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Appendix G
Supporting Technical Reports and Data

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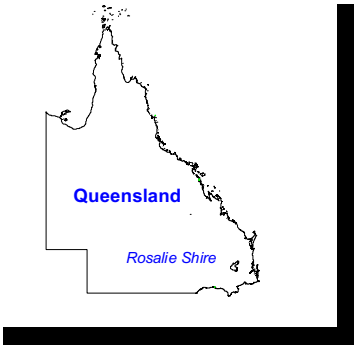
G.1.1 Key Resource Areas Figure

Overlay Map 3



Legend

- Key Resource Area
- Potential Key Resource Areas
- Mining Leases
- Mineral Development Licence
- Potential Coal Resource
- Workable Coal Resources
- Muldu to Jondaryan Haul Route
- Recorded Underground Mining
- Existing/Potential Extractive Resources
- Shire Boundary

Source: DNRM

Scale 1:250 000

Shire of Rosalie Planning Scheme

KEY RESOURCE AREAS
AREAS OF
RECORDED UNDERGROUND MINING

Rosalie Shire Council

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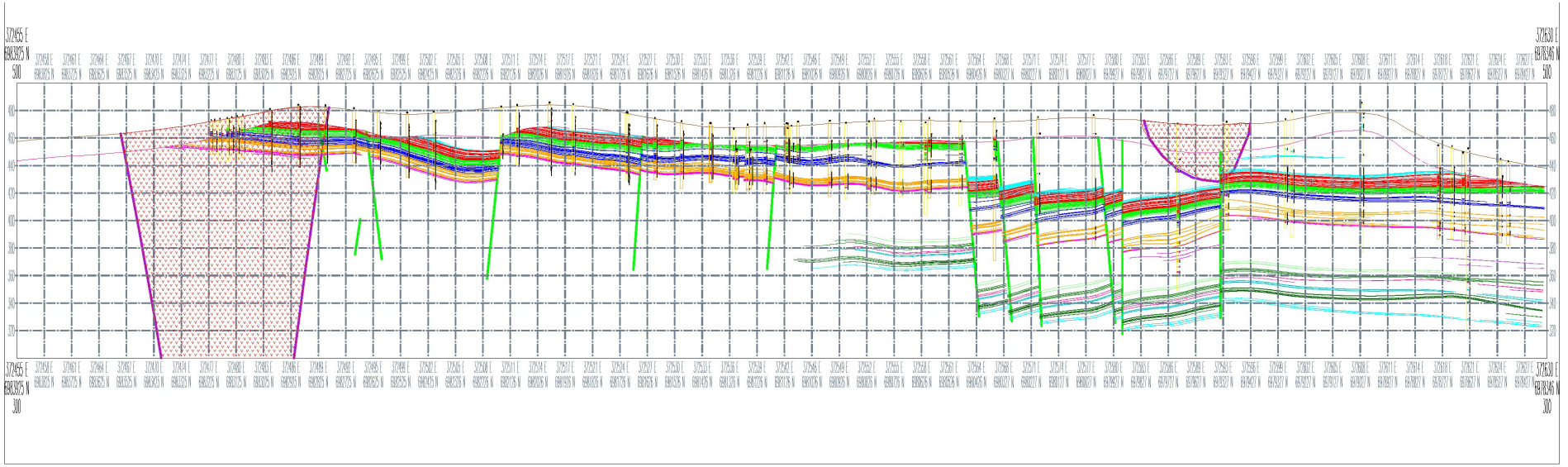
G.1.2 Geological Cross Sections and Stratigraphic Profiles



LEGEND

NOTES

5x vertical exaggeration

NEW ACLAND

Metres

100 50 0 200 400

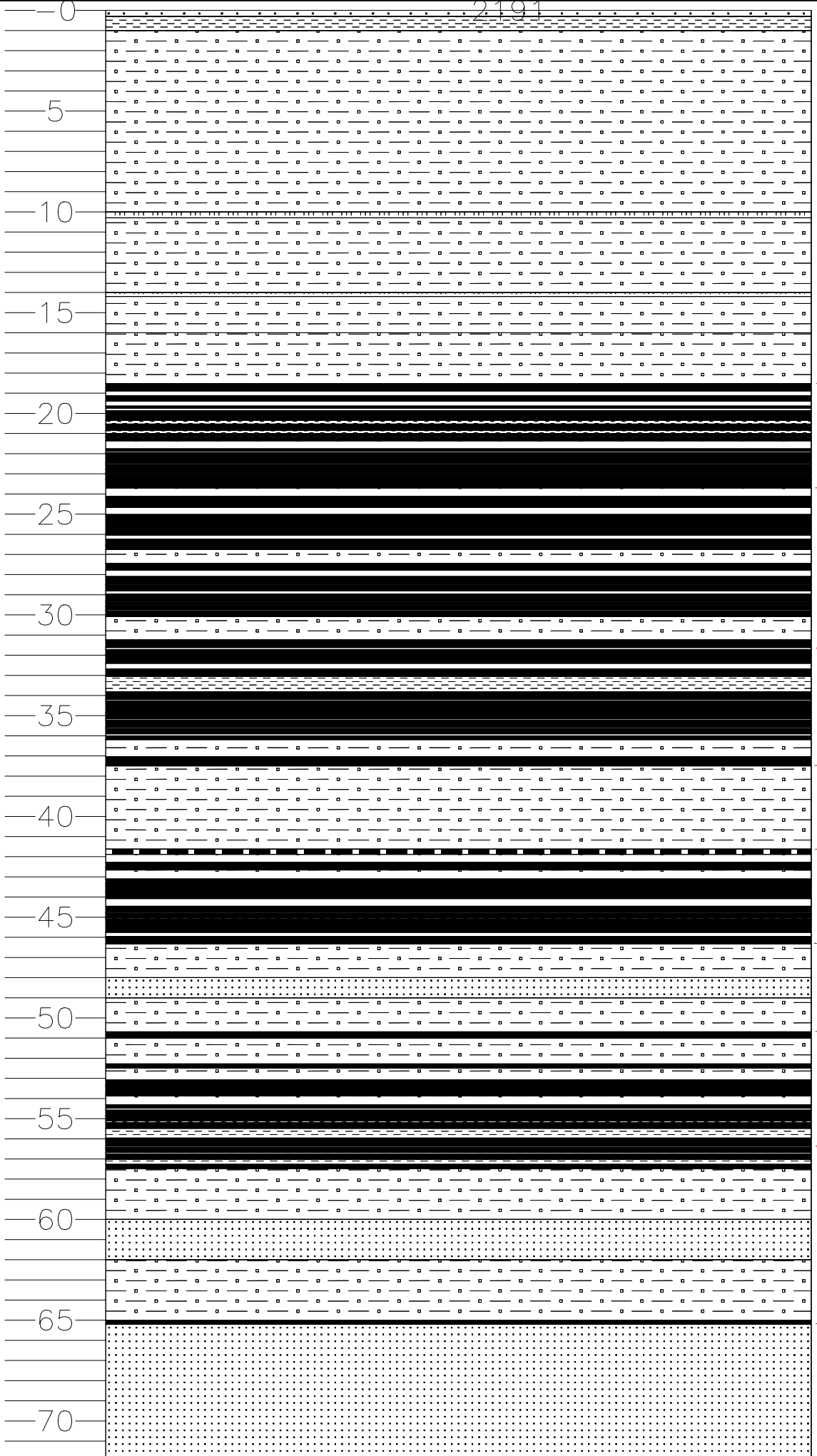
SCALE 1:11,717.68825971

NEW ACLAND

NEW HOPE COAL AUSTRALIA

MDL244 CROSS SECTION
NORTH–SOUTH

Structure Model Date:	new_acland_mar07	Scale:	1:1
Structure Model:	MARCH 2007	Date:	5th May, 2010
Gravity Model Date:	N/A		
Quality Model:	N/A		
Plot File:	100503_nssect0s_mdl244.hpgl2	Drawn:	DBAX
Design File:	dbax	Revision:	
Layer Name:	NS_SECT_01		Figure



LEGEND

- CL–CLAY
- CN–STONY COAL
- CO–COAL
- CS–CLAYSTONE
- IS–IRONSTONE
- SL–SILTSTONE
- SO–SOIL
- SS–SANDSTONE
- XM–CARBONACEOUS MUDSTONE

NEW HOPE COAL AUSTRALIA

Borehole: 2191

CREATED BY: D.BAX

05 MAY 2010

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G.1.3 Insitu Coal Estimates

New Hope Corporation Limited

ASX RELEASE

JORC Reserves & Resources Summary

30 July 2013

New Hope Corporation is pleased to announce an updated JORC compliant reserves and resources statement as at 31st March 2013.

Overall the reserves for the New Hope Group have been set at 643Mt with 413Mt of Proven Reserves, and 231Mt of Probable Reserves as at 31st March 2013. This is down 15% compared with the 2012 total. An explanation for the differences between the 2012 JORC Reserve quantities and the latest estimation is provided below.

This update of coal reserves and resources is as a result of further extensive geological work including:

- A complete review of all databases together with addition of further points of observation for particular project areas;
- Subsequent re-modelling of the geological data; and
- Further exploration drilling.

The following points should be noted in regard to this Statement:

- No geological losses have been assumed in the calculation of resources; and
- Calculations are based on topography surfaces as at 31st March 2013.

		COAL RESOURCES (million tonnes) (Coal resources are inclusive of the reserves reported below)				
Deposit	**Status**	**Inferred**	**Indicated**	**Measured**	**2013 Total**	**2012 Total**
New Acland	Mine	2	390	440	832	857
Ownaview	Exploration	38	119	-	157	157
West Moreton	Mine	11	72	44	127	129
Lenton (1)	Exploration	524	134	83	741	693
Bee Creek	Exploration	104	-	-	104	104
Elimatta	Exploration	50	101	108	259	259
Yamala (2)	Exploration	187	23	13	223	223
Maryborough	Exploration	60	16	-	76	76
Ashford (3)	Exploration	5	8	-	13	13
TOTAL		**981**	**864**	**687**	**2,532**	**2,511**

Notes

(1) Figures shown are 100% of total resources. New Hope share is 90%

(2) Figures shown are 100% of total resources. New Hope share is 50%.

(3) Figures shown are 100% of total resources. New Hope share is 83%

		COAL RESERVES (million tonnes)			
Deposit	**Status**	**Probable**	**Proved**	**2013 Total**	**2012 Total**
New Acland (1)	Mine	149	292	441	495
Lenton (2)	Exploration	31	21	52	52
Elimatta	Exploration	40	100	139	191
Maryborough (Colton)	Exploration	11		11	15
TOTAL		**231**	**413**	**643**	**753**

Notes

(1) 34Mt of reserves are located in the Far East deposit which could be influenced by strategic cropping land legislation.

(2) Figures shown are 100% of total reserves. New Hope share is 90%.

(3) Small differences are due to rounding

New Acland

New Hope Corporation has made a public commitment that the town of Acland will be left untouched under the revised New Acland Coal Mine Stage 3 Project. Subsequently the model has been adjusted to allow for an exclusion zone around the township and reserves in this area have been excluded from the 2013 figures.

In addition, the amended mine plan excludes mining of the Lagoon Creek area which has the effect of sterilising approximately 29Mt of coal which were included in the previous reserve estimates.

There has been additional drilling carried out over the project area since the previous Reserves Statement was developed in 2012, specifically in the area between the Sabine and Willeroo resource areas. This new drilling information has partially reduced the resource thickness in this area compared with previous stratigraphy models. This has led to a reduction in area being mined as a result of the increased strip ratio and a corresponding reduction in the reserve tonnes included within the new pit boundary.

Mining economics have also been updated within the southern resource areas based on New Hope Corporation's latest prediction of long term coal prices and operating costs. This has resulted in additional areas included within the mine design, previously not considered economically viable.

Due to the ongoing extraction of coal from the project area, there was also a reduction in reserve tonnages associated with depletion over the past 12 month period.

Lenton

There has been no change to the coal reserves estimated for Lenton since the previous JORC statement. This is a result of there being no refinement to the mine plan over the previous year.

Elimatta

The Elimatta reserves have decreased from the previous year as a result of an updated financial evaluation on the deposit. There has been no update to the geological model associated with this resource compared with what was previously used to develop the 2012 JORC statement. The latest Reserve tonnages have been developed taking into account the long term price forecasts, to determine a reasonable break-even strip ratio. This mining ratio was used to define the pit boundary which is smaller than the boundary of the previous model. In addition, some of the lower seam has now been excluded due to the high incremental strip ratio required to mine this coal.

Maryborough (Colton)

The Maryborough reserves have declined by a total of 4Mt from that identified in 2012 to the current value of 11Mt. For the most part this change has resulted from updated economic assumptions.

JORC Declaration

The estimates of coal resources herein have been prepared in accordance with the guidelines of the "Australian Code for Reporting of Exploration Results, Mineral Resources and Ore Resources – The JORC Code. These resources are inclusive of the reserves reported in the reserves statement. The work has been undertaken internally and reviewed by Mr Phillip Bryant who is a Member of AusIMM. Mr Bryant has sufficient experience which is relevant to the style of mineralization and type of deposit under consideration and to the activity which he is undertaking, to qualify as a Competent Person as defined in the 2004 Edition of the JORC Code. Mr Bryant consents to the inclusion in this report of the matter based on this information in the form and context in which it appears.

The information in this Coal Reserves Statement that relates to coal reserves is based on information compiled by Mr Brett Domrow, who is a Member of AusIMM. Mr Domrow is a full time employee of the company. Mr Domrow has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent person as defined in the 2004 Edition of the 'Australian Code for Reporting Exploration Results, Mineral Resources and Ore Reserves'. Mr Domrow consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

For further information, please contact:

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G.1.4 Soil Sampling Site Assessment Report – Mining Area

Appendix G.1.4 Soil Sampling Sites Assessment

Site	Easting	Northing	Soil type	Soil Profile	Comments
1	374465	6978012	B1v (steeper slope)	Fine self-mulching surface. Deep cracking clay. 3% slope. Midslope. Occasional river worn gravel on surface. 0-30cm AP fine self-mulching, 8.5, some carb nod, 10YR3/2 30-50cm carb nods, 8.5, medium clay, 10YR3/2 50-100cm increasing carb, 8.0, med clay, 10YR3/3. 100-140+cm small mixed gravels increasing, 8.0, 10YR3/3	Piggery wheat paddock. Dark cracking clay on sediments 1.30pm. Sampled site
2	373535	6978164	B2	Surface soft fine mulch, cracking. few small ironstone A11 0- 5mm 8.5, fine granular, self-mulching, medium heavy clay, dark brown 10YR3/1. B21 5 – 450mm med heavy clay, 8.5, moderate angular blocky, some carb nods 2-5mm, moist, dark 10YR3/1, gradual, B22 450-1200mm medium clay, strong subangular blocky 6.5, reddish brown 5YR4/3, no inclusions, moist	Brigalow scrub soils on Greenwood School road. Lower midslope. 1%. 2.20pm, Dark brown/black uniform clay. Possible linear gilgai pre cropping. Sample
3	372648	6978500	B2	0-25cm moist, dark grey brown med clay 25-70 dark grey med heavy clay, angular blocky fine gravels, very little carb	Midslope 4% wheat cropping ‘Moola’
4	371234	6978850	B4	0-40cm 5YR4/4 light sandy clay, 7.5, 40+ basalt rock	Reddish brown non cracking clay on basalt gravel & rock

Site	Easting	Northing	Soil type	Soil Profile	Comments
5	370731	6978700	B2	At least 50 cm of good light clay soil -	Wheat paddock. Mid to upper slope 2-3%.
6	370548	6978500	B4	'Acland' soil	Reddish non cracking clay. Some rock / gravel on surface
7	370308	6978600	B4	Shallow gravelly sandy clay loam	Slope <1%
8	370380	6979021	B4	Red brown gravelly clay non cracking.	Centre of Acland town
9	370260	6979872	B4	Uf631 uniform clay non cracking . Surface firm sandy. 0-40cm 5YR4/4 light sandy clay, pH7.5, 40 – 65cm hard dark reddish brown medium clay. Carb nodules. Angular blocky. 65cm mixed sediments (basalt?)	Red light sandy clay surface with termite mounds. Non cracking clay on basalt. Slope 3%
10	374211	6982200	Ba1	Uf6	Red brown gravelly non cracking clay with termite mounds. Slope 1% upper to crest position
11	369152	6981361	Ba1	Uf6	Red brown gravelly non cracking clay
12	369950	6977840	B4	Dr413 Red ferrosol A1 0 – 20cm. Dark reddish brown (5YR3/2), clay loam, gravelly, granular, field pH 7.5, no inclusions, dry, abrupt change to, B21 20 –70cm Dark red (2.5YR3/6), light clay, strong angular blocky, field pH 7.5, some small ironstone gravels, gradual change to, B22 70 -100cm Yellowish red (5YR5/6), medium clay, strong sub-angular blocky, field pH 8.0, calcareous nodules increasing with	<u>Excavator site</u> Upper mid slope 1.5%, surface is firm with some rounded ironstone up to 5mm. sampled

Site	Easting	Northing	Soil type	Soil Profile	Comments
				depth, moist. Sandstone gravels increasing with depth	
13	369600	6978080	B4		Same as 12
14	369850	6977501	B4	0-15cm fine sandy clay loam, brown, 8.0, 15-25cm dark brown medium clay 5YR3/1, 8.0. angular blocky 25 – 80cm+ pale brown hard med heavy clay	<u>Excavator site</u> Poplar box, carissa
15	369138	6977359	B4	0-15cm light clay loam, grey brown, pH 8.0, 5YR5/4 15 - 65cm pale yellowish brown stiff clay with carbonate. pH 8.5 65cm weathered material	Shallow cultivation. Note site 14 probably a disturbed version of 15
16	368936	6977385	B4		Boundary between reddish clay (15) and gravelly duplex on ridge margin
17	368806	6977405	-		Boundary 16 and dark grey alluvial clay cultivation
18	369942	6976600	A2	Cracking and mulching (coarser) surface no gravel. A1,0 – 20 Dark brown (10YR3/3), medium heavy clay, granular, field pH 7.5, no inclusions, moist, abrupt to; B21 ,20 – 60 Very dark greyish brown (10YR3/2), medium heavy clay, no bleach, coarse angular blocky, field pH 7.5, moist, gradual to, B22 ,60 -90+ Yellowish brown (10YR5/4), medium heavy clay, hard and dense angular blocky, field pH 9.0, common calcareous concretions, moist	<u>Excavator site</u> Old alluvial plain with Poplar Box mixed. Old cultivation area – old dairy farm

Site	Easting	Northing	Soil type	Soil Profile	Comments
19	369774	6976350	A2	0-15cm light clay loam, dark grey, pH 8.0, 15-20cm sporadic bleach, pH 7.5, 25-90+cm 10YR3/2, grey brown, hard blocky with prominent soft carbonate. pH 8.5	Same as 18. Old Brigalow Poplar Box now cultivation. Slope 0.5%, alluvial plain,
20	370400	6976300	A2	Surface is quite hard setting. 0-15cm sandy clay loam, dark grey, pH 7.0, 15-20cm conspicuous bleach, pH 7.5, 25-90+cm 10YR3/2, grey brown, hard blocky with carb	Excavator site Old cultivation. Level old alluvial plain. Same as 19. Used for crops but quite poor, very hard, poor infiltration with shallow topsoil.
21	369700	6975730	A2		Same as 19 & 20
22	369654	6975149	A2	Surface is sandy & hard setting. 0-10cm sandy clay loam, grey brown, pH 7.5, 10- 70+cm 10YR3/2, grey brown, hard blocky with carb	Poplar Box level plain. House paddock. Same as 20
23	370775	6975661	A2		Same as 20
24	370166	6975072	-	Top 40cm same as 20	Boundary Site to red clay above alluvia. Looks same as 20 except slope 2%.
25	370570	6975000	B4	0-20cm pH 8.0, 5YR3/2, brown sandy clay loam, gravelly. 20-60cm pH8.5, 5YR3/6, firm medium clay, red brown, angular blocky. 60-90cm+ pH 8.5, 7.5YR5/6, some soft lime. Medium clay	Crest of broad ridge. Similar to site 12
26	371145	6974920	B4	Hard setting sandy surface with ironstone gravel.	Old Poplar Box country. Barley crop struggling with

Site	Easting	Northing	Soil type	Soil Profile	Comments
				0-7cm pH 7.0, fine sandy clay loam, grey brown . 7-60cm, pH 8.0, hard brown clay.	moisture stress
27	371000	6974390	B4	Hard setting surface 0 – 8cm pH 7.5, reddish brown fine sandy clay loam. 8-60cm very hard brown clay	Old Poplar Box country. Barley crop patchy
28	371033	6973954	B1	Dark grey brown self-mulching cracking clay. Few surface pebbles. UG516 A1 0 – 0.5cm. Very dark greyish brown (10YR3/2), medium heavy clay, fine granular, field pH 8.5, no inclusions, dry, abrupt change to, Ap 0.5 – 30 cm. Very dark greyish brown (10YR3/2), medium heavy clay, strong sub-angular blocky, field pH 8.5, some carbonate nodules 2-5mm, moist, clear change to, B21 30 – 50cm. Dark grey (10YR4/1), medium heavy clay, strong sub-angular blocky, field pH 9.0, some calcareous concretions, moist, gradual change to; B22 50 -120cm. Greyish brown (10YR5/2. heavy clay, strong lenticular structure, some manganese and carbonate concretions, field pH 9.0.	Cultivation. Slope 3% upper slope. Old Brigalow and Belah softwood scrub.
29	371300	6973954	B1		Same as 28. Midslope 3% slope.
30	371217	6973698	B1	AP 0-25cm pH 8.0, strong granular, brown 10YR3/4 cracking light clay 25-80cm strong lenticular structure, grey brown medium clay. 10YR3/2, field pH 8.7, common carbonate	Same soil as as 28.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				nodules, 80 – 120cm medium heavy clay, no mottles. 10YR4/3 pH 8.5.	
31	370724	6973733	B4	Surface is firm sandy with 20% ironstone gravel strew. A1 0-20 red brown sandy clay loam, pH 6.5, B21 20-90 blocky very firm medium caly, carb, pH 8.0, red brown 90 + calcareous sandstone bedrock pH 9.0	<u>Excavator site</u> Midslope 3% gradient. Looks classic 'Acland' soil
32	370400	6973710	B4	0-25cm Dark brown over red brown subsoil to 70cm	
33	370480	6973510	B4	Red Acland soil	Slope 4%
34	370904	6973300	B1	Dark grey brown self-mulching cracking clay.	Under cultivation. Upper midslope 2%. Same as 28. Deep dark brown / black cracking clay
35	371238	6973251	B1	Dark grey brown self-mulching cracking clay.	Same as 34. Lower slope 2%
36	371518	6973214	A1	Deep black cracking clay. Surface coarse self-mulching and deep wide cracks. No gravels. UG516. AP 0- 20cm pH 8.0, 10YR3/2, medium heavy clay, no inc,dry,abrupt, B21 20-40cm pH 8.5, 10YR3/2, angular blocky, MHC, some carb nodules 2-5mm, moist, grad to, B22 40-120cm. pH 9.0, increasing soft lime, med heavy clay, 10YR4/2,	<u>Excavator site</u> Flat alluvial plain <1% slope. with coarser self-mulching surface than upslope clays nearby. Barley cultivation looks ok. Basaltic alluvium. Roots to 120cm.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				s/subangular blocky,	
37	371900	6973164	A4	Brown sandy coming up from flat alluvia	Moreton Bay Ash, Termite mounds, Boundary with alluvial 36 to west
38	372126	6973100	A4	Hardsetting sandy surface non cracking. Db113 A1 0-20cm - Dark Brown (7.5YR4/4), weak structure, fine sandy loam, field pH 6.0, no inclusions, dry, clear to; B21 20-50cm. Yellowish brown (10YR5/6), sandy clay, very hard and coarse columnar, field pH 8.5, few orange mottles and calcareous nodules, dry, gradual to; B22 50-100 Reddish brown (5YR4/3), medium clay, very hard blocky, field pH 8.5, yellow and grey mottles common, some rounded ironstone gravels to 10mm.	Termite mounds common 0.7m, Moreton Bay Ash, Belah and Poplar Box. Slope 1%. Slightly more elevation than alluvial A1.
39	372083	6972703	A4		Change from sandy duplex to dark alluvial clay with Poplar Box. Small area dark clay. Lower slope 1%.
40	372026	6972354	A1	Deep dark grey cracking clay. Surface self-mulching and deep cracking. No gravels. A1 0-5cm pH 8.0, 10YR3/2, medium heavy clay mulch, B21 5-45cm pH 8.5, 10YR3/2, angular blocky, some carb nodules, B22 45-100cm. pH 9.0, increasing	Level old alluvial plain. Poplar Box. 'Waco'?

Site	Easting	Northing	Soil type	Soil Profile	Comments
				lime, med heavy clay, 7.5YR4/6, strong subangular blocky,	
41	372500	6972500	A1		Same as 40
42	371750	6972450	A1		Same as 40
43	372175	6973338	A4	Hard sandy surface duplex. 0-20cm Fine sandy loam, pH 6.0, 7.5YR4/3, sporadic bleach 20+ cm hard sandy clay, 7.5YR5/6, pH 8.5, coarse angular, some grey mottles.	Level plain, ants nests, sally wattle Poplar Box
44	372231	6973764	-		Boundary between duplex and black alluvial clay. Level plain
45	372000	6973854	A1	Dark cracking clay. Surface self-mulching 0-5cm pH 8.0, 10YR3/2, medium heavy clay mulch, B21 5-40cm pH 8.5, 10YR3/2, angular blocky, some carb nodules, B22 40-100cm. pH 9.0, lime, med heavy clay, 7.5YR4/6, subangular blocky,	Flat alluvial plain
46	372592	6973814	A1		Black clay
47	372580	6973500	A4		Fine sandy loam duplex same as 38
48	373044	6973746	A4		Fine sandy loam duplex same as 38
49	373040	6973600	A4		Fine sandy loam duplex same as 38
50	373637	6973479	A3	Surface is firm and sandy and cracking. A11, 0 – 20 cm. Brown (7.5YR4/2), Light sandy clay, angular, field pH	Excavator site Level old alluvial plain. Very tight soil.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				6.5, no inclusions, dry, abrupt to; A12, 20 – 22cm. Sporadic bleach. B21 22 – 50 cm. Dark brown (10YR3/3), sandy clay, very hard and coarse angular blocky, field pH 9.0, common calcareous nodules, moist, gradual to, B22 50 -100+cm Reddish brown (5YR4/3), medium heavy clay, very hard and dense angular blocky, field pH 9.0, common calcareous nodules, moist	
51	372380	6974766	B1	AP 0-20cm soft granular and cracking surface, light clay, field pH 8.0, brown 10YR3/2 20-75cm strong angular blocky structure, medium clay. 10YR3/2, field pH 8.5. carbonate nodules, 75 – 150cm lighter colour med heavy clay. 10YR5/3, carb nodules common, pH 8.5.	Gently undulating black clays with fine self-mulching cracking surface. Same as 29
52	372906	6975615	B1v	0-10cm pH 7.0, Fine non-cracking clay loam, grey brown 10-60cm well structured grey brown medium clay. pH 8.5. carbonate nodules, 60 – 90+cm decomposing sandstone pH 9.0.	Excavator site sampled 10cm and 70cm Brown clay on sandstone at 60cm. Shallow variant. Near old yards & farm sheds
53	373829	6972799	A1	Cracking strong mulching soft surface no stone. 0-60cm + dark 10YR4/2 medium heavy clay, well structured lenticular, no mottles, pH 8.5, 60+ dark clay continues. Carb increasing.	Flat old alluvial plain.

Site	Easting	Northing	Soil type	Soil Profile	Comments
54	373857	6972993	A3	Surface is hard and sandy and cracking. 0-20cm Light sandy clay, 7.5YR4/2, pH 6.5, Yellowish brown, 20-22cm bleach. 22-50cm Quite hard medium sandy clay, dark 10YR3/3, carb nodules, pH 9.0, angular blocky, 50-90cm 5YR4/3, reddish, pH 9.0, very hard. Very restricted drainage in subsoils.	Excavator site Level old alluvial plain. Hard clay soil.
55	374038	6974139	A3	Surface looks a bit softer than 50	Same as 50 , 54
56	374138	6974802	-		Boundary flatter alluvial clays and good upland soil
57	373956	6975298	B1		Dark good cropping clays (some basalt rock on surface?)
58	373191	6975844	B1	AP 0-20cm pH 7.0, cracking light clay, grey brown 20-60cm well structured grey brown medium clay. 10YR3/2pH 8.5. carbonate nodules, 60 – 90+cm firmer clay but ok. 10YR4/3 pH 8.5.	Excavator site Lower mid slope. Good cropping.
59	373258	6976283	B1	0-5mm granular mulch. Cracking dark clay 5mm – 45cm dark well structured med heavy clay, pH 8.5, 10YR3/2, some carb, 45 – 100cm+ dark brown well structured clay. No sign bedrock.	Excavator site Erosion gully in black soil, Belah
60	373323	6976714	B1	Dark, deep clay as for 59	Broad ridge slope <1%. Cropping. Belah.

Site	Easting	Northing	Soil type	Soil Profile	Comments
61	373449	6977342	B1		Same as 60
62	373900	6977343	B1	AP 0-20cm cracking light clay pH 8.0, , brown 10YR3/3 20-70cm lenticular structure, grey brown medium clay. 10YR3/2, field pH 8.7. lots carbonate nodules, 70 – 120+cm firmer clay. 10YR4/3 pH 8.5.	
63	373462	6977756	B1	0-5mm granular mulch. Cracking dark well structured clay	Brigalow Belah. Deep black clay – alluvial?
64	373167	6977799	B1	Deep black cracking clay in small pockets of predominantly red clay	. Mid upper slope 2%. Few ironstone gravels.
65	372923	6978050	A5		Flat plain of dark alluvial clay. Brigalow scrub
66	372720	6978160	A5	Surface is self-mulching and cracking. UG526 A1 0 – 20 Brownish grey (10YR4/3), medium clay, granular, field pH 8.5, some carbonate concretions to 5mm, dry, clear to, B21 20 – 70 Dark greyish brown (10YR4/2), medium clay, sub-angular blocky, field pH 8.5, some carbonate nodules 2-5mm, moist, gradual to, B22 60 -120Brown (10YR5/3), medium heavy clay, strong subangular blocky, field pH 8.5, increasing carbonate nodules 2-5mm, moist.	Active recent alluvial plain of Lagoon Creek. Good soil under cultivation. Slope <0.5%. Old Poplar Box, Brigalow scrub.
67	373044	6978477	A5	Deep brown alluvial clay – same top 50cm as 66	Lagoon Creek alluvia
68	372093	6978286	B2	Brown cracking light clay scrub soil	Upper slope 5%. Appears similar to site 2.

Site	Easting	Northing	Soil type	Soil Profile	Comments
69	372015	6977811	B2	Gravelly brown cracking clay with reddish subsoil same as 2	Same as 68.
70	374900	6977900	Ba3	Over 60% basalt cobble on surface and through profile. Not cracking. A1 0 – 35 reddish brown (5YR4/4) light clay, strong granular, field pH 7.0, C 35cm +Basalt bedrock	Red basalt soil
71	374369	6976229	B1v		Red brown shallow basalt clay
72	374898	6977574	Ba3	Red basalt soil lots rock	
73	374681	6976887	Ba3	Brown clay skeletal. Lots rock. Weathered basalt.	
74	374323	6975933	-		Boundary site. Red basalt upland shallow and dark brown thicker clay soils.
75	372526	6975500	B1	Brown fine self-mulching clay	Very good dark clay cropping soil on gentle ridge. 0.5% slope.
76	372431	6975087	B1	Reddish brown clay with some gravels on surface A1 0-0.5cm granular mulch, cracking light clay pH 8.0, reddish brown 5YR3/3 0.5 -60cm darker brown medium clay. 7.5YR3/2, field pH 8.5. carbonate nodules, well structured 60 – 120+cm medium clay. 7.5YR4/3 pH 8.5.	South face slope 3%.
77	371778	6974828	B1		Deep good dark cropping clay
78	371620	6975128	B4		Deep good dark cropping clay to east and poorer ‘duplex’ to west.

Site	Easting	Northing	Soil type	Soil Profile	Comments
79	369701	6976110	A2	Poorer, harder yellowish brown hard sandy clay. Cracking. Looks like doghouse.	Poplar Box grazing paddock.
80	369099	6979112	A1	Surface is cracking and self-mulching with minor mixed rounded gravels. Cultivated. AP 0-25cm Black medium heavy clay, 10YR2/1, pH 7.5, strong subangular blocky, B21 25-60cm Black 10YR3/1 medium heavy clay, carb nodules, pH 7.5, strong subangular blocky structure, whole coloured, B22 60-180cm Pale brown 7.5YR4/2, hard compact medium clay, carb nodules increasing, pH 8.5. B23 180+cm pH 9.0, alluvial washed gravels increasing.	Excavator site level cropping land. Good soil. Very large area on west side of Acland
81	368586	6979200	A1	Black cracking clay 100+ cm deep. Same as 80	Same as 80 cultivation
82	368409	6978681	A1	Cracking and s/mulching. Soft. Cultivated. AP 0-25cm Black medium heavy clay, 10YR3/1, pH 7.5, strong subangular blocky, B21 25-60cm Black 10YR3/2 medium heavy clay, carb nodules, pH 8.5, strong subangular blocky structure, B22 60-120cm+ Pale brown 7.5YR4/2, compact medium heavy clay, lots carb nodules, pH 8.7.	Excavator site
83	368170	6978150	A1	Same as 82	Same as 82. level alluvial plain. Old Poplar Box. Cultivation

Site	Easting	Northing	Soil type	Soil Profile	Comments
84	367810	6977677	A1	Cracking and s/mulching. A1 0-5cm Black medium clay granular mulch, 10YR3/2, pH 7.5, B21 5-60cm Black 10YR3/1 medium heavy clay, carb nodules, pH 8.5, strong subangular blocky structure, B22 60+ Pale brown 7.5YR4/2, compact medium heavy clay, lots carb nodules, pH 9.0	Level old alluvial plain.
85	367188	6977050	Ba3	Gravelly light clay on surface and through profile. Not cracking. 0 – 45 reddish brown (5YR5/4) light clay, strong granular, field pH 7.0, lots basalt rock included 45cm +Basalt bedrock	Skeletal basalt on edge of ridge.
86	366482	6976457	A1	Flat alluvial clay plains same as 84.	Wattle and Poplar Box regrowth
87	367526	6979296	B3	Texture contrast. Surface is firm, non cracking. Dy213 A10 – 20 Very dark greyish brown (10YR3/2), clay loam, strong granular, field pH 7.0, no inclusions, dry, abrupt change to, B21 20 –60cm. Very dark grey (10YR3/1), medium heavy clay, strong angular blocky, field pH 8.0, some 2-5mm, moist, gradual change to, B22 60 -150cm. Pale brown (10YR5/3), medium heavy clay, strong sub-angular blocky, field pH 9.0, carbonate nodules increasing with depth, moist. Sandstone gravels	<u>Excavator site</u> Upland area used for grazing. Mature bush regrowth. 2% slope. Pasture cover 60%. Tall Poplar Box, Brigalow Belah. Good soil. sampled

Site	Easting	Northing	Soil type	Soil Profile	Comments
				common and increasing with depth BC 150cm Sandstone bedrock	
88	367310	6979259	B3	Dark soil with surface 20cm clay loam on black dense medium clay.	Same as 87. poplar Box Wilga. Slope 5%
89	366552	6979273	B4		Upper slope of small hill. Soils brown and lighter colored. Gravels common on surface.
90	366505	6979900	B4		Red brown uniform clay with surface gravels
91	368742	6979959	B3	A1 0-20cm Dark brown 10YR3/2, loamy clay, pH 7.5, B21 20-60cm Very dark 10YR3/1, medium heavy clay, strong angular blocky, quite hard, pH 8.0, some lime nodules, B22 60-100cm+ Pale brown 10YR5/3, medium heavy calcareous clay, pH 9.0.	Excavator site Upper / mid slope 3%, Cultivation. Appears same as 87.
92	368750	6980460	Ba3	Shallow red brown skeletal clay soils formed on basalt	Basalt quarry on side of low hill. Mountain Coolibah.
93	368596	6980914	A1	Deep dark alluvial basalt soil to 150cm +	Excavator site Low relief between basalt ridges. Alluvial pathway.
94	368300	6980900	Ba2	Cracking and s/mulching surface. Soft granular. 0-45cm dark 10YR3/1 medium clay, well structured, pH 8.0, 45-70cm dark 10YR4/1 medium heavy clay, carb nodules common, lenticular structure strong, pH 8.5 70+cm weathered basalt	Mt Coolibah. Upper flat area along broad ridge.
95	368504	6980975	Ba3	Skeletal black clay	Basalt scree slope. Very

Site	Easting	Northing	Soil type	Soil Profile	Comments
					rocky. 7%.
96	368313	6980887	Ba2	Cracking and self-mulchinging. Soft. 0-40cm very dark 10YR3/1 medium clay, well structured, pH 8.0, 40-75cm dark 10YR4/2 medium heavy clay, carb nodules common, lenticular structure strong, pH 8.5 75cm basalt bedrock	Excavator site Level cropping soil
97	367651	6980967	Ba1	Surface has 10% basalt rock cover. A1 0-40cm 5YR3/3, light sandy clay, granular , field pH 8.0, B21 40-70cm 5YR5/4, firm medium clay, no mottles, field pH 8.5, carb nodules BC 70+cm weathered basalt	Brown non cracking crusty clay with some surface gravels which include basalt
98	368000	6980500	Ba1		Same as 97
99	368000	6981400	Ba1		Same as 97
100	367900	6980935	-		Boundary between black Mt Coolibah basalt to brown lighter soil
101	367845	6980937	Ba1	non cracking surface. 0-40cm 5YR3/3 dark reddish brown fine sandy clay 40-90cm 5YR4/6 yellowish red medium clay 90+ weathered basalt	Excavator site Brown cropping clay on yellow brown clay subsoil
102	370348	6979881	B4	Non cracking sandy firm surface. 0-20cm light sandy clay. 5YR5/4, 20-60cm Hard angular blocky. Massive medium clay. 5YR4/4 reddish brown.	Excavator site Under pasture 100% cover. Large termite mounds common. Mid slope 5%. Similar site 12 ‘Acland’.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				60 – 90+cm Mixed weathered sediments in river gravels (ironstones common) and weathered sandstone	
103	370313	6980566	Ba3	Deep red clay with lots of basalt rock on surface.	Basalt ridge. Moreton Bay Ash.
104	369500	6980801	A1		Dark clay alluvia on drainage line
105	369150	6980566	Ba3		Basalt ridge
106	370009	6982320	Ba1	Red sandy clay loam to 20cm over gravel over medium clay	Level area old cultivation now grazing paddock. Appears as basaltic soil (roaks on surface).
107	369261	6982248	Ba1	Red brown surface fine few gravels. 0-20cm light clay red / brown. 20-70cm medium clay. Red brown 5YR4/4. pH 8.5. 70 basalt weathered rock	Old cultivation. Mid slope 5%. Similar to 106. profile moist to rock.
108	368900	6982015	Ba3	A1 0 – 20 Dark reddish grey (5YR4/2) light medium clay, strong granular, field pH 8.0, some calcareous nodules to 3mm, moist, B21 20 – 60, Dark red brown (5YR3/2 medium clay, calcareous nodules common, strong blocky structure, field pH 8.5, clear change to, C 60+Basalt bedrock	Shallow rocky ridge basalt. Lots basalt rock on surface. Mt Coolibah.
109	369222	6981815	Ba1	Surface is soft non-cracking with light basalt rock. A1 0-35cm 5YR3/4, light clay, granular structure, pH 7.5, B21 35-60cm 5YR4/4, sandy clay, subangular, pH 8.5, carb nodules increasing	Same as 107 – basalt cropping soil

Site	Easting	Northing	Soil type	Soil Profile	Comments
				BC 60+cm weathered basalt	
110	368928	6981798	Ba3		Basalt soil same as 108.
111	369012	6981504	Ba1		Same as 107. Red basalt cropping soil.
112	368772	6981161	Ba1	Surface is firm and non-cracking with 15% basalt rock cover. AP 0-40cm 5YR4/4, light clay, fine granular structure, pH 7.5, whole coloured, B21 40-80cm 5YR5/4, dense hard gravelly clay, few mottles, BC 80+cm weathered basalt	Excavator site Cultivation on red brown basaltic clay. Slope 5%.
113	368197	6981190	Ba1	Red brown non-cracking light clay surface with 10% basalt rock strew.	Same as 112. Old cultivation with nearby Mt Coolibah. Slope 5%.
114	368109	6981450	Ba1	Approx 40cm light red brown clay over harder clay.	Same as 112. Slope 3%
115	368343	6981012	Ba2	Soft surface which is cracking and self-mulchinging. 0-40cm Black 10YR3/1 medium clay, well structured, pH 8.0, 40-70cm dark 10YR4/2 medium heavy clay, carb nodules common, lenticular structure, pH 8.5 70+cm weathered basalt	Dark basaltic cropping soil.
116	366900	6981080	Ba3	Shallow skeletal basalt upland soil – light clay	Rocky basalt ridge with Mt Coolibah
117	367280	6981002	Ba1	Surface is non-cracking with 10% basalt rock cover. A1 0-45cm 5YR3/4, light clay, fine granular structure, pH 7.0, B21 45-70cm 5YR5/4, hard medium clay, few mottles, pH 8.5, carb	Excavator site Mid lower slope 4%. Old cultivation. Lots annual weed.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				nodules moderate BC 70+cm weathered basalt	
118	368584	6979880	B3	Surface is non-cracking with 10% basalt gravels. A1 0-20cm 7.5YR3/4, brown clay loam, granular, pH 7.0, B21 20-60cm 7.5YR5/4, hard medium clay, no mottles, pH 8.5, carb nodules moderate BC 60cm+ weathered bedrock (possibly basalt)	Excavator site Upper midslope 3%. Old cultivation.
119	368307	6979971	A1	Surface is cracking and self-mulching with some rounded gravels. Cultivated. A1 0- 30cm Black medium heavy clay, 10YR3/1, pH 7.5, strong subangular blocky, B21 30-90cm+ Black 10YR3/2 medium heavy clay, strong subangular blocky structure, whole coloured, carb nodules increasing, pH 8.5.	Drainage pathway in basalt landscape.
120	367876	6979909	B3	Surface is cracking and self-mulching with mixed ironstone and basalt gravels about 15% of surface. AP 0-20cm black clay loam 10YR3/2, pH 8.0, angular, B21 20-80cm Stiff coarse blocky medium heavy clay. Black. 10YR2/1. pH 8.5. B22 80-120+cm Pale yellowish brown medium heavy clay 7.5YR5/4, increasing ironstone gravel, pH 9.0.	Excavator site Undulating lands with 2-3% slope. Strong pasture cover. Entire profile is moist. Old cropping soil – probably very productive. Nearby is Poplar Box with wilga and prickly pear.

