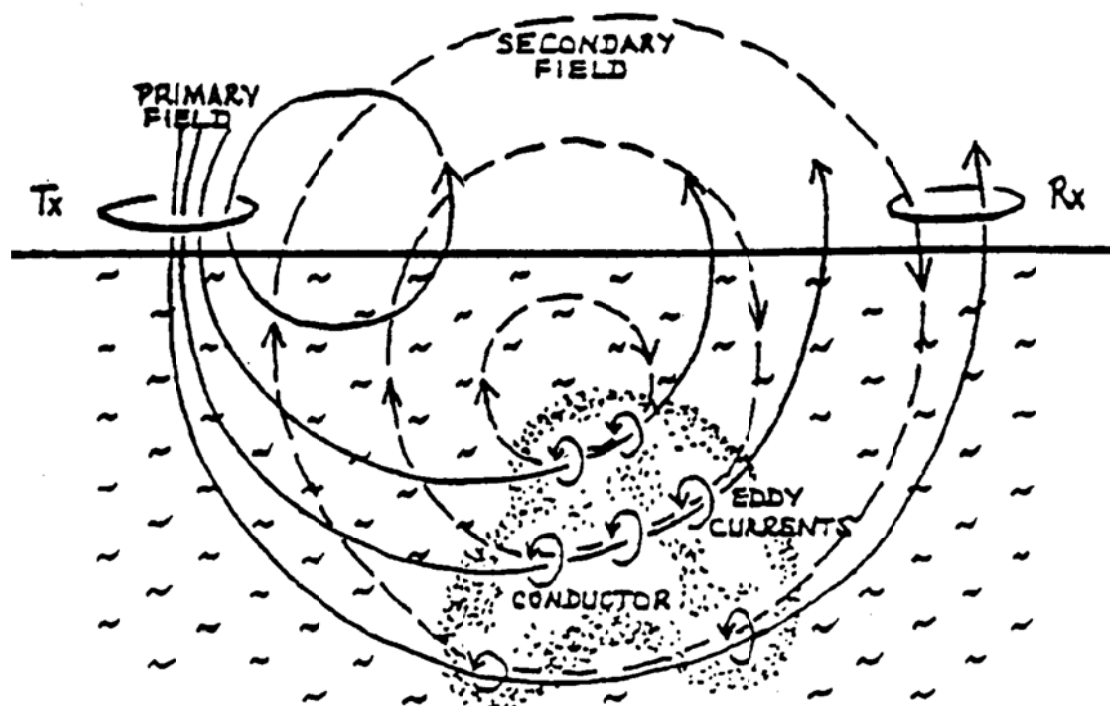


Figure A1. Electromagnetic induction in the earth

In summary the EM 31 instrument produces the primary field, detects the secondary field and then assigns a value to the strength of this secondary field. This value has been calibrated to reflect the conductivity of the soil profile.

Cultural Anomalies

Cultural anomalies are man-made objects that interfere with the readings produced by the EM 31. These objects are usually metal or encased metal such as reinforced concrete. When they are close to the meter they produce a negative response bordered by very high responses. In the case of this survey the most common anomalies were fences. Where possible these features were avoided.

Most agricultural soils are made up of layers of soil within the profile. The EM 31 does not directly measure any one of these layers. Instead the EM 31 measures the average conductivity of the soil to a depth of 6 metres. This reading is known as the “**apparent conductivity**” (ECa).

Interpretation of EM 31 data

Six factors influence conductivity recorded by the EM 31. These are:

- The amount of space between the soil particles in the ground (the spaces are called pores, and the total amount of pores is called porosity).
- The amount of groundwater in the pores.
- The salinity of the groundwater in the pores.
- Temperature
- The type and amount of clay in the soil and rock.
- The type and amount of organic matter.

These six factors combine in a way that is unique to each site and determines the TRUE conductivity of the soil under the instrument.

Because each value of apparent conductivity represents a combination of the six factors described above, further information must be collected from the site to correlate the EM 31 data to soil types. Once the soil data has been collected from a number of areas within a survey site it should be possible to correlate each soil type with a range of values of apparent conductivity.

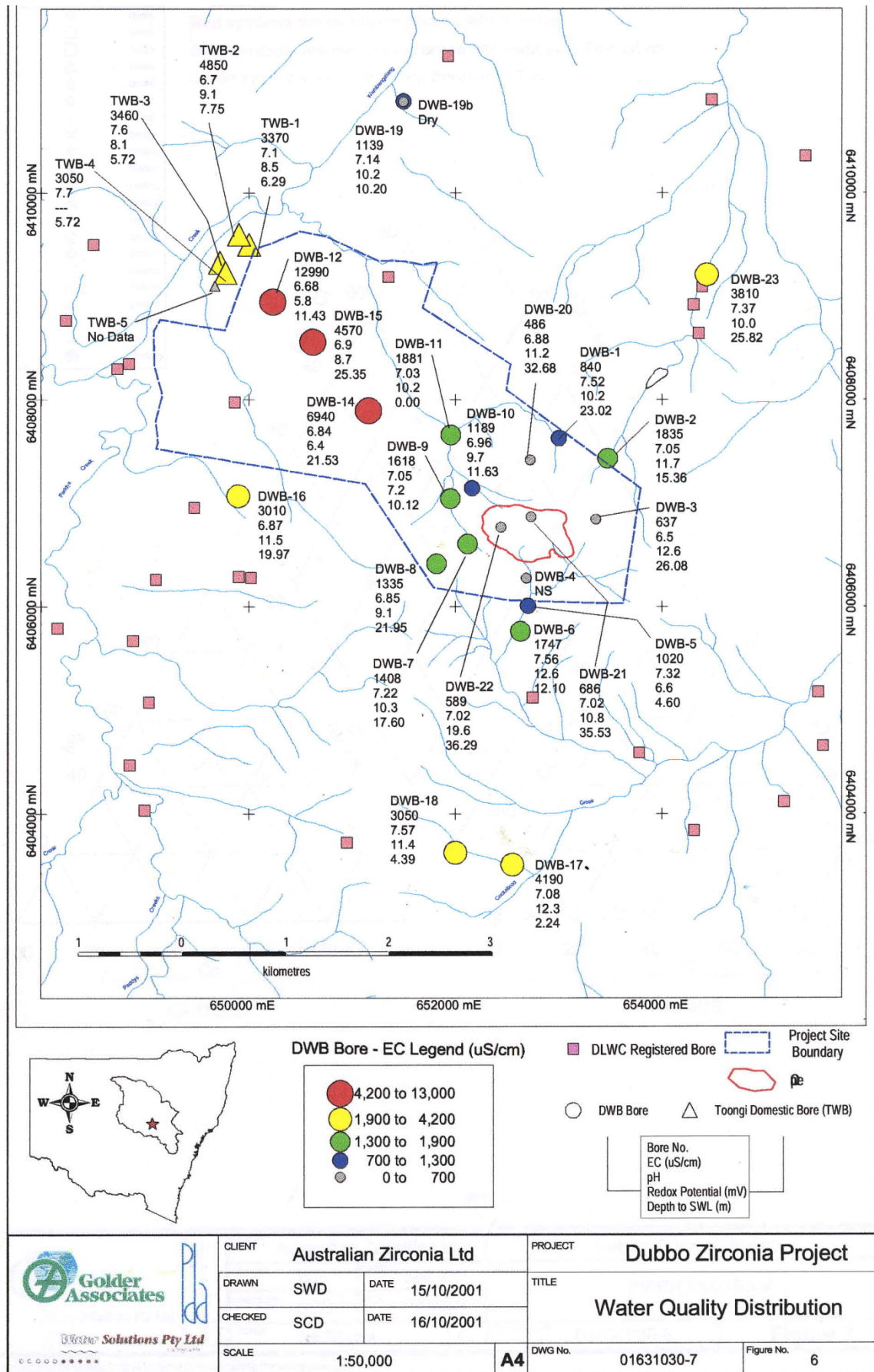
It is important to take geology, geomorphology, and prior land use into account when interpreting the generated during the EM 31 survey.