Site	Easting	Northing	Soil type	Soil Profile	Comments
121	367574	6980075	B3	Surface same as 120(cracking and self-mulchinging) A1 0-20cm clay loam 10YR3/2, pH 8.0, B21 20-70cm Hard blocky medium heavy clay. Black. 10YR2/1. pH 8.5. B22 70-90+cm Pale yellowish brown medium heavy clay 7.5YR5/4, increasing ironstone gravel, pH 9.0.	<u>Excavator site</u> Same as 120. Big Poplar Box.
122	367169	6980290	Ba2	Black self-mulching clay loam surface. AP 0-30cm fine sandy clay, 10YR3/2, pH 8.0, B21 30-60cm well structured angular blocky, medium clay, dark brown 7.5YR4/3, pH 8.5, carb, BC 60cm + weathered basalt starts	Excavator site Ben Muirhead, Pastoral manager, 0427721698 Excellent cropping soil. Midslope 2%. Old cultivation soon to be reestablished.
123	366808	6980177	Ba2	Black soft clay loam surface.	Strip of Poplar Box along fence. Same soil as 122. Old cultivation.
124	366326	6980235	Ba2		Similar to 123 but becoming lighter coloured. Good light clay cropping soil.
125	366480	6980480	Ba2		Black cropping soil same as 122.
126	367201	6980023	Ba2	Surface is cracking and self-mulching with mixed ironstone and basalt gravels about 10% of surface. AP 0-25cm black clay loam 10YR3/2, pH 8.0, angular, B21 20-80cm Stiff coarse blocky medium heavy clay. Black. 10YR2/3. pH 8. B22 80-120+cm Pale yellow brown medium heavy clay 7.5YR5/4,	Similar to 120 old cropping soil – sloping 3-4%

Site	Easting	Northing	Soil type	Soil Profile	Comments
				increasing ironstone gravel, pH 9.0.	
127	367603	6980255	B3	Cracking with fine self-mulching	Similar to 120, but steeper.
128	368504	6980100	B3	Surface is non-cracking with 5-10% basalt gravels. A1 0-20cm 7.5YR3/5, brown clay loam, granular, pH 7.5, B21 20-60cm 7.5YR5/4, hard medium clay, no mottles, pH 8.5, carb nodules moderate BC 60cm+ weathered bedrock (possibly basalt)	Upper midslope 3%. Old cultivation..
129	368421	6980530	A1	Surface is cracking with some self-mulching. Some rounded gravels. Cultivated. A1 0- 35m dark medium heavy clay, 10YR3/2, pH 7.5, strong subangular blocky, B21 30-90cm+ Black 10YR3/3 medium heavy clay, strong subangular blocky structure, whole coloured, carb nodules increasing, pH 8.0.	Drainage pathway. Less 1%. Probable basalt landscape Similar to 119.
130	368719	6979610	B3	Dark brown 10YR3/1, loamy clay on Very dark 10YR3/1, medium heavy clay.	Lower to mid slope 2.5% Some Cultivation. Similar to 87 and 91.
131	369104	6979350	B3	Non to lightly cracking brown clay loam with scattered gravels 25cm. over a hard medium clay, no mottles.	Upper midslope 3%. Old cultivation. Similar to 118.
132	369509	6979413	A1	Cracking and s/mulching. AP 0-25cm Black medium heavy clay, 10YR3/2, pH 7.5, strong subangular blocky, B21 25-60cm Black 10YR3/2 medium	Old alluvial clay drainage area. Less than 1%.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				heavy clay, carb nodules, pH 8.5, strong subangular blocky structure, B22 60-120cm+ Pale brown 7.5YR4/2, compact medium heavy clay, lots carb nodules, pH 8.7.	
133	370062	6979209	B4	Non cracking sandy firm surface. 0-20cm light sandy clay. 5YR5/4, 20-60cm Hard angular blocky. Massive medium clay. 5YR4/4 reddish brown. 60 – 90+cm Mixed weathered sediments in river gravels (ironstones common) and weathered sandstone	Under thick pasture cover. Mid slope 3%. Similar to site 12 and 102.
134	371120	6978790	B4	0-30cm 5YR4/4 light sandy clay, 7.5, 40+ basalt rock	Mid slope area with 2% slope. Reddish brown non cracking clay on basalt gravel & rock. Similar to 68.
135	371702	6978654	B2	Brown cracking light clay scrub soil	Slope 2%. Appears similar to site 2 and 68.
136	372180	6978208	B2	Brown cracking light clay scrub soil	Upper slope 4%. Appears similar to site 2 and 68.
137	371857	6977951	B2	Brown cracking light clay scrub soil	Slope 3%. Appears similar to site 136.
138	372590	6978005	A5	Self-mulching and cracking. UG526 A1 0 – 20 Brown (10YR5/3), medium clay, granular, field pH 8.5, some carbonate concretions to 5mm, dry, clear to, B21 20 – 70 Dark greyish brown (10YR4/2), medium clay, sub-angular blocky, field pH 8.5, some carbonate nodules 2-5mm, moist, gradual to, B22 60 -120Brown (10YR4/3), medium heavy clay, strong	Active recent alluvial plain of Lagoon Creek. Good soil. Slope <0.5%.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				subangular blocky, field pH 8.5, increasing carbonate nodules 2-5mm, moist.	
139	374005	6978100	B1	AP 0-20cm cracking light clay pH 8.0, dark brown 10YR3/3. 20-70cm lenticular structure, dark grey brown medium clay. 10YR3/2, field pH 8.5. lots carbonate nodules, 70 – 120+cm firmer clay. 10YR4/3 pH 8.0.	Old crop area. <2%.
140	373160	6977112	B1	Dark, deep clay as for 59 and 60.	Broad ridge slope <1.5%. Cropping. Belah.
141	373083	6975228	B1	AP 0-20cm soft granular and cracking surface, light clay, field pH 8.0, brown 10YR3/2 20-75cm strong angular blocky structure, medium clay. 10YR3/2, field pH 8.5. carbonate nodules, 75 – 150cm lighter colour med heavy clay. 10YR5/3, carb nodules common, pH 8.5.	Gently undulating black clays with fine self-mulching cracking surface. Similar to 51, 291,39,140. <2% slope.
142	373380	6974076	A3	Surface is firm and sandy and cracking brown sandy clay over a hard dark brown (10YR3/3) sandy clay.	Level old alluvial plain. Fairly tight soil. Grazing. Similar to 50.
143	372810	6974155	A1	Dark gray brown self-mulching and cracking clay. 0-5cm pH 8.0, 10YR3/3, medium heavy clay mulch, B21 5-40cm pH 8.5, 10YR3/2, angular blocky, some carb nodules, B22 40-100cm. pH 8.5, carb, med heavy clay, 7.5YR4/6, subangular blocky,	Near level alluvial plain. Old cropping area. Similar to 45.
144	372056	8974387	B1	AP 0-25cm soft granular and cracking surface, light clay, field pH 8.0, dark	Gently undulating black clays with fine self-mulching

Site	Easting	Northing	Soil type	Soil Profile	Comments
				grey brown 10YR3/2 25-75cm strong angular blocky structure, medium to heavy clay. 10YR3/2, field pH 8. carbonate nodules, 75 – 150cm lighter colour brown med heavy clay. 10YR5/3, carb nodules common, pH 8.	cracking surface. Same as 29, 51, 76 and 77.
145	371902	6976258	B1	Brown fine self-mulching clay	Very good dark clay cropping soil on 1.5% mid slope.
146	371780	6976709	B1	Brown fine self-mulching clay	Very good dark clay cropping soil on gentle ridge. 0.5% slope.
147	372051	6977099	B1	Brown fine self-mulching clay	Very good dark clay cropping soil on gentle ridge. 0.5% slope.
148	371563	6973400	A1	Very dark cracking clay with coarse self-mulching. No gravels.	Near level alluvial plain <0.5% slope. Slightly coarse self-mulching surface than upslope clays nearby. Similar to 36.
149	371507	6973060	A1	Dark cracking clay with some surface mulch. No gravels. UG516.	Near level alluvial plain <0.5% slope.
150	373655	6974807	A1	Dark cracking clay with some self-mulching over dark medium clay. pH 8 surface, 9 at 40cm.	Flat alluvial plain
151	372680	6976686	B1	AP 0-25cm pH 7.0, cracking light clay, grey brown 25-60cm well structured grey brown medium clay. 10YR3/2pH 8.5. carbonate nodules, 60 – 90+cm firmer stiff brown clay. 10YR4/3 pH 8.5.	Lower mid slope. <1% Good cropping soil.
152	370356	6976621	A2	Surface is quite hard setting.	Poss old cultivation. Some scattered trees. Level old

Site	Easting	Northing	Soil type	Soil Profile	Comments
				0-20cm sandy clay loam, dark grey, pH 7.0, 20-25cm conspicuous bleach, pH 7.5, 25-90+cm 10YR3/2, grey brown, hard blocky with carb	alluvial plain. Similar to 19. Harder soils. poor infiltration with shallow topsoil.
153	369500	6976925	B4	0-20cm light clay loam, grey brown, pH 8.0, 5YR5/4 20 - 75cm pale yellowish brown stiff clay with carbonate. pH 8.5 >75cm weathered material	Shallow cultivation. Similar to 15. Relatively steep 4% slope.
154	369802	6978306	B4	Dr413 Red ferrosol Shallow dark reddish brown (5YR3/3), gravelly clay loam. field pH 7.5,.	Mid slope 1.5%, surface is firm with some rounded ironstone up to 5mm. sampled Similar to 12, 13 and 15.
155	367405	6978830	B3	Cracking and self-mulching surface with mixed ironstone and basalt gravels about 10 -15% of surface. AP 0-20cm dark black brown clay loam 10YR3/3, pH 8.0, angular, B21 20-80cm Stiff coarse blocky medium heavy clay. Black. 10YR2/1. pH 8.5. B22 80-100+cm Pale yellowish brown medium heavy clay 7.5YR5/4, increasing ironstone gravel, pH 9.0.	Undulating lands with 2-3% slope. Similar to 120. Strong pasture cover. Entire profile is moist. Old cropping soil – probably very productive. Nearby is Poplar Box with wilga and prickly pear.
156	368200	6979240	A1	Black cracking clay 100+ cm deep. Same as 80 - 84	Less 1% slope.
157	368520	6977786	A1	Dark self-mulching and cracking clay. Similar to 80 – 84.	Level alluvial plain. Old Poplar Box country. Some cultivation in area.

Site	Easting	Northing	Soil type	Soil Profile	Comments
158	369401	6977521	B4	0-15cm fine sandy clay loam, brown, 8.0, 15-25cm dark brown medium clay 5YR3/1, 8.0. angular blocky 25 – 80cm+ pale brown hard med heavy clay	1% mid upper slope area. Similar to 14.
159	371228	6977583	B2	Brown cracking light clay scrub soil	Lower mid slope 4%. Scattered trees. Appears similar to site 2 and 68.
160	370320	6977659	B2	0-25cm moist, dark grey brown med clay 10YR3/3. 25-70 cm dark grey 10YR4/2 med heavy clay, angular blocky fine gravels, very little carb	Lower Midslope 1% Good cropping soil. Similar to 3.
161	370750	6977911	B2	Sim to 160	MId slope area<1%.
162	372965	6974688	B1	Reddish brown granular clay with some gravels on surface over well structured deeper clay.	Lower mid slope 2%. Sim to 76
163	373561	6976176	B1	Dark, deep clay as for 59	Similar to 59.
164	371453	6976066	B1	Similar to 52. Soft granular and cracking surface, light clay, field pH 8.0, brown 10YR3/2 20-80cm strong angular blocky structure, medium clay. 10YR3/3, field pH 8.5. carbonate nodules, 80 – 130cm lighter colour med heavy clay. 10YR5/3, carb nodules common, pH 8.5.	Mid slope <1%. Old cropping area.
165	369406	6978815	A1	Black cracking clay 100+ cm deep. Same as 80	Level alluvial clay area – drainage line influence. Similar to 80 cultivation
166	371581	6974673	B1	AP 0-25cm pH 8.0, strong granular, brown 10YR3/4 cracking light clay	Near level, scattered trees. Similar soil to 28 and 30.

Site	Easting	Northing	Soil type	Soil Profile	Comments
				25-8 UG516.0cm strong lenticular structure, grey brown medium clay. 10YR3/2, field pH 8.7, common carbonate nodules, 80 – 120cm medium heavy clay, no mottles. 10YR4/3 pH 8.5.	
167	372085	6974997	B1	Similar to 76 and 166. Reddish brown well structured friable clay with some gravels on surface.	Deep good dark cropping clay on moderate 3-4% slope.
168	372890	6976002	B1	Brown fine self-mulching clay – similar to 59, 70,166,167.	Very good dark clay cropping soil on gentle 1% slope.
169	373186	6977321	B1	Dark, deep clay – similar to 168.	Broad ridge slope 1-21%. Cropping.
170	368300	6976915	**A2**	Poorer, harder yellowish brown hard sandy clay. Cracking. Similar to 79.	Poplar Box grazing paddock.

NEW HOPE GROUP

G.1.5 Soils Technical Report – Rail and Road

New Acland Coal Mine Stage 3

ROAD AND RAIL CORRIDOR

SOIL TECHNICAL REPORT

September 2013

SINCLAIR KNIGHT MERZ

SKM

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Contents

Executive Summary

This Soil Technical Report presents the outcomes of a supplementary soil survey for the New Acland Coal Mine Stage 3 Project (the revised Project), conducted by Sinclair Knight Merz Pty Ltd (SKM) for New Acland Coal Pty Ltd (NAC). The revised Project includes the construction of a rail spur and diversions to the Jondaryan-Muldu Road (the Road and Rail Corridor). SKM were commissioned to conduct a soil survey of the Road and Rail Corridor.

The Soil Technical Report addresses the following objectives:

- Objective 1. Describe and classify the soils of the Road and Rail Corridor;
- Objective 2. Assess the land suitability (LSA) and good quality agricultural land (GQAL) for the Road and Rail Corridor;
- Objective 3. Describe the soil mapping units (SMUs) in the Road and Rail Corridor; and
- Objective 4. Describe the strategies that will be used to manage soil resources.

Seventeen sites were assessed at a frequency of approximately 1 site per 1 linear km in areas to be disturbed by the Road and Rail Corridor. Site location sought to sample changes in terrain patterns and landscape position so that all indicated terrain units were samples. Of the seventeen sites investigated, all were described in detail. Soil samples from eleven of these sites were submitted for laboratory analysis to confirm a selection of relevant diagnostic properties.

Three soil orders were identified along the Road and Rail Corridor, with Vertosols predominating with minor areas of Dermosols and Kandosols. In addition, Land Resource Area (LRA) mapping of Harris et al (1999) were overlain along the Road and Rail Corridor and a list of possible component soil types described for each soil order.

Field work resulted in the refinement of LRA mapping following verification of existing soil type which resulted in four soil mapping units (SMUs) along the Road and Rail Corridor. Specific management implications for the soils were developed from the SMUs. A summary of the SMUs, the field verified classification, and management considerations for these soils are presented in **Table A**.

Table A Field Verified Classification and Management Considerations for SMUs of the Road and Rail Corridor.

SMU	Aust. Soil Order	Description	LRA and major indicated soil type(s) of Harris et al 1999.	Major Management Issues
A1	Vertosols	Deep dark brown to black cracking clays >100 cm deep with self-mulching surface. Broad level old alluvial plains of basaltic colluvium. Possibly saline below 60 cm.	**LRA 3a.** Cecilvale and Waco	Cropping soil comprised of uniform and deep cracking clay with high water storage potential. Saline to highly saline subsoils are common below 0.8m depth.
B1	Mainly Vertosols with associated Dermosols	Dark and deep to moderately deep cracking and non cracking clay on gently undulating plains. Possibly saline below 0.8 m.	**LRA 6a** Edgefield with Moola	Overall, similar to A1 but with generally lighter clay texture and reduced subsoil salinity risk.
Ba2	Vertosols	Black cracking clay on basalt with weathered basalt horizon below 0.65m. Non-saline.	**LRA 7a** Charlton	Deep cropping soil with strong structure and cracking self mulching surface which are non-saline but with increasing susceptibility to soil erosion.

SMU	Aust. Soil Order	Description	LRA and major indicated soil type(s) of Harris et al 1999.	Major Management Issues
Ba3	Dermosols and Kandosols	Generally shallow basaltic clay and clay loam uplands. Non-saline.	**LRA 7a** Kenmuir	Shallow clay loams to uniform clay with low water storage potential and possible higher slope gradients.

The primary soil constraints are subsoil salinity in the alluvial and scrub soil units (A1 and B1) which reduces effective soil depth to about 0.8 m. Ba2 soils are deep well-structured basaltic clays with minor limitations to cropping.

1 Introduction

New Acland Coal Pty Ltd (NAC) currently operates the existing New Acland Coal Mine (the Mine), as a 4.8 million tonne (product coal) per annum (Mtpa) open cut coal mine on mining lease (ML) 50170 and ML 50216 within Mineral Development Licence (MDL) 244, under the approval of Environmental Authority (EA) EPML00335713.

NAC is proposing to develop the New Acland Coal Mine Stage 3 Project (the revised Project), which involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within MLA 50232. These resource areas are identified as the Manning Vale and Willeroo resource areas. The revised Project is expected to extend the Mine's operating life until approximately 2029.

The revised Project includes the construction of a rail spur and diversions to the Jondaryan-Muldu Road (the Road and Rail Corridor). SKM were commissioned to undertake a soil survey of the Road and Rail Corridor.

1.1 Objectives

The primary objectives of the survey were:

- **Objective 1. Describe and classify the soils of the Road and Rail Corridor.** To satisfy Objective 1, the soils were described following the methods in the Australian Soil and Land Survey Field Handbook (NCST 2009) (the ASLS Field Handbook) and classified according to the Australian Soil Classification (Isbell 2002) (the ASC). Soil mapping units (SMUs) were defined based on soil morphology, recognisable landscape features and land use management.

- **Objective 2**. **Assess the land suitability (LSA) and good quality agricultural land (GQAL) for the Road and Rail Corridor.** To satisfy Objective 2, the land was assessed according to the following documents:

  - Guidelines for Agricultural Land Evaluation in Queensland (DPI 1990 and EHP 1995); and

  - Planning Guidelines: The Identification of Good Quality Agricultural Land (DPI/DHLGP 1993).

- **Objective 3. Describe the soil mapping units (SMUs) in the Road and Rail Corridor.** To satisfy Objective 3, the findings of Objectives 1 and 2 were combined to develop soil mapping units (SMUs) for the Road and Rail Corridor for the purpose of soil and land management for the duration of the revised Project.

- **Objective 4. Describe the strategies that will be used to manage the soil resource** including topsoil and erosion and sediment control measures, particularly in relation to managing sodic and saline soil materials.

1.2 Legislation and Environmental Guidelines

This Soil Technical Report has been prepared with consideration to the following legislation:

- *State Development and Public Works Organisation Act 1971*;

- *Mineral Resources Act 1989*;

- *Environmental Protection Act 1994*;

- *Soil Conservation Act 1986*; and

- *Environmental Protection (Water) Policy 2009.*

The regulatory framework for assessing GQAL is documented in *State Planning Policy 1/92 Development and the Conservation of Agricultural Land* (SPP 1/92) and *Planning Guidelines: The Identification of Good Quality Agricultural Land* (DPI/ DHLGP, 1993). These guidelines define GQAL as land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources (DPI/ DHLGP, 1993).

2 Background Information

2.1 Location

The revised Project site is located within southeast Queensland's Darling Downs region 12 km north-northwest of Oakey, 35 km northwest of Toowoomba and 177 km west of Brisbane, Queensland's capital city. Toowoomba is the closest regional centre to the revised Project and is one of Australia's largest provincial cities with a population of 90 000 (http://www.toowoomba.org/). Toowoomba is the economic hub of the Darling Downs.

The Darling Downs is located within the Condamine River catchment at the headwaters of the Murray-Darling Basin and is characterised by fertile soils and a long history of agricultural development. In recent times the Darling Downs, like many agricultural regions, has experienced significant change in land use activities driven by a combination of new policy initiatives, technological developments, changing commodity markets, and broader demographic and cultural shifts.

The revised Project site is located within the Lagoon catchment. Lagoon Creek is the main local water course and is an ephemeral creek which forms a tributary of Oakey Creek, within the greater Condamine River catchment. Lagoon Creek flows roughly across the middle of the revised Project site in a northeast to southwest direction. The elevation of the surrounding area ranges from 390 m above sea level at Lagoon Creek up to 525 m above sea level on a local basaltic ridge. The revised Project site average is 420 m above sea level.

2.2 Geology

The revised Project site lies within the Cecil Plains Sub-Basin which is located within the western portion of the Clarence-Moreton Basin. In Queensland, the Clarence-Moreton Basin merges with the Surat Basin. The Kumbarilla Ridge is a basement high consisting of the Upper Devonian to Upper Carboniferous Texas beds and separates the Cecil Plains Sub-Basin of the Clarence Moreton Basin, from the Surat Basin. The Clarence-Moreton Basin represents an eastern portion of the Mesozoic GAB. In this portion, major aquifers of the GAB comprise the Marburg Sandstone and Helidon Sandstone. The Walloon Coal Measures is also considered to form a GAB aquifer.

The economic coal-bearing sediments of the Surat and Clarence-Moreton basins occur in the Walloon Coal Measures. The Walloon Coal Measures are Middle to Upper Jurassic in age and are a part of the Injune Creek Group. Although the Kumbarilla Ridge is considered to structurally separate the Clarence-Moreton Basin from the Surat Basin, the Walloon Coal Measures occur on both sides of the Kumbarilla Ridge and are laterally continuous between the Clarence-Moreton Basin and the Surat Basin.

The Injune Creek Group cannot be identified as a distinct unit in the western Clarence-Moreton Basin. However it is broken up into a productive coal bearing lower unit, the Walloon Coal Measures, and a coal resource barren upper unit, the Kumbarilla Beds.

Within the revised Project site, the major coal bearing unit within the Walloon Coal Measures is referred to as the Acland-Sabine Sequence. The Acland-Sabine Sequence occurs in the lower coal bearing unit (Taroom Coal Measures equivalent) of the Walloon Coal Measures.

Tertiary Basalts unconformably overlie the Walloon Coal Measures in some areas of the revised Project site. The Tertiary age was a period of intense volcanic activity during which the eroded palaeosurface of the Walloon Coal Measures was covered with basalt flows. Basalt filled palaeo-channels occur within the north western and southern margins of the current Mine's Central and Southern Pits. Quaternary age alluvium is associated with present day natural drainage channels within the region. Chapter 6 provides a detailed assessment of regional geology.

2.2.1 Local Geology

The local geology of the Study area is described below.

Quaternary Deposits

Quaternary deposits consist of recent alluvium deposited by creeks and rivers. Within the revised Project site, these deposits are only likely to occur in association with the Lagoon Creek catchment in the west of the revised Project site.

Tertiary Basalt

The Tertiary Basalt unconformably overlies the Walloon Coal Measures in several localities within the revised Project site. Remnants of Tertiary age basalt flows occur on hill tops, and show that the basalt formed as low lying horizontal continuous flows within palaeochannels eroded into the Walloon Coal Measures palaeosurface. Given the depositional environment, it is likely that in some locations the elevation of the base of the basalt flows lies below the elevation of the top of the older Walloon Coal Measures formation lying adjacent to the basalt flow, such that the basalt and coal measures in part lie at similar depths. Following basalt deposition, preferential erosion of the softer Walloon Coal Measures around the channelled basalt flows has resulted in the elevated basalt remnants currently seen at the revised Project site.

The presence of weathered basalt below fresh basalt, in combination with relict soil profiles and sedimentary layers interbedded with the flows, indicates that there has been a succession of basalt flows within the revised Project site. Evidence of two to three distinct flows have been observed during drilling investigations. There is some outcrop of the Tertiary Basalt in the northern section of the Study area, but only very minor outcrop within the proposed western pit (Manning Vale West pit) area.

Borehole logs show that the basalt thickness is highly variable within the revised Project site. In general, whilst basalt extent and thickness is shown to be highly variable, it is known to become more prolific and widespread immediately west of the revised Project site.

Walloon Coal Measures

The Walloon Coal Measures are around 120 m to 130 m thick across most of the revised Project site, although planned mining activities are limited to the base of the economically recoverable coal reserves lying less than 75 m below ground level at their deepest point. Chapter 3 outlines the mine plan for the revised Project.

The three major coal intervals identified within the lower Walloon Coal Measures (Taroom Coal Measures equivalent) are the Waipanna, Acland-Sabine, and Balgowan. The Mine currently extracts coal from the Acland-Sabine interval within the lower Walloon Coal Measures. The Acland-Sabine interval contains six seam groups. From the top to bottom these are nominated as A to F. Each seam group contains up to 10 seam plies. Seam plies are discrete layers of coal within a seam group. In total, the Acland-Sabine interval has 47 seam plies. The average thickness of an individual seam ply is 0.23 m. Individual seam plies are unlikely to extend great lateral distances, but rather form isolated pods of coal.

The Waipanna interval contains six seam groups which contain 53 seam plies. The Balgowan interval contains seven seam groups which contain 21 seam plies. The regional dip of the Walloon Coal Measures is one to three degrees south-southwest. Local variations of both dip and strike occur due to both folding and faulting. The general geological structure of the revised Project site can best be described as a fault modified southwesterly plunging syncline, with the fold axis centred on the Lagoon Creek drainage channel.

Faulting is known to have occurred from observations made from underground mines in the Acland area and has also been interpreted from drilling results and from the existing open cut. Faulting is developed along two main trends, northeast-southwest and northwest-southeast; however east-west faults with significant throws have also been observed in the mine pits.

Marburg Sandstone

The Marburg Sandstone is typically around 200 m to 300 m thick at the revised Project site and regionally dips to the southwest. The unit outcrops 3 km northeast of the Mine, however at the revised Project site the unit lies at a depth of approximately 150 m below ground surface and 75 m below the base of the current and proposed mine workings. The Marburg Sandstone is made up of poorly sorted, coarse to medium-grained, feldspathic sublabile sandstone and fine-grained, well sorted quartzose sandstone. Minor carbonaceous siltstone, mudstone, coal and rare pebble conglomerate also occur within the Marburg Sandstone.

Evergreen Formation

The Evergreen Formation is a dominantly finer grained unit than the overlying and underlying Marburg and Helidon sandstones, and is generally up to 200 m thick in the Study area. As described above, the boundary is transitional with the overlying Marburg Sandstone which may be responsible for the Evergreen Formation not being described separately in some parts of the Clarence Moreton Basin. The Evergreen Formation has been described on the 1:250 000 Geology Map of Ipswich (Geological Survey of Queensland, 1980) as consisting of sandstone, siltstone, shale, mudstone and oolitic ironstone.

Helidon Sandstone

The Helidon Sandstone is up to 170 m thick and is extensive within the Cecil Plains Sub-Basin of the Clarence-Moreton Basin. The unit is generally found at depths of between 500 m and 600 m below ground level at the revised Project site, however the sandstone is known to outcrop near the township of Helidon located approximately 50 km southeast of the revised Project site. The Helidon Sandstone can be divided into two sections, an upper section of interbedded shale and sandstone with kaolinitic clays that is difficult to distinguish from the Evergreen Formation, and a lower section of fine to very coarse quartz sandstone.

Texas Beds

The Upper Carboniferous Texas Beds consist of greywacke, conglomerate, siltstone, mudstone, slate, local phyllite, chert, basalt, limestone and rare tuff. Generally, the Texas Beds are rich in felsic volcanic detritus which were derived from an active magmatic arc to the west. The Texas Beds are low grade regionally metamorphosed and variably deformed. Chapter 6 provides a detailed assessment of regional and local geology. Figure 4 4 depicts the geology of the Study area.

2.3 Desktop Study

2.3.1 Land Systems Mapping

The Eastern Darling Downs which includes the Road and Rail Corridor, has been the focus of a range of land resource investigations and surveys over a long period by officers of the Queensland Government. Land systems reports particularly relevant for the Study area include:

- Central Darling Downs Land Management Manual (Harris,P.S., Biggs,A.J.W. and Stone,B.J. (eds), 1999); and
- Land Inventory and Technical Guide Eastern Darling Downs (Vandersee, B.E. 1975).

2.3.2 Existing New Acland Coal Mine Soil Surveys

Soil assessments historically undertaken by NAC at the Mine were reviewed and include:

- Shell Coal Australia Soil and Land Suitability Survey (B.R. Emmerton 2004);
- Proposed Stage 3 Acland Coal Mine Expansion (P.W. Baker and G. A. Tuck 2008);
- Soil Laboratory Properties Summary – Acland Coal Project (D.E. Baker 2007); and
- Acland Airborne Survey Area – Basalt Interpretation (New Hope Exploration Pty Ltd 2007).

2.4 Existing Land Use

Harris (1999) described the Study area as having a range of fertile soils with a desirable climate which is capable of growing a wide variety of crops and producing quality livestock. The summary of historical land use patterns in the area which follows is based mainly on comments of Harris (1999).

2.4.1 Cropping Lands

Cropping for grain production is one of the largest agricultural land uses and industries within the Study area with cultivation for cropping and/or sown pasture carried out to some extent in most LRAs. While both summer and winter crops are grown, summer crops are preferred due to higher economic returns and the summer dominant rainfall patterns on the Central Darling Downs. The deep black and grey clays of the recent and older alluvial plains (Soil types A1 and A2), the brigalow belah plains (B1 – B4) and basaltic clays (Ba1 and Ba2) have been intensely used, in varying degrees for grain, oil, fibre and some fodder crops, using fallow management systems. Other shallower or coarser structured brigalow/belah grey, brown cracking clays have also been used for opportunity summer cropping, winter grain and forage crops.

Harris (1999) considers that soil types associated with LRAs 7a and 8 in the Eastern Uplands (which include the Road and Rail Corridor) depend largely on seasonal soil moisture or, in limited areas, irrigation, where it is available. At the time of the survey the Road and Rail Corridor had undergone a period of above average rainfall.

2.4.2 Livestock production

Pasture lands areas occur throughout the Study area and mainly occur in soil types with significant limitations to cropping such as limited soil water storage, susceptibility to flooding or slope. Most of these areas carry native or sown grasses supporting grazing livestock. These lands are, or were, the basis of the beef enterprises and previously, dairy enterprises of the Study area. The greatest proportion of these lands is under native pasture. Harris (1999) considered that although sown pastures are more productive, they represent a very small part of this total resource.

3 Methodology

3.1 Desktop Study

A review of relevant soils information has been undertaken to understand the regional soil conditions and align the results of the field survey against established soils information.

The reports listed in **Section 2.3** were used in compiling this Soils Technical Report to:

- identify the land suitability profiles and associated soil types likely to occur in the Road and Rail Corridor (particularly those of Harris 1999);
- align the morphological aspects of soil types confirmed during the field survey with existing data and mapping;
- confirm 'best fit' soil types with the SMUs identified during the field survey; and
- determine the land use suitability for each SMU.

The SMUs along the Road and Rail Corridor were developed from soil associations in relation to recognisable landscape features following the definitions of Powell (2008). In the desktop review, a preliminary SMU legend and boundaries were predicted from the interpretation of aerial imagery in consultation with LRA mapping of Harris et al (1999). Boundaries and SMU types were refined and confirmed during the field program.

The soils of the Road and Rail Corridor and the existing soil mapping for Queensland (Dominant Soils of Queensland) are mapped at different scales. For this reason the sites investigated for the Road and Rail Corridor may belong to a different soil order (ASC) to the base map (Dominant Soils of Queensland). The field verification and creation of Project specific SMUs adds a level of detail to the existing mapping performed at a broader scale.

3.2 Field Survey

3.2.1 Site Locations

A combination of integrated and free survey techniques was adopted for the survey (McKenzie et al. 2008). Free survey is a conventional form of soil survey efficient for medium scale investigations. The integrated survey component was based on aerial photography interpretation of the landscape and correlations between soil, landform, parent material and vegetation which enabled large areas to be mapped efficiently (Hewitt et al. 2008).

The field survey was conducted at a scale and frequency of approximately 1 site per 1000 m. The sites were located on or as near to the Road and Rail Corridor as practicable. In each case, interpretation of aerial terrain patterns and topography indicated good compatibility with the landforms on the Road and Rail Corridor.

3.2.2 Soil Survey

The field survey involved investigating a total of 17 detailed site descriptions along the route. GPS instruments were used to locate the pre-determined sites. Survey sites are shown in **Appendix B**.

The soils were described according to the ASLS Field Handbook (NCST, 2009) and classified according to the ASC (Isbell, 2002). The soil morphological features were determined in the field by thorough observation, description and interpretation. A description of the field survey methodology is provided in **Appendix A**. Copies of the soil description sheets are presented in **Appendix C.**

3.2.3 Sampling and Laboratory Analysis

Sampling for site descriptions involved the use of a drill-rig mounted on the rear of a light vehicle. The drill-rig advanced a 50 mm diameter push-tube into the soil to a depth of 1-1.5 m or practical refusal to extract intact soil materials. Where the push-tube method was not possible the site was sampled by manual augering.

All samples were submitted to the ALS laboratory in Brisbane, which is an accredited member of the National Association of Testing Authorities (NATA). **Table 3-1** summarises the range of analysis conducted. The results of the laboratory analyses were used to determine the soil order (ASC), indicate variability within SMU's, and isolate major chemical and physical limiting factors.

All samples were analysed for the soil chemical and physical properties listed in **Table 3-2**. The tests, significance of the tests, and methods used are described in **Appendix D**. The detailed results of the laboratory analyses are provided in **Appendix E**.

Table 3-1: Soil Analysis Program

Attribute	Sites	Depths (m)
1:5 pH, electrical conductivity. Exch. Ca, Mg,K, Na, Al. CEC, Ca:Mg, SO4, chloride	1, 3,4,7,8,11,13 15,17 6 10	0-0.1, 0.2-0.3, 0.5-0.6, 0.8-0.9, 1.0-1.1 0-0.1, 0.2-0.3, 0.5-0.6 0.5-0.6 (sulphate and chloride only) 1.0-1.1
Particle size distribution	1, 7, 11, 13 17	0.2-0.3, 0.8-0.9 0-0.1, 0.2-0.3
Total Kjeldahl N, Bicarb P. Organic matter	1,3,4,7,8,11,13,15,17	0 – 0.1
Extractable K (Colwell), metals	7,11,13,17	0 – 0.1

3.3 Land Suitability Assessment

The methodology used to assess the Road and Rail Corridor for land suitability for agriculture follows the guidelines established by the former Queensland Department of Primary Industries (DPI) Land Resources Branch (1989), which forms the basis of the *Land Suitability Assessment Techniques of the Department of Mines and Energy* (DME, 1995). Further detail on the assessment method for each of the land suitability criteria is presented in **Appendix F**.

The Road and Rail Corridor was assessed for suitability for rainfed cropping and grazing land uses and assigned Land Suitability (LS) Classes (see **Table 3-2**) as outlined by DME (1995).

Table 3-2 : Land Suitability and Good Quality Agricultural Land Classes#

Land Suitability Class	Agricultural Land Suitability Description
1 (LS1)	Suitable land with negligible limitations and is highly productive requiring only simple management practices.
2 (LS2)	Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use.
3 (LS3)	Suitable land with moderate limitations – Land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use.
4 (LS4)	Marginal land with severe limitations on land use requiring major inputs to ensure sustainability. Such inputs may outweigh the returns from the land.
5 (LS5)	Unsuitable land with extreme limitations that precludes its use.

Source *Technical guidelines for the environmental management of exploration and mining in Queensland (Department of Mines and Energy Qld 1995)*

The land suitability class for a land area is determined by the highest ranking limiting factor or a combination of a number of factors defined by DME (1995). Typically only the most severe two or three limiting factors would determine the land suitability and the remainder become irrelevant.

3.4 Good Quality Agricultural Land

The Road and Rail Corridor was assessed for GQAL in accordance with the *Guidelines for the identification of Good Quality Agricultural Land* (DPI / DLGP, 1993). Agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses (i.e. feedlots and piggeries). GQAL is land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources.

Descriptions of the agricultural land classes and the correlation between GQAL and Land Suitability classes are summarised in **Table 3-3**.

Table 3-3 : Scheme for Classifying Good Quality Agricultural Land and Correlations with Land Suitability Classes~

Agricultural Land Class	Land Suitability (Cropping)	Land Suitability (Grazing)	Description
A	1-3	1-3	Crop land - Land that is suitable for current and potential crops with limitations to production that range from none to moderate.
B	4	1-3	Limited crop land - Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
C1	5	1-2	Pasture land - Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
C2	5	3	Land suitable for native pastures.
C3	5	4	Land suitable for limited grazing of native pastures.
D	5	5	Non-agricultural land - Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

~ Sourced from Planning Guideline: The Identification of Good Quality Agricultural Land (Department of Primary Industries, 1993)

4 Results

4.1 Field Survey

The field survey identified soils of the Road and Rail Corridor which could be grouped based on similar morphological and chemical properties. Recognisable landscape features and land management factors were also considered in the development of the SMUs which may consist of one or more ASC soil orders. The SMUs described along the Road and Rail Corridor and corresponding LRA's identified by Harris 1999 are summarised in **Table 4-1**.

Table 4-1: Relationship between SMU's and LRA Mapping of Harris et al (1999) along the Proposed Road/ Rail Route

SMU	Sites	Aust. Soil Order	Description	LRA and major indicated soil type(s) of Harris et al 1999.
A1	4,5,6,7,8,9, 10,11,12	Vertosols	Deep dark brown to black cracking clays >100cm deep with self mulching surface. Broad level old alluvial plains of basaltic colluvium. Possibly saline below 60cm.	**LRA 3a.** Cecilvale and Waco
B1	1,2,3	Mainly Vertosols with associated Dermosols	Dark and deep to moderately deep cracking and non cracking clay on gently undulating plains. Possibly saline below 80cm.	**LRA 6a** Edgefield with Moola
Ba2	13,14	Vertosols	Black cracking clay on basalt with weathered basalt horizon below 65cm. Non saline	**LRA 7a** Charlton
Ba3	15, 16,17	Vertosols, Dermosols and Kandosols	Generally shallow basaltic clay and clay loam uplands. Non saline	**LRA 7a** Kenmuir

The three soil orders (Dominant Soils of Queensland 2006) and LRA's (Harris et al 1999) identified during the survey could be placed into four SMUs which are shown in **Table 4-1**. In addition to the characteristics of each individual soil profile investigated, the SMUs provide the basis for the Land Suitability and GQAL assessments for the Road and Rail Corridor. The actual SMU boundaries were predicted from interpretation of digital terrain images and existing topographic maps during the desktop review and refined after interpretation of the results of the field program. The SMUs are shown in **Appendix B**. Descriptions of the SMUs are provided as follows.

Soil Mapping Unit A1

Site No.	8	**Vegetation (woody)**	nil
AMG Reference	-	**Vegetation (non-woody)**	Dense (>70%) Unidentified Grasses
ASC	Dermosol	**Land Use**	Grazing
Landform Element	-	**Depth of sample (mm)**	0-100, 200-300, 500-600, 800-900,1000 - 1100
Landform Pattern	Flat		
Slope %	0.0	**Land Suitability**	Class 2 (Grazing) Class 3 (Rainfed Cropping)
Microrelief	No evidence of microrelief		
Drainage	Moderately well-drained	**General Comments**	Soil surface condition is moist and soft. The area is a floodplain.
Land Condition	Good condition		
Surface Condition	Soft (Dry)		

General Description: the SMU consists of old alluvial plains with deep well-structured dark cracking clay. The major features of the soil mapping unit include:

- Deep, alkaline and dark heavy clay;
- The surface is deeply cracking, with a fine, soft granular self-mulch;
- Subsoils are strong angular or lenticular structure becoming coarser below 75cm;
- Carbonates occur in deeper subsoils;
- Reaction trend is slightly acidic to strongly alkaline;
- Electrical conductivity and chloride within the top 60cm is very low and increases with depth;
- CEC indicates low to moderate ratings throughout the soil profile;
- Bicarbonate phosphorous is high;
- PAWC considered moderate to high; and
- Overall fertility is considered reasonable however fertiliser inputs would improve soil condition.

Site 8: Soil Profile Description

Profile Photo	Depth (mm)	Horizon	Description	Field pH	Field EC (µs/cm)	Laboratory pH	Laboratory EC (µs/cm)	Chloride (mg/kg)	ESP %	Ca:Mg	CEC (meq/100)
	0-250	A1	Medium Clay 10YR2/1 No mottles, segregations or coarse fragments Structure is polyhedral, weak grade and weak consistence Many medium roots	8.7	0.021	0-100 6.5 200-300 7.5	0-100 60 200-300 61	0-100 30 200-300 30	0-100 3.92 200-300 4.67	0-100 1.85 200-300 1.86	0-100 10.2 200-300 21.4
	250-1000	B21	Medium Heavy Clay 10YR2/2 No mottles or coarse fragments 2-10% carbonates Structure is polyhedral, strong grade and firm consistence Common fine roots	8.1	0.274	500-600 8.4 800-900 7.6	500-600 533 800-900 3870	500-600 580 800-900 1650	500-600 16.67 800-900 8.33	500-600 1.55 800-900 2.23	500-600 9.6 800-900 10.8
	1000-1300+	B22	Medium Heavy Clay 10YR3/2, mottle 7.5YR7/2 (2-5%) <2% carbonates, no coarse fragments Structure is angular blocky, moderate grade and firm consistence Few and very fine roots	8.4	0.428	1000-1100 8.5	100-1100 1280	100-1100 1620	100-1100 9.3	100-1100 2.13	1000-1100 43

Soil Mapping Unit B1

Site No.	1	**Vegetation (woody)**	Isolated clumps (<0.2%)
AMG Reference	-	**Vegetation (non-woody)**	Dense (>70%) Unidentified Grasses (grazed and no inflorescence)
ASC	Dermosol	**Land Use**	Grazing
Landform Element	Lower	**Depth of sample (mm)**	0-100, 200-300, 500-600, 800-900,1000 - 1100
Landform Pattern	Flat Plain		
Slope %	0.5	**Land Suitability**	Class 2 (Grazing) Class 2 (Rainfed Cropping)
Microrelief	Nil		
Drainage	Moderately well-drained	**General Comments**	Soil surface condition was recorded under moist conditions. Landform was flat with a gentle slope. Classified as a Kandosol due to weak structure of the B Horizon. The structure of these soils will become more obvious in drier conditions so suspect it may grade into a Dermosol.
Land Condition	Good condition		
Surface Condition	Soft		

General Description: the SMU consists of deep, well structured, self-mulching and cracking softwood scrub soils on undulating plains. A highly productive cropping soil. The major features of the soil mapping unit include;

- Deep and dark well-structured medium clays which are freely drained.
- The surface is cracking with strong self-mulching character.
- Soil reaction is alkaline becoming strongly alkaline with depth.
- Electrical conductivity and chloride within the top 80cm is very low however increases significantly >80cm;
- PAWC considered very high; and
- Very strong overall fertility. Fertiliser inputs in evidence.

Site 1 Soil Profile Description

Profile Photo	Depth (mm)	Horizon	Description	Field pH	Field EC (µs/cm)	Laboratory pH	Laboratory EC (µs/cm)	Chloride (mg/kg)	ESP %	Ca:Mg	CEC (meq/100)
	0-600	A1	Medium Heavy Clay 7.5YR2.5/1, mottel 10YR6/2 2-6mm, Distinct 2% <2% Iron and <2% 0-2mm coarse fragments Structure is subangular blocky with moderate grade and weak consistence Many fine roots	9.8	0.212	0-100 8.4 200-300 9.1 500-600 9.4	0-100 100 200-300 206 500-600 483	0-100 <10 200-300 30 500-600 140	0-100 1.41 200-300 8.79 500-600 9.36	0-100 5.38 200-300 3.88 500-600 3.59	0-100 21.3 200-300 9.1 500-600 43.8
	600-1000	B2	Medium Heavy Clay 10YR4/3, no mottles 2-10% carbonates and 2-10% 0-2mm coarse fragments Structure is subangular blocky with weak grade and firm consistence Few fine roots	9.5	0.687	800-900 7.9	800-900 3780	800-900 930	800-900 0.83	800-900 25.85	800-900 144
	1000-1300+	B3	Medium Heavy Clay 10YR4/2, mottle 10YR5/4 Weathered parent material and 10-20% 0-2mm coarse fragments Structure is subangular blocky with weak grade and firm consistence Few very fine roots	9.7	0.642	1000-1100 9.0	1000-1100 1260	1000-1100 1140	1000-1100 26.92	1000-1100 1.59	1000-1100 7.8

Soil Mapping Unit Ba2

Site No.	13	**Vegetation (woody)**	n/a
AMG Reference	-	**Vegetation (non-woody)**	Unidentified grass species, leg/waist height with prickly bushes nearby (>70%)
ASC	Vertosol	**Land Use**	Grazing
Landform Element	-	**Depth of sample (mm)**	0-100, 200-300, 500-600, 800-900, 1000-1100
Landform Pattern	Midslope		
Slope %	4.0	**Land Suitability**	Class 1 (Grazing) Class 2 (Rainfed Cropping)
Microrelief	Gilgai is moderate, hummocky with depths up to 20-30cm and 1-2m in diameter		
Drainage	Moderately well-drained	**General Comments**	-
Land Condition	Good condition		
Surface Condition	Soft, cracking in drier sections		

General Description: the SMU consists of black cracking clay on basalt with weathered basalt horizon below 65cm and non-saline. The major features of the soil mapping unit include:

- Moderately deep and dark medium heavy clays on basalt;
- The surface is soft, granular and deeply cracking;
- Soil reaction is slightly alkaline throughout;
- Non saline throughout top horizons, slightly saline at depth;
- Strong overall fertility;
- Fresh and decomposing basalt may be encountered from 70 cm; and
- Effective rooting and PAWC only restricted by depth to basalt rock. (Normally 70 – 80cm however some exceptions are >100cm).

Site 13 Soil Profile Description

Profile Photo	Depth (mm)	Horizon	Description	Field pH	Field EC (µs/cm)	Laboratory pH	Laboratory EC (µs/cm)	Chloride (mg/kg)	ESP %	Ca:Mg	CEC (meq/100)
	0-850	A1	Medium Clay 10YR2/2, no mottle No segregations or coarse fragments Structure is polyhedral with weak grade and weak consistence Common very fine roots	9.0	0.422	0-100 8.5 200-300 8.9 500-600 9.0	0-100 156 200-300 211 500-600 510	0-100 10 200-300 20 500-600 170	0-100 2.27 200-300 13.27 500-600 14.65	0-100 3.34 200-300 2.27 500-600 1.85	0-100 13.2 200-300 9.8 500-600 59.4
	850-1300	B2	Medium Heavy Clay 10YR3/3, no mottles No segregations or coarse fragments Structure is subangular blocky with weak grade and firm consistence Few very fine roots	9.5	0.877	800-900 9.1 1000-1100 9.2	800-900 899 1000-1100 926	800-900 440 1000-1100 560	800-900 10.98 1000-1100 25.74	800-900 3.20 1000-1100 1.11	800-900 440 1000-1100 560
	1300-1500	BC	Light Clay 2.5YR6/3, no mottles No segregations or coarse fragments Coarse fragments include 0-2mm at 20-50% Structure is apedal with massive grade and firm consistence No roots evident	9.6	11.5	-	-	-	-	-	-

Soil Mapping Unit Ba3

Site No.	17	**Vegetation (woody)**	n/a
AMG Reference	-	**Vegetation (non-woody)**	Unidentified grasses and weed species
ASC	Kandosol	**Land Use**	Grazing
Landform Element	-	**Depth of sample (mm)**	0-100, 200-300, 500-600
Landform Pattern	Midslope		
Slope %	1.5	**Land Suitability**	Class 3 (Grazing) Class 5 (Rainfed Cropping)
Microrelief	No microrelief evident		
Drainage	Well-drained	**General Comments**	Stones present on surface 10 cm by 5cm, approximately 15%. Soil surface is firm under moist conditions. Surface is uneven, may have a history of cultivation).
Land Condition	Good condition		
Surface Condition	Firm		

General Description: the SMU consists of generally shallow basaltic clay and clay loam uplands. The major features of the soil mapping unit include:

- Shallow and very rocky red brown clays on fresh basalt;
- The surface is firm, often with extensive basalt rock and usually non-cracking;
- The surface 20 – 30 cm layer has polyhedral granular to angular blocky structure;
- Soil reaction is neutral to slightly alkaline;
- Non saline;
- PAWC considered low (<70mm); and
- Quite good fertility but major issue is lack of soil.

Site 17 Soil Profile Description

Profile Photo	Depth (mm)	Horizon	Description	Field pH	Field EC (µs/cm)	Laboratory pH	Laboratory EC (µs/cm)	Chloride (mg/kg)	ESP %	Ca:Mg	CEC (meq/100)
	0-180	A1	Clay Loam 7.5YR3/1, no mottle No segregations and 10-20% 2-6mm coarse fragments Structure is polyhedral with weak grade and weak consistence Common fine roots	9.1	0.040	0-100 7.1	0-100 35	0-100 <10	0-100 0.35	0-100 2.58	0-100 28.5
	180-650	B2	Medium Heavy Clay 7.5YR3/4, no mottles No segregations and 50-90% 20-60mm coarse fragments Structure is angular blocky with weak grade and firm consistence Few very fine roots	8.2	0.073	200-300 7.70 500-600 7.9	200-300 24.00 500-600 43	200-300 <10 500-600 <10	200-300 1.01 500-600 0.80	200-300 2.59 500-600 2.51	200-300 9.90 500-600 12.5
	650-950 (refusal)	C	n/a	-	-	-	-	-	-	-	-

4.2 Land Suitability Assessment

As described previously, the evaluation of major limiting factors for dryland cropping and grazing of native and improved pastures used in this field survey have been discussed in **Section 3.3**.

4.2.1 Agricultural Suitability Classes

The land suitability classification identifies limitations of the different soil types present and identifies suitable uses. Land suitability class is determined by the highest ranking limiting factor or a combination of a number of factors. Normally, only the most severe two or three limiting factors would determine suitability and therefore, the remainder become irrelevant. For this reason, only the major limiting factors determining suitability are presented. In this survey, the main limiting factors which determined crop and grazing suitability class include:

- plant available water capacity (m);
- water erosion (e);
- nutrient deficiency (n);
- salinity (s); and
- rockiness (r).

Table 4-2 shows the severity of major limiting factors and overall suitability classification for non-irrigated cash crops and grazing for each SMU. Lands in classes 1 to 3 are considered well suited to cropping as the benefits should outweigh the inputs required to initiate and maintain production. Class 4 is marginal for the specified use and the economic long term suitability is doubtful from the extent of inputs required. Class 5 has limitations so severe that inputs required would not justify that use.

Table 4-2 Major Limitations and Land Suitability Classes

SMU	DRYLAND CROPPING		GRAZING	
	Major Limitations and severity	Suitability class	Major Limitations and severity	Suitability class
A1	Plant water availability 3 Susceptibility to erosion 2 Salinity 2 Nutrient deficiency 2 Rockiness1 Wetness 2	**3**	Plant water availability 2 Susceptibility to erosion 1 Salinity 2 Nutrient deficiency 1	**2**
B1	Plant water availability 4 Susceptibility to erosion 2 Salinity 1 Nutrient deficiency 1 Rockiness1 Wetness 1	**4**	Plant water availability 3 Susceptibility to erosion 2 Salinity 1 Nutrient deficiency 1	**3**
BA2	Plant water availability 2 Susceptibility to erosion 2 Salinity 1 Nutrient deficiency 1 Rockiness2	**2**	Plant water availability 1 Susceptibility to erosion 1 Salinity 1 Nutrient deficiency 1	**1**

SMU	DRYLAND CROPPING		GRAZING	
	Major Limitations and severity	Suitability class	Major Limitations and severity	Suitability class
BA3	Plant water availability 5 Susceptibility to erosion 4 Salinity 1 Nutrient deficiency 2 Rockiness 3	**5**	Plant water availability 3 Susceptibility to erosion 3 Salinity 1 Nutrient deficiency 1	**3**

4.3 Good Quality Agricultural Land

Table 4-3 shows the GQAL Land Classes for each SMU and the distribution along the Road and Rail Corridor.

Table 4-3 GQAL class and SMUs

Soil map units	Cropping Suitability class	Grazing Suitability class	Important Limitations	GQAL Land Classification
A1	3	2	Plant water availability	Class A – Cropping Land
B1	4	3	Susceptibility to erosion Plant water availability	Class B – limited crop land suitable to pastures
Ba2	2	1	Plant water availability	Class A – Cropping Land
Ba3	5	3	Plant water availability Susceptibility to erosion	Class C2 – Land suitable for native pastures

4.4 Erosion and Sediment Control

4.4.1 Erodibility of Soil Materials

The soil characteristics that affect the erodibility of the soil materials and may increase the erosion hazard during the project are:

1. Exchangeable sodium percentage (ESP)

The presence of excessive amounts of exchangeable sodium relative to the other exchangeable cations in the soil (soil sodicity) has an effect on soil physical properties. Sodic soil materials disperse (clay disaggregation) which may result in surface crusting and sealing and surface and subsoil hardsetting. Sodic soil materials are identified by calculating the exchangeable sodium percentage (ESP) expressed as:

$$ESP = \frac{\text{Exchangeable Sodium}}{\text{Cation Exchange Capacity}}$$

2. Low exchangeable calcium to magnesium (Ca:Mg) ratios (CMR)

A high concentration of magnesium compared to calcium has a negative effect on soil physical properties. One explanation for this is that calcium ions are more effective than magnesium in aggregating clays due to the hydration energy of magnesium being greater than calcium. This causes larger separation between the clay layers (than would occur with the exchange of calcium) resulting in a weaker attraction and reduced likelihood of aggregation.

3. Electrical conductivity (EC)

Electrical conductivity is a measure of salt in the soil. The EC of a 1:5 soil/water suspension (EC_w) is an estimation of soil salt content and a reasonable indication of soil salinity. Soil salinity may have an adverse effect on the growth and survival of non-salt tolerant vegetation and may reduce the risk of dispersion of sodic soil materials.

4. Soil texture

Soil texture is defined as the relative amounts of sand (0.06-2.00 mm), silt (2-60µm), and clay (<2µm) sized particles in a soil. Strictly speaking this definition relates to laboratory determined particle size analysis as factors other than the proportions of sand, silt and clay influence field texture. For example, field texture may provide an indication of the organic matter component in soil materials, or whether soil materials reflect plastic or sub-plastic behaviours. In general, soil texture is an important determinant of a diverse range of soil properties including soil stability, erosivity, trafficability, hydraulic conductivity and fertility. Both the field determined soil texture and laboratory determined particle size analysis provide an indication of soil cohesiveness, and therefore stability, of soil materials.

In addition soils may slake (the immediate break-up of soil aggregates into fragments when wetted due to the swelling of the clay and entrapped air.

4.4.2 Soil Erosion Potential

Table 4-4 summarises the calculated data for Exchangeable Sodium Percent for the representative sites, and conclusions about the saline and/or sodic nature of each SMU are presented in **Table 4-5.**

Table 4-4 Exchangeable Sodium at Varying Depths for each of the Representative Sites

SMU	Representative Site	Depth	ESP %
A1	8	0-100	3.92
		200-300	4.67
		500-600	16.67
		800-900	8.33
		1000-1100	9.30
B1	1	0-100	1.41
		200-300	8.79
		500-600	9.36
		800-900	0.83
		1000-1100	26.92
Ba2	13	0-100	2.27
		200-300	13.27
		500-600	14.65
		800-900	10.98
		1000-1100	25.74
Ba3	17	0-100	0.35
		200-300	1.01
		500-600	0.80

Table 4-5: The Saline and/or Sodic SMU's

SMU	Saline sites indicated by chloride lab tests (below 0.5m depth)	Saline sites and depth indicated by field EC tests	Sodic sites indicated by lab tests
A1	6,7,8,10,11	5 (.0.9m), 6 (>0.3m), 9 (>0.35m), 10 (>0.7m), 11 (>0.65m), 12 (>0.8m)	7,8,11 (below 0.5m)
B1	1,3	1 (>0.6m), 2 (>0.9m), 3 (>0.8m),	nil
Ba2	13	13 (>0.85m)	13 (below 0.3m)
Ba3	nil	Nil	nil

A brief description of limitations for soils is included below.

Saline-sodic and saline soil materials (SMU's A1, B1, Ba2)

Sodic materials that are saline are less likely to disperse while they remain saline, however leaching can remove the salt and make the soil dispersive and prone to tunnel and gully formation. Based on the soil salinity criteria of McKenzie et al. (2004) the sites that are classed as moderately saline to saline are 1 and 3 (A1 SMU) as well as sites 6,7,8,10 and 11 from SMU B1. One site in SMU Ba2 was also saline below 0.8m depth. Of these, stes 7,8,11 and 13 are also sodic at depth.

Non-sodic soil materials of low cohesion (silts and fine sands) (SMU Ba3)

Soil materials dominated by silt and fine sand components do not disperse as a result of high ESP but may act like dispersive soils. Unlike clay particles, the silt and fine sand components of soil materials carry few electric charges resulting in weak, inter-particle bonds and little cohesion. These soils subsequently have relatively poor structure, further degraded by soil profile disturbance. Only the very minor SMU Ba3 exhibits possible effects from this effect.

It should be noted that the dispersivity of soil materials may vary greatly over short distances. The results presented in the table above are indicative of the soil materials that were observed along the Road and Rail Corridor.

5 Impacts and Management Strategies

5.1 Impacts

The factors influencing land suitability that may change in response to disturbance from the revised Project activities including the physical, chemical and biological properties of the disturbed soil materials, changes in soil profile depth, and changes in the quality of both the topsoil and the subsoil materials.

5.1.1 Impacts to Topsoil

The topsoils of the Road and Rail Corridor are defined as the uppermost soil layers (A horizons) of the soil profiles. These A horizons contain more organic matter, biota and nutrients than the soil layers below (subsoil). In addition to seed viability and fertility, assessing the depth of topsoil along the transport route is important for the assessment of the stability of the surface soil materials post disturbance and the prompt re-establishment of land surface cover (vegetation).

Areas of the Road and Rail Corridor will be subject to ground disturbance due to construction and operations activities associated with the Road and Rail Corridor. The major type of land disturbance will initially involve land clearing and preparation land ahead of the construction of infrastructure associated with the Road and Rail Corridor. These areas will require stripping of topsoil and possibly subsoil for reuse in rehabilitation programs.

The Road and Rail Corridor includes topsoil reserves with beneficial material for rehabilitation within one metre (1.0 m) depth in many areas. The upper soil layer should be stockpiled and managed separately from the lower material as the topsoil generally has:

- higher intrinsic fertility;
- better (finer) soil structure and drainage;
- higher organic matter content; and
- existing seed bank.

5.1.2 Impacts to Cropping Soils and Cracking Clays

The primary potential impact on productivity following disturbance of these soil materials is a reduction in the crop yield of the replaced soil. Major limitations to reinstating these soils relate to successful profile restoration. Factors such as increasing salinity with depth, dispersivity of subsoils, crusting of the soils if mixed, and the potential compaction that could occur during the stripping, stockpiling and replacement process all require management for successful rehabilitation.

5.1.3 Impacts to Sodic Soil Materials

The behaviour of sodic soil materials (slaking and dispersion) can lead to surface sealing, hardsetting, low permeability and drainage, and tunnel and gully erosion. The likelihood of these processes occurring is greater for soil materials with high clay content. However, soil materials with clay contents as low as 10% may still slake and/or disperse when disturbed. Where sodic materials occur close to the ground surface it is important to accurately identify topsoil stripping depths to avoid the mixing of non-sodic topsoils with sodic subsoils.

The application of soil conditioners (type and application rates are best confirmed by further soil analysis) may stabilise potentially dispersive soils. Depending on the type of conditioner, other beneficial nutrients may be released in the newly constructed soil. In addition, the incorporation of

organic matter in combination with soil conditioners will further improve the development of soil structure. A more detailed assessment of the extent of sodic soil materials along the Road and Rail Corridor is recommended for integration into the development of a construction Soil Management Plan.

Evidence of possible sodic materials below 0.5 m depth was found at 4 of 11 sites tested in the Road and Rail Corridor. These were in SMUs A1, B1 and Ba2.

5.1.4 Impacts to Saline Soil Materials

Evidence of possible saline materials below 0.5 m depth was found at most sites across all SMUs apart from Ba2 and Ba3. This was indicated both from laboratory and field tests.

Capillary rise of salts into the topsoil layers can occur where saline materials are being excavated and placed on or near the reconstructed land surface. Elevated salinity in the topsoil layers can prevent seed germination, retard plant growth and reduce ecosystem diversity.

It is important to note that the presence of saline conditions may suppress the dispersion of clays so the method of promoting the leaching of salts should not be implemented on sodic subsoil materials. For example, tunnel erosion often starts from points in the landscape where ponded water results in the leaching of salts triggering clay dispersion.

5.1.5 Impacts to Erosion Susceptibility

The erodibility ratings of the soils of the route are presented in **Table 5-1**. It is recommended that the exposure time of the soil materials be minimised and disturbed areas stabilised as soon as practicable. Erosion and sedimentation control measures should be implemented in areas of high slope or where erosion due to high rainfall events may occur.

Table 5-1 Erodibility Ratings for the Soils of the Route^

SMU	ASC Soil Order (field verified)	Characteristics	Erodibility Rating
Ba3 and minor B1	Dermosols	Texture gradually increases from a loamy surface to sandy clay loam or clay with depth. Massive to strong structure in the subsoil horizons.	Low
A1, B1, Ba2	Vertosols	Light medium to heavy clays that shrink and crack open when dry and swell when wet. Well structured subsoils.	Low to Moderate
Ba3	Kandosols	Texture gradually increases from a sandy surface to sandy clay loam or sandy light clay with depth; single grain to massive structure.	Moderate

^Source DTMR, 2010

5.2 Management Strategies

5.2.1 Topsoil Management

The soils of the A1, B1 and BA2 mapping units vary in depth to salinity and sodicity which may limit topsoil and subsoil stripping depths. These SMUs comprise most of the Rail Corridor and are deep medium to heavy clays of over 1.0 m in depth with high CEC ratings, and neutral to alkaline pH levels. Some areas (particularly A1) have been identified as saline and possibly sodic below 0.5 m depth.

The stripping depths recommended for the Rail Corridor are based on laboratory data for the soils of each soil mapping unit (not just the representative site for the soil mapping unit).

A summary of recommended topsoil stripping information is presented below in **Table 5-2**.

Table 5-2 Recommended Topsoil Stripping Depths

Soil Mapping Unit	Topsoil Strip Depth (m)	Subsoil strip depth (m)	Comment
A1	0 - 0.3	0.3 – 0.5	Moderate to high risk of inclusion of saline and sodic material below 0.5 m
B1	0 - 0.2	0.2 – 0.5	
Ba2	0 - 0.2	0.2 – 0.8	All soil material to weathered basalt could be used. Subsoils are saline and sodic below 0.8 m.
Ba3	0 - 0.3/0.4 (variable)	nil	Rocky parent material presents gravel opportunity.

The rehabilitation strategy will include the following measures that are designed to minimise the loss of soil material respread on rehabilitated areas:

- Contour ripping to encourage rainfall infiltration and minimise runoff;
- Reseeding soon after respreading to establish a vegetation cover as early as possible;
- Installation of slope drainage control to limit slope lengths and runoff velocities; and
- Installation of collection drains and catches dams to collect runoff and remove suspended sediment.

5.2.2 Cracking Clay and Cropping Soils

These soil types (A1, B1, Ba2) are useful on a range of rehabilitation applications and feature good quality topsoil but with possibly saline subsoil. Stripping volumes should be developed such that the reinstated soil profile soil water storage potential (>100 mm) and effective depth (>0.6 m) where practicable.

It is recommended that the following provisions be put in place where practicable for the management of cracking clays:

- managed at a moisture content appropriate to their clay content;
- stripped in layers according to physical and chemical properties;
- stockpiled separately according to the stripped layers; and
- disturbed areas should be backfilled in sequence of removal.

5.2.3 Sodic Soil Materials

Where sodic materials occur close to the ground surface it is important to accurately identify topsoil stripping depths to avoid the mixing of non-sodic topsoils with sodic subsoils.

The application of soil conditioners (type and application rates are best confirmed by further soil analysis) may stabilise potentially dispersive soils. Depending on the type of conditioner, other beneficial nutrients may be released in the newly constructed soil. In addition, the incorporation of organic matter in combination with soil conditioners will further improve the development of soil

structure. A more detailed assessment of the extent of sodic soil materials along the transport route is recommended for integration into the development of a construction Soil Management Plan.

5.2.4 Erosion Control

Many of the soil types within the Road and Rail Corridor include soil horizons which exhibit a slight potential for dispersion and may be subject to sheet, rill and gully erosion if left exposed and unprotected during mine construction or mining operations.

Proposed infrastructure construction erosion and sediment controls, which may be implemented during infrastructure construction, are as follows:

- vegetation clearing will be conducted progressively so that the minimum area necessary for construction is cleared at any time;
- runoff from higher areas will be directed around construction sites;
- runoff from bare earthworks areas will be collected in drains and directed through sediment traps and settling ponds to remove suspended sediment prior to discharge from the site;
- stockpiles of topsoil and any excess cut material will be sown with grass seed and have side slopes reduced to at least a 4:1 gradient;
- earthworks batters will be constructed to stable slopes and vegetated soon after construction; and
- earthworks areas will be landscaped and vegetated as soon as possible after construction is completed.

6 Conclusions and Recommendations

This Soil Technical Report presents the following for the Road and Rail Corridor:

- a description and classification of the soils along the proposed road and rail corridor;
- an assessment of the pre-disturbance land suitability and GQAL of soils according to the relevant standards; and
- soil associations and derived soil mapping units for the purpose of soil and land management for the duration of the revised Project.

6.1.1 Soil Description and Classification

Three soil orders, as classified using the ASC (Isbell 2002), were identified as part of the field survey, including Vertosols, Dermosols and Kandosols. These soils aligned with previously identified SMUs and land resource areas.

The soil constraints common to these soils are low soil fertility status, soil sodicity, soil salinity, erosivity, rockiness and shallow effective rooting depth (limiting plant available water capacity). These limitations will require management during both the construction and rehabilitation phases of the revised Project.

6.1.2 Land Suitability and Good Quality Agricultural Land Assessment

The majority of land in the Road and Rail Corridor is used for cropping where water supply is sufficient (through irrigation or rainfall). Where land is not cropped, livestock grazing of native and improved pasture is common. The baseline capability for the majority of land proposed to be disturbed (76%) is considered to be suitable for cropping (GQAL Class A), whilst the remainder of the Road and Rail Corridor (24%) is considered suitable for grazing of livestock on native pasture (GQAL Class C2). The impact of the project on the land suitability on areas of the Road and Rail Corridor currently under grazing or native bushland is considered to be minor.

Once completed, road diversions will remain permanently in place as a public asset.

Decommissioning and rehabilitation of disturbance associated with the Rail Corridor will initially involve a decision on the value of retaining the asset for the future benefit of the community. Should it be considered preferable for the rail line to be removed and rehabilitated then the overall rehabilitation objective will be the return the rail corridor to return land to a land use which supports grazing where practicable.

6.1.3 Management Recommendations

A summary of potential management recommendations has been provided in this report.

Prior to construction a Soil Management Plan (SMP) should be developed to include management strategies for the excavated soil material of the Road and Rail Corridor to maintain soil and land use capability and minimise environmental risks that may arise during construction and rehabilitation activities.

7 Statement of Limitations

The sole purpose of this report and the associated services performed by SKM is to assess soil units and land suitability in accordance with the scope of services set out in the contract between SKM and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, SKM has relied upon, and presumed accurate, certain information (or absence thereof) provided by the Client and other sources. Except as otherwise stated in the report, SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

This report is based on assumptions that the site conditions as revealed through sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and (to the best of our knowledge) they represent a reasonable interpretation of the current conditions on the site. However all sampling techniques, by definition, cannot determine the conditions between the sample points and so the report cannot be taken to be a full representation of the sub-surface conditions. It is an indication of the likely sub-surface conditions. All reports and conclusions that deal with sub-surface conditions are based on interpretation and judgement and as a result have uncertainty attached to them.

SKM derived the data in this report from information sourced from the Client, available in the public domain, and facilitated by SKM at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose of the project and by reference to applicable standards, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SKM for use of any part of this report in any other context.

This report was prepared under limited timeframes, with restrictions on land access and methodology beyond the scope of SKM's control. Subsequently, this report provides an interpretation of ground conditions deduced from within these limitations.

This report has been prepared on behalf of, and for the exclusive use of, SKM's Client, and is subject to, and issued in connection with, the provisions of the agreement between SKM and its Client. SKM accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

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Acronyms

AHD	Australian Height Datum
ALS	Australian Laboratory Services
ASC	Australian Soil Classification
bgl	Below ground level
DERM	(former) Department of Environment and Resource Management, see EHP
DHLGP	Department of Housing, Local Government and Planning
DLGP	Department of Local Government and Planning
DME	Department of Mines and Energy
DPI	Department of Primary Industries
DPIF	Department of Primary Industries and Fisheries
EC	Electrical Conductivity
EHP	Department of Environment and Heritage Protection (previously DERM and EPA)
EIS	Environmental Impact Statement
EMS	Environmental Management System
ESP	Exchangeable Sodium Percentage
GPS	Global Positioning System
GQAL	Good Quality Agricultural Land
LS	Land Suitability
LSA	Land Suitability Assessment
MLA	Mine Lease Area
MU	Mapping Unit
NATA	National Association of Testing Authorities
NCST	The National Committee on Soil and Terrain
PAWC	Plant Available Water Capacity
ppm	parts per million
PSD	Particle Size Distribution
SMU	Soil Mapping Unit
TOR	Terms of Reference

Glossary

Alluvium	Stream-laid sediment deposit found in a stream channel and/ or in low parts of a stream valley subject to flooding.
Clay-sized	Natural mineral particles with a diameter less than 0.002 mm.
Dermosols	Soils with a structured B2 horizon and lacking a strong texture-contrast between the A and B horizons.
Gilgai	Microtopography characterised by mounds and depressions that may vary in width and depth. Gilgai form as clay soils shrink and swell with changes in soil water content.
Horizon (soil)	Soil layer parallel to the soil surface, whose physical characteristics differ from the layers above and beneath. The main soil horizons are: O – surface layer dominated by organic material in varying stages of decomposition. A – one or more surface mineral horizons with some organic accumulation. Ap – mineral horizon which has been ploughed, tilled or undergone other disturbance by humans. A1 – mineral horizon at or near surface with some accumulation of humified organic matter. Usually darker in colour than underlying horizons. A2 – mineral horizon having less organic matter than the immediately adjacent horizons. Usually paler in colour than the A1 horizon. A3 – transition horizon between the A and B horizons, most similar to the A horizon. B – one or more mineral soil layers characterised by a concentration of silicate clay, iron, aluminium and/or organic material; and/ or a differing structure, consistence or colour of the A horizon. B1 – transitional horizon between the A and B horizon, most similar to the B horizon. B2 – horizon dominated by an alluvial, residual or other concentrate of silicate clay, iron, aluminium and/ or humus, and/ or maximum development of pedological organisation. B3 – transitional horizon between the B and C horizon, most similar to the B horizon. C – consolidated and unconsolidated material below the A and B horizon. Usually partially weathered and little affected by pedological processes.
Kandosols	Strongly weathered soils with a gradational clay increase of no more than 15% clay in the B horizons.
Overburden	Soil or other mineral matter overlying the material of interest/ economic value.
Ped	Individual natural soil aggregate consisting of a cluster of primary particles.
Quaternary	The geological period of time from the present to two million years ago.
Rehabilitation	Landscape reconstruction (including soil profile construction) followed by revegetation.
Revegetation	Establishment of suitable plant species to support the agreed post-disturbance land use.
Rigid soils	Soils with minimal capacity to shrink and swell with changes in soil water content.
Sand-sized	Natural mineral particles with a diameter between 0.02 and 2.0 mm.

Silt-sized	Natural mineral particles with a diameter between 0.002 and 0.02 mm.
Sodic	Soil with high amounts of exchangeable sodium relative to other exchangeable cations resulting in an exchangeable sodium percentage (ESP) >6.
Sodosols	Soils with a strong texture-contrast between the A horizons and sodic B horizons that are not strongly acid.
Soil	The unconsolidated mineral or organic material on the immediate surface of the Earth that is a natural medium for the plant growth.
Subsoil	The soil layers lying immediately below the topsoil or A1 horizon.
Topsoil	The uppermost A horizon of the soil profile usually containing more organic matter, biota and nutrients than the soil layers below.
Vertosols	Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have clay accumulations on the ped surfaces (slickensides) and/or lenticular structural aggregates.

Appendix A Field Survey Methodology

A.1 Survey Scale

Following the Guidelines for Linear features (DERM 2011), the road and rail corridor field survey was undertaken at 1:50 000 scale (approximately 1 site per 1 km).

A.2 Soil Description and Classification

The sites and soils were described following the methods outlined in the *Australian Soil and Land Survey Field Handbook* (NCST 2009). Soils were classified according to the *Australian Soil Classification* (ASC) scheme of Isbell (2002) and correlated to published soil types where applicable. An integrated survey approach (McKenzie et al. was adopted to value-add to the existing soil mapping.

A.3 Soil Sampling Procedure

The soil description, recording and sampling was extended to below 1 m (for the assessment of Criteria 8 Soil Water Storage) and/ or to the diagnostic (B) horizon (whichever is reached first) to allow classification to ASC soil order.

A.4 Sampling Method

Excavation of the soil was performed by core-sampling by a direct-push method to >1 m BGL or until rock/ refusal (drilling Subcontractor) and/or manual excavation (hand-augering).

A.5 Sampling Density

Approximately 1 in 2 (50%) of the detailed sites were sampled for laboratory analysis. Data collected included the following.

- Location (coordinates)
- Photograph (landscape and profile/ soil core)
- Observation Type
- Landform
- Slope Vegetation Type
- Soil Surface Condition
- Horizon Designation
- Horizon Depth
- Soil Colour and Mottles
- Field Texture
- Horizon Boundary
- Soil Consistence
- Soil Structure
- Segregations
- Coarse Fragments
- Roots
- Soil pH (field and laboratory)
- Soil EC (field and laboratory)

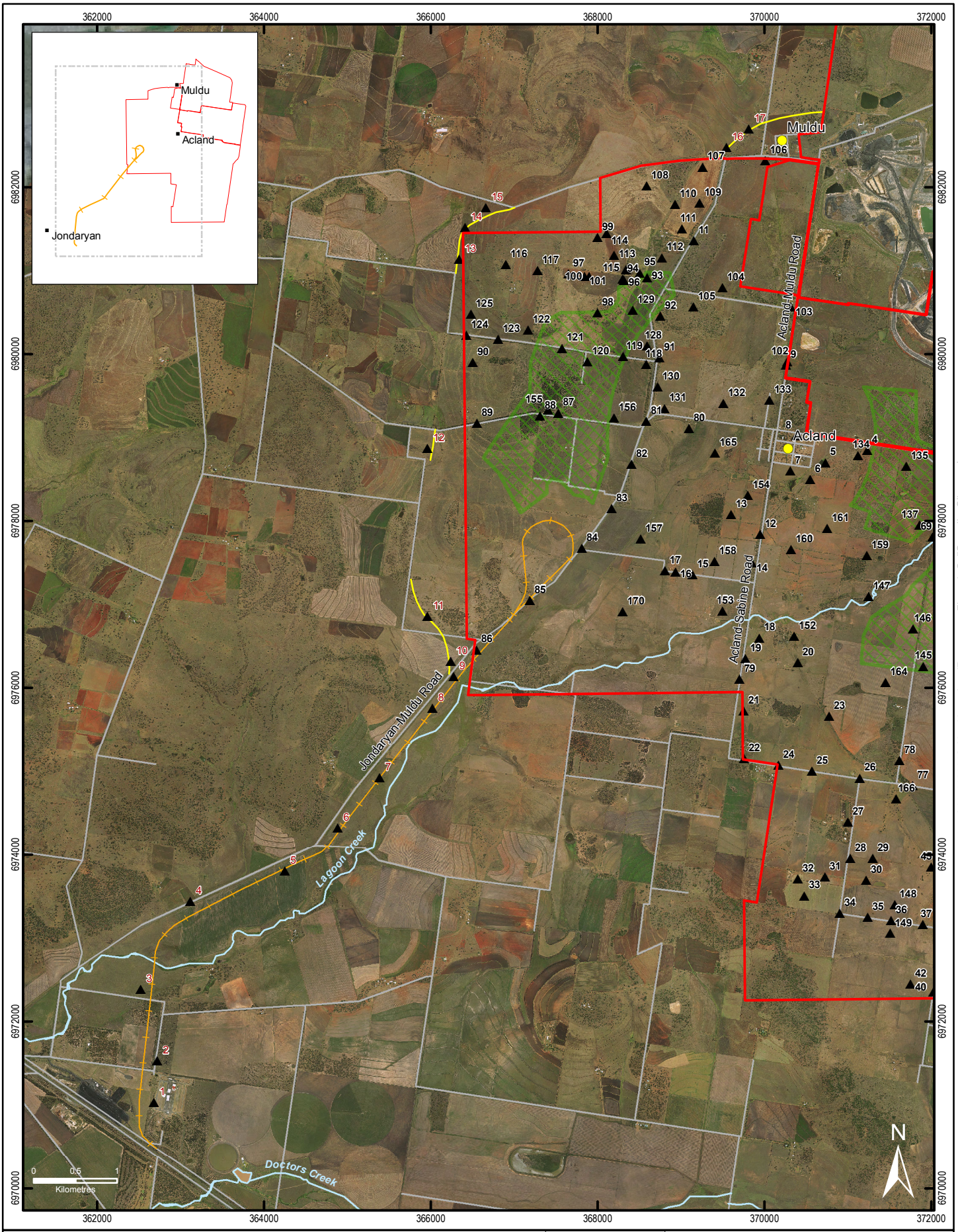
A.6 Sampling Depths

Samples will be taken from a minimum of 5 depths in the detailed soil profile (bulked soil surface sample, 200-300 mm, 500-600 mm, 800-900 mm and 1000-1100 mm). Samples will be bagged and labelled according to the location identifier and depth of sample (e.g. Site 1 0.0 - 100 mm).

A.7 Laboratory Analysis

Laboratory analysis will be undertaken by an accredited NATA laboratory. Laboratory analyses will follow the methods outlined in *Soil and Water Chemical Methods – Australasia* (Rayment and Lyons 2011) with reference to the Guidelines.