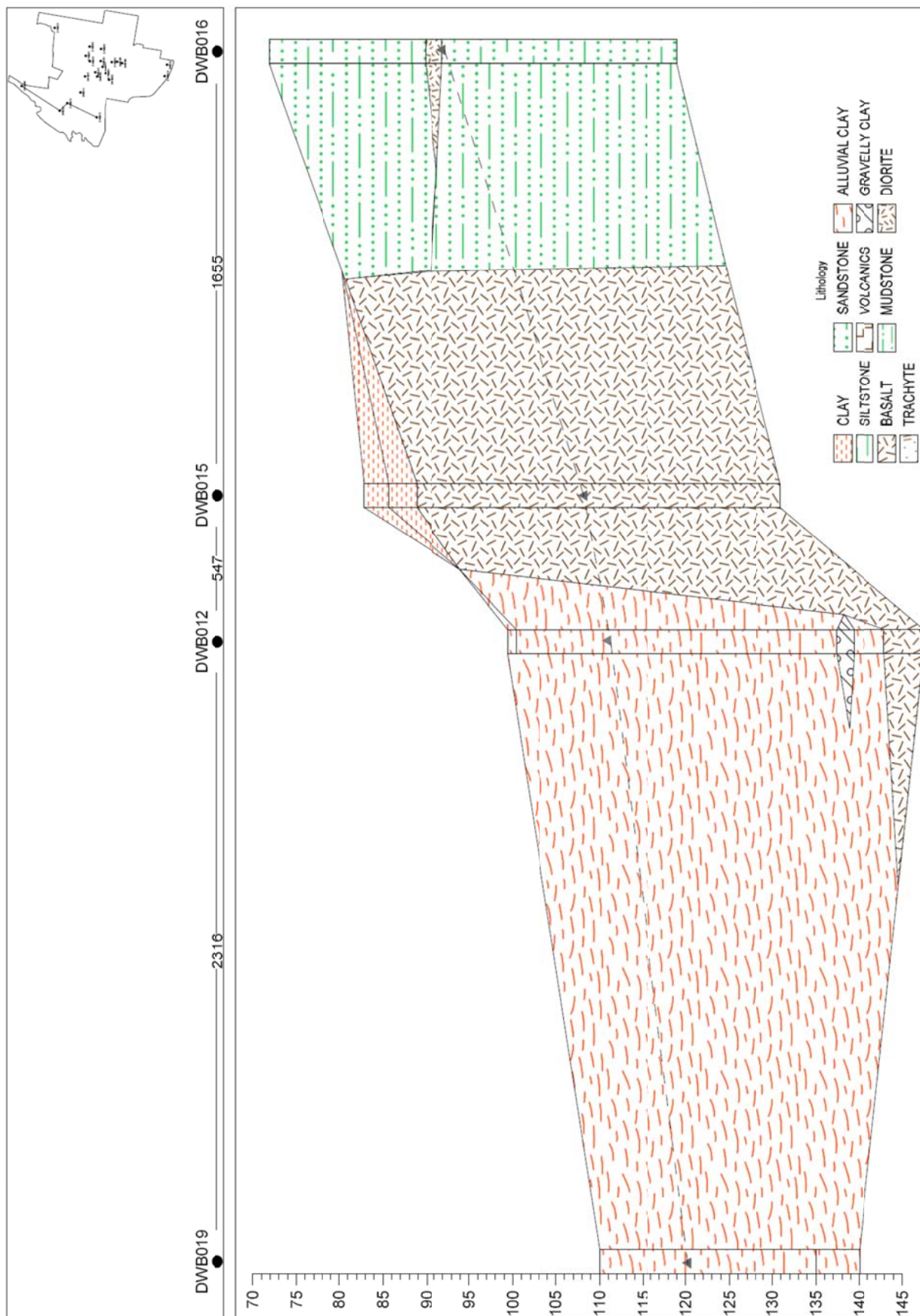
Appendix 2

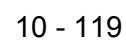
Piezometer Locations and Landscape Sections

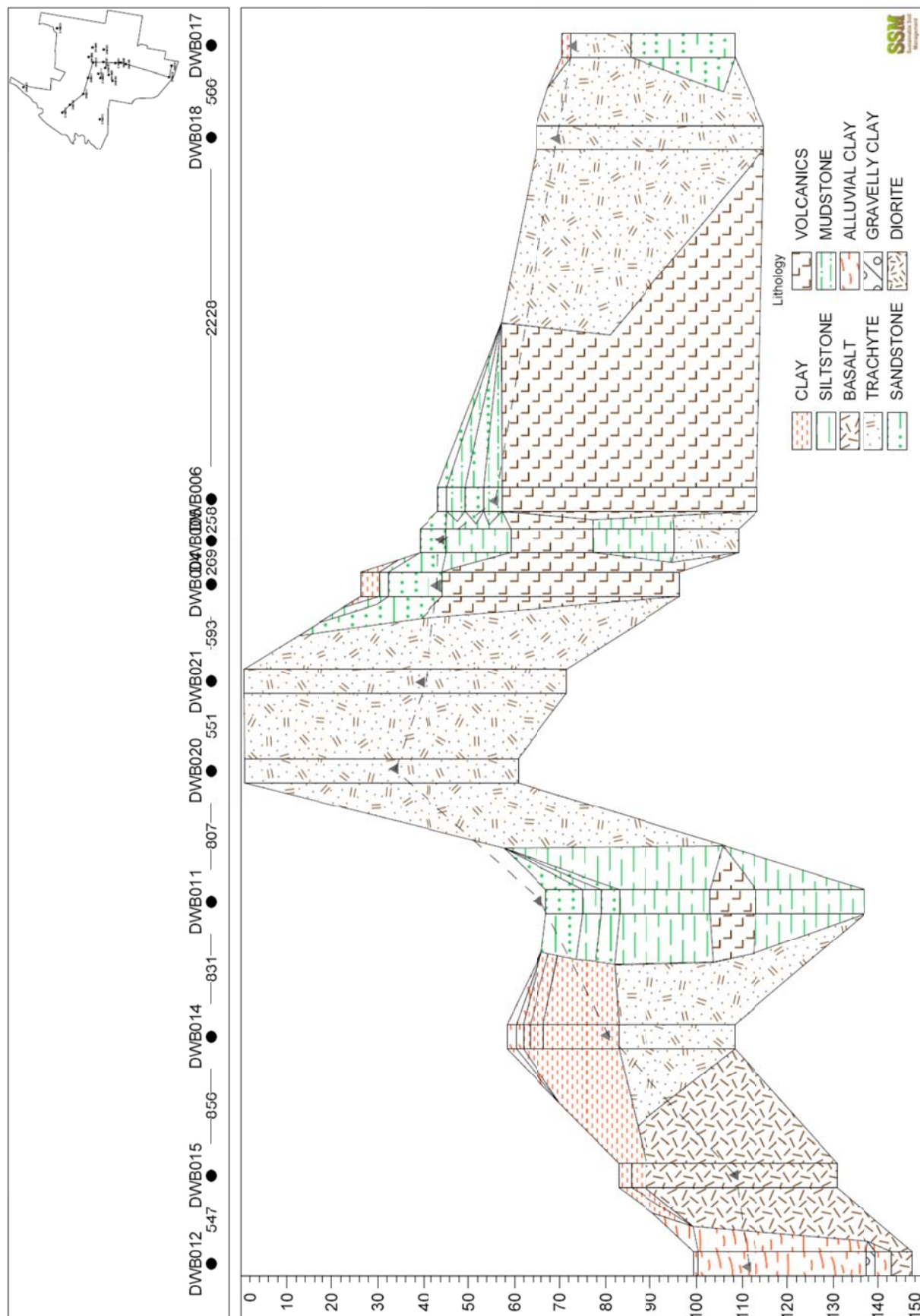
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Appendix 3


Geotechnical Logs

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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD201									
Date Excavated: 22/3/12		Logged by: PJH		Datum: WGS84		Easting: 649817		Northing: 6408045			
Equipment: Hitachi EX55UR		Surface Elevation(m): 307.0		ECa 163 mS/m							
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)		
0.5		CLAY (CI) Brown grey, moderately plastic, no dilatancy, medium toughness, high dry strength.	Firm		•	Wet	0	None			
		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, smooth clay coat	Firm		•	Moist	0	None	0.1		
		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, smooth clay coat	Firm		•	Moist	0	None			
1.0		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, smooth clay coat	Firm		•	Moist	0	None	0.3		
1.5		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, smooth clay coat			•						
2.0		EXTREMELY WEATHERED TRACHYTE Yellow grey, coarse grained, extremely low strength, extremely weathered trachyte									
2.5		Extremely weathered trachyte Bottom of hole at 1.9									



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Dubbo Zirconia Project Toongi Cr262									
TEST PIT OD202									
Date Excavated: 22/3/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 335.0		Easting: 650926		Northing: 6407852			
		ECa 38 mS/m							
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Silty CLAY (CL) Grey brown, slightly plastic, slow dilatancy, medium toughness, low dry strength, roots common		Hard	7.5	Moist	2	None	0
0.5		CLAY (CL) Grey brown, moderately plastic, slow dilatancy, low toughness, low dry strength, rough prismatic		Firm	15	Moist	0	Partial	0
1.0		Silty CLAY (CL) Orange brown, moderately plastic, no dilatancy, medium toughness, high dry strength, rough blocky							
1.5		DISTINCTLY WEATHERED TRACHYTE Yellow grey, very low strength							
2.0		Trachyte							
2.5		Bottom of hole at 1.2							
									
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TEST PIT OD203

Date Excavated: 22/3/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 324.0 Easting: 650683
ECa 59 mS/m Northing: 6407508

DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE CONSIS- TENCY	STRENGTH (kg/cm ²) 7.5 15	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		Silty CLAY (CL) Yellow brown, moderately plastic, moderate dilatancy, low toughness, low dry strength, structure blocky with rough surfaces, good bearing strength when dry, 2cm hard setting crust, macropore stable	Firm		Moist	0	None	
1.0		Silty CLAY (CL) Brown yellow, moderately plastic, no dilatancy, medium toughness, medium dry strength, structure blocky with rough surfaces,	Firm		Moist	0	Partial	0.1
1.5		Silty CLAY (CL) Brown yellow, moderately plastic, slow dilatancy, medium toughness, medium dry strength, structure blocky with rough surfaces,	Firm		Moist	0		
2.0		Silty CLAY (CL) Brown yellow, moderately plastic, slow dilatancy, medium toughness, medium dry strength, structure blocky with rough surfaces, manganese mottle common	Firm		Moist	0		0.1
2.5		Floaters coarse sandstone, Nodules manganese/ironstone Bottom of hole at 1.2						





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Date Excavated: 22/3/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 297.0		Easting: 649972					
		ECa 46 mS/m		Northing: 6408757					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Gravelly CLAY (CL) Orange red, slightly plastic, no dilatancy, low toughness, medium dry strength, structure blocky with rough surfaces, little silt; 30% subrounded sand		Firm		Moist	0	Partial	
0.5		Gravelly CLAY (CL) Orange red, moderately plastic, no dilatancy, low toughness, medium dry strength, structure blocky with rough surfaces, 40% subrounded fine gravel		Firm		Moist	0		0.1
1.0		Gravelly CLAY (CL) Brown yellow, moderately plastic, no dilatancy, medium toughness, medium dry strength, structure prismatic with rough surfaces, 30% subrounded fine gravel		Firm			0	Partial	0.1
1.5		Gravelly CLAY (CL) Brown yellow, moderately plastic, no dilatancy, medium toughness, medium dry strength, 40% subrounded fine to medium conglomerate		Firm		Moist	0	Partial	0.1
2.0		EXTREMELY WEATHERED CONGLOMERATE Brown yellow, matrix extremely weathered , extremely low strength Hill appears to be weathered conglomerate Bottom of hole at 1.4							
2.5									

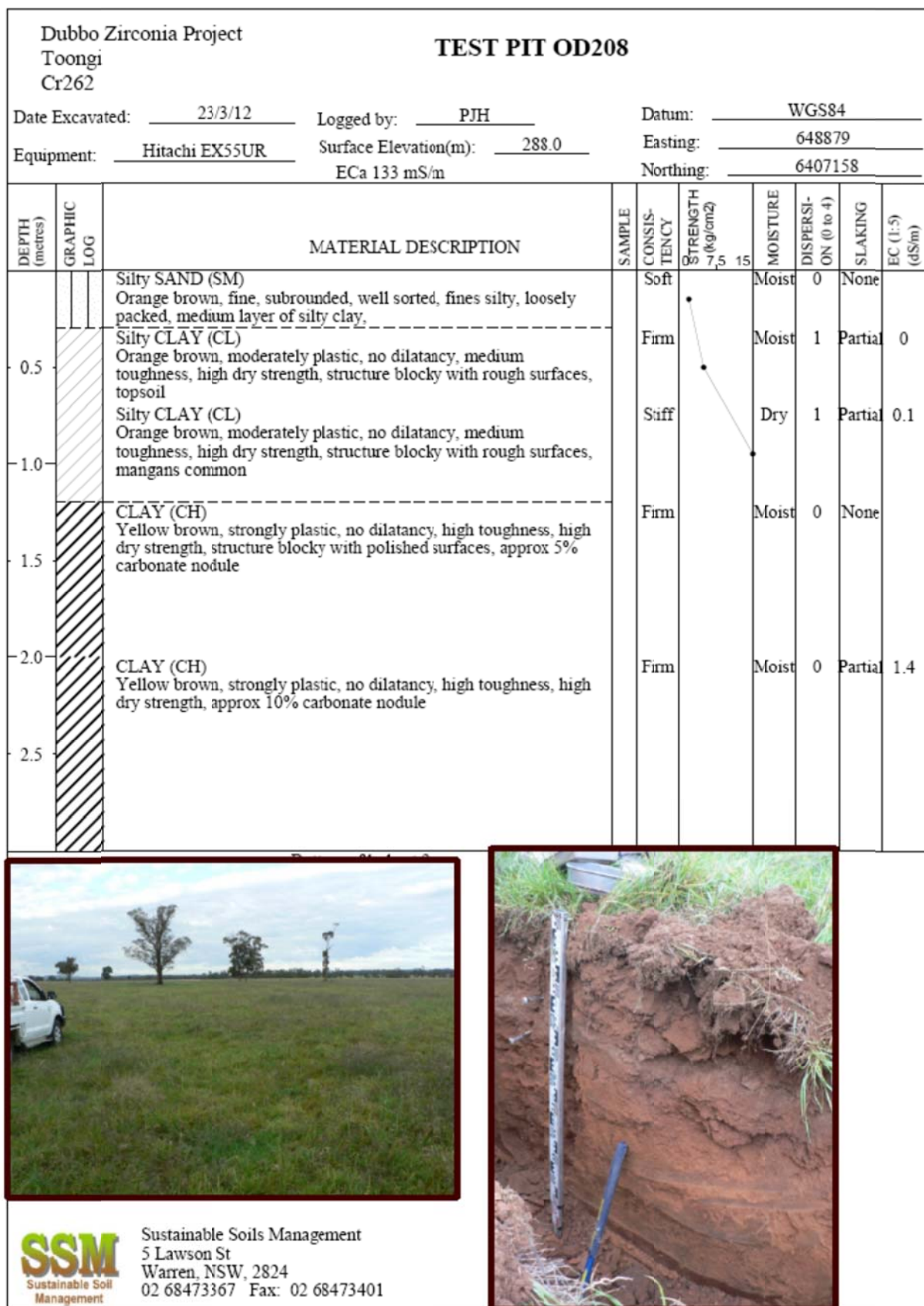


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Date Excavated: 22/3/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 377.0		Easting: 651668					
		ECa 122 mS/m		Northing: 6405509					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with polished surfaces,		Hard		Moist	0	Partial	
0.5		CLAY (CH) Brown yellow, strongly plastic, no dilatancy, high toughness, high dry strength, thick layer, structure blocky with polished surfaces, carbonate common (30%). Gravelly clay layer 10 cm thick		Hard		Moist	0	Partial	0.1
1.0		CLAY (CH) Brown yellow, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with polished surfaces, some slickensides		Stiff		Moist	0	Partial	0.6
1.5		Parent material is basalt Bottom of hole at 1.5							
2.0									
2.5									



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TEST PIT OD209

Date Excavated: 23/3/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 287.0 Easting: 648694
ECa 103 mS/m Northing: 6407430

DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		SILT (ML) Grey brown, slightly plastic, moderate dilatancy, low toughness, low dry strength, thick layer silty clay, structure blocky with rough surfaces, topsoil		Soft		Moist	0	Partial	
0.5		Silty CLAY (CL) Orange brown, slightly plastic, slow dilatancy, low toughness, medium dry strength, structure blocky with slickensided surfaces, macropores common		Soft		Moist	0	Partial	0
1.0		Silty CLAY (CL) Red brown, slightly plastic, no dilatancy, low toughness, medium dry strength, structure blocky with slickensided surfaces, macropores common. grey mottle common		Firm		Moist	0	Partial	0
1.5		CLAY (CL) Grey brown, moderately plastic, no dilatancy, medium toughness, medium dry strength,		Firm		Moist	3	Partial	
2.0									
2.5		Sandy CLAY (CL) Grey brown, slightly plastic, no dilatancy, medium toughness, medium dry strength, with fine sand, stiffer at bottom		Firm		Moist	3	Partial	0.6

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TEST PIT OD210

Date Excavated: 23/3/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 328.0 Easting: 652756
ECa 50 mS/m Northing: 6404493

DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Sandy CLAY (CL) Red brown, moderately plastic, no dilatancy, medium toughness, medium dry strength, with fine sand, thick layer, structure blocky with rough surfaces.		Soft		Moist	0	None	
0.5		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces, angular gravel		Firm		Moist	0	Partial	0
1.0		DISTINCTLY WEATHERED ANDESITE Grey yellow, low strength, breaks to angular blocks. Likely to be andesite, could be metasediment							
1.5		Bottom of hole at 1.4							
2.0									
2.5									

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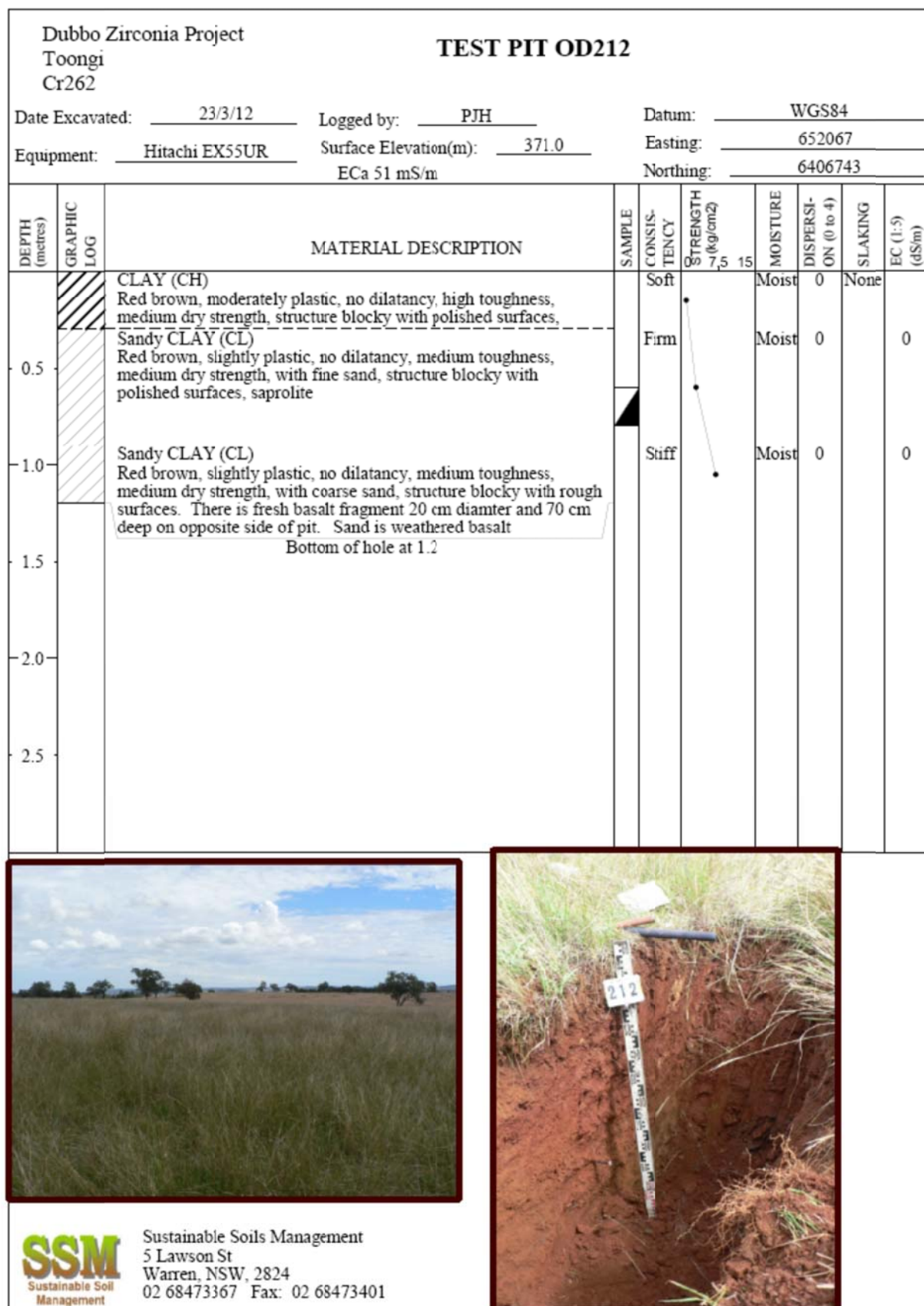
TEST PIT OD211