Appendix B Figures



LEGEND

- Towns and Localities
- Soil Survey Locations
- Rail Spur
- Jondaryan-Muldu Road Diversion Soil Survey Segments
- Roads
- Creeks
- Mining Tenements
- Stage 3 Pit Areas

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 1 - Soil Sampling Sites

Scale 1:60,000 on A4

Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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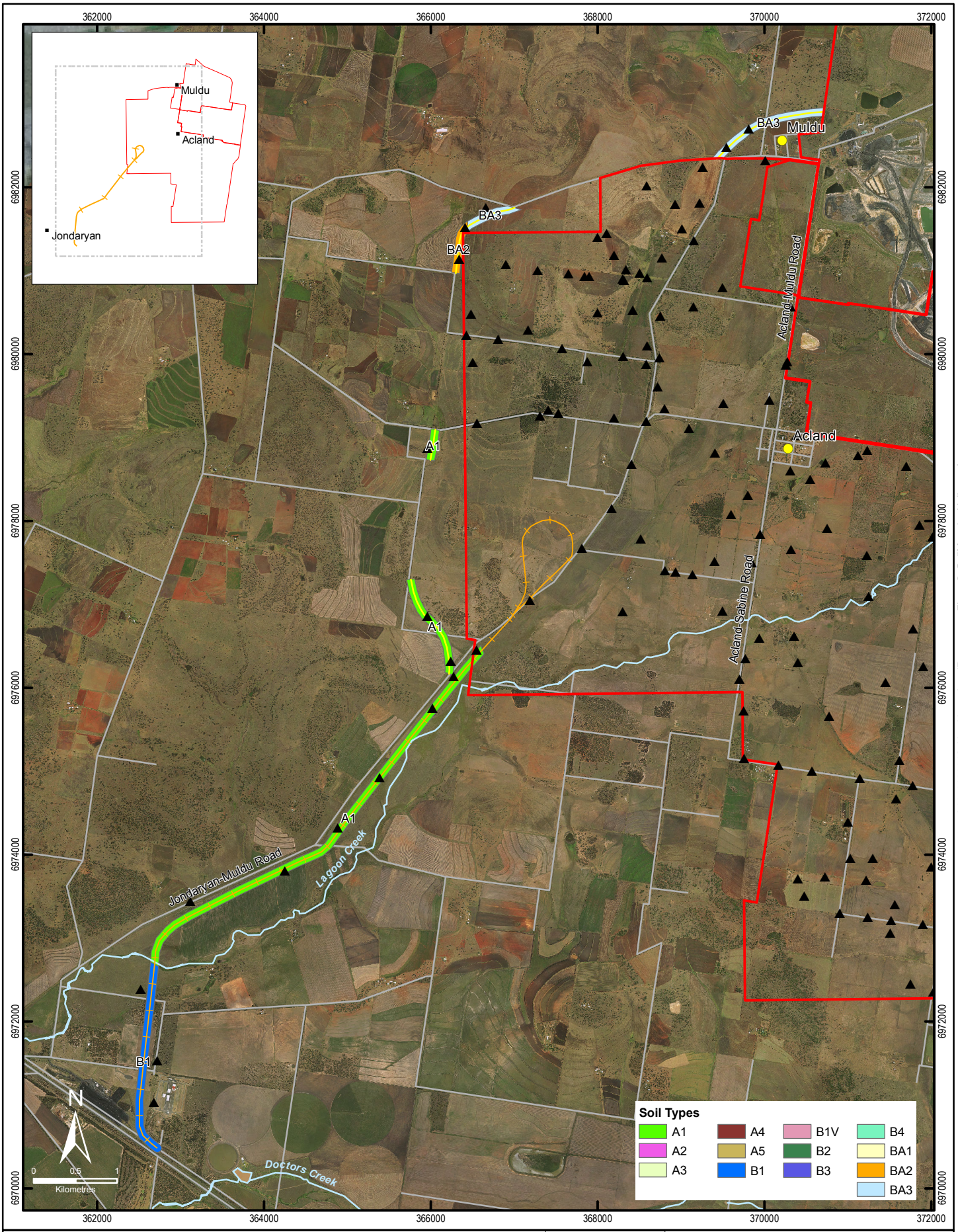

LEGEND

- Towns and Localities
- Soil Survey Locations
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- Roads
- Creeks
- Mining Tenements

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2 - Soil Mapping Units Road and Rail Corridor

Scale 1:60,000 on A4

Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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Produced: 13/09/2013

Appendix C Soil Description Sheets

Appendix C Soil Profile Description, Road and Rail Corridor

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	22/7/2013	I. Kelder/K. Brown	Site 01	Drill boring	032682		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6971029		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Isolated Clumps (<0.2%)	0.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentifed Grasses (grazed & no inflorescence)	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

No evidence of micro-relief

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface condition was recorded under moist conditions. Landform was flat with a gentle slope. Classified as a Kandosol due to weak structure of the B Horizon. The structure of these soils will become more obvious in drier conditions so suspect it may grade into a Dermosol.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Appendix C Soil Profile Description, Road and Rail Corridor

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-600		Abrupt	Medium Heavy Clay	7.5YR 2.5/1	10YR 6/2 2-6 mm Distinct 2%	<2% Iron	<2% 0-2 mm	Subangular blocky	Moderate	Weak (moist)	Many (25-200) Fine (1-2 mm)	9.8	0.212	0-100 200-400
B2	600-1000		Clear	Medium Heavy Clay	10YR 4/3	None evident	2-10% Carbonates	2-10% 0-2 mm	Subangular blocky	Weak	Firm (moderately moist)	Few (1-10) Fine (1-2 mm)	9.5	0.687	400-800 800-900
B3	1000-1300+		N/A	Medium Heavy Clay	10YR 4/2	10YR 5/4	Weathered parent material	10-20% 0-2 mm	Subangular blocky	Weak	Firm (moderately moist)	Few (1-10) Very fine (<1 mm)	9.7	0.642	1000-1100

Other information

Very fine orange/red mottles (distinct) at 1000 mm. Other mottles of different colours red/yellow/brown (fine) increasing from 450-600 mm depth in A horizon. Increase in coarse fragments in A horizon to 2-10% 0-2 mm at 400-600 mm in depth. High EC in B horizom (high salinity rating from 600 mm).

Site 01

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	22/07/2013	I. Kelder/K. Brown	Site 02	Drill boring	0362720		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6971531		Kandosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Isolated Clumps (<0.2%)	0.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses, use photos	Imperfectly drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
No micro-relief evident

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Soil surface condition was recorded under moist conditions. Landform was flat with a gentle slope. Classified as a Kandosol due to weak structure of the B Horizon. The structure of these soils will become more obvious in drier conditions so suspect it may grade into a Dermosol.

Vegetation Photo

Vegetation Photo

Appendix C Soil Profile Description, Road and Rail Corridor

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-600		Gradual	Medium Clay	10YR 2/1	None evident	None evident	None evident	Polyhedral	Moderate	Weak (moist)	Common (10-25) Fine (1-2 mm)	9.1	0.213	N/A
B2	600-900		Abrupt	Medium Heavy Clay	10YR 4/1	None evident	<2% Carbonates	<2% 2-6mm	Subangular blocky	Weak	Strong (moist)	Few (1-10) Fine (1-2 mm)	9.3	0.359	N/A
BC	900-1300+		N/A	Light Medium Clay (fine sandy)	10YR 6/3	10YR 7/8 Fine, Distinct 0-2mm	None evident	10-20% 2-6mm	Subangular blocky	Weak	Firm (moderately moist)	Few (1-10) Fine (1-2 mm)	8.5	0.987	N/A

Other information
Very wet (surface water). High EC in BC horizon (medium to high salinity rating from 600 mm depth).

Site 02

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	25/07/2013	I. Kelder/K. Brown	Site 03	Drill boring	0362522		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	North	6972387		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Microrelief is evident, gilgai is minor, with depressions 10-20cm deep and size 1-2m.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface is soft and moist. Cracking and self-mulching evident in dry sections (peds 2-6 mm in size).

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-800		Diffuse	Medium Clay	10YR 3/1	None evident	<2% Carbonates	None evident	Polyhedral	Weak	Weak (moist)	Many (25-200) Medium (2-5 mm)	7.4	0.551	0-100 200-300 500-600 800-900
B2	800-1450+		N/A	Medium Clay	10YR 4/2	None evident	2-10% Carbonates	None evident	Polyhedral	Weak	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	7.0	3.68	1000-1100
													7.1	1.41	pH/EC taken at 800 mm

Other information

Cracking, slickenslides and smooth faced peds present throughout the profile. Black clay from A1 is present in the cracks of the brown clay horizon. Similar to what we have seen at Sites 10, 11 and 12. Gradational profile, carbonates (?) start at 500 mm which coincides with an increase in strength and a decrease in moisture content. Structure changes from polyhedral to angular blocky in A1 horizon. Subplastic in A1 horizon. Significant increase in EC in B horizon (high salinity rating from 0 mm to 900 mm increasing to an extreme salinity rating at 1000 mm.

Site 03

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	23/07/2013	I. Kelder/K. Brown	Site 04	Manual auger	0363115		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6973441		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Isolated Plants (<0.2%)	1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses, emergent regrowth	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Cropping	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
No evidence of microrelief

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Soil surface condition is soft, but recorded under moist conditions. Landscape is flat with a simple slope

Vegetation Photo

Vegetation Photo

Vegetation Photo

Appendix C Soil Profile Description, Road and Rail Corridor

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-450		Clear	Medium Clay	10YR 2/2	None evident	None evident	None evident	Polyhedral	Moderate	Weak (moist)	Many (25-200) Fine (1-2 mm)	7.5	0.019	0-100 200-300
B22	450-900		Clear	Medium Heavy Clay	7.5YR 3/2	None evident	2-10% Carbonates	None evident	Polyhedral	Moderate	Weak (moderately moist)	Common (10-25) Fine (1-2 mm)	9.1	0.132	500-600 800-900
B23	900-1400+		N/A	Medium Heavy Clay	10YR 3/3	7.5YR 8/2 Few, medium and distinct	<2% Carbonates	None evident	Polyhedral	Moderate	Weak (moderately moist)	Few (1-10) Fine (1-2 mm)	9.5	0.165	1000-1100

Other information - Soil was sticky to touch in A1 and B22 horizon. Roots in A1 were very fine, fine, medium and coarse in size. Mottling was evident in B23 horizon.

Site 04

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	23/07/2013	I. Kelder/K. Brown	Site 05	Drill boring	0364250		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6973809		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Isolated Plants (<0.2%)	1.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses, some grass regrowth	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Cropping	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
No microrelief evident

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Soil surface condition is soft, but recorded under moist conditions. Landscape is flat with a simple slope

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-50		Abrupt	Light Medium Clay	10YR 3/1	None evident	None evident	<2% 0-2mm	Subangular blocky	Moderate	Weak (moist)	Common (10-25) Fine (1-2 mm)	9.0	0.079	N/A
B21	50-950		Gradual	Medium Clay	10YR 3/1	None evident	None evident	<2% 0-2mm	Subangular blocky	Moderate	Weak (moderately moist)	Few (1-10) Fine (1-2 mm)	8.6	0.055	N/A
B22	950-1700+		N/A	Medium Heavy Clay	10YR 3/2	Faint mottling 2-5mm fragments	2-10% Carbonates	2-10% 0-2mm	Subangular blocky	Moderate	Weak (moderately moist)	Few (1-10) Very fine (<1 mm)	7.8	4.05	N/A

Other information

There are obvious cracks that appear in the profile once it began to dry out. It appears that the darker material from the A1 and B21 horizons has moved down the profile through the cracks in the B22 below. Cracks that are visible are approx 1-2 mm in size and abundant. Clay coatings (slickenslides?) covers the ped faces (smooth-faced peds). Very large increase in EC from B21 to B22 horizon (extreme salinity from 950 mm).

Site 05

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	22/07/2013	I. Kelder/K. Brown	Site 06	Drill boring	0364882		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6974320		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody		0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

There is minor gilgai present. Similar to site 09.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface condition is moist and soft. There is some soil surface cracking evident and the surface is also poached.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-300		Clear	Medium Clay	10YR 2/1	None evident	None evident	<2% 0-2mm	Polyhedral	Weak	Weak (moist)	Abundant (>200) Medium (2-5 mm)	8.5	0.190	N/A
B21	300-1000		Clear	Medium Heavy Clay	7.5YR 2.5/1	None evident	<2% Carbonates	<2% 0-2mm	Polyhedral	Moderate	Firm (moderately moist)	Many (25-200) Medium (2-5 mm)	7.6	4.06	N/A
B22	100-1500+		N/A	Medium Heavy Clay	7.5YR 2.5/1	None evident	None evident	<2% 0-2mm	Angular blocky	Strong	Strong (moderately moist)	Few (1-10) Medium (2-5 mm)	8.1	1.51	N/A

Other information

Macropores evident. Stones present on surface (10 cm by 4 cm) approx 2-10%. Cracking occurs in the soil as it dries, leadin to structure becoming more prominent. Significant increase in EC in B horizon (extreme salinity between 300 mm and 1000 mm).

Site 06

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	23/07/2013	I. Kelder/K. Brown	Site 07	Drill boring	0365385		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6974925		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody		0.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Gilgai evident, size from 2 m-1 m and a depth of 30-40 cm and about 70% of land affected.

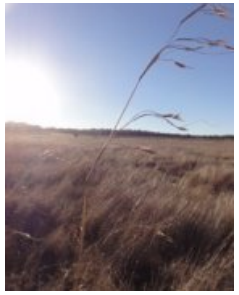
Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Vegetation Photo



Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-300		Abrupt	Medium Clay	10YR 2/1	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Many (25-200) Fine (1-2 mm)	8.2	0.039	0-100 200-300
B21	300-1300		Clear	Medium Heavy Clay	10YR 2/1	None evident	2-10% Carbonates	None evident	Polyhedral	Moderate	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	8.6	0.132	500-600 800-900
B22	1300+		N/A	Medium Heavy Clay	10YR 2/2	None evident	<2% Carbonates	None evident	Polyhedral	Weak	Firm (moderately moist)	Few (1-10) Fine (1-2 mm)	7.9	2.85	1000-1100

Other information

Gilgai microrelief. This site was sampled on a mound. Tough to tell if carbonate or course fragments, recorded as carbonate. Macropores are evident. Significant increase in EC from B21 to B22 horizon (extreme salinity rating from 1000 mm).

Site 07

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	23/07/2013	I. Kelder/K. Brown	Site 08	Drill boring	0366022		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6975760		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody		0.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Gilgai are evident, 1.5 m, 1.0 m depth of 20 cm and estimate >75% of th eland areas is affected.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface condition is moist and soft. The area is a floodplain.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-250		Clear	Medium Clay	10YR 2/1	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Many (25-200) Medium (2-5 mm)	8.7	0.021	0-100
B21	250-1000		Abrupt	Medium Heavy Clay	10YR 2/2	None evident	2-10% Carbonates	None evident	Polyhedral	Strong	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	8.1	0.274	300-400 500-600 800-900
B22	1000-1300+		N/A	Medium Heavy Clay	10YR 3/2	7.5 YR 7/2 (2-5%)	<2% Carbonates	None evident	Angular blocky	Moderate	Firm (moderately moist)	Few (1-10) Very fine (<1 mm)	8.4	0.428	1000-1100

Other information
Carbonates start at 800 mm. Fe/Mn segregations in B22. Increase in EC from B21 to B22 horizon (medium to extreme salinity rating from 250 mm to 1300 mm) and a faint orange mottle (2-5%)

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	23/07/2013	I. Kelder	Site 09	Drill boring	0366275		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6976137		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody		0.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

There is minor gilgai present, broader than than Site 08 and not as deep (2 m, 1.5 m by 5-10 cm deep).

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Surface condition is moist, cracks are evident as profile dries rapidly on exposure. There is evidence of self-mulching peds 2-6 mm in size. Area is poached.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-350		Abrupt	Medium Clay	10YR 2/1	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Many (25-200) Fine (1-2 mm)	8.0	0.053	N/A
B21	350-750		Clear	Medium Heavy Clay	10YR 3/1	None evident	<2% Carbonates	2-10% 0-2mm	Polyhedral	Moderate	Firm (moderately moist)	Few (1-10) Fine (1-2 mm)	7.9	1.33	N/A
B22	750-1600+		N/A	Medium Heavy Clay	7.5YR 3/2	7.5 YR 7/2 2-5% and a faint orange mottle (2-5%)	<2% Carbonates	<2% 0-2mm	Angular blocky	Strong	Strong (moderately moist)	Few (1-10) Very fine (<1 mm)	7.7	2.41	N/A

Other information
Smooth-faced peds present. Coarse fragments/carbonate at 600 mm (unidentifed). Significant increase in EC in B horizon (medium salinity rating from 750 mm).

Site 09

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/2013	I. Kelder/K. Brown	Site 10	Manual auger	0366238		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6976318		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody		0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified crop or forage crop	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Cropping	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

No evidence of microrelief. Gilgai occurs in adjacent fields.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-700		Clear	Medium Clay	7.5YR 2.5/1	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Common (10-25) Fine (1-2 mm)	8.8	0.173	N/A
B1	700-850		Gradual	Medium Heavy Clay	7.5YR 3/2	None evident	None evident	None evident	Angular blocky	Weak	Firm (moist)	Few (1-10) Fine (1-2 mm)	8.4	1.89	N/A
B2	850-1250+		N/A	Medium Heavy Clay	10YR 3/6	None evident	None evident	None evident	Angular blocky	Weak	Firm (moist)	Few (1-10) Fine (1-2 mm)	8.4	2.75	1000

Other information

A1 ribbon does not break (plastic clay). Course fragments start 300 mm (unidentified may be hard carbonate, approximately 5% and 0-2 mm in size) increasing to 2-10% in the B2 horizon. B horizons are less plastic than A1. Roots go from common to fine from the top to bottom of A1. Structure is likely to be moderate to strong when dry as seen in Sites 8 and 9. Smooth-faced peds. Signficant increase in EC in B horizon (medium salinity rating from 850 mm).

Site 10

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/2013	I. Kelder/K. Brown	Site 11	Drill boring	0365957		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6976857		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Sparse (10-30%)	0.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentifed grasses, Short trees with bark	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Minor gilgai evident, large depressions but shallow and not prominant throughout all of the landscape.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Site is located next to tree line. Landform nearby is simple slope. Soil surface is soft but moist.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-800		Clear	Medium Clay	10YR 3/1	None evident	None evident	None evident	Polyhedral	Moderate	Weak (moderately moist)	Many (25-200) Fine (1-2 mm)	8.8	0.361	0-100 200-300 500-600
B1	650-800		Gradual	Medium Heavy Clay	10YR 3/2	None evident	None evident	None evident	Polyhedral	Weak	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	7.8	3.32	800-900
B2	800-1500+		N/A	Medium Clay	10YR 3/3	None evident	None evident	None evident	Angular blocky	Moderate	Very firm (moderately moist)	Few (1-10) Fine (1-2 mm)	7.8	1.44	1000-1100
			Other information Coarse fragments (2-10%, 0-2mm to 2-6mm) recorded at 400 mm coniciding with a firm consistence (moist soil water status). As observed at Site 10 (and others), these coarse fragments may be carbonates (segregations) and are yet to be identified). Coarse fragments/ segregations increase to 15-25% (2-6 mm) at 600 mm. This continues throughout the profile (into B1, B2).										

Other information continued

Smooth-faced peds are evident along the entire profile. Structure of profile becomes more obvious as profile dries out and cracks. A horizon is sticky when wet, and both A1 and B1 are sub-plastic (texture increase when manipulating for up to 10 mins). Roots are fine and medium in size in A horizon. Very few roots present in B2 horizon decreasing in abundance and size with depth. A1 horizon clays are plastic. Evidence of A1 material in between cracks of B2 matrix. Significant increase in EC in B horizon (medium salinity rating 0-800 mm increasing to extreme at 800-900 mm and very high in the B2).

Site 11

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/2013	Brown/ Kelder		Drill boring	0365961		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	N/A	6978868		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified species	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Simple slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
Minor microrelief evident, shallow.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Surface soil condition is soft but recorded under moist conditions. Evidence of cracking and self-mulching on drier parts of the surface

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-800		Gradual	Medium Clay	10YR 2/1	None evident	None evident	None evident	Polyhedral	Moderate	Weak (moist)	Many (25-200) Fine (1-2 mm)	7.9 7.8	0.676 1.63	200-300 500-600
B2	800-1500+		N/A	Medium Heavy Clay	10YR 3/3	None evident	None evident	None evident	Angular blocky	Weak	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	8.7	2.52	1200-1300
			Other information Smooth-faced peds present throughout the profile, however soil is friable. Cracks become more prominent as the profile dries due to exposure and structure becomes more obvious (increase in structure grade from weak to moderate to strong). Coarse fragments/ segregations? present at 400 mm (2-6 mm, 5%), increasing at 600 mm (2-6 mm, 10%) and (2-6 mm and 0-2 mm, 15-25%) in the B. Some orange, red and white coarse fragments/segregations throughout (red appears to be iron).											

Other information
A horizon gets firmer possibly due to a combination of decrease in moisture and increase in the occurrence of coarse fragments/ segregations. Significant increase in EC in bottom part of A1 horizon and into B2 horizon (high salinity rating from 200 mm increasing to extreme at 500 mm).

Site 12

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/14	I. Kelder/K. Brown	Site 13	Drill boring	0366339		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	South	6981138		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		4.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grass species, leg/waist height, prickly bushes present	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Gilgai is moderate, hummocky, with depths up to 20-30 cm and 2-1 m in size. Vegetation cover makes it difficult to tell.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface is soft but moist, with some cracks forming in drier sections.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-850		Sharp	Medium Clay	10YR 2/2	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Common (10-25) Very fine (<1 mm)	9.0	0.422	0-100 200-300 500-600
B2	850-1300		Abrupt	Medium Heavy Clay	10YR 3/3	None evident	None evident	None evident	Subangular blocky	Weak	Firm (moderately moist)	Few (1-10) Very fine (<1 mm)	9.5	0.877	850-950 1000-1100
BC	1300-1500+		N/A	Light Clay	2.5Y 6/3	None evident	None evident	20-50% 0-2mm	Apedal	Massive	Firm (moderately moist)	None evident	9.6	1.15	N/A

Other information

Macropores and faunal channels observed in the the top 100 mm. Refer to "other information" recorded for Sites 10, 11 and 12. Fewer smooth-faced peds in this profile compared to others, not as well structured. At 500 mm coarse fragments / segregations? present (0-2 mm, 2-5%). Increasing in B2 horizon (0-2 mm, 5-10%), increasing to approximately 20-50% in BC horizon (0-2mm). Iron and manganese nodules present. Increase in EC from A1 to B2 horizon. Salinity rating ranges from medium (0-850 mm) to high (850-1300 mm) to extreme from 1300 mm.

Site 13

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/13	I. Kelder/K. Brown	Site 14	Drill boring	0366412		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	South	6981522		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		4.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grass species, leg/waist height, prickly bushes present	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Gilgai is moderate, hummocky, with depths up to 20-30 cm and 2-1 m in width. Vegetation cover makes it difficult to tell.

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information

Soil surface is soft but moist, with some cracks forming in drier sections, some evidence of self mulching. Soil surface also appears poached

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-700		Gradual	Medium Clay	10YR 2/1	None evident	2-10% Unidentified	<2% 0-2mm	Polyhedral	Weak	Weak (moist)	Common (10-25) Fine (1-2 mm)	9.0 9.2	0.219 0.158	200-300 600-700
B2	700-1400+		N/A	Medium Heavy Clay	7.5YR 3/4	None evident	<2% Unidentified	<2% 0-2mm	Angular blocky	Weak	Firm (moderately moist)	Few (1-10) Fine (1-2 mm)	9.1	1.30	1000-1100

Other information

Smooth-faced peds more prominent than at Site 13, no evidence of BC. Refer to "other information" recorded for Sites 10, 11 and 12. Slickenslides in B2. Coarse fragments/ segregations(?) start at 500 mm (0-2 mm, 2-10%) decreasing to (0-2 mm, <2%) in the B horizon. Some iron segregations evident. Consistence increases to firm as the profile dries. Significant increase in EC in B horizon (from low to extreme at 700 mm).

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/2013	I. Kelder/K. Brown	Site 15	Drill boring	0366661		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Dense (>70%)	South	6981758		Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		3.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grass species, leg/waist height, bushes nearby	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief

Gilgai is moderate, hummocky, with depths up to 20-30 cm and 2-1 m in size. Vegetation cover makes it difficult to tell.

Landscape Photo (South)

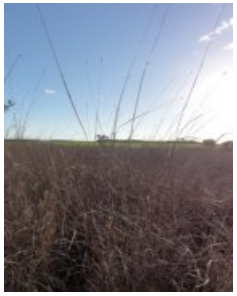
Landscape Photo (West)

Other Photo

Other Information

Soil surface is soft but moist, with some cracks forming in drier sections. Coarse stones on surface (10-30 cm, 15%). Classified as a Vertosol due to presence of gilgai and cracking (over-riding weak structure when moist).

Vegetation Photo



Vegetation Photo

Vegetation Photo

Appendix C Soil Profile Description, Road and Rail Corridor

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-350		Clear	Medium Clay	10YR 2/2	None evident	None evident	None evident	Polyhedral	Weak	Weak (moist)	Many (25-200) Fine (1-2 mm)	8.7	0.038	0-100 200-300
B2	350-450		Abrupt	Medium Heavy Clay	10YR 3/3	None evident	None evident	20-50% 6-20mm	Angular blocky	Weak	Weak (moist)	Common (10-25) Fine (1-2 mm)	8.1	0.058	500-600
Gravel layer	450-700		N/A	N/A	N/A	N/A	N/A	50-90% 6-20mm	N/A	N/A	N/A	Few (1-10) Very fine (<1 mm)	N/A	N/A	N/A
BC	700-1200		N/A	N/A	N/A	N/A	N/A	50-90% 60-200mm	Apedal	Massive	N/A	Few (1-10) Very fine (<1 mm)	N/A	N/A	N/A
	Refusal														

Other information

Segregations <2% and 0-2 mm in the A and B horizon starting at 150 mm depth.

Site 15

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	25/07/2013	I. Kelder/K. Brown	Site 16	Drill boring	0369545		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	East	6982477		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		4.0	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses, weed species	Well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
No evidence of microrelief

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Stones present on surface 10 cm by 5 cm, approximately 15%. Soil surface is firm under moist conditions. Surface is uneven, may have a history of cultivation.

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-150		Clear	Light Clay	7.5YR 2.5/2	None evident	None evident	2-10% 0-2mm	Polyhedral	Weak	Weak (moderately moist)	Common (10-25) Fine (1-2 mm)	7.4	0.051	N/A
B2	150-400		Abrupt	Light Medium Clay	7.5YR 3/3	None evident	None evident	2-10% 0-2mm	Polyhedral	Weak	Weak (moderately moist)	Few (1-10) Very fine (<1 mm)	7.3	0.040	N/A
BC	400-1500		N/A	Sandy Clay Loam	7.5YR 3/4	None evident	None evident	50-90% 6-20mm	Apedal	Massive	Weak (moderately moist)	None evident	7.1	0.049	N/A
	Refusal														

Other information
Slickenslides and smooth-faced peds evident in B horizon. Both A and B horizon textures are sticky (indicates plasticity).

Site 16

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
NHG	24/07/2013	I. Kelder/K. Brown	Site 17	Drill boring	0369811		

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	East	6982701		Kandosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
		1.5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Unidentified grasses, weed species	Well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Microrelief
No microrelief evident

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information
Stones present on surface 10 cm by 5 cm, approximately 15%. Soil surface is firm under moist conditions. Surface is uneven, may have a history of cultivation)

Vegetation Photo

Vegetation Photo

Vegetation Photo

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample (mm)
A1	0-180		Abrupt	Clay Loam	7.5YR 3/1	None evident	None evident	10-20% 2-6mm	Polyhedral	Weak	Weak (moderately moist)	Common (10-25) Fine (1-2 mm)	9.1	0.040	0-100
B2	180-650		Clear	Medium Heavy Clay	7.5YR 3/4	None evident	None evident	50-90% 20-60mm	Angular blocky	Weak	Weak (moderately moist)	Few (1-10) Very fine (<1 mm)	8.2	0.073	200-300 500-600 Jars only
C	650-950		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Refusal														

Other information

A horizon is sticky (indicates plasticity). BC horizon has smooth-faced peds (15%). The gravel is similar to what was seen in Site 15. Clay accumulation in the B horizon amongst the gravel. C horizon is parent material (no clay present).

Site 17

Appendix D Soil Laboratory Tests

Test	Soils Analysed	Reason for Inclusion
Chemical Analysis		
pH, Electrical Conductivity (EC) and Chloride Content	Surface and subsoil	pH is regarded as a useful indicator of other soil properties (e.g. values >8.5 usually indicate high exchangeable sodium levels and the presence of carbonates) and of the need for amendment with lime. Some plants tolerate a wide range of pH, while some are sensitive to acidity and some to alkalinity. The availability of some nutrients will be affected by soil pH. The measure of EC is used as a means of appraising soil salinity. The electrical conductance increases with soluble salt content and thus allows simple interpretation of readings. Plants vary considerably in their tolerance to salt The chloride anion is usually present in soil in association with sodium and is an important constituent of many salty soils. Its high mobility makes it a valuable indicator of the direction of salt and water movement, and it can be specifically toxic to some plants.
Carbonate Equivalent Content	Surface and subsoil	Carbonate may exist in soil as predominately either calcite or dolomite. Its presence, which may vary from trace amounts to high percentages of the soil, is of significance because of its effect on the general physical condition, especially on consistence. When present in large amounts as fine-earth carbonate it can modify soil texture. It can constitute a potential source of calcium for the replacement of exchangeable sodium, thus improve stability.
Cation Exchange Capacity and Exchangeable Calcium (Ca), Magnesium (Mg), Sodium (Na) (Cations)	Surface and subsoil	The amounts and relative proportions of the exchangeable cations in soil have important effects on both physical and chemical properties. High levels of exchangeable sodium cause dispersion and increased swelling, reducing water movement and affecting near surface aeration whereas exchangeable calcium flocculates colloids and will reduce swelling tendencies. Excessively high or low concentrations of one or the other of the cations may result in nutritional disturbances to germinating plants. Exchangeable cations are held in the soil at negatively charged surfaces and are exchanged by all 'strong' cations. The total amount that can be held is designated the cation exchange capacity.
Soluble Sulphate (SO_4)	Surface and subsoil	Knowledge of soluble cations and anions and their relative proportions is valuable in assessing saline and alkaline soils and their response to various treatments. Chloride is usually the principal anion in extracts of soil and it is specifically toxic to some plants. Other anions may also be toxic to plants. Bicarbonate is a normal constituent of saline and sodic soil extracts. Both carbonate (CO_3) and bicarbonate (HCO_3) have a tendency to precipitate the divalent cations Ca and Mg, resulting in an increase in the ratio of Na to Ca-Mg in the soil solution. This favours the absorption of Na by the exchange complex and the development of unfavourable sodic-soil conditions.
Phosphorous, Nitrogen	Surface soil	If the amount of phosphorous in soil is too small then yield is jeopardised, but increasing reserves to very high levels is an unnecessary expense. Thus the concept of a critical level in soil is necessary.
Organic Matter	Surface soil	Organic matter is important in maintaining soil structure, in slightly increasing the soil's water holding capacity and holding a small store of N, P, S and trace elements in organic forms. These cannot be taken up directly by plant roots but have first to be converted by soil microbes to inorganic (ionic) forms identical to those supplied in fertilisers.
Total digest for molybdenum, manganese, iron, copper, zinc, boron, chloride, sodium and cobalt.	Surface and subsoil	Although only required in small amounts, trace elements (or micronutrients) are essential for plant growth. These nutrients often act as catalysts in chemical reactions. It is possible to have toxicities of trace elements, as well as deficiencies. A deficiency may reduce plant growth. An excess of a trace element, although not common, may be toxic to the plant and may cause an imbalance, reduced yield, impaired quality or increased susceptibility to disease.
Bicarbonate Extractable Phosphorus (P)	Surface soil	Defines the very soluble (also termed available or labile) phosphorus in soils.

Test	Soils Analysed	Reason for Inclusion
Physical Analysis		
Particle Size Distribution (PSD)	Subsoil	Defines the relative amounts of silt, clay and sand in the sample
Calculated Analysis		
ESP %	Surface and subsoil	Exchangeable sodium percentage was used to assess the relative abundance of exchangeable Na.
Ca/Mg	Surface and subsoil	The ratio of Ca to Mg provides a guide to the relative abundance of the two major cations an is useful when used in conjunction with ESP for predicting soil physical behaviour.

Appendix E Soil Profile Analytical Data and Laboratory Certificates

Soil Mapping Unit		B1					B1						
ASC Class		Dermosol					Vertosol						
ALS Sample Number		EB1318018001	EB1318018002	EB1318018003	EB1318018004	EB1318018005	EB1318018024	EB1318018025	EB1318018026	EB1318018027	EB1318018028	EB1318018029	EB1318018030
Sample ID		Site 1_0-100mm	Site 1_200-300mm	Site 1_500-600mm	Site 1_800-900mm	Site 1_1000-1100mm	Site 3_0-100mm	Site 3_200-300mm	Site 3_500-600mm	Site 3_800-900mm	Site 3_1000-1100mm	Site 4_0-100mm	Site 4_200-300mm
Sample Date		22/07/2013	22/07/2013	22/07/2013	22/07/2013	22/07/2013	25/07/2013	25/07/2013	25/07/2013	25/07/2013	25/07/2013	25/07/2013	25/07/2013
Chemical Paramters	Units												
pH Value	pH Unit	8.4	9.1	9.4	7.9	9	6.9	7.7	8	8.2	8.2	7.8	8
Electrical Conductivity @ 25°C	µS/cm	100	206	483	3780	1260	37	106	545	978	1190	45	70
Particle Sizing													
+75µm	%	-	44	-	30	-	-	-	-	-	-	-	-
+150µm	%	-	22	-	18	-	-	-	-	-	-	-	-
+300µm	%	-	5	-	8	-	-	-	-	-	-	-	-
+425µm	%	-	3	-	6	-	-	-	-	-	-	-	-
+600µm	%	-	2	-	6	-	-	-	-	-	-	-	-
+1180µm	%	-	2	-	5	-	-	-	-	-	-	-	-
+2.36mm	%	-	<1	-	2	-	-	-	-	-	-	-	-
+4.75mm	%	-	<1	-	<1	-	-	-	-	-	-	-	-
+9.5mm	%	-	<1	-	<1	-	-	-	-	-	-	-	-
+19.0mm	%	-	<1	-	<1	-	-	-	-	-	-	-	-
+37.5mm	%	-	<1	-	<1	-	-	-	-	-	-	-	-
+75.0mm	%	-	<1	-	<1	-	-	-	-	-	-	-	-
Clay (<2 µm)	%	-	36	-	52	-	-	-	-	-	-	-	-
Fines (<75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Sand (>75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Silt (2-60 µm)	%	-	15	-	16	-	-	-	-	-	-	-	-
Sand (0.06-2.00 mm)	%	-	48	-	30	-	-	-	-	-	-	-	-
Gravel (>2mm)	%	-	1	-	2	-	-	-	-	-	-	-	-
Cobbles (>6cm)	%	-	<1	-	<1	-	-	-	-	-	-	-	-
Exchangable Ions													
Exchangeable Calcium	meq/100g	17.2	6.6	30.9	137	3.5	13.4	4	6.1	5.5	4.7	9	23.6
Exchangeable Magnesium	meq/100g	3.2	1.7	8.6	5.3	2.2	7.7	2.7	4.4	4.3	3.5	6.7	16.3
Exchangeable Potassium	meq/100g	0.6	<0.1	0.2	0.2	<0.1	1.2	<0.1	0.1	0.1	0.1	0.3	0.7
Exchangeable Sodium	meq/100g	0.3	0.8	4.1	1.2	2.1	0.3	0.7	1.4	1.2	1	0.1	0.2
Exchangeable Aluminium	meq/100g												
Cation Exchange Capacity	meq/100g	21.3	9.1	43.8	144	7.8	22.5	7.5	12.1	11.1	9.4	16.1	40.8
Exchangeable Sodium Percent [1]	%	1.41	8.79	9.36	0.83	26.92	1.33	9.33	11.57	10.81	10.64	0.62	0.49
Calcium/Magnesium Ratio [1]	-	5.38	3.88	3.59	25.85	1.59	1.74	1.48	1.39	1.28	1.34	1.34	1.45
Magnesium/Potassium Ratio	-												
Ammonium Ion Exchange Capacity	meq/100g												
Alkalinity													
Total Alkalinity as CaCO3	mg/kg												
Bicarbonate Alkalinity as CaCO3	mg/kg												
Carbonate Alkalinity as CaCO3	mg/kg												
Organic Matter													
Organic Matter	%	1.37	-	-	-	-	3.4	-	-	-	-	2.54	-
Nutrients													
Bicarbonate Extractable K (Colwell)	mg/kg	260	-	-	-	-	590	-	-	-	-	<200	-
Sulfate as SO4 2-	mg/kg	<10	<10	230	13800	1340	<10	10	160	490	730	<10	<10
Chloride	mg/kg	<10	30	140	930	1140	10	90	810	1420	1690	<10	<10
Boron	mg/kg	<0.2	-	-	-	-	-	-	-	-	-	-	-
Copper	mg/kg	<1.00	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/kg	17.6	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	31.8	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/kg	<1.00	-	-	-	-	-	-	-	-	-	-	-
Calcium	mg/kg	20	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	<10	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/kg	100	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	20	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate as N (Sol.)	mg/kg												
Total Kjeldahl Nitrogen as N	mg/kg	1000	-	-	-	-	2200	-	-	-	-	1200	-
Total Nitrogen as N	mg/kg												
Total Phosphorus as P	mg/kg												
Bicarbonate Ext. P (Colwell)	mg/kg	<2	-	-	-	-	17	-	-	-	-	17	-

Soil Mapping Unit		A1			A1	A1							A1
ASC Class		Dermosol			Vertosol	Vertosol							Vertosol
ALS Sample Number		EB1318018031	EB1318018032	EB1318018033	EB1318018043	EB1318018006	EB1318018007	EB1318018008	EB1318018009	EB1318018010	EB1318018034	EB1318018035	EB1318018036
Sample ID		Site 4_500-600mm	Site 4_800-900mm	Site 4_1000-1100mm	Site 6_500-600mm	Site 7_0-100mm	Site 7_200-300mm	Site 7_500-600mm	Site 7_800-900mm	Site 7_1000-1100mm	Site 8_0-100mm	Site 8_200-300mm	Site 8_500-600mm
Sample Date		25/07/2013	25/07/2013	25/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013	23/07/2013
Chemical Paramters	Units												
pH Value	pH Unit	8.50	8.6	6.6		8	8.6	8.80	8.5	8.4	6.5	7.5	8.4
Electrical Conductivity @ 25°C	µS/cm	196.00	216	258		101	140	317.00	735	854	60	61	533
Particle Sizing													
+75µm	%	-	-	-	-	-	24.00	-	24.00	-	-	-	-
+150µm	%	-	-	-	-	-	16.00	-	16.00	-	-	-	-
+300µm	%	-	-	-	-	-	5.00	-	4.00	-	-	-	-
+425µm	%	-	-	-	-	-	4.00	-	3.00	-	-	-	-
+600µm	%	-	-	-	-	-	3.00	-	2.00	-	-	-	-
+1180µm	%	-	-	-	-	-	2.00	-	2.00	-	-	-	-
+2.36mm	%	-	-	-	-	-	2.00	-	1.00	-	-	-	-
+4.75mm	%	-	-	-	-	-	<1	-	<1	-	-	-	-
+9.5mm	%	-	-	-	-	-	<1	-	<1	-	-	-	-
+19.0mm	%	-	-	-	-	-	<1	-	<1	-	-	-	-
+37.5mm	%	-	-	-	-	-	<1	-	<1	-	-	-	-
+75.0mm	%	-	-	-	-	-	<1	-	<1	-	-	-	-
Clay (<2 µm)	%	-	-	-	-	-	56.00	-	60.00	-	-	-	-
Fines (<75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Sand (>75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Silt (2-60 µm)	%	-	-	-	-	-	19.00	-	15.00	-	-	-	-
Sand (0.06-2.00 mm)	%	-	-	-	-	-	23.00	-	24.00	-	-	-	-
Gravel (>2mm)	%	-	-	-	-	-	2.00	-	1.00	-	-	-	-
Cobbles (>6cm)	%	-	-	-	-	-	<1	-	<1	-	-	-	-
Exchangable Ions													
Exchangeable Calcium	meq/100g	15.30	24.8	21.6	-	6.2	19	5.90	4.6	5.2	6.1	13	4.8
Exchangeable Magnesium	meq/100g	10.20	14.8	16.9	-	2.7	8.3	3.50	3.4	3.8	3.3	7	3.1
Exchangeable Potassium	meq/100g	0.30	0.3	0.40	-	0.3	0.2	<0.1	<0.1	<0.1	0.3	0.4	0.1
Exchangeable Sodium	meq/100g	0.20	0.4	0.60	-	0.1	0.9	1.00	1.4	1.5	0.4	1	1.6
Exchangeable Aluminium	meq/100g												
Cation Exchange Capacity	meq/100g	26.10	40.3	39.6	-	9.4	28.4	10.40	9.6	10.5	10.2	21.4	9.6
Exchangeable Sodium Percent [1]	%	0.77	0.99	1.52	-	1.06	3.17	9.62	14.58	14.29	3.92	4.67	16.67
Calcium/Magnesium Ratio [1]	-	1.50	1.68	1.28	-	2.30	2.29	1.69	1.35	1.37	1.85	1.86	1.55
Magnesium/Potassium Ratio	-												
Ammonium Ion Exchange Capacity	meq/100g												
Alkalinity													
Total Alkalinity as CaCO3	mg/kg												
Bicarbonate Alkalinity as CaCO3	mg/kg												
Carbonate Alkalinity as CaCO3	mg/kg												
Organic Matter													
Organic Matter	%	-	-	-	-	2.95	-	-	-	-	4.55	-	-
Nutrients													
Bicarbonate Extractable K (Colwell)	mg/kg	-	-	-	-	290.00	-	-	-	-	400.00	-	-
Sulfate as SO4 2-	mg/kg	20.00	40	40	1180	<10	<10	20.00	20	20	30	20	310
Chloride	mg/kg	<10	<10	<10	3060	<10	30	290.00	1170	1540	30	30	580
Boron	mg/kg	-	-	-	-	<0.2	-	-	-	-	-	-	-
Copper	mg/kg	-	-	-	-	1.54	-	-	-	-	-	-	-
Iron	mg/kg	-	-	-	-	33.8	-	-	-	-	-	-	-
Manganese	mg/kg	-	-	-	-	28.1	-	-	-	-	-	-	-
Zinc	mg/kg	-	-	-	-	<1.00	-	-	-	-	-	-	-
Calcium	mg/kg	-	-	-	-	30	-	-	-	-	-	-	-
Magnesium	mg/kg	-	-	-	-	<10	-	-	-	-	-	-	-
Sodium	mg/kg	-	-	-	-	80	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	<10	-	-	-	-	-	-	-
Nitrite + Nitrate as N (Sol.)	mg/kg												
Total Kjeldahl Nitrogen as N	mg/kg	-	-	-	-	1990.00	-	-	-	-	5110.00	-	-
Total Nitrogen as N	mg/kg												
Total Phosphorus as P	mg/kg												
Bicarbonate Ext. P (Colwell)	mg/kg	-	-	-	-	16.00	-	-	-	-	28.00	-	-