Date Excavated: 23/3/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 344.0 Easting: 652366
ECa 143 mS/m Northing: 6404861

DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Silty CLAY (CL) Brown grey, moderately plastic, no dilatancy, high toughness, high dry strength, tr silt, structure blocky with polished surfaces,		Soft		Moist	0	None	
0.5		CLAY (CI) Red grey, moderately plastic, no dilatancy, high toughness, high dry strength, with silt, structure blocky with polished surfaces,		Soft		Moist	2	Partial	0.1
1.0		CLAY (CH) Grey red, strongly plastic, no dilatancy, high toughness, high dry strength, tr silt, structure blocky with polished surfaces, trace carbonate nodule		Stiff		Dry	3	Partial	0.2
2.0		Silty CLAY (CL) Grey yellow, slightly plastic, no dilataacy, medium toughness, medium dry strength, tr silt, marl, strongly effervescent				Moist	1	Partial	
2.5		Silty CLAY (CL) Grey yellow, slightly plastic, no dilataacy, medium toughness, medium dry strength, carbonate common				Moist	1	Partial	

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TEST PIT OD213

Date Excavated: 23/3/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 346.0 Easting: 654590
ECa 34 mS/m Northing: 6408182

DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		Clayey SAND (SC) Brown grey, coarse, subangular, well sorted, fines clayey, loosely packed, weakly cemented, with clay Sandy CLAY (CL) Grey yellow, moderately plastic, no dilatancy, medium toughness, medium dry strength, with coarse sand, structure blocky with rough surfaces, red mottle common, trachyte floaters 10 to 50 cm Trachyte		Firm	15	Wet	0	None	
1.0		Bottom of hole at 1				Moist	1	Partial	0
1.5									
2.0									
2.5									

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Dubbo Zirconia Project Toongi Cr262			TEST PIT OD214						
Date Excavated: 23/3/12			Logged by: PJH			Datum: WGS84			
Equipment: Hitachi EX55UR			Surface Elevation(m): 356.0			Easting: 653448			
ECa 153 mS/m						Northing: 6408023			
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSISTENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSION (0 to 4)	SLAKING	EC (1:5) (dS/m)
		CLAY (CH) Grey red, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand,		Firm	7	Moist	2	Partial	
0.5		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand, structure blocky with polished surfaces, strongly slickenside carbonate modules common		Firm	15	Moist	0	None	1.2
		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand, structure blocky with polished surfaces, carbonate modules common		Stiff		Moist			
1.0		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand, few carbonate nodules		Stiff			0	None	
1.5									
2.0		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand, few carbonate nodules					0	None	
2.5									

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Dubbo Zirconia Project Toongi Cr262			TEST PIT OD236						
Date Excavated: 25/7/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 308.3		Easting: 654110					
		ECa 111 mS/m		Northing: 6411792					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH γ (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Silty CLAY (CL) Red grey, moderately plastic, no dilatancy, medium toughness, high dry strength, trace silt, structure blocky with rough surfaces, organic, trace fine gravel of angular sandstone,		Soft Firm	●	Moist	2	None	0
0.5		CLAY (CH) Grey red, strongly plastic, no dilatancy, high toughness, high dry strength, structure prismatic with polished surfaces, medium fissured,		Firm	●	Moist	0	Partial	1.7
1.0		CLAY (CH) Grey yellow, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with polished surfaces, few slickensides,		Firm	●	Moist	1	Partial	1.9
1.5		Sandy CLAY (CL) Grey yellow, slightly plastic, no dilatancy, medium toughness, medium dry strength, with fine sand, structure bedded with rough surfaces, mangans common. layer of extremely weathered sandstone from 80 to 90 cm.,				Moist			
2.0		EXTREMELY WEATHERED SANDSTONE Grey yellow, fine grained, extremely low strength, thinly laminated, with subhorizontal inclination, Bottom of hole at 1.2							
2.5									



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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD237							
Date Excavated: 25/7/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 295.5		Easting: 654333					
		ECa 74 mS/m		Northing: 6410950					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		Silty CLAY (CL) Red grey, slightly plastic, slow dilatancy, low toughness, medium dry strength, with silt, structure blocky with rough surfaces, roots common, Sandy CLAY (CL) Yellow brown, slightly plastic, slow dilatancy, low toughness, medium dry strength, trace silt, structure blocky with rough surfaces, macropores common, Sandy CLAY (CL) Yellow brown, slightly plastic, slow dilatancy, low toughness, medium dry strength, trace fine to medium gravel, structure blocky with rough surfaces, macropores common, water running into pit at 70 cm. ec 0.6 ds/m, Sandy CLAY (CL) Yellow brown, slightly plastic, slow dilatancy, low toughness, medium dry strength, with fine to medium gravel, Bottom of hole at 1.3		Soft	7.5	Moist	2	Partial	0
1.0				Soft	15	Moist	1	Partial	0
1.5				Soft		Wet	1	Partial	0
2.0				Soft		Wet	0	Partial	0
2.5									

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TEST PIT OD238



Date Excavated: 25/7/12 Logged by: PJH Datum: WGS84
Equipment: Hitachi EX55UR Surface Elevation(m): 313.3 Easting: 654435
ECa 67 mS/m Northing: 6409623


DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Clayey SAND (SC) Dark grey, fine to medium, subangular, poorly sorted, fines clayey, loosely packed, with clayey silt, roots common.				Moist	2	Partial	0
0.5		CLAY (CH) Yellow grey, strongly plastic, no dilatancy, high toughness, high dry strength, trace medium sand, structure blocky with rough surfaces, macropores common.		Firm		Moist	4	Partial	0
		Sandy CLAY (CL) Orange yellow, moderately plastic, no dilatancy, high toughness, medium dry strength, trace medium sand, structure blocky with rough surfaces, cemented layer 90 to 95 cm. cobbles extremely weathered sandstone common.		Firm		Moist	3	Complete	0.2
1.0		EXTREMELY WEATHERED SANDSTONE Grey white, fine grained, extremely low strength, medium laminated, with subhorizontal inclination, blocks medium sized, tabular shaped,				Moist	2	Partial	0.2
1.5		Bottom of hole at 1.4							
2.0									
2.5									

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

Dubbo Zirconia Project Toongi Cr262		TEST PIT OD239							
Date Excavated: 25/7/12		Logged by: PJH		Datum: WGS84		Easting: 653075		Northing: 6409634	
Equipment: Hitachi EX55UR		Surface Elevation(m): 330.5		ECa 111 mS/m					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		Silty CLAY (CL) Red grey, slightly plastic, slow dilatancy, medium toughness, high dry strength, with silt, structure blocky with rough surfaces, roots common.	Soft		7.5	Wet	0	Partial	0
		CLAY (CH) Grey brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces.	Firm		15	Wet	4	Partial	0
1.0		CLAY (CH) Grey brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces, carbonate nodules common. much drier than other pits sampled.	Stiff			Dry	0	Complete	0.7
1.5		CLAY (CH) Grey brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces, carbonate nodules common.,	Stiff			Dry	0	Complete	1.3
2.0		Bottom of hole at 1.2							
2.5									









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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD240							
Date Excavated: 26/7/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 332.4		Easting: 653175					
		ECa 36mS/m		Northing: 6409797					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Sandy CLAY (CL)		Soft		Moist	0	Partial	0
		Red grey, moderately plastic, no dilatancy, low toughness, low dry strength, with fine sand, structure blocky with rough surfaces, roots common. high organic matter. with fine gravel,		Soft		Moist	2	Partial	0
0.5		Gravelly CLAY (CH)		Stiff		Moist	0	None	0
		Red grey, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with rough surfaces, with fine gravel. high organic matter,		Stiff		Dry	0	None	0.2
1.0		Gravelly CLAY (CH)							
		Yellow grey, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, with fine gravel. carbonate nodules commcn. cobbles trachyte.,							
1.5		Gravelly CLAY (CH)				Dry			
		Yellow grey, strongly plastic, no dilatancy, high toughness, high dry strength, structure lenticular with slickensided surfaces, with fine gravel. carbonate nodules commcn. cobbles trachyte.,							
		EXTREMELY WEATHERED TRACHYTE							
		Yellow brown, , extremely low strength,							
		Bottom of hole at 1.3							
2.0									
2.5									






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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD242							
Date Excavated: 26/7/12		Logged by: PJH		Datum: WGS84		Easting: 653220		Northing: 6410268	
Equipment: Hitachi EX55UR		Surface Elevation(m): 332.2		ECa 151 mS/m					
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2)	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		CLAY (CH) Brown grey, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with rough surfaces, roots common,		Soft		Moist	1	Partial	0
		CLAY (CH) Brown grey, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with rough surfaces,		Soft		Moist	1	Partial	0.1
		CLAY (CH) Brown grey, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with rough surfaces,		Firm		Moist	1	Complete	0.5
1.0		CLAY (CH) Yellow brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces, macropores common,		Stiff		Moist	2	Complete	0.7
1.5		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces, few vertical macropores, Bottom of hole at 1.3							
2.0									
2.5									








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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD243							
Date Excavated: 26/7/12		Logged by: PJH		Datum: WGS84					
Equipment: Hitachi EX55UR		Surface Elevation(m): 328.0		Easting: 653267		Northing: 6410545			
ECa 53 mS/m									
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE	CONSIS- TENCY	STRENGTH (kg/cm2) 7.5 15	MOISTURE	DISPERSI- ON (0 to 4)	SLAKING	EC (1:5) (dS/m)
		Clayey SAND (SC) Grey brown, fine to medium, subangular, poorly sorted, fines clayey, loosely packed, with clayey silt, roots common.		Soft		Moist	0	Partial	0
0.5		CLAY (CH) Red brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace coarse sand, structure blocky with rough surfaces, grey mottle common.		Firm		Moist	2	Partial	0.3
1.0		CLAY (CH) Orange grey, strongly plastic, no dilatancy, high toughness, high dry strength, structure blocky with polished surfaces, with cobbles extremely weathered extremely low strength trachyte.,				Moist	1	Partial	1
1.5		EXTREMELY WEATHERED SANDSTONE White grey, fine grained, extremely low strength, medium bedded, with subhorizontal inclination.				Moist			
		EXTREMELY WEATHERED SILTSTONE White grey, , extremely low strength, thinly bedded, with subhorizontal inclination,							
		Bottom of hole at 1.4							
2.0									
2.5									