Soil Mapping Unit				A1	A1					BA2			
ASC Class				Vertosol	Vertosol					Vertosol			
ALS Sample Number		EB1318018037	EB1318018038	EB1318018042	EB1318018014	EB1318018015	EB1318018016	EB1318018017	EB1318018018	EB1318018019	EB1318018020	EB1318018021	EB1318018022
Sample ID		Site 8_800-900mm	Site 8_1000-1100mm	Site 10_1000-1100mm	Site 11_0-100mm	Site 11_200-300mm	Site 11_500-600mm	Site 11_800-900mm	Site 11_1000-1100mm	Site 13_0-100mm	Site 13_200-300mm	Site 13_500-600mm	Site 13_800-900mm
Sample Date		23/07/2013	23/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013
Chemical Paramters	Units												
pH Value	pH Unit	7.60	8.5	8.6	7.2	7.7	8.6	7.80	8.6	8.5	8.9	9	9.10
Electrical Conductivity @ 25°C	µS/cm	3870.00	1280	1220	46	234	1300	3010.00	1330	156	211	510	890.00
Particle Sizing													
+75µm	%	-	-	-	-	9.00	-	15.00	-	-	16.00	-	12.00
+150µm	%	-	-	-	-	5.00	-	9.00	-	-	7.00	-	6.00
+300µm	%	-	-	-	-	2.00	-	4.00	-	-	2.00	-	4.00
+425µm	%	-	-	-	-	<1	-	3.00	-	-	1.00	-	3.00
+600µm	%	-	-	-	-	<1	-	3.00	-	-	<1	-	2.00
+1180µm	%	-	-	-	-	<1	-	2.00	-	-	<1	-	1.00
+2.36mm	%	-	-	-	-	<1	-	2.00	-	-	<1	-	<1
+4.75mm	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
+9.5mm	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
+19.0mm	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
+37.5mm	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
+75.0mm	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
Clay (<2 µm)	%	-	-	-	-	60.00	-	37.00	-	-	53.00	-	52.00
Fines (<75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Sand (>75 µm)		-	-	-	-	-	-	-	-	-	-	-	-
Silt (2-60 µm)	%	-	-	-	-	31.00	-	47.00	-	-	29.00	-	33.00
Sand (0.06-2.00 mm)	%	-	-	-	-	9.00	-	14.00	-	-	18.00	-	14.00
Gravel (>2mm)	%	-	-	-	-	<1	-	2.00	-	-	<1	-	1.00
Cobbles (>6cm)	%	-	-	-	-	<1	-	<1	-	-	<1	-	<1
Exchangable Ions													
Exchangeable Calcium	meq/100g	6.70	26.2	3.6	4.2	4.1	4.2	3.50	3.5	9.7	5.9	32.8	17.30
Exchangeable Magnesium	meq/100g	3.00	12.3	2.6	3	2.7	3.3	2.80	3.2	2.9	2.6	17.7	5.40
Exchangeable Potassium	meq/100g	0.10	0.5	0.1	0.3	<0.1	<0.1	<0.1	0.10	0.30	<0.1	0.30	0.10
Exchangeable Sodium	meq/100g	0.90	4	2	0.6	1.6	2.2	1.40	2	0.3	1.3	8.7	2.80
Exchangeable Aluminium	meq/100g												
Cation Exchange Capacity	meq/100g	10.80	43	8.5	8.1	8.4	9.8	7.80	8.8	13.2	9.8	59.4	25.50
Exchangeable Sodium Percent [1]	%	8.33	9.3	23.53	7.41	19.05	22.45	17.95	22.73	2.27	13.27	14.65	10.98
Calcium/Magnesium Ratio [1]	-	2.23	2.13	1.38	1.40	1.52	1.27	1.25	1.09	3.34	2.27	1.85	3.20
Magnesium/Potassium Ratio	-												
Ammonium Ion Exchange Capacity	meq/100g												
Alkalinity													
Total Alkalinity as CaCO3	mg/kg												
Bicarbonate Alkalinity as CaCO3	mg/kg												
Carbonate Alkalinity as CaCO3	mg/kg												
Organic Matter													
Organic Matter	%	-	-	-	2.7	-	-	-	-	1.87	-	-	-
Nutrients													
Bicarbonate Extractable K (Colwell)	mg/kg	-	-	-	390.00	-	-	-	-	220.00	-	-	-
Sulfate as SO4 2-	mg/kg	14400.00	1020	570	<10	50.00	900.00	8050.00	940	<10	<10	60.00	370.00
Chloride	mg/kg	1650.00	1620	2240	30	190	1820	2100.00	2040	10	20	170	440.00
Boron	mg/kg	-	-	-	<0.2	-	-	-	-	<0.2	-	-	-
Copper	mg/kg	-	-	-	2.05	-	-	-	-	<1.00	-	-	-
Iron	mg/kg	-	-	-	68.6	-	-	-	-	19.5	-	-	-
Manganese	mg/kg	-	-	-	151	-	-	-	-	21.1	-	-	-
Zinc	mg/kg	-	-	-	<1.00	-	-	-	-	<1.00	-	-	-
Calcium	mg/kg	-	-	-	<10	-	-	-	-	30.00	-	-	-
Magnesium	mg/kg	-	-	-	<10	-	-	-	-	<10	-	-	-
Sodium	mg/kg	-	-	-	30	-	-	-	-	180	-	-	-
Potassium	mg/kg	-	-	-	<10	-	-	-	-	<10	-	-	-
Nitrite + Nitrate as N (Sol.)	mg/kg												
Total Kjeldahl Nitrogen as N	mg/kg	-	-	-	1780.00	-	-	-	-	1360.00	-	-	-
Total Nitrogen as N	mg/kg												
Total Phosphorus as P	mg/kg												
Bicarbonate Ext. P (Colwell)	mg/kg	-	-	-	10.00	-	-	-	-	26.00	-	-	-

Soil Mapping Unit			BA3			BA3		
ASC Class			Vertosol			Kandosol		
ALS Sample Number		EB1318018023	EB1318018039	EB1318018040	EB1318018041	EB1318018011	EB1318018012	EB1318018013
Sample ID		Site 13_1000-1100mm	Site 15_0-100mm	Site 15_200-300mm	Site 15_500-600mm	Site 17_0-100mm	Site 17_200-300mm	Site 17_500-600mm
Sample Date		24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013	24/07/2013
Chemical Paramters	Units							
pH Value	pH Unit	9.2	6.7	7.2	7.2	7.1	7.70	7.9
Electrical Conductivity @ 25°C	µS/cm	926	22	26	21	35	24.00	43
Particle Sizing								
+75µm	%	-	-	-	-	19.00	30.00	-
+150µm	%	-	-	-	-	13.00	27.00	-
+300µm	%	-	-	-	-	11.00	26.00	-
+425µm	%	-	-	-	-	10.00	25.00	-
+600µm	%	-	-	-	-	9.00	25.00	-
+1180µm	%	-	-	-	-	7.00	24.00	-
+2.36mm	%	-	-	-	-	4.00	23.00	-
+4.75mm	%	-	-	-	-	<1	18.00	-
+9.5mm	%	-	-	-	-	<1	12.00	-
+19.0mm	%	-	-	-	-	<1	<1	-
+37.5mm	%	-	-	-	-	<1	<1	-
+75.0mm	%	-	-	-	-	<1	<1	-
Clay (<2 µm)	%	-	-	-	-	36.00	53.00	-
Fines (<75 µm)		-	-	-	-	-	-	-
Sand (>75 µm)		-	-	-	-	-	-	-
Silt (2-60 µm)	%	-	-	-	-	43.00	16.00	-
Sand (0.06-2.00 mm)	%	-	-	-	-	17.00	8.00	-
Gravel (>2mm)	%	-	-	-	-	4.00	23.00	-
Cobbles (>6cm)	%	-	-	-	-	<1	<1	-
Exchangable Ions								
Exchangeable Calcium	meq/100g	3.9	20.1	8.2	31.9	19.6	7.00	8.8
Exchangeable Magnesium	meq/100g	3.5	5.3	1.9	4.8	7.6	2.70	3.5
Exchangeable Potassium	meq/100g	0.10	1.10	0.20	0.30	1.20	<0.1	<0.1
Exchangeable Sodium	meq/100g	2.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Aluminium	meq/100g							
Cation Exchange Capacity	meq/100g	10.1	26.5	10.4	37.2	28.5	9.90	12.5
Exchangeable Sodium Percent [1]	%	25.74	0.38	0.96	0.27	0.35	1.01	0.8
Calcium/Magnesium Ratio [1]	-	1.11	3.79	4.32	6.65	2.58	2.59	2.51
Magnesium/Potassium Ratio	-							
Ammonium Ion Exchange Capacity	meq/100g							
Alkalinity								
Total Alkalinity as CaCO3	mg/kg							
Bicarbonate Alkalinity as CaCO3	mg/kg							
Carbonate Alkalinity as CaCO3	mg/kg							
Organic Matter								
Organic Matter	%	-	2.05	-	-	1.73	-	-
Nutrients								
Bicarbonate Extractable K (Colwell)	mg/kg	-	450.00	-	-	550.00	-	-
Sulfate as SO4 2-	mg/kg	450	<10	<10	<10	<50	<10	<10
Chloride	mg/kg	560	<10	<10	<10	<10	<10	<10
Boron	mg/kg	-	-	-	-	<0.2	-	-
Copper	mg/kg	-	-	-	-	1.33	-	-
Iron	mg/kg	-	-	-	-	60.4	-	-
Manganese	mg/kg	-	-	-	-	69.9	-	-
Zinc	mg/kg	-	-	-	-	1.05	-	-
Calcium	mg/kg	-	-	-	-	<50	-	-
Magnesium	mg/kg	-	-	-	-	<50	-	-
Sodium	mg/kg	-	-	-	-	<50	-	-
Potassium	mg/kg	-	-	-	-	<50	-	-
Nitrite + Nitrate as N (Sol.)	mg/kg							
Total Kjeldahl Nitrogen as N	mg/kg	-	1750.00	-	-	1310.00	-	-
Total Nitrogen as N	mg/kg							
Total Phosphorus as P	mg/kg							
Bicarbonate Ext. P (Colwell)	mg/kg	-	157.00	-	-	127.00	-	-

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1318018**	Page	: 1 of 16
Amendment	: **(Preliminary Report)**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: MR JEREMY WICKS	Contact	: Customer Services
Address	: 32 CORDELIA STREET SOUTH BRISBANE QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: jwicks@globalskm.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3026 7526	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: NAC Supplementary Soil Survey QE06644 033	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-JUL-2013
Sampler	: K Bromn / I Kelder	Issue Date	: 05-AUG-2013 15:53
Site	: ----		
		No. of samples received	: 43
Quote number	: EN/003/13	No. of samples analysed	: 43

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ED021 (Bicarbonate Extractable K - Colwell) : The LOR for EB1318018-029 (Site 04-0-100mm) has been raised due to matrix interference.**
- **ED040S (Major Anion - Soluble) : The LOR for EB1318018-011 (Site 17-0-100mm) has been raised due to insufficient sample volume.**

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
		Brisbane Inorganics
		Brisbane Inorganics
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils
		Brisbane Inorganics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Site 01 0-100mm	Site 01 200-300mm	Site 01 500-600mm	Site 01 800-900mm	Site 01 1000-1100mm
				Client sampling date / time	22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00
Compound	CAS Number	LOR	Unit		EB1318018-001	EB1318018-002	EB1318018-003	EB1318018-004	EB1318018-005
EA150: Particle Sizing									
+75µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+150µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+300µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+425µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+600µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+1180µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+2.36mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+4.75mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+9.5mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+19.0mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+37.5mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+75.0mm	----	-	-		----	Not Authorised	----	Not Authorised	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.4	9.1	9.4	7.9	9.0
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		100	206	483	3780	1260
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		17.8	21.2	17.0	15.6	14.2
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Silt (2-60 µm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Sand (0.06-2.00 mm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Gravel (>2mm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Cobbles (>6cm)	----	-	-		----	Not Authorised	----	Not Authorised	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		17.2	6.6	30.9	137	3.5
Exchangeable Magnesium	----	0.1	meq/100g		3.2	1.7	8.6	5.3	2.2
Exchangeable Potassium	----	0.1	meq/100g		0.6	<0.1	0.2	0.2	<0.1
Exchangeable Sodium	----	0.1	meq/100g		0.3	0.8	4.1	1.2	2.1
Cation Exchange Capacity	----	0.1	meq/100g		21.3	9.1	43.8	144	7.8
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		260	----	----	----	----
ED040S : Soluble Sulfate by ICPAES									

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 01 0-100mm	Site 01 200-300mm	Site 01 500-600mm	Site 01 800-900mm	Site 01 1000-1100mm
				Client sampling date / time: 22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00	22-JUL-2013 15:00
				EB1318018-001	EB1318018-002	EB1318018-003	EB1318018-004	EB1318018-005
ED040S : Soluble Sulfate by ICPAES - Continued								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	**230**	**13800**	**1340**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	**30**	**140**	**930**	**1140**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	----	----	----	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	----	----	----	----
Iron	7439-89-6	1.00	mg/kg	**17.6**	----	----	----	----
Manganese	7439-96-5	1.00	mg/kg	**31.8**	----	----	----	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**20**	----	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
Sodium	7440-23-5	10	mg/kg	**100**	----	----	----	----
Potassium	7440-09-7	10	mg/kg	**20**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1000**	----	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**1.37**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Site 07 0-100mm	Site 07 200-300mm	Site 07 500-600mm	Site 07 800-900mm	Site 07 1000-1100mm
				Client sampling date / time	23-JUL-2013 15:00	23-JUL-2013 15:00	23-JUL-2013 15:00	23-JUL-2013 15:00	23-JUL-2013 15:00
Compound	CAS Number	LOR	Unit		EB1318018-006	EB1318018-007	EB1318018-008	EB1318018-009	EB1318018-010
EA150: Particle Sizing									
+75µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+150µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+300µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+425µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+600µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+1180µm	----	-	-		----	Not Authorised	----	Not Authorised	----
+2.36mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+4.75mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+9.5mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+19.0mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+37.5mm	----	-	-		----	Not Authorised	----	Not Authorised	----
+75.0mm	----	-	-		----	Not Authorised	----	Not Authorised	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.0	8.6	8.8	8.5	8.4
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		101	140	317	735	854
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		28.0	24.0	20.3	17.9	18.6
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Silt (2-60 µm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Sand (0.06-2.00 mm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Gravel (>2mm)	----	-	-		----	Not Authorised	----	Not Authorised	----
Cobbles (>6cm)	----	-	-		----	Not Authorised	----	Not Authorised	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		6.2	19.0	5.9	4.6	5.2
Exchangeable Magnesium	----	0.1	meq/100g		2.7	8.3	3.5	3.4	3.8
Exchangeable Potassium	----	0.1	meq/100g		0.3	0.2	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g		0.1	0.9	1.0	1.4	1.5
Cation Exchange Capacity	----	0.1	meq/100g		9.4	28.4	10.4	9.6	10.5
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		290	----	----	----	----
ED040S : Soluble Sulfate by ICPAES									

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 07 0-100mm Client sampling date / time: 23-JUL-2013 15:00 EB1318018-006	Site 07 200-300mm 23-JUL-2013 15:00 EB1318018-007	Site 07 500-600mm 23-JUL-2013 15:00 EB1318018-008	Site 07 800-900mm 23-JUL-2013 15:00 EB1318018-009	Site 07 1000-1100mm 23-JUL-2013 15:00 EB1318018-010
ED040S : Soluble Sulfate by ICPAES - Continued								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	**20**	**20**	**20**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	**30**	**290**	**1170**	**1540**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	----	----	----	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	**1.54**	----	----	----	----
Iron	7439-89-6	1.00	mg/kg	**33.8**	----	----	----	----
Manganese	7439-96-5	1.00	mg/kg	**28.1**	----	----	----	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**30**	----	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
Sodium	7440-23-5	10	mg/kg	**80**	----	----	----	----
Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1990**	----	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**16**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**2.95**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 17 0-100mm	Site 17 200-300mm	Site 17 500-600mm	Site 11 0-100mm	Site 11 200-300mm
Client sampling date / time				24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00
				EB1318018-011	EB1318018-012	EB1318018-013	EB1318018-014	EB1318018-015
EA150: Particle Sizing								
+75µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+150µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+300µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+425µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+600µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+1180µm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+2.36mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+4.75mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+9.5mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+19.0mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+37.5mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
+75.0mm	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.1	7.7	7.9	7.2	7.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	35	24	43	46	234
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	----	25.6	22.2	24.1	24.8
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
Silt (2-60 µm)	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
Sand (0.06-2.00 mm)	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
Gravel (>2mm)	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
Cobbles (>6cm)	----	-	-	Not Authorised	Not Authorised	----	----	Not Authorised
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	19.6	7.0	8.8	4.2	4.1
Exchangeable Magnesium	----	0.1	meq/100g	7.6	2.7	3.5	3.0	2.7
Exchangeable Potassium	----	0.1	meq/100g	1.2	<0.1	<0.1	0.3	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.6	1.6
Cation Exchange Capacity	----	0.1	meq/100g	28.5	9.9	12.5	8.1	8.4
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	550	----	----	390	----
ED040S : Soluble Sulfate by ICPAES								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 17 0-100mm	Site 17 200-300mm	Site 17 500-600mm	Site 11 0-100mm	Site 11 200-300mm
				Client sampling date / time: 24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00
				EB1318018-011	EB1318018-012	EB1318018-013	EB1318018-014	EB1318018-015
ED040S : Soluble Sulfate by ICPAES - Continued								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<50	<10	<10	<10	**50**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	**30**	**190**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	----	----	<0.2	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	**1.33**	----	----	**2.05**	----
Iron	7439-89-6	1.00	mg/kg	**60.4**	----	----	**68.6**	----
Manganese	7439-96-5	1.00	mg/kg	**69.9**	----	----	**151**	----
Zinc	7440-66-6	1.00	mg/kg	**1.05**	----	----	<1.00	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<50	----	----	<10	----
Magnesium	7439-95-4	10	mg/kg	<50	----	----	<10	----
Sodium	7440-23-5	10	mg/kg	<50	----	----	**30**	----
Potassium	7440-09-7	10	mg/kg	<50	----	----	<10	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1310**	----	----	**1780**	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**127**	----	----	**10**	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**1.73**	----	----	**2.70**	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 11 500-600mm	Site 11 800-900mm	Site 11 1000-1100mm	Site 13 0-100mm	Site 13 200-300mm
				Client sampling date / time: 24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00
				EB1318018-016	EB1318018-017	EB1318018-018	EB1318018-019	EB1318018-020
EA150: Particle Sizing								
+75µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+150µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+300µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+425µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+600µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+1180µm	----	-	-	----	Not Authorised	----	----	Not Authorised
+2.36mm	----	-	-	----	Not Authorised	----	----	Not Authorised
+4.75mm	----	-	-	----	Not Authorised	----	----	Not Authorised
+9.5mm	----	-	-	----	Not Authorised	----	----	Not Authorised
+19.0mm	----	-	-	----	Not Authorised	----	----	Not Authorised
+37.5mm	----	-	-	----	Not Authorised	----	----	Not Authorised
+75.0mm	----	-	-	----	Not Authorised	----	----	Not Authorised
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.6	7.8	8.6	8.5	8.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	1300	3010	1330	156	211
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	19.9	19.2	22.1	25.5	26.3
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	-	-	----	Not Authorised	----	----	Not Authorised
Silt (2-60 µm)	----	-	-	----	Not Authorised	----	----	Not Authorised
Sand (0.06-2.00 mm)	----	-	-	----	Not Authorised	----	----	Not Authorised
Gravel (>2mm)	----	-	-	----	Not Authorised	----	----	Not Authorised
Cobbles (>6cm)	----	-	-	----	Not Authorised	----	----	Not Authorised
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.2	3.5	3.5	9.7	5.9
Exchangeable Magnesium	----	0.1	meq/100g	3.3	2.8	3.2	2.9	2.6
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.1	0.3	<0.1
Exchangeable Sodium	----	0.1	meq/100g	2.2	1.4	2.0	0.3	1.3
Cation Exchange Capacity	----	0.1	meq/100g	9.8	7.8	8.8	13.2	9.8
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	----	----	----	220	----
ED040S : Soluble Sulfate by ICPAES								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Site 11 500-600mm	Site 11 800-900mm	Site 11 1000-1100mm	Site 13 0-100mm	Site 13 200-300mm
				Client sampling date / time	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00
Compound	CAS Number	LOR	Unit		EB1318018-016	EB1318018-017	EB1318018-018	EB1318018-019	EB1318018-020
ED040S : Soluble Sulfate by ICPAES - Continued									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		900	8050	940	<10	<10
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	10	mg/kg		1820	2100	2040	10	20
ED091 : Calcium Chloride Extractable Boron									
Boron	7440-42-8	0.2	mg/kg		----	----	----	<0.2	----
ED092: DTPA Extractable Metals									
Copper	7440-50-8	1.00	mg/kg		----	----	----	<1.00	----
Iron	7439-89-6	1.00	mg/kg		----	----	----	19.5	----
Manganese	7439-96-5	1.00	mg/kg		----	----	----	21.1	----
Zinc	7440-66-6	1.00	mg/kg		----	----	----	<1.00	----
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		----	----	----	30	----
Magnesium	7439-95-4	10	mg/kg		----	----	----	<10	----
Sodium	7440-23-5	10	mg/kg		----	----	----	180	----
Potassium	7440-09-7	10	mg/kg		----	----	----	<10	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	----	1360	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	2	mg/kg		----	----	----	26	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		----	----	----	1.87	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 13 500-600mm Client sampling date / time: 24-JUL-2013 15:00 EB1318018-021	Site 13 800-900mm 24-JUL-2013 15:00 EB1318018-022	Site 13 1000-1100mm 24-JUL-2013 15:00 EB1318018-023	Site 03 0-100mm 25-JUL-2013 15:00 EB1318018-024	Site 03 200-300mm 25-JUL-2013 15:00 EB1318018-025
EA150: Particle Sizing								
+75µm	----	-	-	----	Not Authorised	----	----	----
+150µm	----	-	-	----	Not Authorised	----	----	----
+300µm	----	-	-	----	Not Authorised	----	----	----
+425µm	----	-	-	----	Not Authorised	----	----	----
+600µm	----	-	-	----	Not Authorised	----	----	----
+1180µm	----	-	-	----	Not Authorised	----	----	----
+2.36mm	----	-	-	----	Not Authorised	----	----	----
+4.75mm	----	-	-	----	Not Authorised	----	----	----
+9.5mm	----	-	-	----	Not Authorised	----	----	----
+19.0mm	----	-	-	----	Not Authorised	----	----	----
+37.5mm	----	-	-	----	Not Authorised	----	----	----
+75.0mm	----	-	-	----	Not Authorised	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	9.0	9.1	9.2	6.9	7.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	510	890	926	37	106
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	20.6	19.9	19.0	26.2	15.7
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	-	-	----	Not Authorised	----	----	----
Silt (2-60 µm)	----	-	-	----	Not Authorised	----	----	----
Sand (0.06-2.00 mm)	----	-	-	----	Not Authorised	----	----	----
Gravel (>2mm)	----	-	-	----	Not Authorised	----	----	----
Cobbles (>6cm)	----	-	-	----	Not Authorised	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	-	-	Not Authorised	----	----	----	----
Exchangeable Calcium	----	0.1	meq/100g	----	17.3	3.9	13.4	4.0
Exchangeable Magnesium	----	-	-	Not Authorised	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	5.4	3.5	7.7	2.7
Exchangeable Potassium	----	-	-	Not Authorised	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	0.1	0.1	1.2	<0.1
Exchangeable Sodium	----	-	-	Not Authorised	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	2.8	2.6	0.3	0.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Site 13 500-600mm	Site 13 800-900mm	Site 13 1000-1100mm	Site 03 0-100mm	Site 03 200-300mm
				Client sampling date / time	24-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00	25-JUL-2013 15:00	25-JUL-2013 15:00
Compound	CAS Number	LOR	Unit		EB1318018-021	EB1318018-022	EB1318018-023	EB1318018-024	EB1318018-025
ED008: Exchangeable Cations - Continued									
Cation Exchange Capacity	----	-	-		Not Authorised	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g		----	25.5	10.1	22.5	7.5
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		----	----	----	590	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		60	370	450	<10	10
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	10	mg/kg		170	440	560	10	90
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	----	2200	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	2	mg/kg		----	----	----	17	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		----	----	----	3.40	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 03 500-600mm	Site 03 800-900mm	Site 03 1000-1100mm	Site 04 0-100mm	Site 04 200-300mm
				Client sampling date / time: 25-JUL-2013 15:00	25-JUL-2013 15:00	25-JUL-2013 15:00	25-JUL-2013 15:00	25-JUL-2013 15:00
				EB1318018-026	EB1318018-027	EB1318018-028	EB1318018-029	EB1318018-030
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.2	8.2	7.8	8.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	545	978	1190	45	70
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.4	15.1	16.4	33.8	31.2
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.1	5.5	4.7	9.0	23.6
Exchangeable Magnesium	----	0.1	meq/100g	4.4	4.3	3.5	6.7	16.3
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.1	0.3	0.7
Exchangeable Sodium	----	0.1	meq/100g	1.4	1.2	1.0	0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g	12.1	11.1	9.4	16.1	40.8
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	----	----	----	<200	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	160	490	730	<10	<10
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	810	1420	1690	<10	<10
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	1200	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	----	----	----	17	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	----	----	----	2.54	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Site 04 500-600mm	Site 04 800-900mm	Site 04 1000-1100mm	Site 08 0-100mm	Site 08 200-300mm
				Client sampling date / time	25-JUL-2013 15:00	25-JUL-2013 15:00	25-JUL-2013 15:00	23-JUL-2013 15:00	23-JUL-2013 15:00
Compound	CAS Number	LOR	Unit		EB1318018-031	EB1318018-032	EB1318018-033	EB1318018-034	EB1318018-035
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.5	8.6	6.6	6.5	7.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		196	216	258	60	61
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		30.6	28.0	26.0	27.0	19.8
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		15.3	24.8	21.6	6.1	13.0
Exchangeable Magnesium	----	0.1	meq/100g		10.2	14.8	16.9	3.3	7.0
Exchangeable Potassium	----	0.1	meq/100g		0.3	0.3	0.4	0.3	0.4
Exchangeable Sodium	----	0.1	meq/100g		0.2	0.4	0.6	0.4	1.0
Cation Exchange Capacity	----	0.1	meq/100g		26.1	40.3	39.6	10.2	21.4
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		----	----	----	400	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		20	40	40	30	20
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	10	mg/kg		<10	<10	<10	30	30
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	----	5110	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	2	mg/kg		----	----	----	28	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		----	----	----	4.55	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID: Site 08 500-600mm	Site 08 800-900mm	Site 08 1000-1100mm	Site 15 0-100mm	Site 15 200-300mm
			Client sampling date / time	23-JUL-2013 15:00	23-JUL-2013 15:00	23-JUL-2013 15:00	24-JUL-2013 15:00	24-JUL-2013 15:00
				EB1318018-036	EB1318018-037	EB1318018-038	EB1318018-039	EB1318018-040
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.4	7.6	8.5	6.7	7.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	533	3870	1280	22	26
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	19.8	23.6	19.0	25.3	25.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.8	6.7	26.2	20.1	8.2
Exchangeable Magnesium	----	0.1	meq/100g	3.1	3.0	12.3	5.3	1.9
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.5	1.1	0.2
Exchangeable Sodium	----	0.1	meq/100g	1.6	0.9	4.0	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	9.6	10.8	43.0	26.5	10.4
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	----	----	----	450	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	310	14400	1020	<10	<10
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	580	1650	1620	<10	<10
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	1750	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	----	----	----	157	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	----	----	----	2.05	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Site 15 500-600mm	Site 10 1000-1100mm	Site 06 500-600mm	----	----
			Client sampling date / time	24-JUL-2013 15:00	24-JUL-2013 15:00	23-JUL-2013 15:00	----	----
Compound	CAS Number	LOR	Unit	EB1318018-041	EB1318018-042	EB1318018-043	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.2	8.6	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	21	1220	----	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	25.2	24.8	19.0	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	31.9	3.6	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	4.8	2.6	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.1	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	2.0	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	37.2	8.5	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	570	1180	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	2240	3060	----	----

Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1318018**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: MR JEREMY WICKS	Contact	: Customer Services
Address	: 32 CORDELIA STREET SOUTH BRISBANE QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: jwicks@globalskm.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3026 7526	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: NAC Supplementary Soil Survey QE06644 033	Page	: 1 of 4
Order number	: ----		
C-O-C number	: ----	Quote number	: EM2013SINKNI0402 (EN/003/13)
Site	: ----		
Sampler	: K Bromn / I Kelder	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 26-JUL-2013	Issue Date	: 27-JUL-2013 16:04
Client Requested Due Date	: 02-AUG-2013	Scheduled Reporting Date	: **02-AUG-2013**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 20.9°C 18.9°C 19.3°C
No. of coolers/boxes	: 3 MEDIUM	No. of samples received	: 43
Security Seal	: Intact.	No. of samples analysed	: 43

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- **Please be advised that ALS does not offer analysis for Chloride and Molybdenum using DTPA extraction.**
- **Particle Size Distribution will be conducted at ALS Newcastle. The expected due date for this data is 11/08/2013.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane and ALS Newcastle.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Any sample identifications that cannot be displayed entirely in the analysis summary table will be listed below.

EB1318018-005	: 22-JUL-2013 15:00	: Site 01 - 1000-1100mm
EB1318018-010	: 23-JUL-2013 15:00	: Site 07 - 1000-1100mm
EB1318018-018	: 24-JUL-2013 15:00	: Site 11 - 1000-1100mm
EB1318018-023	: 24-JUL-2013 15:00	: Site 13 - 1000-1100mm
EB1318018-028	: 25-JUL-2013 15:00	: Site 03 - 1000-1100mm
EB1318018-033	: 25-JUL-2013 15:00	: Site 04 - 1000-1100mm
EB1318018-038	: 23-JUL-2013 15:00	: Site 08 - 1000-1100mm
EB1318018-042	: 24-JUL-2013 15:00	: Site 10 - 1000-1100mm

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA150H Particle Sizing by Hydrometer	SOIL - ED008 Def Exchangeable Cations with pre-treatment Default	SOIL - ED021 Bicarbonate Extractable K (Colwell)	SOIL - ED091 Calcium Chloride Extractable Boron	SOIL - ED092 DTPA Extractable Metals	SOIL - EK061G (Solids) Total Kjeldahl Nitrogen as N (TKN) By Discrete	SOIL - EK080 Bicarbonate Extractable P (Colwell)	SOIL - EP003 Total Organic Carbon (TOC) in Soil
EB1318018-001	22-JUL-2013 15:00	Site 01 0-100mm		✓	✓	✓	✓	✓	✓	✓
EB1318018-002	22-JUL-2013 15:00	Site 01 200-300mm	✓	✓						
EB1318018-003	22-JUL-2013 15:00	Site 01 500-600mm		✓						
EB1318018-004	22-JUL-2013 15:00	Site 01 800-900mm	✓	✓						
EB1318018-005	22-JUL-2013 15:00	Site 01 1000-1100mm		✓						
EB1318018-006	23-JUL-2013 15:00	Site 07 0-100mm		✓	✓	✓	✓	✓	✓	✓
EB1318018-007	23-JUL-2013 15:00	Site 07 200-300mm	✓	✓						
EB1318018-008	23-JUL-2013 15:00	Site 07 500-600mm		✓						
EB1318018-009	23-JUL-2013 15:00	Site 07 800-900mm	✓	✓						
EB1318018-010	23-JUL-2013 15:00	Site 07 1000-1100mm		✓						
EB1318018-011	24-JUL-2013 15:00	Site 17 0-100mm	✓	✓	✓	✓	✓	✓	✓	✓
EB1318018-012	24-JUL-2013 15:00	Site 17 200-300mm	✓	✓						
EB1318018-013	24-JUL-2013 15:00	Site 17 500-600mm		✓						
EB1318018-014	24-JUL-2013 15:00	Site 11 0-100mm		✓	✓	✓	✓	✓	✓	✓
EB1318018-015	24-JUL-2013 15:00	Site 11 200-300mm	✓	✓						
EB1318018-016	24-JUL-2013 15:00	Site 11 500-600mm		✓						
EB1318018-017	24-JUL-2013 15:00	Site 11 800-900mm	✓	✓						
EB1318018-018	24-JUL-2013 15:00	Site 11 1000-1100mm		✓						
EB1318018-019	24-JUL-2013 15:00	Site 13 0-100mm		✓	✓	✓	✓	✓	✓	✓
EB1318018-020	24-JUL-2013 15:00	Site 13 200-300mm	✓	✓						
EB1318018-021	24-JUL-2013 15:00	Site 13 500-600mm		✓						
EB1318018-022	24-JUL-2013 15:00	Site 13 800-900mm	✓	✓						
EB1318018-023	24-JUL-2013 15:00	Site 13 1000-1100mm		✓						
EB1318018-024	25-JUL-2013 15:00	Site 03 0-100mm		✓	✓			✓	✓	✓
EB1318018-025	25-JUL-2013 15:00	Site 03 200-300mm		✓						
EB1318018-026	25-JUL-2013 15:00	Site 03 500-600mm		✓						
EB1318018-027	25-JUL-2013 15:00	Site 03 800-900mm		✓						
EB1318018-028	25-JUL-2013 15:00	Site 03 1000-1100mm		✓						

			SOIL - EA150H Particle Sizing by Hydrometer	SOIL - ED008 Def Exchangeable Cations with pre-treatment Default	SOIL - ED021 Bicarbonate Extractable K (Colwell)	SOIL - ED091 Calcium Chloride Extractable Boron	SOIL - ED092 DTPA Extractable Metals	SOIL - EK061G (Solids) Total Kjeldahl Nitrogen as N (TKN) By Discrete	SOIL - EK080 Bicarbonate Extractable P (Colwell)	SOIL - EP003 Total Organic Carbon (TOC) in Soil
EB1318018-029	25-JUL-2013 15:00	Site 04 0-100mm		✓	✓			✓	✓	✓
EB1318018-030	25-JUL-2013 15:00	Site 04 200-300mm		✓						
EB1318018-031	25-JUL-2013 15:00	Site 04 500-600mm		✓						
EB1318018-032	25-JUL-2013 15:00	Site 04 800-900mm		✓						
EB1318018-033	25-JUL-2013 15:00	Site 04 1000-1100mm		✓						
EB1318018-034	23-JUL-2013 15:00	Site 08 0-100mm		✓	✓			✓	✓	✓
EB1318018-035	23-JUL-2013 15:00	Site 08 200-300mm		✓						
EB1318018-036	23-JUL-2013 15:00	Site 08 500-600mm		✓						
EB1318018-037	23-JUL-2013 15:00	Site 08 800-900mm		✓						
EB1318018-038	23-JUL-2013 15:00	Site 08 1000-1100mm		✓						
EB1318018-039	24-JUL-2013 15:00	Site 15 0-100mm		✓	✓			✓	✓	✓
EB1318018-040	24-JUL-2013 15:00	Site 15 200-300mm		✓						
EB1318018-041	24-JUL-2013 15:00	Site 15 500-600mm		✓						
EB1318018-042	24-JUL-2013 15:00	Site 10 1000-1100mm		✓						

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - IN-4S pH plus EC (1:5)	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1318018-001	22-JUL-2013 15:00	Site 01 0-100mm	✓	✓	✓
EB1318018-002	22-JUL-2013 15:00	Site 01 200-300mm	✓		✓
EB1318018-003	22-JUL-2013 15:00	Site 01 500-600mm	✓		✓
EB1318018-004	22-JUL-2013 15:00	Site 01 800-900mm	✓		✓
EB1318018-005	22-JUL-2013 15:00	Site 01 1000-1100mm	✓		✓
EB1318018-006	23-JUL-2013 15:00	Site 07 0-100mm	✓	✓	✓
EB1318018-007	23-JUL-2013 15:00	Site 07 200-300mm	✓		✓
EB1318018-008	23-JUL-2013 15:00	Site 07 500-600mm	✓		✓
EB1318018-009	23-JUL-2013 15:00	Site 07 800-900mm	✓		✓
EB1318018-010	23-JUL-2013 15:00	Site 07 1000-1100mm	✓		✓
EB1318018-011	24-JUL-2013 15:00	Site 17 0-100mm	✓	✓	✓
EB1318018-012	24-JUL-2013 15:00	Site 17 200-300mm	✓		✓
EB1318018-013	24-JUL-2013 15:00	Site 17 500-600mm	✓		✓
EB1318018-014	24-JUL-2013 15:00	Site 11 0-100mm	✓	✓	✓
EB1318018-015	24-JUL-2013 15:00	Site 11 200-300mm	✓		✓
EB1318018-016	24-JUL-2013 15:00	Site 11 500-600mm	✓		✓

			SOIL - IN-4S pH plus EC (1:5)	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1318018-017	24-JUL-2013 15:00	Site 11 800-900mm	✓		✓
EB1318018-018	24-JUL-2013 15:00	Site 11 1000-1100mm	✓		✓
EB1318018-019	24-JUL-2013 15:00	Site 13 0-100mm	✓	✓	✓
EB1318018-020	24-JUL-2013 15:00	Site 13 200-300mm	✓		✓
EB1318018-021	24-JUL-2013 15:00	Site 13 500-600mm	✓		✓
EB1318018-022	24-JUL-2013 15:00	Site 13 800-900mm	✓		✓
EB1318018-023	24-JUL-2013 15:00	Site 13 1000-1100mm	✓		✓
EB1318018-024	25-JUL-2013 15:00	Site 03 0-100mm	✓		✓
EB1318018-025	25-JUL-2013 15:00	Site 03 200-300mm	✓		✓
EB1318018-026	25-JUL-2013 15:00	Site 03 500-600mm	✓		✓
EB1318018-027	25-JUL-2013 15:00	Site 03 800-900mm	✓		✓
EB1318018-028	25-JUL-2013 15:00	Site 03 1000-1100mm	✓		✓
EB1318018-029	25-JUL-2013 15:00	Site 04 0-100mm	✓		✓
EB1318018-030	25-JUL-2013 15:00	Site 04 200-300mm	✓		✓
EB1318018-031	25-JUL-2013 15:00	Site 04 500-600mm	✓		✓
EB1318018-032	25-JUL-2013 15:00	Site 04 800-900mm	✓		✓
EB1318018-033	25-JUL-2013 15:00	Site 04 1000-1100mm	✓		✓
EB1318018-034	23-JUL-2013 15:00	Site 08 0-100mm	✓		✓
EB1318018-035	23-JUL-2013 15:00	Site 08 200-300mm	✓		✓
EB1318018-036	23-JUL-2013 15:00	Site 08 500-600mm	✓		✓
EB1318018-037	23-JUL-2013 15:00	Site 08 800-900mm	✓		✓
EB1318018-038	23-JUL-2013 15:00	Site 08 1000-1100mm	✓		✓
EB1318018-039	24-JUL-2013 15:00	Site 15 0-100mm	✓		✓
EB1318018-040	24-JUL-2013 15:00	Site 15 200-300mm	✓		✓
EB1318018-041	24-JUL-2013 15:00	Site 15 500-600mm	✓		✓
EB1318018-042	24-JUL-2013 15:00	Site 10 1000-1100mm	✓		✓
EB1318018-043	23-JUL-2013 15:00	Site 06 500-600mm			✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MR JEREMY WICKS

- *AU Certificate of Analysis - NATA (COA)	Email	jwicks@globalskm.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	jwicks@globalskm.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	jwicks@globalskm.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	jwicks@globalskm.com
- A4 - AU Tax Invoice (INV)	Email	jwicks@globalskm.com
- Attachment - Report (SUBCO)	Email	jwicks@globalskm.com
- Chain of Custody (CoC) (COC)	Email	jwicks@globalskm.com
- EDI Format - ENMRG (ENMRG)	Email	jwicks@globalskm.com
- EDI Format - ESDAT (ESDAT)	Email	jwicks@globalskm.com
- EDI Format - XTab (XTAB)	Email	jwicks@globalskm.com

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
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☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: SKM Global	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: South Brisbane		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT: NAC Supplementary Soil Survey QE06644.033	**ALS QUOTE NO:**	**COC SEQUENCE NUMBER (Circle)**	Free Ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: (1) 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Jeremy Wicks	**CONTACT PH: 0419 029 509**	OF: 1 2 3 4 (5) 6 7	Other comment:
SAMPLER: Katharine Brown/ Isaac Kelder	**SAMPLER MOBILE: 0400 197 312/ 0427 843 685**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	*Isaac Kelder*	0700 29
Email Reports to (will default to PM if no other addresses are listed): JWicks@globalskm.com/ IKelder@globalskm.com		DATE/TIME: 26/07/13	DATE/TIME: 26/07/13 10:15
Email Invoice to (will default to PM if no other addresses are listed): JWicks@globalskm.com		**RELINQUISHED BY:** DATE/TIME:	**RECEIVED BY:** DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).														Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	pHw and ECw (IN-4S)		Exchangeable Cations + ECEC (ED008)		Major Anions SO_4^{2-} & Cl^- (NT-2S)		OM, OC, CO_3^{2-} (EP003)	Total Nitrogen as N (EK061)	Colwell Bicarb Extractable P (EK080)	Colwell Bicarb Extractable K (ED021)	Major Cations Soluble Ca, Mg, K, Na (NT-1S)		Micronutrients (B, Cu, Fe, Cl, Mn, Mo, Zn)		Particle Sizing (Hydrometer)	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	Site 01 0-100 mm	22/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x	x		x			
2	Site 01 200-300 mm	22/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x	
3	Site 01 500-600 mm	22/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											**If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)**
4	Site 01 800-900 mm	22/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x	
5	Site 01 1000-1100 mm	22/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
6	Site 07 0-100 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x	x		x			
7	Site 07 200-300 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x	
8	Site 07 500-600 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
9	Site 07 800-900 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x	
10	Site 07 1000-1100 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
				TOTAL	20	10		10		10		2	2	2	2	2		2		4	

Environmental Division Brisbane

Work Order

EB1318018

Telephone : +61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
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CLIENT: SKM Global	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: South Brisbane		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT: NAC Supplementary Soil Survey QE06644.033	**ALS QUOTE NO:**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 (2) 3 4 5 6 7	Random Sample Temperature on Receipt °C
PROJECT MANAGER: Jeremy Wicks	**CONTACT PH: 0419 029 509**	OF: 1 2 3 4 (5) 6 7	Other comment:

SAMPLER: Katharine Brown/ Isaac Kelder	**SAMPLER MOBILE: 0400 197 312/ 0427 843 685**	**RELINQUISHED BY:**	**RECEIVED BY:**	**RELINQUISHED BY:** / **RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	*Isaac Kelder*		
Email Reports to (will default to PM if no other addresses are listed): JWicks@globalskm.com/ IKelder@globalskm.com		DATE/TIME: 26/07/13	DATE/TIME:	DATE/TIME: / DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): JWicks@globalskm.com				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).															Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	pHw and ECw (IN-4S)		Exchangeable Cations + ECEC (ED008)		Major Anions SO_4^{2-} & Cl^- (NT-2S)		OM, OC, CO_3^{2-} (EP003)	Total Nitrogen as N (EK061)	Colwell Bicarb Extractable P (EK080)	Colwell Bicarb Extractable K (ED021)	Major Cations Soluble Ca, Mg, K, Na (NT-1S)		Micronutrients (B, Cu, Fe, Cl, Mn, Mo, Zn)		Particle Sizing (Hydrometer)		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
11	Site 17 0-100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x	x		x		x		
12	Site 17 200-300 mm	24/07/2013	SOIL	1 Jar	2	x		x		x										x		
13	Site 17 500-600 mm	24/07/2013	SOIL	1 Jar	2	x		x		x												**If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)**
				TOTAL	6	3		3		3		1	1	1	1	1		1		2		

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide**: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: SKM Global	**TURNAROUND REQUIREMENTS :** ☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: South Brisbane	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact?	Yes No N/A
PROJECT: NAC Supplementary Soil Survey QE06644.033	**ALS QUOTE NO:**	Free ice / frozen ice bricks present upon receipt?	Yes No N/A
ORDER NUMBER:	COC SEQUENCE NUMBER (Circle) COC: 1 2 (3) 4 5 6 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Jeremy Wicks **CONTACT PH: 0419 029 509**	OF: 1 2 3 4 (5) 6 7	Other comment:	
SAMPLER: Katharine Brown/ Isaac Kelder **SAMPLER MOBILE: 0400 197 312/ 0427 843 685**	**RELINQUISHED BY:**	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO) **EDD FORMAT (or default):**	*Isaac Kelder*			
Email Reports to (will default to PM if no other addresses are listed): JWicks@globalskm.com/ IKelder@globalskm.com	DATE/TIME: 26/07/13	DATE/TIME:	DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): JWicks@globalskm.com				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).															Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	pHw and ECw (IN-4S)		Exchangeable Cations + ECEC (ED008)		Major Anions SO_4^{2-} & Cl^- (NT-2S)		OM, OC, CO_3^{2-} (EP003)	Total Nitrogen as N (EK061)	Colwell Bicarb Extractable P (EK080)	Colwell Bicarb Extractable K (ED021)	Major Cations Soluble Ca, Mg, K, Na (NT-1S)		Micronutrients (B, Cu, Fe, Cl, Mn, Mo, Zn)		Particle Sizing (Hydrometer)		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
14	Site 11 0-100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x	x		x				
15	Site 11 200-300 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x		
16	Site 11 500-600 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												**If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)**
17	Site 11 800-900 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x		
18	Site 11 1000-1100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
19	Site 13 0-100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x	x		x				
20	Site 13 200-300 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x		
21	Site 13 500-600 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
22	Site 13 800-900 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x										x		
23	Site 13 1000-1100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
				TOTAL	20	10		10		10		2	2	2	2	2		2		4		

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

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CLIENT: SKM Global	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: South Brisbane		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
NAC Supplementary Soil Survey	**ALS QUOTE NO:**	**COC SEQUENCE NUMBER (Circle)**	Free Ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 (4) 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Jeremy Wicks	**CONTACT PH: 0419 029509**	OF: 1 2 3 4 (5) 6 7	Other comment:
SAMPLER: Katharine Brown/ Isaac Kelder	**SAMPLER MOBILE: 0400 197 312/ 0427 843 685**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	*Katharine Brown/ Isaac Kelder*	DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed): JWicks@globalskm.com/ IKelder@globalskm.com		DATE/TIME: 26/07/13	
Email Invoice to (will default to PM if no other addresses are listed): JWicks@globalskm.com			

RELINQUISHED BY:	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).														Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	pHw and ECw (IN-4S)		Exchangeable Cations + ECEC (ED008)		Major Anions SO_4^{2-} & Cl^- (NT-2S)		OM, OC, CO_3^{2-}(EP003)	Total Nitrogen as N (EK061)	Colwell Bicarb Extractable P (EK080)	Colwell Bicarb Extractable K (ED021)							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
24	Site 03 0-100 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x							
25	Site 03 200-300 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
26	Site 03 500-600 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)
27	Site 03 800-900 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
28	Site 03 1000-1100 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
29	Site 04 0-100 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x							
30	Site 04 200-300 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
31	Site 04 500-600 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)
32	Site 04 800-900 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
33	Site 04 1000-1100 mm	25/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x												
				TOTAL	20	10		10		10		2	2	2	2							

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle**: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane**: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville**: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide**: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: SKM Global	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: South Brisbane		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
NAC Supplementary Soil Survey	**ALS QUOTE NO:**	**COC SEQUENCE NUMBER (Circle)**	Free Ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 (5) 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Jeremy Wicks	**CONTACT PH:** 0419 029509	OF: 1 2 3 4 (5) 6 7	Other comment:
SAMPLER: Katharine Brown/ Isaac Kelder	**SAMPLER MOBILE:** 0400 197 312/ 0427 843 685	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	*Katharine Brown/ Isaac Kelder*	
Email Reports to (will default to PM if no other addresses are listed): JWicks@globalskm.com/ IKelder@globalskm.com		DATE/TIME: 26/07/13	DATE/TIME: 24/7/13
Email Invoice to (will default to PM if no other addresses are listed): JWicks@globalskm.com		**RELINQUISHED BY:** DATE/TIME:	**RECEIVED BY:** DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).														Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	pHw and ECw (IN-4S)		Exchangeable Cations + ECEC (ED008)		Major Anions SO_4^{2-} & Cl^- (NT-25)		OM, OC, CO_3^{2-} (EP003)	Total Nitrogen as N (EK061)	Colwell Bicarb Extractable P (EK080)	Colwell Bicarb Extractable K (ED021)						Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
34	Site 08 0-100 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x						
35	Site 08 200-300 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
36	Site 08 500-600 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)
37	Site 08 800-900 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
38	Site 08 1000-1100 mm	23/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
39	Site 15 0-100 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x		x	x	x	x						
40	Site 15 200-300 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											
41	Site 15 500-600 mm	24/07/2013	SOIL	1 Jar + 1 Bag	2	x		x		x											If sample is alkaline, please substitute Exch. Cations and ECEC method ED008 with method ED006 (for alkaline soils only)
42	Site 10 1000-1100	24/07/2013	SOIL	1 Bag	1	x		x		x											
43	Site 06 500-600 mm	23/07/2013	SOIL	1 Jar	1					x											
				TOTAL	18	9		9		10		2	2	2	2						

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Certificate of Analysis

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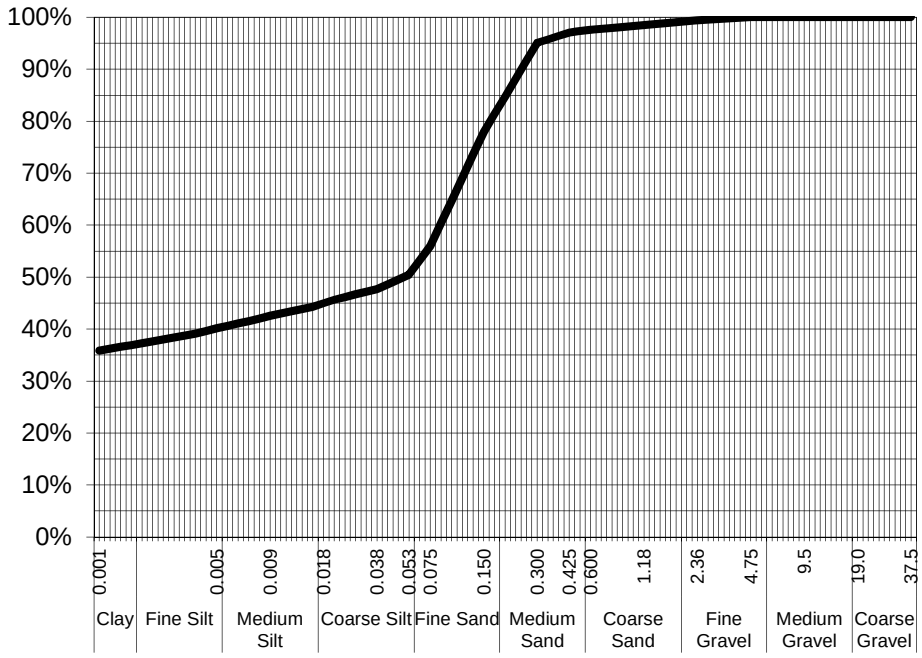
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-002 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 01 200-300mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	99%
1.18	99%
0.600	98%
0.425	97%
0.300	95%
0.150	78%
0.075	56%
Particle Size (microns)	
53	50%
38	48%
18	45%
9	43%
5	40%
3	39%
1	36%

Median Particle Size (mm)	0.051

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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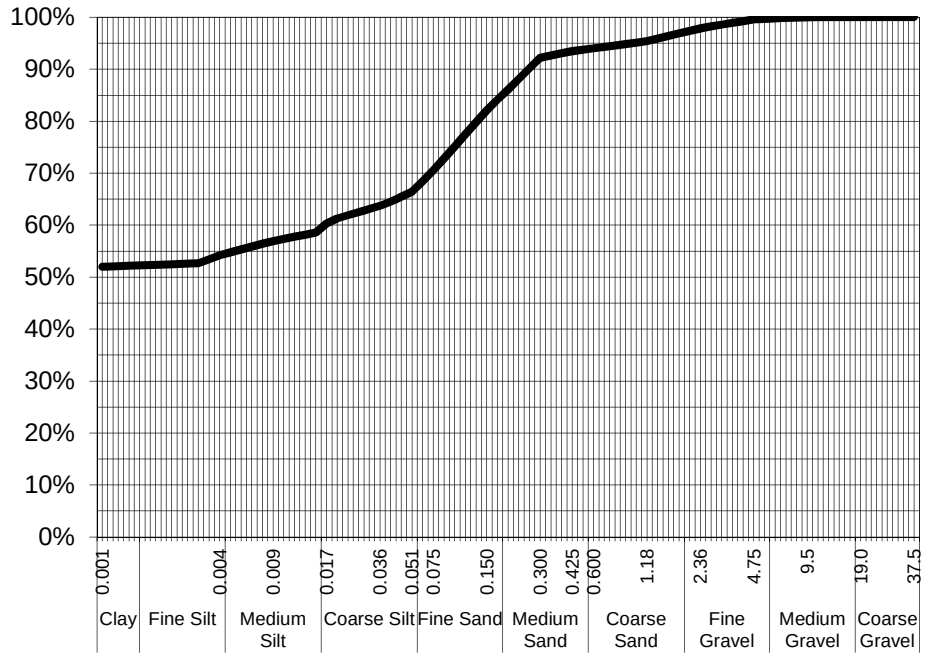
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-004 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 01 800-900mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	98%
1.18	95%
0.600	94%
0.425	94%
0.300	92%
0.150	82%
0.075	71%
Particle Size (microns)	
51	66%
36	64%
17	60%
9	57%
4	54%
3	53%
1	52%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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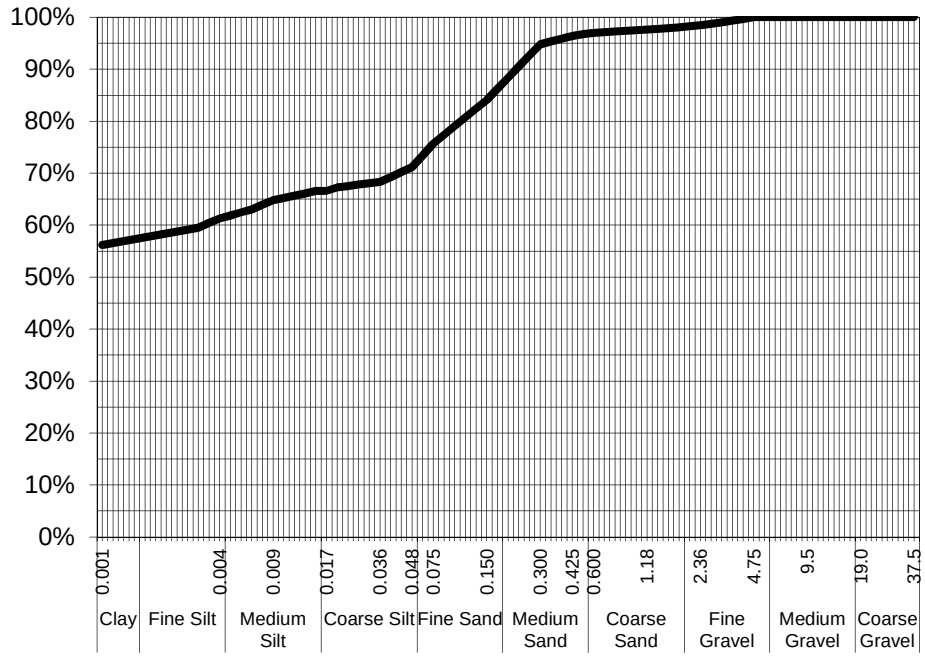
Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-007 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 07 200-300mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	98%
1.18	98%
0.600	97%
0.425	96%
0.300	95%
0.150	84%
0.075	76%
Particle Size (microns)	
48	71%
36	68%
17	67%
9	65%
4	61%
3	60%
1	56%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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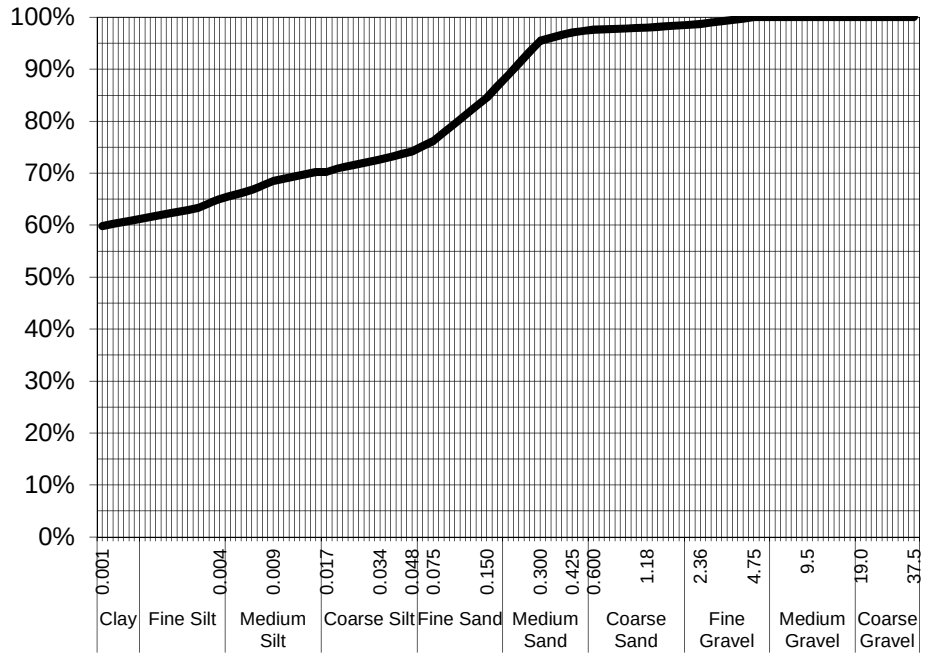
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-009 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 07 800-900mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	99%
1.18	98%
0.600	98%
0.425	97%
0.300	96%
0.150	85%
0.075	76%
Particle Size (microns)	
48	74%
34	73%
17	70%
9	68%
4	65%
3	63%
1	60%

Median Particle Size (mm)	<0.001

Samples analysed as received.

Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

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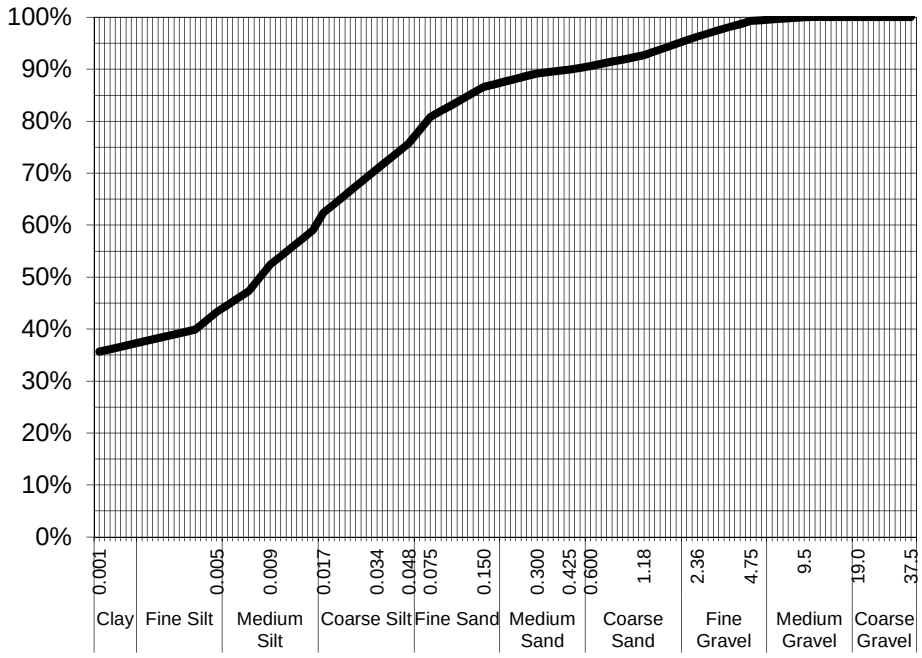
CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-011 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 17 0-100mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	99%
2.36	96%
1.18	93%
0.600	91%
0.425	90%
0.300	89%
0.150	87%
0.075	81%
Particle Size (microns)	
48	76%
34	71%
17	62%
9	52%
5	43%
3	40%
1	36%

Median Particle Size (mm)	0.009

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

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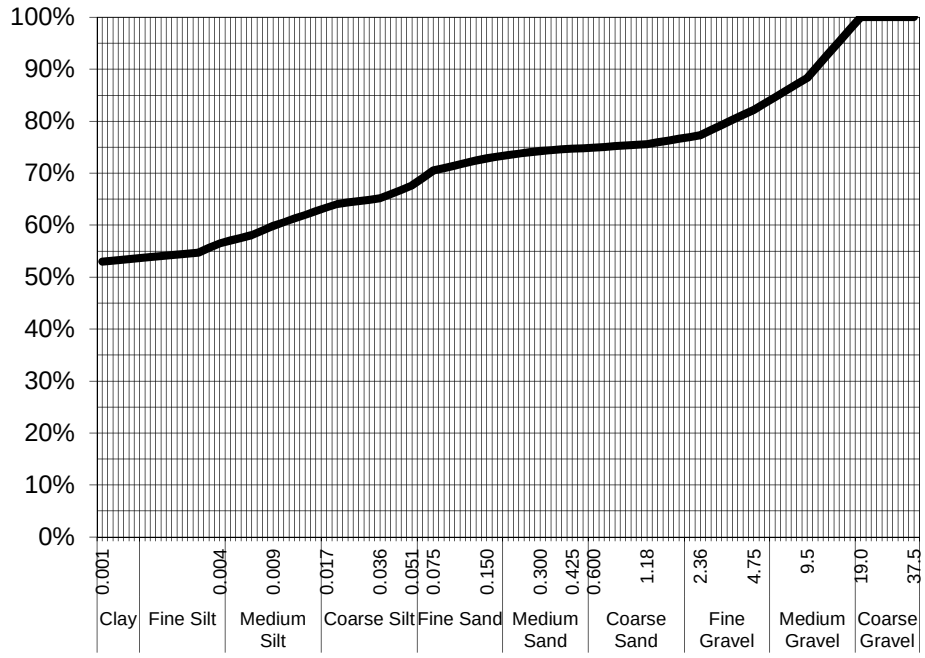
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-012 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 17 200-300mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	88%
4.75	82%
2.36	77%
1.18	76%
0.600	75%
0.425	75%
0.300	74%
0.150	73%
0.075	71%
Particle Size (microns)	
51	68%
36	65%
17	63%
9	60%
4	56%
3	55%
1	53%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and gravel

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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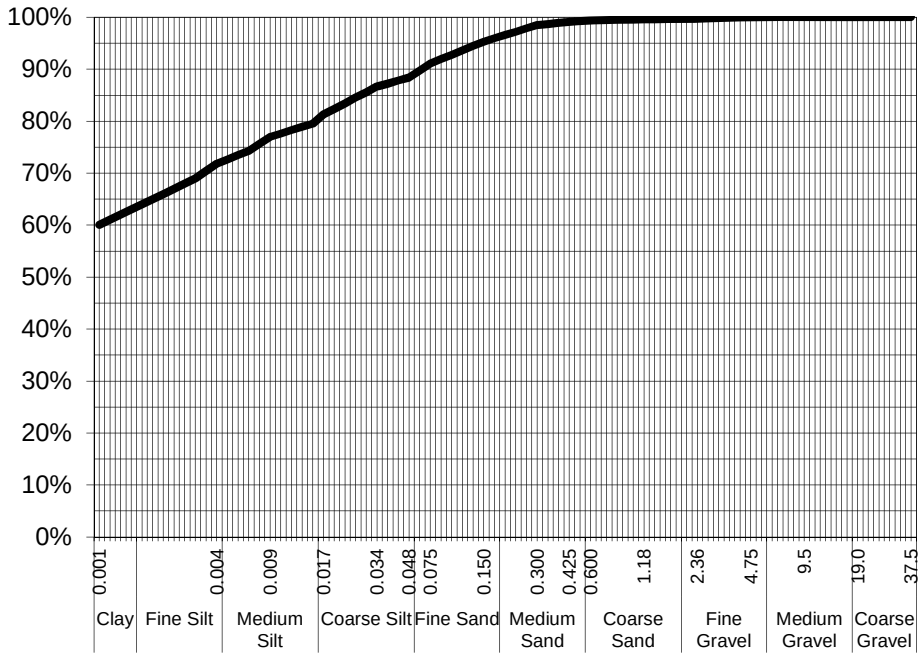
Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-015 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 11 200-300mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	99%
0.150	95%
0.075	91%
Particle Size (microns)	
48	88%
34	87%
17	81%
9	77%
4	72%
3	69%
1	60%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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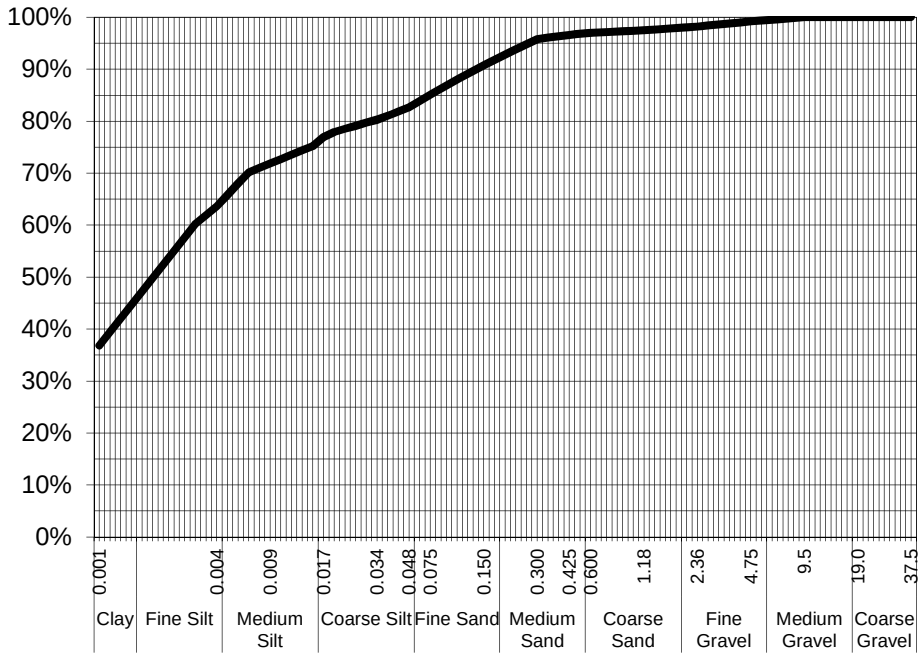
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-017 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 11 800-900mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	99%
2.36	98%
1.18	98%
0.600	97%
0.425	97%
0.300	96%
0.150	91%
0.075	85%
Particle Size (microns)	
48	83%
34	80%
17	77%
9	72%
4	64%
3	60%
1	37%

Median Particle Size (mm)	0.003

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:		**Analysed:**	1-Aug-13
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Silty clay and sand	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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NATA
WORLD RECOGNISED ACCREDITATION

Hamish Murray
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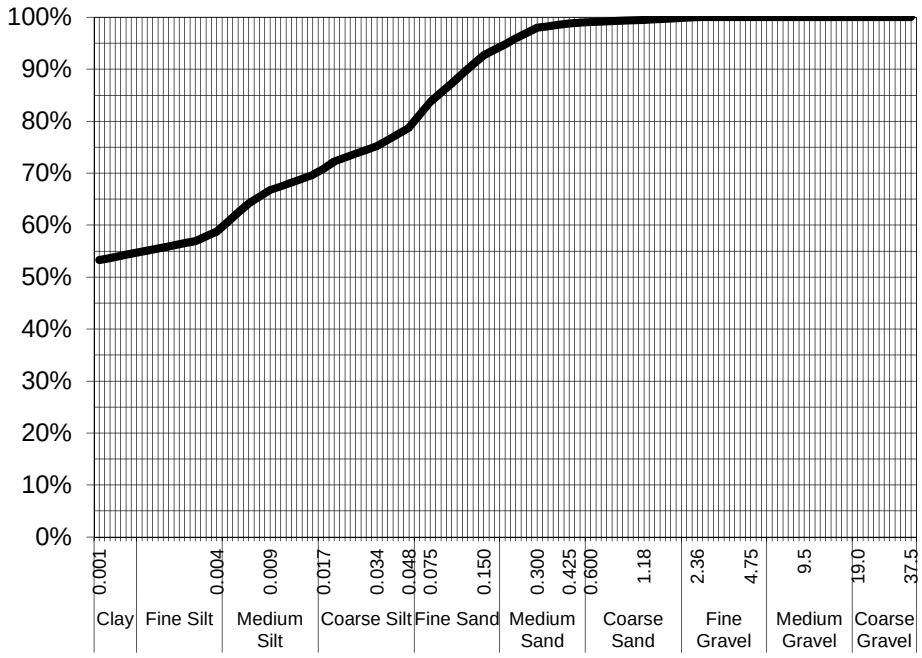
ALS Environmental

Newcastle, NSW

CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-020 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 13 200-300mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	98%
0.150	93%
0.075	84%
Particle Size (microns)	
48	79%
34	75%
17	71%
9	67%
4	59%
3	57%
1	53%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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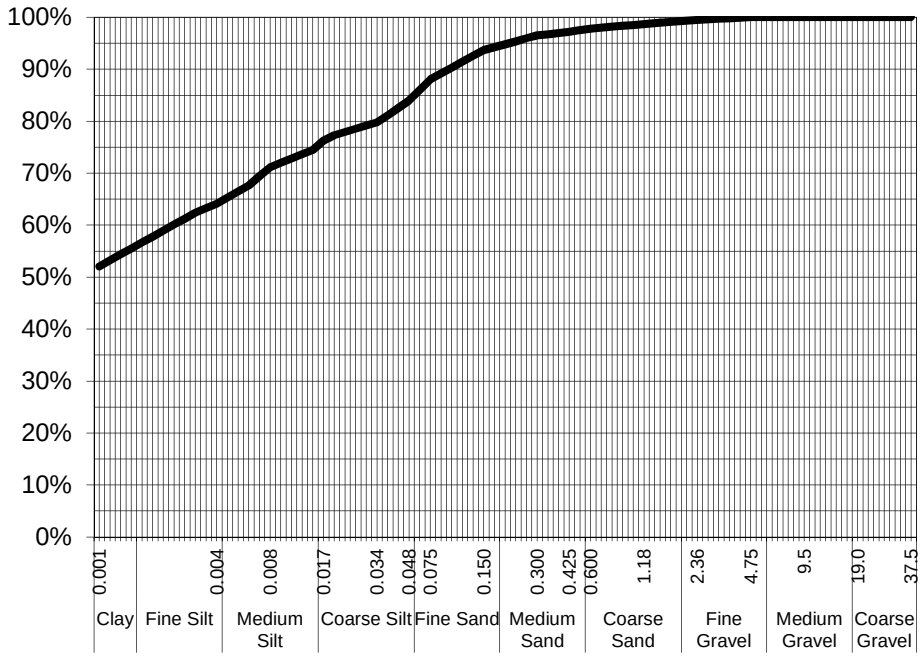
CLIENT:	Jeremy Wicks	**DATE REPORTED:**	6-Aug-2013
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	26-Jul-2013
ADDRESS:	32 Cordelia Street South Brisbane, Qld, Australia 4101	**REPORT NO:**	EB1318018-022 / PSD
PROJECT:	NAC Supplementary Soil Survey QE06644 033	**SAMPLE ID:**	Site 13 800-900mm

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	99%
0.600	98%
0.425	97%
0.300	97%
0.150	94%
0.075	88%
Particle Size (microns)	
48	84%
34	80%
17	76%
8	71%
4	64%
3	62%
1	52%

Median Particle Size (mm)	<0.001

Samples analysed as received.
Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Sample Comments:

Analysed: 1-Aug-13

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Silty clay and sand

Dispersion Method Shaker

Test Method: AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density (<2.36mm) 2.65 g/cm^3

NATA Accreditation: 825 Site: Newcastle
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Authorised Signatory

Appendix F Land Suitability Criteria

The following provides a summary of the Land Suitability Assessment Criteria outlined in the DME (1995) *Land Suitability Assessment Techniques* guidelines.

Plant Available Water Capacity

Plant available water capacity (PAWC) is a significant soil property in this locality as cropping is based on fallow storage of moisture in the soil profile. PAWC is the moisture stored in the soil profile that is available to the plant and is classically defined as the moisture present between field capacity and permanent wilting point (15 bars).

Soil water storage assessment for Land Suitability Assessment was based on estimated PAWC derived from the following surrogate values (DME 1995):

- PAWC ≥ 150mm – (considered LS Class 1 for both cropping and grazing)
    - Cracking clays **≥**900mm deep, very fine self-mulch (peds <2mm), infrequent cracking at surface, alkaline to neutral pH throughout, Chloride anion (Cl-) <600ppm (mg/kg) within 900mm of surface and Exchangeable sodium percentage (ESP) < 15 within 900mm of surface.
- PAWC 125 – 150mm - (considered LS Class 2 for cropping and LS Class 1 for grazing)
    - Cracking clays ≥900mm deep, fine self-mulch (peds 2-10mm), infrequent cracking at surface, alkaline to neutral pH throughout, Cl- <600ppm (mg/kg) within 900mm of surface and ESP < 15 within 900mm of surface.
    - Rigid soils (non sodic). Loams, clay loams, non-cracking clays, duplex soils and gradational earths with > 1250mm depth, or >1250mm to salt bulge with EC>0.9mS/cm or Cl->900ppm
- PAWC 100 –125mm - (considered LS Class 3 for cropping and LS Class 2 for grazing)
    - Cracking clays alkaline to neutral pH throughout, 600-900mm deep before either; Cl- >600ppm (mg/kg), ESP > 15. Alternately cracking clays with acid to neutral pH at depth, with salt bulge at 600-900mm with EC>0.9mS/cm or Cl->900ppm.
    - Rigid soils (non sodic). Loams, clay loams, non-cracking clays, duplex soils and gradational earths with 750- 1250mm depth, or 750-1250mm to salt bulge with EC>0.9mS/cm or Cl->900ppm
- PAWC 75 –100mm – (considered LS Class 4 for cropping and LS Class 3 for grazing)
    - Cracking clays alkaline to neutral pH throughout 400-600mm deep. Alternately cracking clays with acid to neutral pH at depth, with salt bulge at 400-600mm with EC>0.9mS/cm or Cl->900ppm.
    - Rigid soils (non sodic). Loams, clay loams, non-cracking clays, duplex soils and gradational earths with 500-750mm depth, or 500-750mm to salt bulge with EC>0.9mS/cm or Cl->900ppm
    - Sands/sandy loams <900mm deep.
    - Duplex soils with subsoil becoming sodic (ESP 6-14) within 600mm of surface but not strongly sodic (ESP ≥ 15) within 900mm of surface.
- PAWC 50 - 75mm – (considered LS Class 5 for cropping and LS Class 4 for grazing)
    - Cracking clays alkaline pH throughout, 200-400mm deep. Alternately cracking clays with acid to neutral pH at depth, with salt bulge at 200-400mm with EC>0.9mS/cm or Cl->900ppm.

- Rigid soils (non sodic). Loams, clay loams, non-cracking clays, duplex soils and gradational earths with 300-500mm depth, or 300-500mm to salt bulge with EC>0.9mS/cm or Cl->900ppm
- Sands/sandy loams 450-900mm deep.
- Duplex soils with sodic subsoil (ESP 6-14), becoming strongly sodic (ESP ≥ 15) within 600mm of surface.

- PAWC ≤50mm – (considered LS Class 5 for both cropping and grazing)
  - Cracking clays alkaline pH throughout, ≤ 200mm deep. Alternately cracking clays with acid to neutral pH at depth, with salt bulge at ≤ 200mm with EC>0.8mS/cm or Cl->800ppm.
  - Rigid soils (non sodic). Loams, clay loams, non-cracking clays, duplex soils and gradational earths with ≤300mm depth.
  - Shallow sands/sandy loams ≤450mm deep.
  - Duplex soils with strongly sodic subsoil (ESP ≤25) within 450mm of surface.

Effective rooting depth is defined as the depth to which approximately 90% of plant roots will extract water. It is normally limited either by the presence of underlying rock or other hard materials or by chemical or physical attributes within the subsoil that restrict root growth (QDPI, 1990). Field morphology observations and chemical data used included soil texture and barriers to root growth such as high sodium, gravel, poor soil structure, high electrical conductivity and chloride.

Nutrient Deficiency

The proportion of exchangeable cations within soil can be used in the assessment of physical properties. If calcium is dominant (relative to magnesium and sodium) the soil is more likely to have good physical properties, and is an important statement in land use studies.

Based on the DME (1995), primary consideration is given to Bicarbonate phosphorus (P) concentrations, with consideration also given to potassium, calcium, soil depth and pH. Soils with bicarbonate P concentrations greater than 10ppm are generally considered to be fertile soils; land suitability LS Class 1 for cropping and LS Class 1 or 2 (depending on native vegetation type) for grazing land uses.

Salinity

This refers to the reduction in dry matter yield as a result of soluble salt (usually influenced by chloride concentration and measured by electrical conductivity) in the soil profile. It also contributes to reduced water availability limitation.

Salinity in the context of this assessment centres on EC and/or chloride content in the root zone. Land suitability LS Class 1 soils are defined as having an EC of less than 100µs/cm (cropping) or 150µs/cm (grazing), or alternately a chloride content of less than 300ppm (both cropping and grazing).

Soil Physical factors

This limitation deals with conditions which determine sufficient seed contact with moist soil to prevent desiccation prior to germination and establishment. One such condition applies to clay soils which have narrow moisture content suitable for cultivation, as they are susceptible to compaction and smearing when wetter than the plastic limit. Trafficability is also limited by high clay content and moisture retention on the clay soils. With a grazing use, physical factors refer more to restrictions in the establishment and vigour of pastures as a result of soil surface condition and are typically related to size of surface aggregates which affects tendencies to seal and hardset.

Land suitability LS Class 1 soils are described as cracking clays with a very fine mulch (<2mm), or rigid soils loose, soft or firm surface when dry.

Erosion

The risk of soil loss from water erosion magnifies with increased slope gradient combined with water velocity when land is devoid of vegetation.

Slope limits for determining erosion risk and suitability class according to DME (1995) are provided in **Table 7-1**.

Table 7-1 : Slope Erosion Limitations for Cattle Grazing

Soil Type	Land Suitability Class				
	LS1	LS2	LS3	LS4	LS5
Cracking Clays	<3% slope	Slopes 3-6%	Slopes 6-9%	Slopes 9-15%	>45%
Sodic rigid soils	<1% slope	Slopes 1-3%	Slopes 3-6%	Slopes 6-12%	
Non-sodic rigid soils	<3% slope	Slopes 3-12%	Slopes 12-20%	Slopes 20-45%	

Source: DME (1995)

Workability, Flooding and Wetness

Drainage conditions of the soil solum were noted during the soil survey and recorded on the soil logs. Shallow water tables and flooding may impede plant growth and colonisation, and impact on management techniques when working with the soil.

LS Class 1 ratings include flood free soils on undulating or elevated plains, and are characterised by very fine self-mulching cracking clays or loose, soft or firm rigid soils.

Microrelief and Rockiness

Microrelief refers to relief up to a few metres about the plane of the land surface (McDonald et al. 1984b). Melon holes caused by the shrinking/swelling properties of clay rich Vertosols can present a limitation to cropping due to an uneven cultivation surface and impeded trafficability of machinery.

Land suitability LS Class 1 for cropping includes <10% surface rock/rock outcrop and no melonholes. LS Class 1 for grazing land includes <20% surface rock/rock outcrop and <20% melonholes (minimum depth 30cm).

Topography

Topography is assessed in terms of slope and micro-relief. Slope may limit the effective and safe use of machinery and contribute to erosion hazard. Topography has been assessed by field observations of the regional topography and inclinometer readings.

Topographical constraints to cropping land are measured as gully dissection, where the absence of gully erosion indicates a LS Class 1 soil. In grazing land, topography is not considered a limitation unless they are deemed to interfere with pasture sowing, or slopes are >15%.

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NEW HOPE GROUP

G.1.6 Soil Laboratory Properties Summary Report – Mining Area

REPORT

Soil Laboratory Properties Summary
Acland Coal Project

For P W Baker & Assoc

By D E Baker BSc
ASSSI

Environmental Soil Solutions Australia
11 December 2007

Report Introduction

Laboratory chemical and physical measurements of soil characteristics of soils sampled by PW Baker from Acland Coal Project Site (ACP) provide a quantifiable reference base for many purposes and uses of the soil types represented. Within the Acland Coal Project Site (ACP), a total of 11 soil profiles (a total of 89 soil samples) were taken for laboratory analysis to represent the soil profiles listed in Table D1 below. Each site chosen had Soil Chemistry and Physics for the soil it represents.

Table D1. Soil Profile Sites for Laboratory Analysis

Soil Profiles Acland Coal Project	Number of Samples Per Profile
Profile Site S2 Lab Nos 716 – 724	9
Profile Site S12 Lab Nos 725 – 733	9
Profile Site S18 Lab Nos 734 – 742	9
Profile Site S28 Lab Nos 743 – 751	9
Profile Site S36 Lab Nos 752 – 760	9
Profile Site S38 Lab Nos 761 – 768	9
Profile Site S50 Lab Nos 769 – 777	9
Profile Site S80 Lab Nos 778 – 780	3
Profile Site S87 Lab Nos 781 – 787	9
Profile Site S96 Lab Nos 788 – 795	9
Profile Site S101 Lab Nos 796 – 804	9
Project Total	**89**

Discussion of laboratory results, by each soil property measured, are presented in this Analytical Data Report. Analytical results are discussed for individual soil profiles and significant differences occurring for each profile sampled.

A total of 89 soil samples from 11 profiles as listed in Table D1 were submitted for laboratory analysis. The samples were analysed by the Agricultural Chemistry Laboratory (ACL) Analytical Services Laboratory. Soil Analysis Methods used are as listed in Annex D and follow the Methods of soil analysis per Rayment & Higgenson (1992) " Australian Laboratory Methods Handbook" (ALHS).

The range of analyses performed for each representative soil profile was similar to those recommended in Table 1 of the manual "Interpreting Soil Analyses" by Baker and Eldershaw (1993), and are listed in Table D2 in this report.