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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD244						
Date Excavated: 26/7/12		Logged by: PJH						
Datum: WGS84		Easting: 653172						
Equipment: Hitachi EX55UR		Surface Elevation(m): 317.8						
ECa 89 mS/m		Northing: 6411074						
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE CONSISTENCY	STRENGTH (kg/cm ²)	MOISTURE	DISPERSION (0 to 4)	SLAKING	EC (1:5) (dS/m)
0.5		CLAY (CH) Dark grey, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with rough surfaces, widely fissured, roots common,	Soft	•	Moist	2	Partial	0
		CLAY (CH) Grey brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces,	Firm	•	Moist	1	Partial	0.4
1.0		CLAY (CH) Grey brown, strongly plastic, no dilatancy, high toughness, high dry strength, trace fine sand, structure blocky with polished surfaces,	Very Stiff		Very Dry	0	Complete	1.6
		Bottom of hole at 1.05						
1.5								
2.0								
2.5								







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Dubbo Zirconia Project Toongi Cr262		TEST PIT OD245	
Date Excavated: <u>26/7/12</u>		Logged by: <u>PJH</u>	
Equipment: <u>Hitachi EX55UR</u>		Surface Elevation(m): <u>313.0</u> ECa 34 mS/m	
		Datum: <u>WGS84</u> Easting: <u>653368</u> Northing: <u>6411035</u>	
DEPTH (metres)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE CONSIS- TENCY STRENGTH (kg/cm ²) 7.5 15 MOISTURE DISPERSI- ON (0 to 4) SLAKING EC (1:5) (dS/m)
0.5		CLAY (CL)	Soft
		Red grey, moderately plastic, slow dilatancy, low toughness, medium dry strength, with silt, structure blocky with rough surfaces, roots common,	Soft
		CLAY (CI)	Soft
1.0		Grey red, moderately plastic, no dilatancy, high toughness, high dry strength, with fine sand, structure blocky with polished surfaces,	Wet
		CLAY (CL)	Wet
		Brown grey, moderately plastic, slow dilatancy, low toughness, medium dry strength, with fine sand, very little structure, contains cobbles extremely weathered trachyte. appears to be discharge area,	1 Complete 0.1
		Bottom of hole at 0.9	
1.5			
2.0			
2.5			



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Appendix 4

Soil Profile Descriptions

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Key to profile description:

TEXTURE (mineral particles finer than 2 mm.)

S	Sand	CL	Clay loam
LS	Loamy Sand	SiCL	Silty clay loam
CS	Clayey sand	FSCL	Fine sandy clay loam
SL	Sandy loam	SC	Sandy clay
FSL	Fine Sandy Loam	SiC	Silty clay
LSCL	Light Sandy Clay Loam	LC	Light clay
L	Loam	LMC	Light medium clay
LFS	Loam, Fine Sandy	MC	Medium clay
SiL	Silt Loam	HC	Heavy Clay
SCL	Sandy clay loam		

STRUCTURE (distinctness, shape and size of peds, which are natural soil aggregates)

GRADE		TYPE/SHAPE	
Soils with no observable peds:		PL	Platy
G	Single grained (loose individual particles)	PR	Prismatic
V	Massive (coherent)	CO	Columnar
Soils with observable peds:		AB	Angular blocky
W	Weak (<1/3 of soil material consists of peds when displaced)	SAB	Subangular blocky
M	Moderate (1/3 to 2/3 peds)	LE	Lenticular
S	Strong (>2/3 peds)	GR	Granular
		PO	Polyhedral
		Cr	Crumb
PED SIZE ## / ##		SOILPAK SCORE (indicator of soil suitability for root growth)	
First number is primary ped size.		2.0	Excellent
Second number is secondary ped size (smallest ped size).		1.5	Good, but could be better
		1.0	Moderate
		0.5	Poor, but could be worse
		0.0	Terrible

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OD201	Brown Vertisol				649817	m East		6408045	m North																			
	A1	0	7	MHC	5.5	Pink		Red		S	Cr	0.5	1.8		0	N	3					100			2	4		
	B21	7	30	HC	7.5	Light red		Red	common grey	S	LE	5/1	1.5		0	N	2										0.4	Layer 2 mottle looks like
	B22	30	65	HC	8	Light red		Red	common grey	S	LE	10/0.5			0	N	2											topsoil fallen down cracks
	B23	65	110	HC	8	Light red		Red	few grey	S	LE	10/1			0	N	1						50	121			1.1	Slickensides common in sub soil
OD202	Red Ferrosol				650926	m East		6407852	m North																			
	A1	0	15	LC	5	Light red		Red		S	Cr	0.2	2		2	N	3					100			3	5		
	B2	15	65	MHC	6.5	Light red		Red		S	AB	5/0.5	2		0	P	2										0.0	PO secondary structure in B2
	B3	65	100	MHC	7.5	Yellow		Yellow		S	AB	5/0.5	1.7		0	P	2						73	137			0.0	Mn on peds in B3
OD203					650683	m East		6407508	m North																			
	A1	0	15	SICL	5	Light red		Red		M	AB	5/1	1.8		0	N	3					90			3	4		
	B21	15	60	LC	7	Pink		Red		M	PR	5/1	1.7		0	P	2										0.4	Mn moduals below 60cm
	B22	60	135	SIC	7.5	Yellow		Yellow	common red	M	PR	2/1	0.8		0	C	1		Man	5%			81	131			0.5	
OD204					649972	m East		6408757	m North																			
	A1	0	10	CL	4.5	Light red		Red		M	AB	5/5	1.8		0	P	3	30%				100			3	4		
	B21	10	70	LC	6.5	Light red		Red		M	AB	2/2	1.8		0	C	3	40%									0.4	
	B22	70	120	LMC	7.5	Light red		Red	many grey	M	PR	5/5	0.7		0	P	1	30%	Man	10%			56	91			0.4	grey + red mottle
OD205					650199	m East		6408779	m North																			
	A	0	10	CL	4.5	BROWN				M	Cr	2	2		0	P	4	10%				80			3	3		
	B2	10	80	LC	6.5	RED BROWN		#N/A		S	AB	3	1.8		0	P	3											
	B22	80	145	LMC	6.5	YELLOWISH BROWN				M	PR	4	1		2	P	2		Man	10%			72	118				
OD206					649800	m East		6406969	m North																			
	A1	0	10	CL	5.5	Light red		Red		M	PO	1/5	1.8		0	N	3					45			3	5		Bedrock @45cm gravelly on surface
	B2	10	45	LC	6.5	Light red		Red		S	AB	2/5	1.7		0	N	2						42	67				
OD207	Vertic Red Dermosol				651668	m East		6405509	m North																			
	A1	0	10	CL	6	Pink		Red		S	PO	.2	2		0	P	4	10%				130			3	4		Surface is organic,
	B21	10	60	HC	7.5	Light red		Red		S	AB	2/2	1.9		0	P	2	10%									0.4	Slickensides in subsoil
	B22	60	85	MC	8.5	Pink		Red		S	PO	3/5	1.3		0	P	2	60%										
	B23	85	160	MC	9.5	Yellow		Yellow	few red	S	PR	5/5	1.3		0	P	1	0%	Man	15%	V		75	139			2.1	Mn is in B23

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OD208	Brown Chromosol or Sod					648879 m East		6407188 m North																					
	A1		0	30	CL	5.5	Reddish yellow	Yellow		M	AB	2	1.8		0	N	3						70			3	3		Drilled to 3m clay continues, lime present below 2m
	A2		30	40	SiCL	6	Reddish yellow	Yellow		V			1.4		1	P	2												
	B1		40	80	LMC	6.5	Reddish yellow	Yellow		S	AB	4	1.2		1	P	1										0.0		
	B2		80	115	MC	8	Reddish yellow	Yellow		S	PR	5	0.8		0	P	0		MAN	5%			68	103			0.4		
OD209						648694 m East		6407430 m North																					
	A1		0	30	CL	5	Reddish yellow	Yellow		M	AB	1.5	1.8		0	P	3						70			3	4		Variable in pit, light clay to 2.5m
	A2		30	50	SiCL	5.5	Reddish yellow	Yellow		W			1.2		4	C	2												
	B2		50	115	LC	6	Pink	Red	common grey	S	AB	5	1.2		0	P	1										0.0	with some SC till 3m- v disp	
	B22		115	170	LC	6.5	Reddish yellow	Yellow		M	AB	5	0.8		0	P	0						69	103			0.0		
OD210						652756 m East		6404493 m North																					
	A1		0	25	CL	6	Pink	Red		W	AB	0.5	1.9		0	N	3	20%					70			2	3		
	B1		25	45	LC	6.5	Reddish yellow	Yellow		M	AB	2	1.4		0	P	2	20%									0.0		
	B2		45	105	HC	7.5	Reddish yellow	Yellow	few grey	S	PR	6	0.8		0	P	1	20%					45	77			0.0	bedrock metasandiment	
OD211	Red Vertosol					652366 m East		6404861 m North																					
	A1		0	10	HC	8	Pink	Red		S	PO	0.4	1.8		0	N	2						100			2	4		
	B2		10	55	HC	8.5	Pink	Red		S	PR	3	1.7		2	P	1										0.4		
	B22		55	125	HC	9	Pink	Red		S	LE	5	1.5		3	P	1		Lime	2%	H		49	119			0.7		
OD212						652067 m East		6406743 m North																					
	A		0	20	CL	5.6	Pink	Red		S	PO	0.3	2		0	N	4	20%					110			3	5		
	B2		20	80	MC	7	Light red	Red		S	AB	2.3	1.8		0	C	2	20%									0.0		
	C		80	110	CS	7.5	Pink	Red		W			1		0	C	1	20%					77	119			0.0		
OD213						654590 m East		6408182 m North																					
	A1		0	25	SCL	5	Pink	Red		W	SAB	3	1.2		0	N	3	35%					65			1	2		bedrock reached
	B1		25	45	LMC	5.5	Light red	Red	common grey	S	PR	4	1.8		1	P	2	35%									0.0		
	B2		45	60	MC	6	Yellow	Yellow	many grey	S	PR	6	1.8		1	P	1	35%					37	57			0.0		