Table D2. Range of laboratory analyses performed on representative profiles Acland Coal Project

Soil Test Parameter*	P 0-10	P 10-20	P 20-30	P 30-40	P 40-50	P 50-60	P 60-70	P 70-80	P 80-90
pH (1:5 Water)	X	X	X	X	X	X	X	X	X
EC, (1:5 Water)	X	X	X	X	X	X	X	X	X
Cl*, (1:5 Water)	X	X	X	X	X	X	X	X	X
Cations (Alcoholic, pH 8.5)	X		X			X			X
CEC	X		X			X			X
ESP	X		X			X			X
NO3-N, (1:5 Water)	X								
Org. Carbon	X								
Sulfate - S	X								
Bicarbonate P	X								
B, Cu, Zn, Mn, Fe (trace elements)	X								
% ADM	X		X			X			X
PSA (particle size distribution)			X			X			X
-1500 kPa (wilting point) 15 Bar			X			X			X
Dispersion Ratio. R_1 (Dispersion Rating)			X			X			X

Notes:

* For full explanation of terms, see Annex E and ALHS.

P = 'Representative Profile' i.e. a profile chosen as representing a particular soil; the median of the range in characteristics is usually chosen for sampling. The sampling intervals are assumed to provide quantitative expression to the profile characteristics within each soil layer.

Px = Sample depth analysed

X = This analysis is determined, blanks are not determined.

Table D4. Summary chemical properties for the key soil profiles samples – Acland Coal Project

Soil Profile No.	Depth (cm)	pH (H_2O)	Cl mg/kg	EC mS/cm	ESP (Sodicity)	Ca/Mg Ratio	Ca meq/100g	Mg meq/100g	K meq/100g	CEC meq/100g	CCR Ratio	Clay %
S2	10	7.7	25	0.175	1	2.0	25.0	12.2	1.35	40	-	NA
	30	8.7	100	0.309	7	1.0	19.3	18.4	0.58	40	0.65	61
	60	8.6	720	0.89	12	0.56	12.2	21.8	0.51	34	0.53	64
	90	8.5	900	1.032	12	0.50	11.2	22.2	0.53	34	0.55	62
S12	10	6.8	15	0.10	<1	3.7	8.2	2.2	1.08	16	-	NA
	30	7.0	15	0.04	<1	2.7	9.5	3.5	0.71	19	1.1	18
	60	8.3	65	0.138	4	1.6	11.4	6.9	0.64	21	1.1	20
	90	8.7	85	0.224	5	1.6	10.1	6.3	0.48	18	1.1	16
S18	10	6.6	100	0.167	1	2.0	15.9	7.3	1.77	29	-	NA
	30	7.8	60	0.137	9	1.0	15.6	11.1	0.27	32	1.6	20
	60	8.9	930	0.931	28	0.56	11.5	14.0	0.23	29	1.5	19
	90	9.2	850	0.887	31	0.50	7.2	11.0	0.17	22	1.4	16
S28	10	7.4	10	0.147	<1	2.0	18.8	6.0	0.77	29	-	NA
	30	7.7	5	0.146	<1	1.0	20.2	6.3	0.51	29	0.67	43
	60	8.1	15	0.120	2	0.56	19.6	9.5	0.27	31	0.67	46
	90	8.4	30	0.180	3	0.50	20.6	15.4	0.35	39	0.68	57
S36	10	7.1	10	0.060	3	0.76	11.7	15.3	0.61	32	-	NA
	30	7.6	200	0.205	8	0.68	15.9	23.4	0.40	42	0.67	63
	60	7.9	110	0.152	7	1.2	13.9	11.6	0.18	28	0.62	45
	90	8.7	630	0.738	11	0.57	13.0	22.8	0.23	38	0.63	60
S38	10	6.7	350	0.322	14	2.0	2.5	2.8	0.17	8	-	NA
	30	6.6	80	0.116	16	0.56	1.9	3.0	0.05	9	0.39	23
	60	7.0	240	0.256	21	0.50	4.3	7.4	0.09	17	0.45	38
	80	9.2	290	0.524	-	-	-	-	-	-	-	-
S50	10	6.5	70	0.107	5	0.78	3.2	4.1	0.40	12	-	NA
	30	8.8	190	0.243	18	0.72	9.7	13.1	0.23	28	0.65	58
	60	8.9	670	0.809	26	0.47	7.9	16.8	0.27	30	0.53	62
	90	9.2	710	0.978	31	0.38	6.2	16.5	0.40	28	0.55	63
S80	10	7.7	80	0.175	11	0.76	10.8	14.2	0.51	30	-	-
	50	8.5	1300	1.385	22	0.51	11.0	21.2	0.26	38	0.62	61
	100	8.8	1350	1.752	-		-	-	-	-		-

Soil Profile No.	Depth (cm)	pH (H_2O)	Cl mg/kg	EC mS/cm	ESP (Sodicity)	Ca/Mg Ratio	Ca meq/100g	Mg meq/100g	K meq/100g	CEC meq/100g	CCR Ratio	Clay %
S87	10	8.4	10	0.183	1	3.3	23.4	7.0	0..94	28	-	-
	30	8.7	170	0.283	12	1.8	18.1	9.9	0.38	30	0.57	52
	60	8.6	1150	1.033	20	1.2	19.5	15.7	0.42	41	0.61	67
	70	8.7	1020	1.111	-	-	-	-	-	-	-	-
S96	10	8.1	10	0.166	<1	3.4	50.9	14.7	1.56	66	-	-
	30	7.9	5	0.233	<1	3.0	48.1	16.0	1.21	69	0.89	77
	60	7.9	10	0.191	1	1.9	43.2	22.2	1.09	66	0.85	77
S101	10	5.4	15	0.096	<1	0.78	5.0	6.4	1.05	27	-	-
	30	7.5	10	0.095	6	0.63	10.2	16.0	0.35	31	0.40	70
	60	8.6	20	0.309	11	0.56	9.1	17.2	0.38	25	0.35	70
	90	8.9	30	0.372	16	0.33	5.8	17.4	0.51	25	0.34	73

The laboratory chemical and physical analyses for all 11 profiles examined in detail are appended in Appendix A along with soil chemical and physical properties profile data sheets. Chemical properties of the soil profiles are summarised in Table D4.

Soil pH

Soil Reaction (or pH)

Soil pH provides an estimate of a soils' acidity or alkalinity. It is an important measurement since hydrogen and hydroxyl ions have a direct influence on soil conditions and plant growth. Indirect effects are associated with changes in solubility or activity of various biologically important mineral elements and processes which occur according to the soil pH level.

Determination of soil pH was on air-dry (40^{o}C) soil of <2mm and employed a 1:5 soil:deionised water suspension. No correction for residual moisture in the air-dry soil is or should be made. Values in the surface 10 cm of soils are most critical in fertility studies, but profile trends should also be taken into account as they affect plant rooting depth and if excavated may be unsuitable as a growing media.

In the discussion of the soil pH via 1:5 soil:water (pH H_2O) as reported in this section. Soil pH using dilute calcium chloride (pH $CaCl_2$) was not determined as its use is in situations where soil pH is strongly acid which these soils are not.

The most acidic surface soil pH was encountered in the 0 – 10cm layers of the following profiles:

- S12 (with pH H_2O of 6.8); and
- S18 (with pH H_2O of 6.6); and
- S38 (with pH H_2O of 6.7); and
- S50 (with a acid pH of 6.5 recorded for water); and
- S101 (with the most acidic surface pH of 5.4 in the A horizon

The remaining profiles have neutral to alkaline surface soil pH in the 0 – 10cm layers Profiles S36 (neutral pH), and S2, S28, S80, S87, S96 which are mildly to moderately alkaline (pH 7.4 – pH 8.4)

Soil pH trends with depth

Apart from the S96 (where pH is rated moderately alkaline throughout the sampled profile) all other sites studied have increasingly alkaline pH with increasing depth. All have a profile trend to 0.9 m to moderately (pH 8.4) to very strongly alkaline (pH 9.2).

The most strongly alkaline subsoils are in the S18, S38 & S50 profiles.

For best results with pastures and crops on surface soils a pH H2O (1:5) of 6.5–7.5 is recommended. Where the surface soil pH H_2O is less than 6.5, lime application is recommended to decrease soil acidity and exchangeable aluminium, which may become available at these pH levels.

Graphs of soil pH change with depth in the profile are illustrated in Figure 1 in Appendix A.

Soil Salinity

Soil salinity is a measure of the total concentration of *soluble salts* present. The salts, which are dissolved in the soil water at any particular time, are free to move down the profile with drainage (leached) or into the plant roots (uptake). Soil salinity should always be interpreted in conjunction with the hydrology of the area concerned.

Estimates of salinity hazard are derived from both electrical conductivity (EC), which indicates the total soluble salt content, and the more problematic soluble chloride ion concentration. There was considerable variation between soil profiles for both EC and chloride. The inter-profile variation becomes more marked with increasing depth.

Sodium and chloride ions are usually the cause of soil salinity but other anions may be present in the soil solution. In this area, significant sulfate present as crystalline gypsum may be present in the deeper profile and contributes to the overall EC. Soil profiles analysed that contain significant gypsum were noted in S80 and to lesser extent in deeper subsoils such as S2, S36.

The most saline profiles encountered are S2, S18, S80, S87, S50.

Chloride concentration is at a maximum 0.0.135% in S 80 at 90 – 100cm, which theoretically accounts for an EC 1:5 (soil:water) of 0.89 mS/cm. This means that chloride accounts for 66% of the soluble salts in S80. A similar situation exists in S2, S18, S50, and S87.

The S12, S28, S96, S101 profile site soils have low salinity in the 0.9 m of profile sampled.

Of interest is the salt layers found in S38 where moderate salinity was found in the 0 – 10cm sample with the chloride lower deeper in the profile.

Figure 2 shows the EC profile trends for all profiles while Figure 3 shows the Chloride (Cl) profile trends for all profiles.

Soil Sodicity (ESP) and Dispersion

Soil sodicity (ESP) has a detrimental effect on the physical properties of a soil. A soil with high sodicity has a tendency to lose aggregation and develop clay dispersion, cause an impermeable (low hydraulic conductivity) profile, surface crusting and poor aeration.

Soil profiles with these properties in layers, if exposed, will disperse and significant dispersion (erosion) will occur.

Sodicity is a measure of sodium (Na) and CEC content in a soil and is measured as ESP. ESP is defined as Exchangeable Na/CEC, expressed as a percent.

Northcote and Skene (1972) defined three categories of sodicity using ESP:

- Non-Sodic (ESP <6)
- Sodic (ESP 6-14)
- Strongly Sodic (ESP 15+)

When, in addition to sodicity, the magnesium to calcium ratio (Mg:Ca) is less than 1, there is greater susceptibility of the soil to dispersion. Soil clay content and mineralogy can also influence dispersion. For example, the sodic cracking clays will allow water penetration while a sodic non cracking clay will not.

S18, S38, S80, S87 and S 101 are the most sodic soil profiles in the study and are sodic to very strongly sodic in the upper 60 cm of the profile. ESP levels of up to 31 were found in S18 at 90 cm.

In the deeper subsoils at 90 cm S18, S38, S50, S87 & S101 soils analysed are strongly sodic to very strongly sodic (ESP 15-30+).

Site S38 is Sodic at surface and Strongly sodic to the 60cm tested.

Emerson and Bakker (1973) found that soils with exchangeable magnesium dominating exchangeable calcium (Ca:Mg ratio <0.5 , especially) have an additional negative effect similar and additive to the ESP effect on clay dispersion. They found that in a red-brown earth the ESP required for soil dispersion was halved if associated with magnesium as the dominant cation. This additive effect is more pronounced in soils with higher clay content. For example, the S38, S50, S80 & S101 subsoils may be most affected by high levels of soil dispersion. These groups have strongly sodic subsoils with high clay content and Ca:Mg ratios at or below 0.5. However, the effect should be less pronounced in similar soils where gypsum may occur occurs in the profile, such as in S80.

Figure 4 shows the ESP profile trends for selected profiles.

Exchangeable cations and CEC

The proportions of exchangeable cations calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na, already discussed as ESP) are important in assessing a soil's ability to retain positively charged cations (plant nutrients) and their distribution gives information on soil physical and chemical properties.

Calcium dominant and co-dominant soils

Soil profiles with calcium as the dominant cation in the surface layer occur in the S2, S12, S18, S28, S38, S87 and S96. This combined with the low ESP See Table D4 would indicate that these soil surfaces are non dispersive. In fact for S12, S96 these soils profiles would be rated non dispersive and suitable for plant growth in relation to Calcium.

Generally, where exchangeable calcium and exchangeable magnesium are co-dominant (in equal concentrations) they remain co-dominant to only around 30 cm. Profiles that have co-dominant Ca and Mg are S 2, S 18 , S 28, S87.

Profiles where magnesium is dominant are represented in the subsoils of S2, S18, S28, S38.

Where magnesium is dominant throughout the profile and therefore of concern re soil dispersion risk are profile sites S50, S80, and S101.

Critical levels for plant growth are not well defined for exchangeable potassium but levels in the surface need to be greater than a range from 0.2 meq/100g to 0.4 meq/100g.

In general, the red S 38, S50 have not adequate exchangeable K (>0.4 meq/100g) in the upper subsoil. Exchangeable K becomes extremely low in the S38 below 30 cm with levels less than 0.1 meq/100g.

For the clays, the surface levels are adequate and range from 1.77- > 0.4 meq/100g decreasing with depth .

Soil Particle Size Distribution

Clay, silt, fine and coarse sand were determined by hydrometer to estimate the physical proportions of solid particles in the different size ranges. Clay size range is < 0.002 mm, silt is 0.002 – 0.02 mm up and fine sand and corse sand range from 0.02 mm to 2.0 mm.

The highest clay percentages are found in the S101 & S96 profiles. Clay content in the subsoils is greater than 70%, as shown in Figure D4.

Sites S2, S28 , S36, S50, S80 S87 have clay % in the range > 40 to <70% , these would be classed as medium to heavy clay soils.

Sites S 12, S18, are soils with less 20% clay in the profile .

Site S38 is intermediate clay with 23% at 30cm to 38% at 60cm (still sandy surfaced over light clay duplex soil).

CEC to Clay Ratio (CCR)

An indication of the clay mineral type in soils can be inferred from the CEC:clay ratio. Ratios of < 0.2 indicate a dominance of kandites and ratios of > 0.8 indicate a dominance of smectites, the expanding clays. CEC:clay ratios of 0.3-0.5 can indicate a substantial proportion of illites but ratios between 0.3 and 0.8 may also be due to mixed mineralogy.

For the majority of the soils the CCR is in the range 0.6 to >1 depending on the profile the profile, irrespective of soil type and clay content. Two profiles occur with CCR >1 throughout the profile S12 & S18 which are low clay profiles.

Illites are a prominent source of potassium and soils with a high proportion of these minerals tend to have high potassium levels throughout the profile. Though variable, potassium levels are generally present in moderate levels in many profiles except S38 & S50. The soils studied otherwise appear to be of mixed mineralogy and illites are probably present as a prominent component in some soils.

Figure 5 shows the Clay content trends with depth for the soil profiles.

Effective rooting depths and Calculated Plant Available Water Capacity (PAWC)

The following data has been taken from the data report and uses the salinity profile features:

Profile No	Rooting depth (m)
S2	0.6-0.9
S12	0.8-0.9
S18	0.5-0.6
S28	0.9 +

S36	0.8 – 0.9
S38	0.8+
S50	0.6 – 0.7
S80	0.4 – 0.5
S87	0.3 – 0.5
S96	0.5 – 0.6
S101	0.8 – 0.9+

Root zone depths listed above have been used to reflect the effective rooting depth of maximum rooting species. Obviously for shallower rooting species such as perennial pastures and shallow rooting crops PAWC will be less. For deeper rooting crops and lucerne the maximum rooting depth can be used.

The maximum rooting depth under rainfed conditions has also been determined as the depth to a chloride bulge and selected intermediate depths within each representative profile. The table below shows the maximum rooting depth and estimated PAWC (plant available water capacity) for each profile.

Soil Profile	Maximum rainfed rooting depth (m)	Calculated PAWC (mm) for root zones of -		
		0.3 m	0.6 m	0.9 m
S2	0.9m	74	101	114
S12	0.9m	73	115	142
S18	0.6m	69	94	-
S28	0.9+ m	60	90	118
S36	0.9 m	76	105	134
S38	0.8 – 0.9 m	48	-	91@80cm
S50	0.8 m	72	112	133 @ 70cm
S80	0.6 – 0.7 m	-	93	
S87	0.3 – 0.5 m	67	82	-
S96	0.5 – 0.6 m	88	-	124@80cm
S101	0.8 – 0.9+ m	82	126	151

The PAWC at the maximum rooting depth according to the chloride bulge has also been calculated for soils where the maximum varies from the standard root zone depths above and is < 1m:

Soil Fertility

Summary soil fertility attributes for all the sampled profiles are contained in Table D5.

Extractable Phosphorus

Soil bicarbonate extractable P was determined for only each surface sample. No soil P exceeds 43 mg/kg (except for the very high S 101) with most soils less than 20 mg/kg (low). The higher P values probably indicate soil P fertiliser additions. The lowest P was for S 87 and S36.

It would seem that most unfertilised soil would benefit from some P fertiliser but P status should be checked before any pasture cropping enterprise is commenced on all soil types.

The lowest extractable P measured was 4 mg/kg from S87 while S36 profile has a P concentration of 9 mg/kg.

Organic Carbon and Total Nitrogen

Surface soil status for organic carbon (Walkley and Black) and total (Kjeldahl) nitrogen (Total N) have been performed on the bulk 0-10 cm samples.

The range of values for uncorrected Walkley and Black carbon is from <1.0 -3.4% (very low to medium) excluding the sample with 0.81% taken from sandy low clay soil, which is very low.

The average level of Walkley and Black carbon is low for all soil types (except S18) and needs to be maintained or increased. Cultural practices such as trash retention, green manuring and stubble retention are recommended.

The range of Total N values in the top 0-10 cm is 0.09% to 0.33% (low to moderate) the profileS18 has both the higher levels of Organic Carbon & Total Nitrogen.
The lowest Total N are for S 38 and S36 & S50.

The combined C:N ratio obtained for the bulk 0-10 cm samples averages 10.4 (range8.9 - 13) indicating satisfactory nitrogen mineralisation is occurring even for the higher C:N values. Commonly C:N ratios are 10 to 12 are for arable land so that at higher ratios significant N fertiliser inputs may be required to establish non leguminous crops and pastures.

Trace Elements

Most measured values indicate that the trace elements copper, zinc, iron and manganese are in adequate supply. Only Copper in S 36 & S 87 are rated low.

Availability of zinc is influenced by soil pH and phosphate. When soil pH is alkaline some soils may show zinc deficiency when values are less than 0.8 mg/kg. Values in excess of this are recommended in these situations.

Copper levels are generally adequate though levels are low in the 2 profiles mentioned above.

Manganese levels are generally adequate but not high.

Iron levels are generally adequate.

Nitrate Nitrogen

Water soluble nitrate nitrogen (NO_3-N) is in low to medium supply in the top 10cm of 11 soils sampled. Levels are not adequate for the growth of most crops in sites where measured concentrations are 10mg/kg or less.

Sulfate Sulphur

Sulfate sulfur values range from 5 mg/kg (very low) to 24 mg/kg (medium) in the surface 10 cm.

All of the soils however range from 4 to 20 mg/kg, in the very low to medium ranges. Generally, soils with less than 10 mg/kg are deficient. If high rates of P fertiliser are used on such soils then the adsorbed sulfate will be displaced (Blair 1979). Irrigation will also leach sulfate from the root zone. Sulfate is likely deficient especially in pastures.

Soil sulfate levels should be checked on the soils with low to medium sulfate before any development or changes in cultural practice and soil amendments should be added if necessary.

Table D5. Surface soil fertility of sampled profiles

Soil Profile Site	Organic C %	P mg/kg	Cu mg/kg	Zn mg/kg	SO_4 mg/kg	NO_3 mg/kg	Total N %	C:N Ratio
S2	2.4	23	1.7	1.0	12	6	0.228	11
S12	2.1	22	1.3	5.0	9	29	0.221	9.5
S18	3.4	20	1.9	5.4	12	19	0.328	10.3
S28	1.4	43	1.2	1.1	12	34	0.138	10.1
S36	1.1	9	1.8	0.35	5	3	0.11	10
S38	0.81	17	1.0	1.16	24	4	0.091	8.9
S50	1.2	19	1.2	0.7	11	16	0.12	10
S80	1.2	16	1.5	0.58	9	10	0.119	10
S87	1.4	4	1.6	0.38	9	22	0.146	9.6
S96	1.7	34	0.83	0.71	5	20	0.131	13
S101	1.7	113	1.0	1.99	23	31	0.143	12

APPENDIX A

1- Graphical representations of major soil properties
By individual profile

2- Soil Laboratory Data Batch No 07/74, 30 November 2007

Acland Coal Project

Project:

ACLAND ML Soil Survey

All results in this report relate only to the items tested. Results are expressed on an "as received basis".

Client Name: P Baker & Associates

Contact: Peter Baker

Sample Type: Soil

Number of samples: 89

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
716		S2	0 - 10	7.7	0.175	25	6	23	2.4	12	25.0	12.2	1.35	0.31	40	1
717		S2	10 - 20	8.5	0.233	40										
718		S2	20 - 30	8.7	0.309	100					19.3	18.4	0.58	2.7	40	7
719		S2	30 - 40	8.8	0.463	200										
720		S2	40 - 50	8.7	0.554	290										
721		S2	50 - 60	8.6	0.890	720					12.2	21.8	0.51	4.1	34	12
722		S2	60 - 70	8.7	0.760	510										
723		S2	70 - 80	8.6	1.098	1000										
724		S2	80 - 90	8.5	1.032	900					11.2	22.2	0.53	4.2	34	12

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
716		S2	0 - 10	1.716	0.985	13	23	0.228							
717		S2	10 - 20												
718		S2	20 - 30						5	21	15	61	0.38	23	5.6
719		S2	30 - 40												
720		S2	40 - 50												
721		S2	50 - 60						8	19	12	64	0.51	23	4.8
722		S2	60 - 70												
723		S2	70 - 80												
724		S2	80 - 90						8	19	12	62	0.53	23	4.9

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

For P W Baker
ESSA Pty Ltd

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
725		S12	0 – 10	6.8	0.100	15	29	22	2.1	9	8.2	2.2	1.08	<0.1	16	<1
726		S12	10 – 20	6.8	0.038	5										
727		S12	20 – 30	7.0	0.040	15					9.5	3.5	0.71	0.09	19	<1
728		S12	30 – 40	7.2	0.046	10										
729		S12	40 – 50	7.6	0.070	30										
730		S12	50 – 60	8.3	0.138	65					11.4	6.9	0.64	0.8	21	4
731		S12	60 – 70	8.6	0.214	90										
732		S12	70 – 80	8.5	0.231	85										
733		S12	80 – 90	8.7	0.224	85					10.1	6.3	0.48	0.96	18	5

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
				mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
725		S12	0 - 10	1.356	5.046	69	24	0.221							
726		S12	10 - 20												
727		S12	20 - 30						8	27	9	59	0.26	18	2.7
728		S12	30 - 40												
729		S12	40 - 50												
730		S12	50 - 60						4	19	9	69	0.31	20	3.2
731		S12	60 - 70												
732		S12	70 - 80												
733		S12	80 - 90						9	24	13	56	0.45	16	2.7

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Enironmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
734		S18	0 - 10	6.6	0.167	100	19	20	3.4	12	15.9	7.3	1.77	0.27	29	1
735		S18	10 - 20	7.1	0.086	50										
736		S18	20 - 30	7.8	0.137	60					15.6	11.1	0.27	3.0	32	9
737		S18	30 - 40	7.9	0.180	80										
738		S18	40 - 50	8.4	0.327	290										
739		S18	50 - 60	8.9	0.931	930					11.5	14.0	0.23	8.0	29	28
740		S18	60 - 70	9.0	1.055	1070										
741		S18	70 - 80	9.1	0.857	780										
742		S18	80 - 90	9.2	0.887	850					7.2	11.0	0.17	6.8	22	31

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
734		S18	0 - 10	1.937	5.489	32	72	0.328							
735		S18	10 - 20												
736		S18	20 - 30						6	22	19	54	0.46	20	4.6
737		S18	30 - 40												
738		S18	40 - 50												
739		S18	50 - 60						8	17	17	60	0.71	19	3.8
740		S18	60 - 70												
741		S18	70 - 80												
742		S18	80 - 90						7	20	27	49	0.92	16	3.1

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For P W Baker
ESSA Pty Ltd

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

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Client: P Baker

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Lab No	Client Ref No	Profile	Depth	Ph	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		Ms/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
743		S28	0 – 10	7.4	0.147	10	34	43	1.4	12	18.8	6.0	0.77	<0.1	29	<1
744		S28	10 – 20	7.5	0.133	5										
745		S28	20 – 30	7.7	0.146	5					20.2	6.3	0.51	<0.1	29	<1
746		S28	30 – 40	7.9	0.118	5										
747		S28	40 – 50	8.0	0.122	10										
748		S28	50 – 60	8.1	0.120	15					19.6	9.5	0.27	0.47	31	2
749		S28	60 – 70	8.4	0.192	35										
750		S28	70 – 80	8.4	0.200	40										
751		S28	80 – 90	8.4	0.180	30					20.6	15.4	0.35	1.29	39	3

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
743		S28	0 - 10	1.244	1.094	19	14	0.138							
744		S28	10 - 20												
745		S28	20 - 30						11	36	12	43	0.34	16	3.6
746		S28	30 - 40												
747		S28	40 - 50												
748		S28	50 - 60						9	36	9	46	0.34	18	4.0
749		S28	60 - 70												
750		S28	70 - 80												
751		S28	80 - 90						8	27	10	57	0.43	22	4.7

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Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	Ph	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		Ms/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
752		36	0 – 10	7.1	0.060	10	3	9	1.1	5	11.7	15.3	0.61	1.09	32	3
753		36	10 – 20	7.4	0.111	40										
754		36	20 – 30	7.6	0.205	200					15.9	23.4	0.40	3.5	42	8
755		36	30 – 40	7.8	0.272	255										
756		36	40 – 50	7.8	0.076	10										
757		36	50 – 60	7.9	0.152	110					13.9	11.6	0.18	1.88	28	7
758		36	60 – 70	8.3	0.349	330										
759		36	70 – 80	8.6	0.567	500										
760		36	80 – 90	8.7	0.738	630					13.0	22.8	0.23	4.3	38	11

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
752		36	0 - 10	1.861	0.359	22	25	0.110							
753		36	10 - 20												
754		36	20 - 30						4	23	11	63	0.44	25	5.4
755		36	30 - 40												
756		36	40 - 50												
757		36	50 - 60						8	33	15	45	0.32	17	3.4
758		36	60 - 70												
759		36	70 - 80												
760		36	80 - 90						7	23	9	60	0.41	22	4.6

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

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Soil Analysis Report
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Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

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Lab No	Client Ref No	Profile	Depth	Ph	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		Ms/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
761		38	0 – 10	6.7	0.322	350	4	17	0.81	24	2.5	2.8	0.17	1.08	8	14
762		38	10 – 20	6.6	0.259	310										
763		38	20 – 30	6.6	0.116	80					1.9	3.0	0.05	1.42	9	16
764		38	30 – 40	6.4	0.242	240										
765		38	40 – 50	7.2	0.225	220										
766		38	50 – 60	7.0	0.256	240					4.3	7.4	0.09	3.6	17	21
767		38	60 – 70	9.0	0.463	240										
768		38	70 – 80	9.2	0.524	290										

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
761		38	0 - 10	1.021	1.168	59	40	0.091							
762		38	10 - 20												
763		38	20 - 30						31	40	6	23	0.85	7	1.5
764		38	30 - 40												
765		38	40 - 50												
766		38	50 - 60						24	32	10	38	0.88	15	2.6
767		38	60 - 70												
768		38	70 - 80												

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

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Soil Analysis Report
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Client: P Baker

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Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
769		50	0 - 10	6.5	0.107	70	16	19	1.2	11	3.2	4.1	0.40	0.59	12	5
770		50	10 - 20	8.6	0.134	50										
771		50	20 - 30	8.8	0.243	190					9.7	13.1	0.23	5.2	28	18
772		50	30 - 40	9.0	0.470	380										
773		50	40 - 50	8.7	0.252	150										
774		50	50 - 60	8.9	0.809	670					7.9	16.8	0.27	7.7	30	26
775		50	60 - 70	9.1	0.967	780										
776		50	70 - 80	9.2	0.963	680										
777		50	80 - 90	9.2	0.978	710					6.2	16.5	0.40	8.6	28	31

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
769		50	0 - 10	1.196	0.724	38	47	0.120							
770		50	10 - 20												
771		50	20 - 30						10	23	10	58	0.67	23	3.6
772		50	30 - 40												
773		50	40 - 50												
774		50	50 - 60						8	19	11	62	0.82	25	4.0
775		50	60 - 70												
776		50	70 - 80												
777		50	80 - 90						8	19	11	63	0.99	25	4.3

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
778		S80	0 - 10	7.7	0.175	80	10	16	1.2	9	10.8	14.2	0.51	3.2	30	11
779		S80	40 - 50	8.5	1.385	1300					11.0	21.2	0.26	8.3	38	22
780		S80	90 - 100	8.8	1.752	1350										

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
778		S80	0 - 10	1.542	0.582	14	30	0.119							
779		S80	40 - 50						7	22	10	61	0.47	26	4.5
780		S80	90 - 100												

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	Mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
781		87	0 - 10	8.4	0.183	10	22	4	1.4	9	23.4	7.0	0.94	0.18	28	1
782		87	10 - 20	8.6	0.213	40										
783		87	20 - 30	8.7	0.283	170					18.1	9.9	0.38	3.6	30	12
784		87	30 - 40	8.5	0.461	420										
785		87	40 - 50	8.5	0.757	790										
786		87	50 - 60	8.6	1.033	1150					19.5	15.7	0.42	8.4	41	20
787		87	60 - 70	8.7	1.111	1020										

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	Mg/kg	mg/kg	%	%	%	%	%			%
781		87	0 - 10	1.580	0.383	9	13	0.146							
782		87	10 - 20												
783		87	20 - 30						7	31	14	52	0.49	23	3.7
784		87	30 - 40												
785		87	40 - 50												
786		87	50 - 60						4	18	12	67	0.60	29	5.2
787		87	60 - 70												

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
788		96	0 - 10	8.1	0.166	10	20	34	1.7	5	50.9	14.7	1.56	<0.1	66	<1
789		96	10 - 20	8.0	0.179	5										
790		96	20 - 30	7.9	0.233	5					48.1	16.0	1.21	0.20	69	<1
791		96	30 - 40	7.8	0.189	10										
792		96	40 - 50	7.8	0.139	5										
793		96	50 - 60	7.9	0.191	10					43.2	22.2	1.09	0.76	66	1
794		96	60 - 70	8.2	0.283	5										
795		96	70 - 80	8.4	0.194	5										

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
788		96	0 - 10	0.824	0.708	6	23	0.131							
789		96	10 - 20												
790		96	20 - 30						2	12	12	77	0.33	44	9.0
791		96	30 - 40												
792		96	40 - 50												
793		96	50 - 60						2	11	11	77	0.36	45	8.4
794		96	60 - 70												
795		96	70 - 80												

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Environmental Soil Solutions Australia Pty Ltd

Soil Analysis Report
Batch Number: 07/74

Date Received:22/10/2007
Date Completed:30/11/2007

Client: P Baker

Printed: 30/11/2007

Lab No	Client Ref No	Profile	Depth	pH	EC	Cl	NO3-N	Pbic	OC	SO4-S	Ca	Mg	K	Na	CEC	ESP
			cm		mS/cm	mg/kg	mg/kg	mg/kg	%	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%
796		101	0 - 10	5.4	0.096	15	31	113	1.7	23	5.0	6.4	1.05	<0.1	27	<1
797		101	10 - 20	6.7	0.088	15										
798		101	20 - 30	7.5	0.095	10					10.2	16.0	0.35	1.72	31	6
799		101	30 - 40	8.2	0.188	10										
800		101	40 - 50	8.6	0.287	15										
801		101	50 - 60	8.6	0.309	20					9.1	17.2	0.38	2.7	25	11
802		101	60 - 70	8.7	0.340	25										
803		101	70 - 80	8.8	0.351	25										
804		101	80 - 90	8.9	0.372	30					5.8	17.4	0.51	4.0	25	16

Lab No	Client Ref No	Profile	Depth	Cu	Zn	Mn	Fe	Total-N	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1	15 Bar	ADMC
			cm	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%			%
796		101	0 - 10	1.006	1.993	44	119	0.143							
797		101	10 - 20												
798		101	20 - 30						3	15	15	70	0.30	27	4.6
799		101	30 - 40												
800		101	40 - 50												
801		101	50 - 60						8	12	12	70	0.52	27	4.2
802		101	60 - 70												
803		101	70 - 80												
804		101	80 - 90						7	11	11	73	0.68	28	4.4

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Environmental Soil Solutions Australia Pty Ltd

METHOD DESCRIPTIONS

Soil

Methods used to Analyse Samples

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
pH	4A1	1.1	0.1	pH	pH	1:5 water extr, pH meter
EC	3A1	5.4	0.01	dS/m	Electrical conductivity	1:5 water extr, EC meter
Cl	5A2	10.0	10.0	mg/kg	Chloride	1:5 water extr, (AA) colorimetric
NO3-N	7C2	6.7	1.0	mg/kg	Nitrate-nitrogen	1M KCl extr, (AA) colorimetric
NH4-N	7C2	7.8	0.6	mg/kg	Ammonium-nitrogen	1M KCl extr, (AA) colorimetric
Bicarb.P	9B2	16.8	1.0	mg/kg	Bicarb.ext.phosphorus	0.5M NaHCO3 @ pH 8.5, (AA) colorimetric
TN	7A2	12.9	0.01	%	Total Nitrogen	Sulphuric acid digest, (AA) colorimetric
OC	8B1	9.7	0.02	%	Organic Carbon	Walkley & Black, (H2SO4/K2Cr2O7), abs.600nm
Ca (Neut)	15A1	10.3	0.10	meq/100g	Exchangeable calcium	1M NH4Cl @ pH 7.0 shake, AAS
Mg (Neut)	15A1	6.6	0.10	meq/100g	Exchangeable magnesium	1M NH4Cl @ pH 7.0 shake, AAS
Na (Neut)	15A1	7.3	0.03	meq/100g	Exchangeable calcium	1M NH4Cl @ pH 7.0 shake, AAS
K (Neut)	15A1	3.9	0.02	meq/100g	Exchangeable calcium	1M NH4Cl @ pH 7.0 shake, AAS
ECEC	15J1	5.0	1	meq/100g	Effective cation ex.capacity	Sum of exchangeable cations
ESP	15N1	5.0	3	%	Exchangeable Na%	(Exchangeable Na/sum of exch.cations)%
Sand	no ref	22.1	1.0	%	Particle size, sand	Hydrometer, gravimetric
Silt	no ref	16.6	1.0	%	Particle size, silt	Hydrometer, gravimetric
Clay	no ref	12.7	1.0	%	Particle size, clay	Hydrometer, gravimetric

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager
Analytical Services: _____

Environmental Soil Solutions Australia Pty Ltd

METHOD DESCRIPTIONS

Soil

Reference: 07/74
Page 14 of 15

Methods used to Analyse Samples

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
Ca (Alc)	15C1	7.2	0.18	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Mg (Alc)	15C1	4.7	0.31	meq/100g	Exchangeable magnesium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Na (Alc)	15C1	9.6	0.09	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
K (Alc)	15C1	4.8	0.02	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
CEC	15I3	5.7	1.0	meq/100g	Cation Exchange Capacity	KNO3 + Ca(NO3)2 extr, (AA) colorimetric
DTPA-Cu	12A1	17.1	0.26	mg/kg	DTPA ext. copper	DTPA extraction, AAS
DTPA-Zn	12A1	16.4	0.10	mg/kg	DTPA ext. zinc	DTPA extraction, AAS
DTPA-Mn	12A1	9.0	0.32	mg/kg	DTPA ext. manganese	DTPA extraction, AAS
DTPA-Fe	12A1	13.0	0.23	mg/kg	DTPA ext. iron	DTPA extraction, AAS
ADMC	2A1	11.9	0.4	%	Air Dried Moisture Content	Gravimetric oven dry @ 105C
R1	NA	20.2	NA		Dispersion Ratio	Ratio [Aqueous dispersible (Silt + Clay):Total (Silt + Clay)]
SO4-S	10B3	11.5	0.6	mg/kg	Sulfate sulfur	Ca(H2PO4)2 @ pH 4.0 extractable sulfate-sulfur, ICPOES
Al	15G1	NA	NA	meq/100g	Exchangeable Aluminium	Exch. Hydrogen and Aluminium by 1M KCl
H+	15G1	NA	NA	meq/100g	Exchangeable Acidity	Exch. Hydrogen and Aluminium by 1M KCl
15 Bar		NA	NA		15 Bar Analysis	Pressure Plate/Gravimetric oven dry @ 105C

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager
Analytical Services: _____

Environmental Soil Solutions Australia Pty Ltd

QUALITY CONTROL DATA

Soil

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

Test Method	Units		Actual Value	Acceptance Criteria [Range]
pH	pH	B	5.18, 5.18, 5.17,5.17	5.0 - 5.3
EC	dS/m	B	.298, .302, .305, .309	0.27 - 0.32
Cl	mg/kg	B	18, 20, 20, 20	10 - 35
NO3-N	mg/kg	B	13, 13, 13, 14	10 - 16
NH4-N	mg/kg	NA		NA
Bicarb.P	mg/kg	B	56, 54	51 -75
Total Kjeldahl N	%	S8	0.227	0.195 - 0.248
Total P	%	ALS		See ALS Report
Organic Carbon	%	B	1.97, 1.93	1.82 - 2.3
Ca (Exch. cations)pH7	meq/100g	B		6.96 - 8.04
Mg (Exch. cations)pH7	meq/100g	B		1.88 - 2.22
Na (Exch. cations)pH7	meq/100g	B		.057 - .182
K (Exch. cations)pH7	meq/100g	B		1.209 - 1.411
Exch. Acidity	meq/100g			NA
ECEC	meq/100g	A		NA
CEC	meq/100g	S12	63, 62, 63	58 - 73
ESP	%	A		NA
Coarse sand	%	B	2, 2, 2, 2	1.4 - 2.8
Fine Sand	%	B	18, 18, 17, 17	13.1 - 19.1
Silt	%	B	21, 21, 22, 22	20.2 - 26.1
Clay	%	B	60, 60, 59, 59	55.4 - 60.2
R1		B	.18, .18, .18	0.18 - 0.29

Test Method	Units	Test Soil	Actual Value	Acceptance Criteria
DTPA-Cu	mg/kg	SB	2.72, 2.72	2.37 - 3.25
DTPA-Zn	mg/kg	SB	3.78, 3.32	3.15 - 3.81
DTPA-Mn	mg/kg	SB	146, 142	97.7 - 149.0
DTPA-Fe	mg/kg	SB	23.2, 23.2	24.3 - 32.6
Suflate-sulfur	mg/kg	B	110, 115	96 - 120
15 Bar	%	G	24, 23, 27, 27	23 - 30
Ca (Exch. cations)pH8.5	meq/100g	S12	34.5, 32.6, 31.9	27.7 - 35.4
Mg (Exch. cations)pH8.5	meq/100g	S12	24.9, 23.4, 23.4	22.88 - 24.5
Na (Exch. cations)pH8.5	meq/100g	S12	2.2, 2.1, 2.1	2.0 - 2.28
K (Exch. cations)pH8.5	meq/100g	S12	1.96, 1.81, 1.82	1.64 - 2.09