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OD214	Vertosol	A	0	10	MC	5.5	Pink	6408023	Red	S	AB	2	1.2		2	P	2	5%				80			2	3		
		B	10	100	HC	9	Light red	Red		S	PR	6	1		0	N	1	5%			H		41	94			4.2	B horizon Slickensides
OD215		A	0	10	CL	5.5	Light red	6407130	Red	M	AB	2	1.5		0	P	2	15%				95			3	5		
		B2	10	120	LC	6	Light red	Red		S	AB	4	1.4		0	C	2	15%										
		B22	120	140	LMC	7.5	Light red	Red	common grey	S	PR	6	1.8		0	C	0	15%					74	120				
OD216		A1	0	10	CL	5	Pink	6406837	Red	S	PO	0.2	2		0	N	4	50%				10	5	7	3	5		rocky crest
OD217	Dark Red Vertosol	A	0	10	LC	5.5	Pink	6406563	Red	S	PO	0.5	2		0	N	3	15%				100			3	5		
		B	10	100	MC	6	Pink	Red		S	PR	5	1.6		0	N	2	10%									0.4	
		C	100	140	LC	7	Yellow	Yellow	common grey	M	PR	5	0.8		0	C	1	0%					81	133			1.1	
OD218		A	0	10	CL	5	Pink	6405699	Red	S	PO	0.3	2		1	P	4					100			3	4		Bedrock breached
		B2	10	70	LMC	5.5	Light red	Red		S	AB	3	1.8		1	P	2	10%									0.4	
		B22	70	130	HC	7.5	Yellow	Yellow	common red	S	PR	5	1		4	P	1	10%					72	128			0.4	
OD219	Red Vertosol	A	0	10	CL	5	Pink	6405861	Red	S	PO	0.5	2		0	C	4					80			3	3		lower slope
		B1	10	40	MC	6	Pink	Red		S	AB	4	1.8		3	C	2										0.0	waterlogging evident
		B2	40	110	LC	8	Reddish yellow	Yellow	very few grey	S	AB	4	1.2		3	C	1		MAN	10%	H		70	113			0.4	

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OD220	Red Vertosol				651063	m East		6407913	m North																				
	A1	0	10	LC	7	Pink		Red			S	PO	0.2	2		0	P	2					100			3	5		
	B2	10	70	MC	7.5	Pink		Red			S	AB	3	1.8		0	P	1										0.4	
	B22	70	140	HC	8.5	Pink		Red			S	PR	5	1.2		0	C	1						78	140			0.4	
OD221	Red Ferrosol				651270	m East		6408302	m North																				
	A1	0	15	CL	5.5	Pink		Red			M	AB	2	1.4		2	P	2	10%				100			3	5		
	B2	15	100	LC	6.5	Light red		Red			S	AB	4	1.5		2	C	1	10%									0.0	
	B22	100	140	MC	7	Pink		Red		few red	S	PR	5	0.8		0	C	0	10%					83	134			0.0	
OD222	Red Chromosol				653092	m East		6404045	m North																				
	A1	0	20	CL	5.5	Pink		Red			V			1.2		1	P	2					100			3	5		Slight unbleached A2
	B2	20	110	MC	7	Pink		Red			S	AB	4	1.3		0	P	1										0.0	at base of A horizon
	B22	110	130	LC	8	Light red		Red			S	AB	5	0.8		0	C	0				S		93	149			0.4	
OD223					654636	m East		6408602	m North																				
	A1	0	25	L	5	Reddish yellow		Yellow			V			1.2		0	N	4					45			1	1		upper slope near drainage line
	A2e	25	45	SIL	5.5	Reddish yellow		Yellow		few orange	V			1		1	C	3											
	B1	45	90	LC	6	Yellow		Yellow		common orange	S	PR	5	0.8		1	P	2										0.4	
	B2	90	110	MC	6.5	Yellow		Yellow		many orange	S	PR	5	0.6		4	P	0	25%					46	88			0.4	
OD224	Red Vertosol				653046	m East		6408369	m North																				
	A1	0	10	MC	6	Pink		Red			S	AB	2	1.2		0	P	2											
	B2	10	110	HC	8	Light red		Red			S	PR	3	1.1		0	C	1				H						0.7	
	B22	110	135	HC	8.5	Pink		Red			S	PR	8	0.8		0	C	0		Carb	5%	S		26	163			0.4	
OD225	Red Ferrosol				652714	m East		6408737	m North																				
	A1	0	10	CL	5	Pink		Red			S	SAB	0.5	2		2	P	4	50%										
	B2	10	60	MC	6	Pink		Red			S	AB	1	1.8		0	C	2	50%									0.0	
	B22	60	110	HC	5	Yellow		Yellow		many orange	S	PR	5	1		4	C	0	50%					21	75			0.0	

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SPECIALIST CONSULTANT STUDIES

Part 10: Soils and Land Capability Assessment

Pit	Soil Type	Horizon	Depth from	Depth To	Texture	pH (S;W)	Colour	Map Colour	Mottle	Struct. Grade	Struct. Type	Ped Size	SoilPAK	Consistence	Dispersion	Slaking	Roots (0-4)	Grav. %	Concretions Type	Concretions %	Efferv.	Root Zone	Total Readily Available Water	Total Plant Available Water	Permeability	Drainage	ECe	Comments
OD226	Sodosol	A1	0	10	SCL	5	Reddish yellow	Yellow		W			1		0	N	2	50%				50			2	2		bedrock breached
		B1	10	30	LMC	6	Reddish yellow	Yellow	common orange	S	PR	4	0.8		4	P	1										1.1	
		B2	30	100	MHC	7	Reddish yellow	Yellow	common grey	S	PR	6	0.6		4	P	1						37	64			3.2	
OD227	Brown Verosol																											
		A1	0	5	SL	5	Pink	Red		V			1.2		0	N	2	50%				50			2	2		Bedrock at 50 cm
		B1	5	15	FSCL	5	Reddish yellow	Yellow		V					0	P	1	10%										probably past contact with trachyte
		B21	15	35	LC	5	Reddish yellow	Yellow		W	PR	10/5			1	C	1										0.7	
OD228	Red Ferrosol																											
		A	0	10	CL	5.5	Pink	Red		S	PO	0.2	2		0	N		50%				100			3	4		
		B	10	100	MHC	5.5	Light red	Red		S	AB	1.5	1.5		0	C		10%										
		C	100	115	CS	5.5	Pink	Red		W			1.2		1	C		10%				62	117					
OD229	Red Kerrosol																											
		A1	0	30	CL	5	Pink	Red		V			1.2		0	P	3					110			3	3		
		A2	30	50	FSCL	5.5	Pink	Red		V			1		4	C	2											
		B1	50	80	FSCL	7	Pink	Red		M	PR	4	1		4	C	2	5%									0.0	
		B2	80	110	FSCL	7.5	Pink	Red		M	PR	4	1		4	C	2					110	157				0.0	
OD230	Red Kandisol																											
		A1	0	10	L	6.5	Pink	Red		V			1		0	N	2	50%				45			3	5		
		B	10	45	LFS	4.5	Light red	Red		V			1		0	N	0	70%					12	21				0.0
OD231	Brown Sodosol																											
		A1	0	15	FSCL	5	Reddish yellow	Yellow		V			1.2		3	P	3	30%				60			2	3		
		B1	15	60	SC	6.5	Reddish yellow	Yellow		M	PR	3	1		3	P	2	30%									3.9	
		B2	60	110	LMC	7	Reddish yellow	Yellow	few grey	S	PR	4	1		2	C	1	20%										
OD232	Red Chromosol																											
		A1	0	10	SCL	4.5	Pink	Red		V			1.2		0	P										3	4	
		B2	10	90	MC	5.5	Light red	Red		S	AB	4	1.2		3	C		5%									0.4	
		B22	90	130	SC	6.5	Pink	Red		S	AB	5	1.1		0	C			MAN	5%		53	184				0.0	

SPECIALIST CONSULTANT STUDIES

Part 10: Soils and Land Capability Assessment

AUSTRALIAN ZIRCONIA LTD

Dubbo Zirconia Project

Report No. 545/05

Property: DZP Ag Capability

Date: 22/03/2012

Pit	Soil Type	Horizon	Depth from	To	Texture	pH (S:W)	Colour	Map Colour	Mottle	Struct. Grade	Struct. Type	Ped Size	SoilPAK	Consistence	Dispersion	Slaking	Roots (0-4)	Grav. %	Concretions Type	Concretions %	Efferv.	Root Zone	Total Readily Available Water	Total Plant Available Water	Permeability	Drainage	ECe	Comments
OD233					650803	m East	6410242	m North																				
	A1	0	35	CL	5.5	Pink		Red		V			1.4		3	P						110			3	4		end of footslope above creek
	B1	35	70	MC	8	Pink		Red		S	A8	2	1.4		1	P											0.4	
	B2	70	120	LC	8.5	Pink		Red		M	A8	4	1		0	C		5%			S		102	161			0.7	
OD234					650926	m East	6410462	m North																				
	A1	0	45	SC	5.5	Reddish yellow		Yellow		M	P0	0.5	2		0	C	3					120			3	3		
	B2	45	110	MC	6.5	Reddish yellow		Yellow		S	P0	0.5	1.8		1	C	2											
	2B2	110	120	MC	7.5	Reddish yellow		Yellow	few brown	S	LE	1.2	1.2		0	C	1						108	179				
OD235	Brown Dermosol				651160	m East	6410935	m North																				
	A1	0	30	SCL	5.5	Reddish yellow		Yellow		S	P0	0.5	2		0	P						140			3	3		
	B2	30	120	LC	6.5	Reddish yellow		Yellow		S	P0	0.5	1.8		1	C												
	2B2	120	140	SC	8.5	Reddish yellow		Yellow		S	P0	0.6	1.8		0	C					H		129	207				

AUSTRALIAN ZIRCONIA LTD

Dubbo Zirconia Project

Report No. 545/05

Property: Grandale

Date: 25/07/2012

SPECIALIST CONSULTANT STUDIES

Part 10: Soils and Land Capability Assessment

Pit	Soil Type	Horizon	Depth from	Depth To	Texture	pH (S:W)	Colour	Map Colour	Mottle	Struct. Grade	Struct. Type	Ped Size	SoilPAK	Dispersion	Slaking	Roots (0-4)	Grav. %	Concretions Type	Concretions %	Efferv.	Root Zone	Total Readily Available Water	Total Plant Available Water	Permeability	Drainage	ECe	Comments
OD236	Red Chromosol				654110	m East	6411792	m North																			
	A1	0	5	CL	5.5	Pink		Red		S	SAB	2/5	1.1	2	N	4	5%		0%	N	100						0.0 Topsoil depth varies
	B2	5	50	LMC	8	Light red		Red		S	PO	15/1	1.5	0	P	3	0%	Carb	2%	S							0.7 Fissures to 30 cm, slickensides
	B3	50	80	LMC	9	Pink		Red		M	AB	10/1	0.9	0	P	1	0%	Carb	10%	M							6.0 @ 60 cm
	C	80	120	LMC	8	Reddish yellow		Yellow		M	AB	.5	1.1	1	P	1	30%		0%	M		81	134				6.7 Mangans - common in layer 4 Weathered Sandstone (fine)
		120	130	Sandstone																							
OD237	Red Chromosol				654333	m East	6410950	m North																			
	A1	0	20	SiL	5	Pink		Red		S	SAB	2/1	1.5	2	P	3	0%		0%		120						0.0 Water running into pit
	B1	20	40	SiC	5.5	Pink		Red		S	PO	5/1	1.5	1	P	3	5%		0%								0.0 @ 80 cm - 0.6 dS/m
	B2	40	70	SiC	6.5	Pink		Red		S	PR	5/1	1.2	1	P	2	5%		0%								0.0 Discharge area
	B3	70	130	SiCL	7.5	Reddish yellow		Yellow	common red	M	PO	2/1	1.2	0	p	1	20%		0%			104	158				0.0 Infilled root channels in B1
OD238	Yellow Sodosol				654436	m East	6409623	m North																			
	A1	0	25	SCL	5.5	Light red		Red		M	SAB	3/0.5	1.5	2	P	4	0%			N	60						0.0 Cemented layer 90-92
	B1	25	60	MC	6.5	Yellow		Yellow	common brown	S	CO	15/1	1.2	4	P	2	0%			N							0.0 Few macropores to bottom of pit
	B2	60	90	SCL	8	Yellow		Yellow		S	PO	10/1	0.8	3	C	1	0%			N							1.0
	C	90	150	Sandstone	8	Yellow		Yellow														57	88				
OD239	Red Chromosol				653075	m East	6409634	m North																			
	A1	0	20	SiCL	5	Light red		Red		M	SAB	2/1	1.5	0	P	4	2%		0%	N	70						0.0
	B1	20	40	MC	6	Light red		Red		S	PO	5/1	1	4	P	3	0%		0%	N							0.0
	B2	40	80	LMC	8.5	Light red		Red		M	PO	10/5	0.8	0	C	1	0%	Carb	5%	M							2.5
	B3	80	120	MC	8.5	Light red		Red		M	PO	10/5	0.7	0	C	1	0%	Carb	20%	H		63	100				4.6
OD240	Red Dermosol				653175	m East	6409797	m North																			
	A1	0	15	LC	5	Reddish yellow		Yellow		M	CR	.5	1.6	0	P	4	10%		0%	N	110						0.0 Veg: Wiregrass, Red Grass
	A3	15	35	LMC	5.5	Light red		Red		S	SAB	3/1	1.6	2	P	4	20%		0%	n							0.0 (Grassland) Saffron Thistle,
	B1	35	70	MHC	7	Light red		Red		S	LE	4/1	1.3	0	N	3	20%	carb	10%	s							0.0 Spear Grass
	B2	70	120	MHC	8.5	Light red		Red		S	LE	10/1	1	0	N	2	20%	carb	10%	s		63	115				0.7 White Cypress, Kurrajong, Cotton Bush,
OD241	Red Kandosol				653076	m East	6409907	m North																			
	A	0	20	CS	5	Light red		Red			SAB	1/5	1.8	1	C	4	10%		0%		45						Veg: wiregrass, clovers, Love Grass, Red Grass
	B	20	45	CS	5	Light red		Red			PO	20.5	1.5	1	P	3	0%		0%								Blakely's gum, Kurrajong, C Horizon extremely weathered coarse sandstone sand fraction - coarse rounded
	C	45	40	Sandstone																		32	43				

SPECIALIST CONSULTANT STUDIES

Part 10: Soils and Land Capability Assessment

AUSTRALIAN ZIRCONIA LTD

Dubbo Zirconia Project

Report No. 545/05

Property: Grandale

Date: 25/07/2012

Pit	Soil Type	Horizon	Depth from	To	Texture	pH (S:W)	Colour	Map Colour	Mottle	Struct. Grade	Struct. Type	Ped Size	SoilPAK	Dispersion	Slaking	Roots (0-4)	Grav. %	Concretions Type	Concretions %	Efferv.	Root Zone	Total Readily Available Water	Total Plant Available Water	Permeability	Drainage	ECe	Comments	
OD242	Red Dermosol				653220	m East		6410268	m North																			
	A1	0	25	MC	6.5	Pink		Red		S	AB	3/1	1.3	1	P	3			0%		100			2	4	0.0	Grassland	
	A3	25	45	MHC	8	Pink		Red		S		5/1	1.2	1	P	3			0%							0.4	Veg: Red Grass, Wiregrass (minor),	
	B1	45	70	LMC	8	Pink		Red		S		5/1	1.2	1	C	2			0%							1.8	Old Blue Grass (minor), Sporobolus	
	B2	70	130	MHC	7	Pink		Red		S		20/2	0.9	2	C	1			0%			80	142			2.5	creber, clovers, bathurst burr	
																											Mottle in B1 is Macropore infilled with topsoil	
OD243	Red Kurosol				653267	m East		6410545	m North																			
	A	0	15	L	4.5	Reddish yellow		Yellow		M	SAB	1/1.5	1.8	0	P	4	20%		0%		60			1	3	0.0	Veg - Red Grass, Juncus, Wiregrass	
	B1	15	40	MC	5	Pink		Red		S	PR	3	1	3	C	3			0%							0.0	cotton bush, love grass, spear grass,	
	B2	40	70	MHC	6	Reddish yellow		Yellow		S		5/1	0.9	2	P	2	10%		0%							1.1	windmill grass (50 m away), Saffron 1	
	C	70	140	Sandstone	7	Yellow		Yellow						1	P							47	90				white box (cleared ?)	
																											Coarse fragments in B2 - weathered trachyte	
OD244	Sodic Vertic Red Derm				653172	m East		6411074	m North																			
	A1	0	15	LMC	6.5	Reddish yellow		Yellow		S	AB	3/1	1.3	2	P	4			0%		50			1	4	0.0	Veg - grassland windmill grass,	
	B1	15	45	MHC	8.5	Pink		Red		M		10/1	1	1	P	3			0%							1.4	wiregrass	
	B2	45	100	MHC	4.5	Pink		Red		M		20/1	0.7	0	C	1			0%			38	70			5.6	No remaining trees close	
																											No mottles	
																											No mottles	
																											Stump hole	
OD245	Red Dermosol				653368	m East		6411035	m North																			
	A	0	15	SCL	4.5	Pink		Red		S	SAB	2/5	1.5	2	P	4	10%		0%		80			2	2	0.0	Veg Panicum sp, Wiregrass,	
	B	15	35	LMC	5.5	Pink		Red		S		10/1	1.6	0	P	3	5%		0%							0.0	Red Grass, Fleabane (Purple	
	C1	35	55	LC	6	Yellow		Yellow	common grey	W		10/1	1.2	0	C	2	20%	Iron	10%							0.0	Stunted), Clovers, Rye Grass	
	C2	55	90	LC	7.5	Yellow		Yellow	common grey	S		10/1	1.2	1	C	1	10%	Iron	20%			59	95			0.4	Blakely's Gum, White Cypress Pine, Cottonbush	
																											Discharge area	
OD246	Brown Dermosol				652716	m East		6410150	m North																			
	0	5	SCL	7.5	Red Grey			Grey														90			2	3		Veg Degraded native pasture
	5	20	Basalt	7	Grey Brown			Brown																			wiregrass, bathurst burr, clovers,	
	20	60	LC	7	Orange Brown			Brown																			love grass, horehound, thistles,	
	60	100	SCL	7.5	Yellow Grey			Grey																			speargrass	
	100	150	Basalt	7.5	Yellow Grey			Grey																				
OD247	Brown Dermosol				652664	m East		6410187	m North																			
	0	90	MC		Red Brown			Brown														80	72		2	3		Appears that fossils in layer from about 331 to 335 mAHd
	90	110	Basalt																								Appears to be basalt above and below fossil layer	

AUSTRALIAN ZIRCONIA LTD

Dubbo Zirconia Project

Report No. 545/05

Property: Grandale

Date: 25/07/2012

SPECIALIST CONSULTANT STUDIES

Part 10: Soils and Land Capability Assessment

Pit	Soil Type	Horizon	Depth from	Depth To	Texture	pH (S.W)	Colour	Map Colour	Mottle	Struct. Grade	Struct. Type	Ped Size	SoilPAK	Dispersion	Slaking	Roots (0-4)	Grav.%	Concretions Type	Concretions %	Efferv.	Root Zone	Total Readily Available Water	Total Plant Available Water	Permeability	Drainage	ECe	Comments
OD248	Yellow Chromosol																										
	A	0	10	SCL	6.5	Reddish yellow	Yellow			W	SAB	2/1		1	P						80			1	4	0.0	Veg Grassland Sporobolus sp.
	B1	10	45	MC	7.5	Reddish yellow	Yellow							1	P											0.0	Juncus, Fleabane, Purple top red
	B2	45	105	LMC	8	Reddish yellow	Yellow							1	P			Carb	5%	N						1.1	grass, wire grass, thistles, speargras:
	B3	105	140	LMC	8	Reddish yellow	Yellow							0	P			Man				72	116			1.4	Cypress all cleared
																											5 m away topsoil 30 cm deep
																											i.e. AB horizon is wavy
OD249	Yellow Godosol																										
	A1	0	5	CS	5	Reddish yellow	Yellow							1	C						30			2	3		Veg Red Grass, Clover, Rye Grass,
	B1	5	20	SC	5.5	Pink	Red							2	P												Spear grass, Sporobolus
	B2	20	35	LMC	7.5	Yellow	Yellow							1	P												
	C	35	50	SC	6.5	Yellow	Yellow							0	N							26	42				
		50	65			Yellow	Yellow																				
OD250	Red Chromosol																										
	A1	0	10	SCL	5	Pink	Red							2	P						70			1	3	0.0	Veg red Grass, wire grass, juncus,
	B1	10	40	MC	7.5	Pink	Red							1	P											1.4	windmill grass, Purple Top
	B2-1	40	60	MC	8.5	Light red	Red							1	P												Love Grass
	B2-2	60	90	LMC	8.5	Pink	Red							0	C		5%	Carb	5%	S						5.3	
	B3	90	140	LMC	4.5	Pink	Red							0	C							63	102			6.0	Kurrajong, Grey box,
																											White Cypress 80 m away
OD251	Red Chromosol																										
	A	0	25	SCL	4.5	Pink	Red							1	N						70			2	3	0.0	Veg Wire Grass, Purple Top,
	B1	25	45	SC	6.5	Pink	Red							1	C		5%									0.0	Daisy Burr, Kidneyweed, Medics,
	B2	45	70	LMC	5	Yellow	Yellow							1	C		5%									0.0	Rattlepod, Wild sage, saffron,
	B3	70	110	LMC	5	Yellow	Yellow							0	C		5%					64	99			0.0	red grass, clovers
	C	110	120														5%										
																											Kurrajong, Grey Box
OD252	Brown Chromosol																										
	A	0	10	SCL	4.5	Grey Brown	Brown														90			1	4		Veg Grassland, wiregrass,
	B1	10	60	MC	6.5	Orange Brown	Brown																				spear grass, juncus, curly windmill
	B2	60	110	MC	8	Brown Grey	Grey											Carb	20%								grass, cottonbush clovers, flatweed
	B3	110	140	MC	8	Grey Brown	Brown															77	125				white box (100m up slope)
																											White cypress
																											Infilled with topsoil
OD253	Yellow Chromosol																										
	A1	0	15	SiL	6	Reddish yellow	Yellow							2	C						70			2	3	0.0	Veg: Wire Grass, Spear Grass,
	B1	15	30	LC	6.5	Reddish yellow	Yellow							1	P											0.0	Red Grass, wallaby grass,
	B2-2	30	60	LMC	8	Yellow	Yellow		common red					0	N											0.0	clover
	B2-3	60	110	MC	8	Yellow	Yellow							0	N							65	104			0.4	White cypress
																											Kaolinitic Clay

Appendix 5

Soil Engineering Tests Conducted by: Soil Conservation Service, Scone

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Soil Conservation Service

SOIL TEST REPORT

Page 1 of 2

Scone Research Centre

REPORT NO: SCO12/107R1

REPORT TO: David Duncan
Sustainable Soils Management
PO Box 130
Warren NSW 2824

REPORT ON: Seven soil samples

REPORT STATUS: Preliminary

DATE REPORTED: 4 May 2012

METHODS: Information on test procedures can be obtained from Scone
Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

A handwritten signature in blue ink, appearing to read "SR Young".

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO12/107R1 (Preliminary)
Client Reference: David Duncan
Sustainable Soils Management
PO Box 130
Warren NSW 2824

Lab No	Method Sample Id	P7B/2 Particle Size Analysis (%)					P8A/2 D%	P9B/2 EAT	P2B/2 LL (%)	P3A/1 PL (%)	P4A/1 PI (%)
		clay	silt	f sand	c sand	gravel					
1	OD201 0.8-1.2m	59	15	18	7	1	26	4	76	24	52
2	OD202 0.5-1.0m	46	11	18	21	4	28	3(1)	57	19	38
3	OD203 0.5-1.0m	33	12	36	18	1	15	3(1)	33	13	20
4	OD204 0.5-1.0m	30	6	11	8	45	7	5	51	22	29
5	OD207 0.5-1.0m	68	10	11	10	1	36	4	93	28	65
6	OD211 0.5-1.0m	57	15	21	7	<1	50	4	79	23	56
7	OD214 0.6-0.8m	53	15	23	9	<1	41	4	64	17	47



END OF TEST REPORT



Soil Conservation Service

SOIL TEST REPORT

Page 1 of 2

Scone Research Centre

REPORT NO: SCO12/248R1

REPORT TO: David Duncan
Sustainable Soil Management
PO Box 130
Warren NSW 2824

REPORT ON: Four soil samples

PRELIMINARY RESULTS
ISSUED: Not issued

REPORT STATUS: Final

DATE REPORTED: 3 September 2012

METHODS: Information on test procedures can be obtained from Scone
Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

A handwritten signature in blue ink, appearing to read "SR Young".

SR Young
(Laboratory Manager)

Scone Research Centre, PO Box 283 Scone 2337, 709 Gundy Road Scone 2337
Ph: 02 6545 1666, Fax: 02 6545 2520

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO12/248R1
Client Reference: David Duncan
Sustainable Soil Management
PO Box 130
Warren NSW 2824

Lab No	Method Sample Id	P7B/2 Particle Size Analysis (%)					P8A/2 D%	P9B/2 EAT	P2B/2 LL (%)	P3A/1 PL (%)	P6A/1 LS (%)
		clay	silt	f sand	c sand	gravel					
1	OD236 130-200cm	38	24	23	14	1	44	2(1)	61	19	13.5
2	OD242 100-130cm	64	21	9	5	1	58	2(1)	100	28	19.5
3	OD243 70-130cm	31	23	43	3	<1	84	2(2)	36	15	8.5
4	OD244 50-100cm	55	14	25	6	<1	65	2(2)	59	16	13.0

SR Young



END OF TEST REPORT

Appendix 6

Bulk Soil Engineering Tests Conducted by: Aitken Rowe, Wagga Wagga

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AITKEN ROWE Testing Laboratories Pty Ltd 4/2 Riedell St. Wagga Wagga N.S.W. 2650			PAGE: 1 OF: 1		
TEST REPORT CALIFORNIA BEARING RATIO OF SOILS AND GRAVELS			SUBMITTED BY : CLIENT NO OF SAMPLES : 2		
CLIENT: SUSTAINABLE SOILS MANAGEMENT JOB DESCRIPTION: QUALITY CONTROL TESTING			DATE RECEIVED : 15/05/2012 TEST METHODS : T105 T111 T117 T120 *		
ORDER No.: D.Duncan					
SOURCE OF MATERIAL : N/K		LOT NO:	SAMPLING PROCEDURE: AS1289.1.2.1		
PROPOSED USE: LINER			REGISTRATION NO : S12-224		
SAMPLE NO:	OD203	OD214	*	*	*
SITE OR LOCATION	N.K	N.K	*	*	*
DEPTHS BETWEEN WHICH SAMPLES TAKEN (mm)	N.K	N.K	*	*	*
ADDITIVE IF STABILISED	*	*	*	*	*
AMOUNT OF ADDITIVE (%)	*	*	*	*	*
TYPE OF COMPACTION (Standard/modified)	STANDARD	STANDARD	*	*	*
MATERIAL RETAINED ON THE 19.0mm SIEVE (%)	0.0	0.0	*	*	*
OPTIMUM MOISTURE CONTENT (%)	13.3	20.2	*	*	*
MAXIMUM DRY DENSITY (t/m ³)	1.78	1.64	*	*	*
MOULDING MOISTURE CONTENT (%)	13.4	20.4	*	*	*
DRY DENSITY OF TEST SPECIMEN (t/m ³)	1.68	1.55	*	*	*
SPECIFIED LDR (%)	95	95	*	*	*
ACTUAL LDR (%)	95	95	*	*	*
MOISTURE CONTENTS : TOP 30 mm	18.4	29.5	*	*	*
WHOLE SAMPLE	17.4	27.0	*	*	*
ABSORPTION (%)	4.0	6.6	*	*	*
SPECIFIED LMR (%)	100	100	*	*	*
ACTUAL LMR (%)	101	101	*	*	*
NUMBER OF DAYS SOAKING	4	4	*	*	*
SWELL (%)	0.3	0.5	*	*	*
CBR OBTAINED FROM PENETRATION (mm)	2.5	2.5	*	*	*
CALIFORNIA BEARING RATIO (%)	3.5	2.5	*	*	*
NOTES: T117 specifications: LMR - 3% to +2% LDR ± 1%					
COMMENTS: *					
 This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO-IEC 17025 Number: 4679		APPROVED SIGNATORY :  G.D.LYONS DATE : 29/05/2012			

Form: revised R6 17/06/08

4/2 Riedell Street, Wagga Wagga 2650

PROJECT: QUALITY CONTROL TESTING

OF: 1

AS1289.2.1.1

NOMINAL SIEVE SIZE: *

REGISTRATION No: S12-224

DATE: 29/05/2012