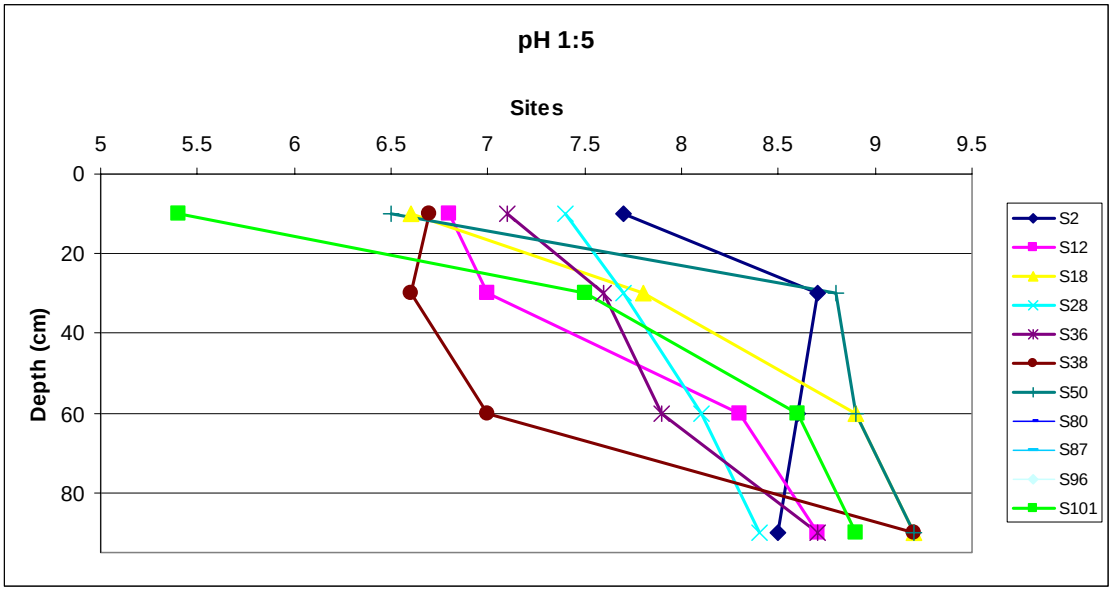

Figure 1

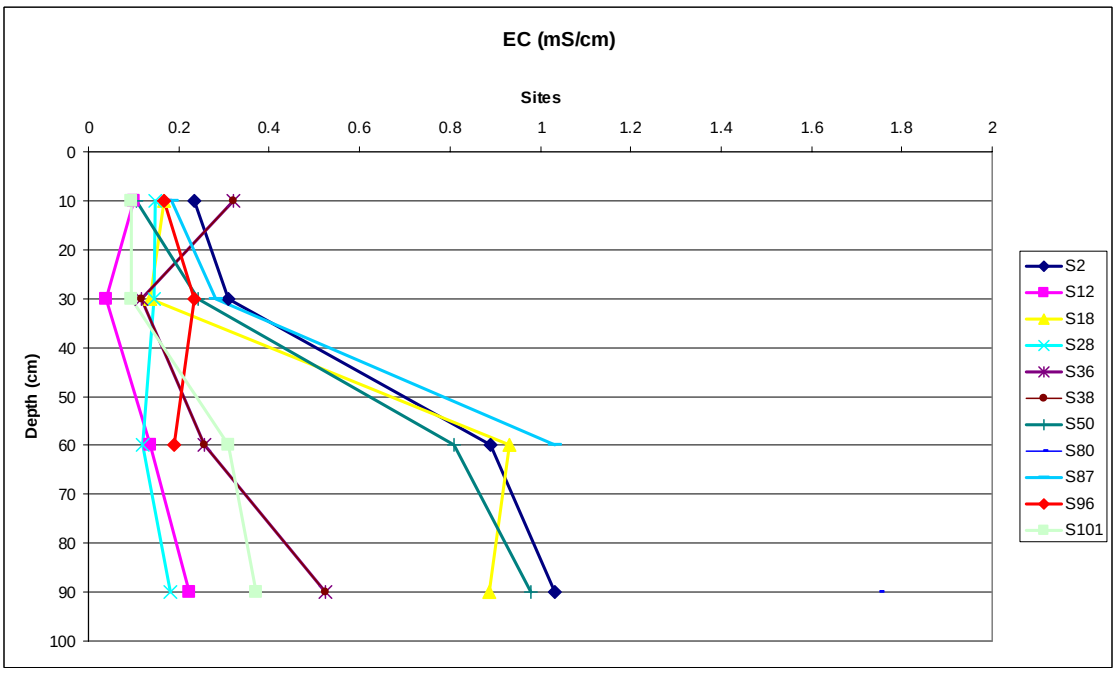

Figure 2

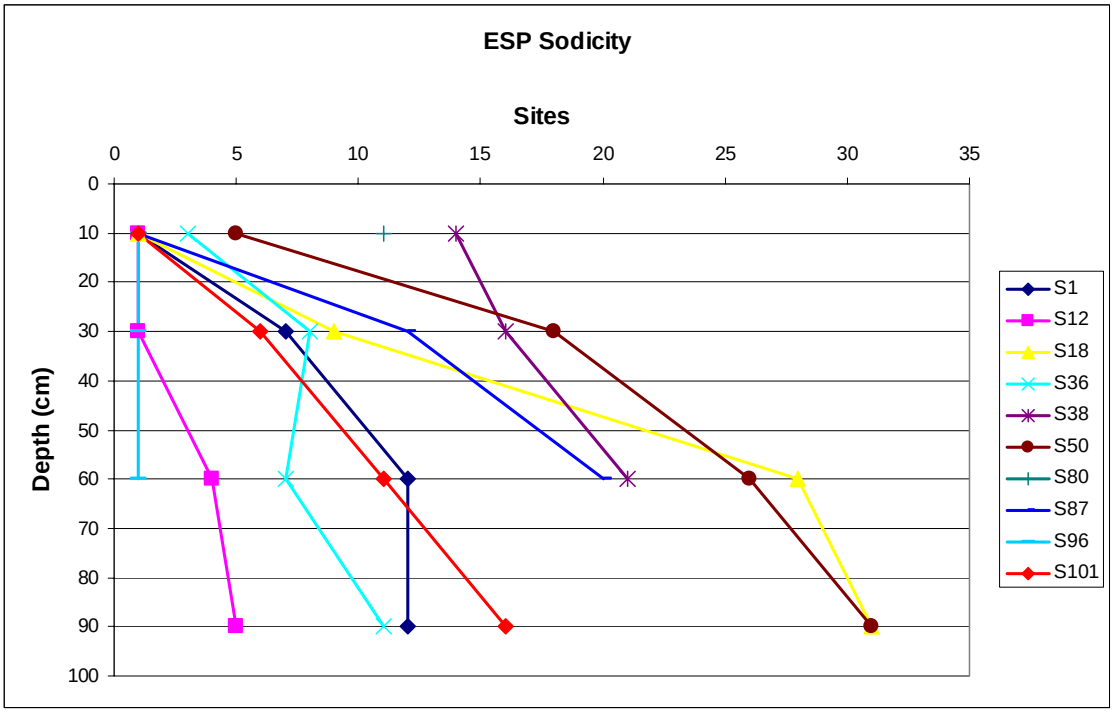

Figure 3

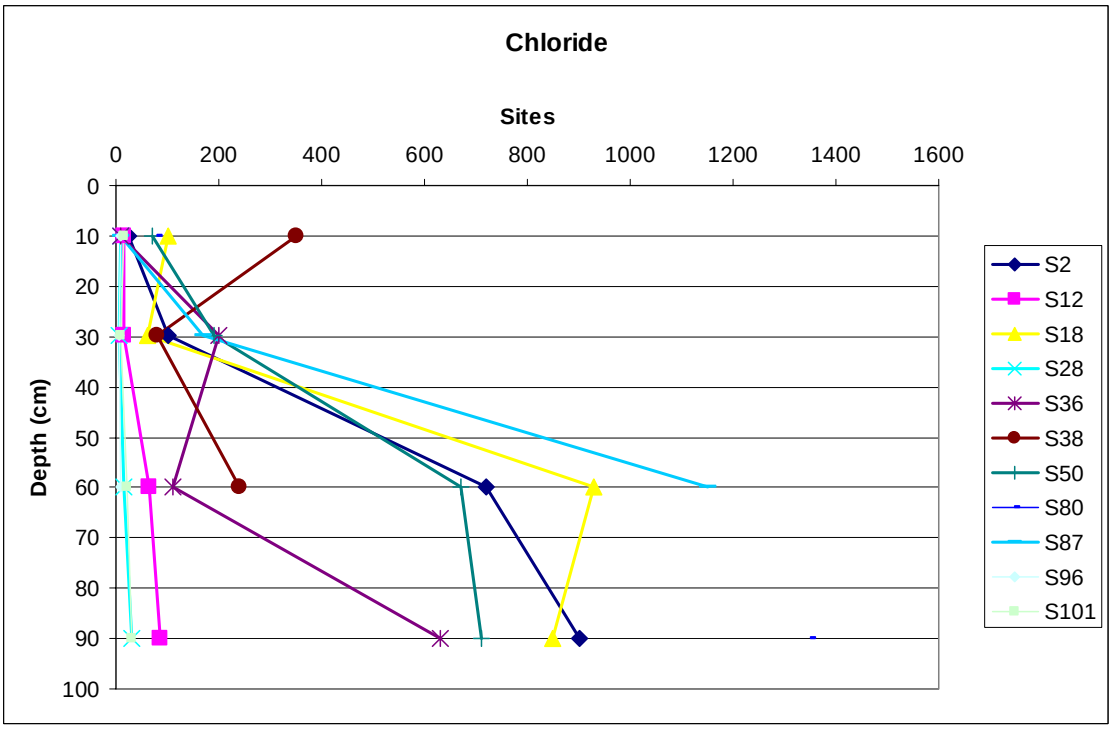

Figure 4

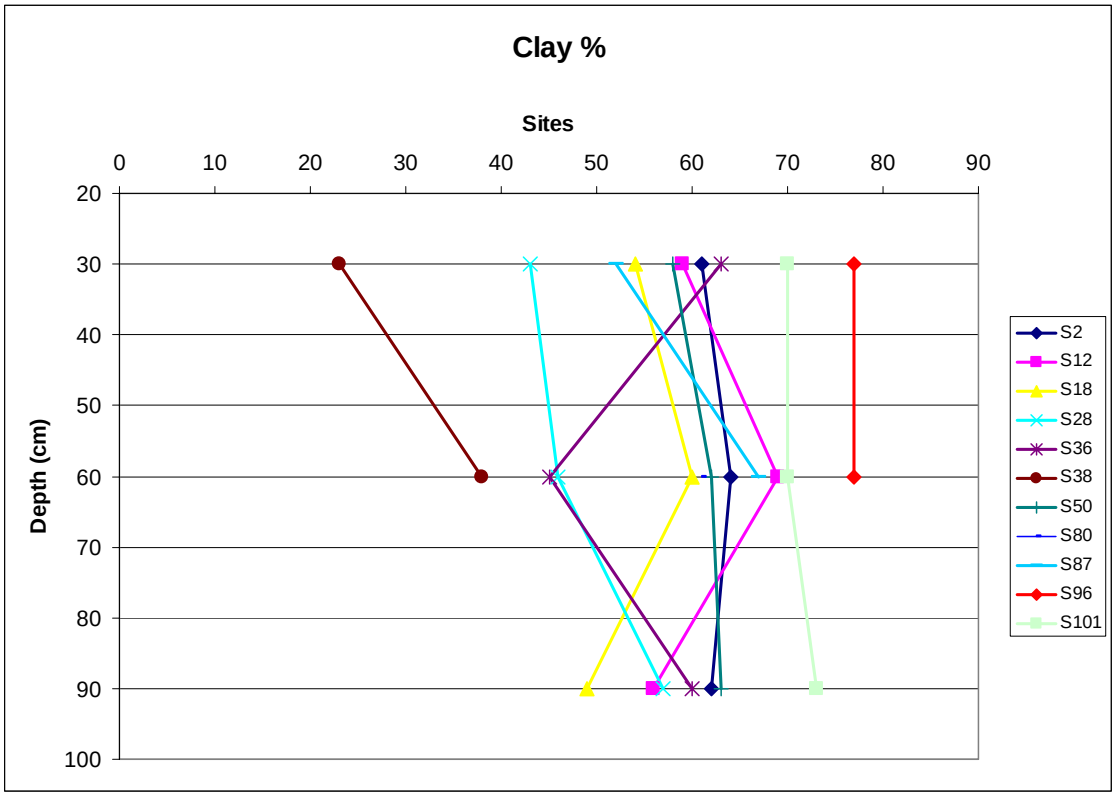

Figure 5

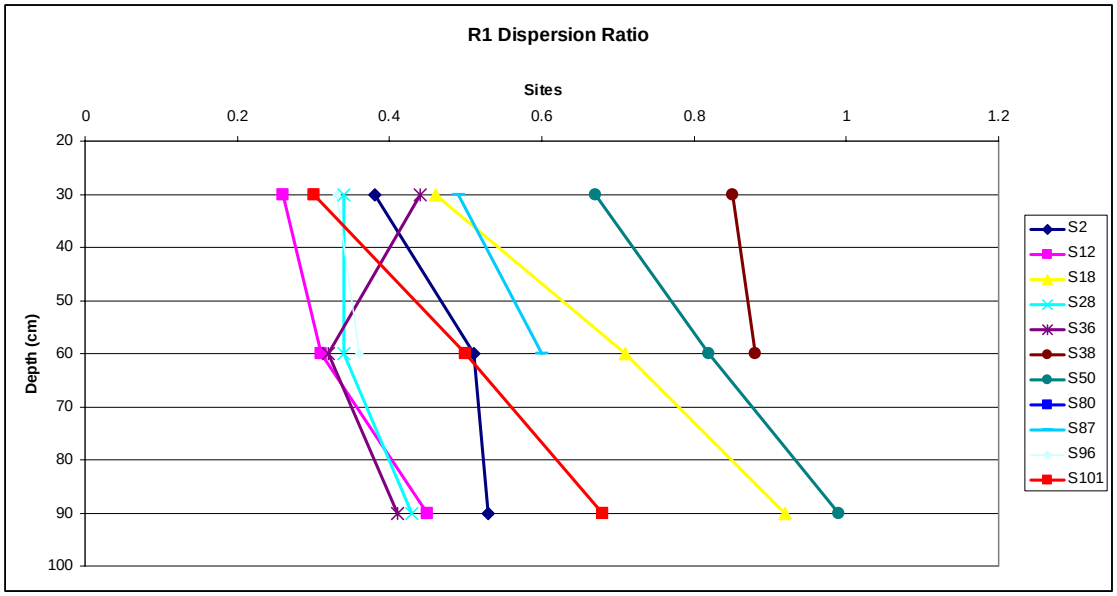

Figure 6

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NEW HOPE GROUP

G.1.7 Soil Types Assessment Report – Mining Area

Appendix G.1.7 Soil Types Assessment

Soil Type: A1

CONCEPT **Old Alluvial Plains of dark grey brown deep well structured cracking clays over dark grey brown heavy clay subsoil** Productive cropping soil.	

MAJOR SOIL FEATURES

- Deep, alkaline and dark heavy clay.
- The surface is deeply cracking, with a fine granular self mulch.
- The surface 40 – 50 cm layer is dark grey brown which becomes browner coloured with depth. Reaction trend is strongly alkaline.
- Subsoils are strong angular or lenticular structure becoming coarser below 50cm.
- Moderate gypsum occurs in deeper subsoils.
- Becoming saline and sodic at variable depths below 50cm.
- PAWC considered moderate to high
- Overall fertility is reasonable except for low P, organic carbon, sulphate and zinc. Fertiliser inputs are likely.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 36

LOCATION: 371518E 6973214N Z56

LANDFORM ELEMENT: Plain

LANDFORM PATTERN: Alluvial plain

SLOPE: <1%

SURFACE COARSE FRAGMENTS: nil

SUBSTRATE: Alluvium

MAIN VEGETATION: Cleared Brigalow, Belah scrub

DISTURBANCE: Cultivation

MICRO RELIEF: Absent

PERMEABILITY: Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking, self mulching

AUST. SOIL CLASSIFICATION: Self mulching, Black Vertosol

SOIL PROFILE MORPHOLOGY

Horizon	Depth (cm)	Description

0 cm 20 cm 40 cm		60 cm 80 cm 100 cm 120 cm	AP B21 B22	0 – 20 20 – 40 40 -120	Very dark greyish brown (10YR3/2), medium clay, strong granular, field pH 8.0, no inclusions, dry, abrupt to; Very dark greyish brown (10YR3/2), medium heavy clay, moderate angular blocky, field pH 8.5, some carbonate nodules 2-5mm, moist, gradual to, Dark brown (10YR4/2), medium heavy clay, strong sub-angular blocky, field pH 9.0, common soft calcareous concretions, moist

Laboratory Data Summary - Sites 36 and 80

Two sites were sampled for chemical assessment. One from flat alluvium occurring to the south east of the study area (site 36) and the other from west of Acland township (site 80). A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 36 is saline below 80cm depth however site 80 is highly saline below 40cm depth.
- Chloride accounts for 66% of soluble salts in site 80.
- Both sites are slightly alkaline becoming strongly alkaline with depth.
- Salt and sodium occur in the A1 alluvial soils to quite variable levels of severity. This variability can probably be attributed to the variable influences of the Walloon sandstones or basalt.
- Site 36 is non sodic however site 80 is highly sodic by 50cm depth. Site 80 also has a Ca to Mg ratio <1 which further indicates dispersive subsoils.
- Surface fertility in both sites is quite good overall. Extractable P at site 36 was the lowest of any soil in the survey and site 80 was also quite low. Organic carbon levels were low to medium probably reflecting the long agronomic history of both sites sampled. Site 36 also had the lowest Total N in the survey area and site 80 was also low, trace elements are in adequate supply and sulphate sulphur is low to medium. Overall, significant fertiliser inputs are recommended for agronomic use.
- Both sites are classes as medium to heavy clay soils with a 63 % clay content.
- Both sites are dominated by expanding smectite clay minerals in the upper soil layer.
- Effective rooting depth varies with depth to the saline layer. Site 36 has 0.8-0.9m effective depth but site 80 only has 0.5m effective rooting depth.
- Calculated plant available water content (PAWC) for site 36 is 134mm and site 80 is 93mm.

Fertility Summary of surface 10cm

(Refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	Very low
P (bicarb)	Very low
Org. carbon	low
Sulphate - S	high
Ca	high
Mg	high
K	medium
Na	Medium low
Cation exchange capacity	high
ESP	low
Cu	medium
Zn	low
Mn	medium
Fe	Medium low
Total N	High

Major Analytical Data Trends of the Shell (1999) survey

This soil type was not described.

AGRICULTURAL LAND SUITABILITY

Dryland cropping Class : 3		**Grazing native and improved pastures** Class : 2	
Major Limitations and Severity:		**Major Limitations and Severity:**	
■ Plant water availability	2-3	■ Plant water availability	2
■ Susceptibility to erosion	2	■ Susceptibility to erosion	1
■ Soil physical factors	2	■ Soil physical factors	2
■ Salinity	2-3	■ Salinity	2
■ Nutrient deficiency	2	■ Nutrient deficiency	1
■ Rockiness	1	■ Flooding	1
■ Wetness	3		
■ Flooding	1		
■ Workability	2		

F.4.2 Soil Type: A2

CONCEPT

Deep Grey brown uniform clay over hard yellowish brown alkaline subsoils

Marginal cropping land.

MAJOR SOIL FEATURES

- Deep grey brown cracking clays which are coarser structured than A1.
- The surface is moderate to coarse granular structure and self mulching.
- The upper 60 cm layer is dark grey/brown, alkaline with a hard angular structure which overlies coarse blocky yellowish brown clay subsoils.
- Strongly saline and sodic below 50cm depth.
- PAWC is restricted by the hard clay subsoil and salinity (calculated at 94mm).
- Overall fertility is quite good. Fertiliser inputs are indicated.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 18

LOCATION: 369942E 6976600N Z56

LANDFORM ELEMENT: Flat plain

LANDFORM PATTERN: Alluvial plain

SLOPE: <1%

SURFACE COARSE FRAGMENTS: nil

AUST. SOIL CLASSIFICATION: Vertosol

MAIN VEGETATION: cleared Poplar Box mixed scrub

DISTURBANCE: Old cultivation

MICRO RELIEF: Absent

PERMEABILITY: Very slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking

SUBSTRATE: Alluvium

SOIL PROFILE MORPHOLOGY

	Horizon Depth (cm)	Description
	A1 0 – 20	Dark brown (10YR3/3), medium heavy clay, granular, field pH 7.5, no inclusions, moist, abrupt to;
	B21 20 – 60	Very dark greyish brown (10YR3/2), medium heavy clay, no bleach, coarse angular blocky, field pH 7.5, moist, gradual to,
	B22 60 – 120	Yellowish brown (10YR5/4), medium heavy clay, hard and dense angular blocky, field pH 9.0, common calcareous nodules, moist

Laboratory Data Summary - Site 18

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 18 is saline below 50cm depth.
- Soil reaction is neutral becoming strongly alkaline with depth.
- The soil is highly sodic below 50cm depth and an R1 of 0.71 together with a magnesium dominated subsoil indicates strong dispersive tendency.
- Surface fertility is reasonable but requires inputs for adequate crop growth and production. Extractable P, organic carbon, Total N are reasonably low, trace elements are in adequate supply and sulfate sulphur is low to medium.
- The surface has a clay % of 54 with silt and fine sand making up most of the remainder. It is classed as medium clay.
- Clay mineralogy is dominated by expanding smectite clay minerals in the upper soil layer.
- Effective rooting depth is restricted by the saline and sodic subsoil and is assessed as 0.5 – 0.6m
- calculated plant available water content (PAWC) is 94 mm.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	medium
P (bicarb)	medium
Org. carbon	high
Sulphate - S	medium
Ca	high
Mg	medium
K	Very high
Na	low

Attribute	Comment
Cation exchange capacity	high
ESP	Very low
Cu	medium
Zn	high
Mn	medium
Fe	Medium
Total N	Very high

Shell (1999) – Major Data Trends

This soil type was not described.

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 4		**Grazing native and improved pastures** **Class** : 3	
Major Limitations and Severity:		**Major Limitations and Severity:**	
■ Water availability	3-4	■ Water availability	3
■ Susceptibility to erosion	2	■ Susceptibility to erosion	2
■ Soil physical factors	3	■ Soil physical factors	2
■ Salinity	2	■ Salinity	2
■ Nutrient deficiency	2	■ Nutrient deficiency	2
■ Rockiness	1		
■ Wetness	2		
■ Flooding	2		
■ Workability	3		

F.4.3 Soil Type: A3

CONCEPT

Old thin sandy alluvial plain on alkaline coarse structured dark brown subsoil.

Often with bleached A2 at 20cm.

Not suited to cropping.

MAJOR SOIL FEATURES

- Coarse, hard structured red brown clays or thin duplex soils.
- The surface is firm, often with ironstone gravels and cracking.
- The surface 30 cm layer has weak crumb or angular structure which overlies quite hard, coarse blocky red brown clay subsoils.
- Effective rooting depth is restricted to about 30cm by very hard sodic clay below this depth.
- Soil reaction is neutral becoming very alkaline with depth.
- Strongly saline below 50cm depth.
- PAWC considered low (approx 72 mm).
- Overall fertility is reasonable except for low cation exchange capacity, organic carbon and potassium.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 50

LOCATION: 373637E 6973479N Z56

LANDFORM ELEMENT: Flat plain

LANDFORM PATTERN: Alluvial plain

SLOPE: <1%

SURFACE COARSE FRAGMENTS: nil

AUST. SOIL CLASSIFICATION: Crusty, Brown Vertosol

MAIN VEGETATION: cleared Poplar Box mixed scrub

DISTURBANCE: very old cultivation

MICRO RELIEF: Absent

PERMEABILITY: Very slow

DRAINAGE: poor

SURFACE CONDITION: Firm, sandy crusty and cracking

SUBSTRATE: Alluvium

SOIL PROFILE MORPHOLOGY

	Horizon	Depth (cm)	Description
	A11	0 – 20	Brown (7.5YR4/2), Light sandy clay, angular, field pH 6.5, no inclusions, dry, clear to;
	A12	20 – 22	Sporadic bleach, abrubt to;
	B21	22 – 50	Dark brown (10YR3/3), sandy clay, very hard and coarse angular blocky, field pH 9.0, common calcareous nodules, moist, gradual to;
	B22	50 – 100+	Reddish brown (5YR4/3), medium heavy clay, very hard and dense angular blocky, field pH 9.0, common calcareous nodules, moist

Laboratory Data Summary - Site 50

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 50 is saline below 50cm depth. Chloride accounts for the major proportion of the EC.
- Soil reaction is neutral becoming strongly alkaline with depth.
- The soil is highly sodic below 20cm depth and an R1 of 0.81 together with a magnesium dominated subsoil indicates strong dispersive tendency.
- Overall fertility is quite good except for low organic carbon and potassium.
- The surface has a clay % of 58 which is classed as medium clay. Clay content in the hard subsoil is 63%.
- Effective rooting depth is restricted by the hard structured, saline and sodic subsoil and is assessed as 30cm in site 50.
- Calculated plant available water content (PAWC) is 72 mm.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	medium
P (bicarb)	medium
Org. carbon	low
Sulphate - S	medium
Ca	medium
Mg	medium
K	low
Na	low
Cation exchange capacity	low

Attribute	Comment
ESP	low
Cu	medium
Zn	medium
Mn	medium
Fe	medium
Total N	high

Shell (1999) – Major Data Trends

This soil type was not described.

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 5		**Grazing native and improved pastures** **Class** : 4	
Major Limitations and Severity:		**Major Limitations and Severity:**	
■ Water availability	5	■ Water availability	4
■ Susceptibility to erosion	3	■ Susceptibility to erosion	2
■ Soil physical factors	4	■ Soil physical factors	3
■ Salinity	2	■ Salinity	2
■ Nutrient deficiency	3	■ Nutrient deficiency	2
■ Rockiness	1	■ ESP	3
■ Wetness	3		
■ Flooding	2		
■ Workability	3		

F.4.4 Soil Type: A4

CONCEPT

Fine thin dark brown sandy loam over hard reddish brown clay subsoil.

Higher relic alluvial plain with Poplar Box.

Often with bleached A2.

Not suitable for cropping.

MAJOR SOIL FEATURES

- Sandy hard setting duplex soils.
- The surface 20 – 30 cm layer is a dispersive sandy loam which overlies very hard, coarse blocky red brown clay subsoils.
- Soil reaction is neutral becoming very alkaline with depth.
- Strongly sodic below 20cm depth.
- PAWC considered very low 48mm).
- Fertility is poor with low N, P, organic carbon, calcium, potassium in addition to having low cation exchange capacity and sodic.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 38

MAIN VEGETATION: Poplar Box, Moreton Bay Ash, Belah

LOCATION: 372126E 6973100N Z56

DISTURBANCE: Grazing land

LANDFORM ELEMENT: Very gently undulating plain

MICRO RELIEF: Absent

SUBSTRATE: Alluvium

LANDFORM PATTERN: Relic Alluvial plain

PERMEABILITY: Very slow

SLOPE: 1%

DRAINAGE: Very poor

SURFACE COARSE FRAGMENTS: minor rounded ironstone

SURFACE CONDITION: Hardsetting. Termite mounds common 0.7m high

A**UST. SOIL CLASSIFICATION:** Mottled Brown Sodosol

SOIL PROFILE MORPHOLOGY

	Horizon	Depth (cm)	Description
	A11	0 – 20	Dark Brown (7.5YR4/4), weak structure, fine sandy loam, field pH 6.0, no inclusions, dry, clear to;
	B21	20 – 50	Yellowish brown (10YR5/6), sandy clay, very hard and coarse columnar, field pH 8.5, few orange mottles and calcareous nodules, dry, gradual to;
	B22	50-100+	Reddish brown (5YR4/3), medium clay, very hard blocky, field pH 8.5, yellow and grey mottles common, some rounded ironstone gravels to 10mm.

Laboratory Data Summary - Site 38

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 38 is non saline throughout but salt is almost at the saline level by 90cm. Chloride accounts for the major proportion of the EC detected.
- Soil reaction is neutral becoming strongly alkaline with depth.
- The soil is sodic at the surface and increases down the profile. This, together with subsoil R1's > 0.85 and magnesium dominated subsoil indicates strong dispersive tendency.
- Fertility is poor with low N, P, organic carbon, calcium, potassium in addition to having low cation exchange capacity and sodic.
- The surface 20cm layer is dominated by coarse sand (31%) and the subsoil by clay (38%) and fine sand (32%). The subsoil is very poorly structured and hard setting.
- Effective rooting depth is restricted by the hard structured, sodic subsoil and is assessed as 30cm.
- Calculated plant available water content (PAWC) is 48 mm.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	Very low
P (bicarb)	low
Org. carbon	low
Sulphate - S	medium
Ca	low
Mg	medium
K	low
Na	medium
Cation exchange capacity	low
ESP	sodic
Cu	medium

Attribute	Comment
Zn	medium
Mn	medium
Fe	medium
Total N	medium

Shell (1999) – Major Data Trends

No sites described matching this soil

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 5	**Grazing native and improved pastures** **Class** : 4
Major Limitations and Severity: ■ Water availability 5 ■ Susceptibility to erosion 3 ■ Soil physical factors 3 ■ Salinity 2 ■ Nutrient deficiency 3 ■ Rockiness 2 ■ Wetness 2 ■ Flooding 2 ■ Workability 2	**Major Limitations and Severity:** ■ Water availability 4 ■ Susceptibility to erosion 2 ■ Soil physical factors 2 ■ Salinity 2 ■ Nutrient deficiency 2 ■ ESP 3

F.4.5 Soil Type: A5

CONCEPT

Recent brown alluvia on Lagoon Creek

Minor unit in survey. Recent alluvia associated with Lagoon Creek. Mainly uniform deep clay with Brigalow.

Flood hazard for cropping.

MAJOR SOIL FEATURES

- Moderately deep light sandy red brown clays.
- The surface is firm, often with ironstone gravels and usually non-cracking.
- The surface 20 – 30 cm layer has weak angular structure which overlies coarse blocky red brown clay subsoils.
- Soil reaction is neutral becoming very alkaline with depth.
- Often saline and sodic below 50cm depth.
- PAWC considered moderate (approx 120 - 140mm).
- Overall fertility is quite good - from Shell (1999) report

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 66

LOCATION: 372720N 6978160E Z56

LANDFORM ELEMENT: Flat plain

LANDFORM PATTERN: Alluvial plain

SLOPE: <0.5%

SURFACE COARSE FRAGMENTS: few small rounded ironstone

AUST. SOIL CLASSIFICATION: Self mulching, Grey Vertosol

MAIN VEGETATION: Cleared Brigalow Poplar Box

DISTURBANCE: Cultivation

MICRORELIEF: nil

PERMEABILITY: Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking, coarse self mulching

SUBSTRATE: Alluvium

		Horizon Depth (cm)		Description
0 cm 20 cm 50 cm		60 cm 80 cm 100 cm	A1 0 – 20 B21 20 – 70 B22 60 -120	Brownish grey (10YR4/3), medium clay, granular, field pH 8.5, some carbonate concretions to 5 mm, dry, clear to, Dark greyish brown (10YR4/2), medium clay, sub-angular blocky, field pH 8.5, some carbonate nodules 2-5 mm, moist, gradual to, Brown (10YR5/3), medium heavy clay, strong sub-angular blocky, field pH 8.5, increasing carbonate nodules 2-5 mm, moist.

Shell (1999) – Major Data Trends

- 2 sites underwent laboratory analysis.
- pH trends are alkaline throughout
- possibly saline below 80cm and sodic below 50cm
- Ca:Mg favourable for sound structure
- Low dispersion indicated in surface layers
- Moderate cation exchange capacity
- Adequate N, P and other major nutrients
- PAWC assessed at 120 - 140mm for effective rooting depth of 80cm

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 5		**Grazing native and improved pastures** **Class** : 3	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	2	▪ Water availability	1
▪ Susceptibility to erosion	2	▪ Susceptibility to erosion	2
▪ Soil physical factors	1	▪ Soil physical factors	1
▪ Salinity	1	▪ Salinity	1
▪ Nutrient deficiency	1	▪ Nutrient deficiency	1
▪ Topography	5	▪ Wetness	2
▪ Wetness	4	▪ Flooding	3
▪ Flooding	4		
▪ Workability	2		

F.4.6 Soil Type: B1

CONCEPT

Deep, dark grey brown well structured, self mulching and cracking softwood scrub soils on undulating plains.

Highly productive cropping soil with two variants for reduced soil depth and increasing slope gradient. Basaltic colluvium on sandstone.

MAJOR SOIL FEATURES

- Light clay scrub soil of very high agricultural value - Class 2 cropping land when slope gradient is less than 3%.
- Deep and dark well structured medium clays which are freely drained.
- The surface is friable with strong self mulching character.
- Soil reaction is slightly alkaline becoming moderately alkaline with depth.
- Non saline or sodic throughout.
- PAWC considered very high but reduces somewhat in the shallow variant.
- The steeper upslope variant varies only because of a higher erosion susceptibility limitation.
- Very strong overall fertility. Fertiliser inputs in evidence.
- Decomposing sandstone or mixed sediments may be encountered from 60 cm in the shallow variant but normally > 100cm.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 28

LOCATION: 371033E 6973954N Z56

LANDFORM ELEMENT: Lower - midslope

LANDFORM PATTERN: Gently undulating plain

SLOPE: 3

SURFACE COARSE FRAGMENTS: few small rounded ironstone

AUST. SOIL CLASSIFICATION: Self mulching, Brown Vertosol

MAIN VEGETATION: Cleared Brigalow Belah softwood scrub

DISTURBANCE: Cultivation

MICRO RELIEF: absent

PERMEABILITY Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking, self mulching

SUBSTRATE: Mixed colluvium

SOIL PROFILE MORPHOLOGY

	Horizon Depth (cm)	Description
	A1 0 – 30 B21 30 – 50 B22 50 - 120	Very dark greyish brown (10YR3/2), medium heavy clay, fine granular, field pH 8.5, no inclusions, dry, abrupt change to, Dark grey (10YR4/1), medium heavy clay, strong sub-angular blocky, field pH 9.0, some calcareous concretions, moist, gradual change to; Greyish brown (10YR5/2. heavy clay, strong lenticular structure, some manganese and carbonate concretions, field pH 9.0.

Laboratory Data Summary - Site 28

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 28 is non saline or sodic throughout.
- Soil reaction is slightly alkaline becoming moderately alkaline with depth.
- The entire soil profile is non dispersive, all R1's <0.43, and calcium dominated cations which indicates strong stable behaviour.
- Very strong overall fertility. Fertiliser inputs in evidence.
- The profile is a uniform smectite clay dominated soil. Clay content varies from 43% in the surface to 57% at 80cm depth. The subsoil is very strongly structured and porous.
- Effective rooting depth is not restricted to 90cm except in the shallow variant where bedrock is encountered from 60 cm.
- Calculated plant available water content (PAWC) is >140 mm for soils > 0.9m deep and 110 mm for a 0.6m deep shallow variant.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	high
P (bicarb)	high
Org. carbon	Low / medium
Sulphate - S	high
Ca	Very high
Mg	high
K	medium
Na	very low
Cation exchange capacity	high

Attribute	Comment
ESP	very low
Cu	medium
Zn	medium
Mn	medium
Fe	medium low
Total N	high

Shell (1999) – Major Data Trends

- 4 sites underwent laboratory analysis.
- pH trends from slightly alkaline surface to highly alkaline with depth
- non saline to at least 150cm and possibly sodic below 110cm
- Ca:Mg favourable for sound structure
- Low dispersion indicated
- High cation exchange capacity
- Moderate to high N, P and other major nutrients
- PAWC assessed 150-160mm (for 100cm plant root effective depth).
- PAWC for the shallow variant with 60cm effective rooting depth is assessed at 110mm

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 2 / 3		**Grazing native and improved pastures** **Class** : 2	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	2	▪ Water availability	1
▪ Susceptibility to erosion	3	▪ Susceptibility to erosion	2
▪ Soil physical factors	1	▪ Soil physical factors	1
▪ Salinity	1	▪ Salinity	1
▪ Nutrient deficiency	1	▪ Nutrient deficiency	1
▪ Rockiness	1		
▪ Wetness	1		
▪ Flooding	1		
▪ Workability	1		

F.4.7 Soil Type: B2

CONCEPT Dark brown cracking self mulching Brigalow and Belah clays over firm red brown clay sub soils Productive cropping capability.	

MAJOR SOIL FEATURES

- Moderately deep uniform red brown clays.
- Higher clay content and plant water storage potential than B1, particularly in the surface layer.
- The surface may have a thin sandy veneer with ironstone gravels.
- The surface 40 to 50cm cm layer overlies well structured blocky brown clay subsoils.
- Soil reaction is neutral becoming very alkaline with depth.
- Possibly saline below 80cm depth.
- PAWC considered high.
- Strong overall fertility. Fertiliser inputs suspected.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 2

LOCATION: 373535E 6978164N Z56

LANDFORM ELEMENT: Lower slope

LANDFORM PATTERN: Gently undulating plain

SLOPE: 1

SURFACE FRAGMENTS: few small rounded ironstone

SUBSTRATE: Mixed colluvium

MAIN VEGETATION: Cleared Brigalow

DISTURBANCE: Cultivation

MICRORELIEF: Possible linear gilgai pre cropping

PERMEABILITY: Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking, self mulching

AUST. SOIL CLASSIFICATION: Self mulching, Brown Vertosol

SOIL PROFILE MORPHOLOGY

	Horizon Depth (cm)	Description
80cm 120 cm		
	A1 0 – 0.5 B21 0.5 – 45 B22 45 -120	Very dark grey (10YR3/1), medium heavy clay, fine granular, field pH 8.5, no inclusions, dry, abrupt to, Very dark greyish brown (10YR3/2), medium heavy clay, , field pH 8.5, some carbonate nodules 2-5mm, moist, gradual to, Brown (10YR4/4), medium clay, strong subangular blocky, field pH 6.5, no inclusions, moist.
Surface 40 cm		

Laboratory Data Summary - Site 2

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 2 is saline below 80cm depth.
- Soil reaction is slightly alkaline becoming moderately alkaline with depth.
- The soil profile is non dispersive to at least 60cm and increasing slightly below this depth. Magnesium dominates the cations below 60cm which may decrease soil stability however all R1's are <0.51 which indicates sound stability. Overall, the soil profile is moderately stable.
- Strong overall fertility. Fertiliser inputs suspected.
- The profile is dominated by smectites with clay content varying from 61% in the surface to 63% at 80cm depth. The subsoil is moderately well structured and porous.
- Effective rooting depth varies from 0.6 – 0.9m depending on salt accumulation layer.
- Calculated plant available water content (PAWC) is >120 mm for soils > 0.9m deep soil. Many soils exceed this depth

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	low
P (bicarb)	medium
Org. carbon	high
Sulphate - S	medium
Ca	high
Mg	high
K	high
Na	low
Cation exchange capacity	Very high
ESP	Very low
Cu	high
Zn	medium

Attribute	Comment
Mn	medium
Fe	medium
Total N	Very high

Shell (1999) – Major Data Trends

- 3 sites underwent laboratory analysis.
- pH trends from neutral surface to alkaline with depth
- non saline throughout but sodic below 50cm
- Ca:Mg favourable for sound structure
- Low dispersion indicated in surface layer
- Moderate cation exchange capacity
- Reasonable N, P and other major nutrients
- PAWC assessed as 100 mm (for 60cm plant root effective depth) and 130mm for 90cm effective depth.

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 2		**Grazing native and improved pastures** **Class** : 1	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	2	▪ Water availability	1
▪ Susceptibility to erosion	2	▪ Susceptibility to erosion	1
▪ Soil physical factors	1	▪ Soil physical factors	1
▪ Salinity	1	▪ Salinity	1
▪ Nutrient deficiency	1	▪ Nutrient deficiency	1
▪ Rockiness	1		
▪ Wetness	1		
▪ Flooding	1		
▪ Workability	1		

F.4.8 Soil Type: B3

CONCEPT

Uplands thin dark cracking and duplex dark grey soils over hard yellowish brown alkaline subsoils on sandstone

Limited Cropping suitability

MAJOR SOIL FEATURES

- Moderately deep clays with clay loam A horizon to about 20cm.
- Cropping suitability class is lower than B1 and B2 because of high salinity below 50cm reducing plant available water content.
- The surface is firm, often with ironstone gravels and usually non-cracking.
- The surface 20 cm layer has weak crumb or angular structure which overlies quite hard, dark clay subsoils.
- Soil reaction is alkaline throughout.
- Strongly saline and sodic below 50cm depth.
- PAWC considered moderate (approx 80 – 100 mm).
- Fertility is reasonable but with very low P, organic carbon, sulphate and zinc.
- Decomposing sandstone or mixed sediments may be encountered from 80 cm.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 87

LOCATION: 367526E 6979296N Z56

LANDFORM ELEMENT: Upper slope

LANDFORM PATTERN: Undulating plain

SLOPE: 2%

SURFACE COARSE FRAGMENTS: nil

AUST. SOIL CLASSIFICATION: Grey chromosol

MAIN VEGETATION: Tall Poplar Box, Brigalow and Belah

DISTURBANCE: Open forest / grazing

MICRO RELIEF: Absent

PERMEABILITY: Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Cracking, self mulching

SUBSTRATE: Sandstone

SOIL PROFILE MORPHOLOGY

	Horizon Depth (cm)	Description
	A1 0 – 20 B21 20 –60 B22 60 -150 BC 150+	Very dark greyish brown (10YR3/2), clay loam, strong granular, field pH 7.0, no inclusions, dry, abrupt change to, Very dark grey (10YR3/1), medium heavy clay, strong angular blocky, field pH 8.0, some 2-5mm, moist, gradual change to, Pale brown (10YR5/3), medium heavy clay, strong sub-angular blocky, field pH 9.0, carbonate nodules increasing with depth, moist. Sandstone gravels common and increasing with depth Sandstone bedrock

Laboratory Data Summary - Site 87

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 28 is highly saline and sodic below 50cm depth. Chloride dominates the EC.
- Soil reaction is slightly alkaline becoming highly alkaline with depth.
- The soil profile is dispersive below 50cm depth although R1's and a calcium dominated cation exchange do not suggest instability.
- Fertility is reasonable but with very low P, organic carbon, sulphate and zinc.
- The profile is a uniform clay dominated soil with a clay content at 30cm of 52% and 67% at 60cm.
- Effective rooting depth is restricted to about 50cm because of highly saline soil below this level.
- Plant available water content (PAWC) is estimated at 80 - 100 mm for most soils.

Note that higher levels of subsoil salinity was detected by the current survey than Shell (1999) found for similar soil types (refer following).

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	medium
P (bicarb)	Very low
Org. carbon	low
Sulphate - S	low
Ca	Very high
Mg	high
K	high
Na	Very low
Cation exchange capacity	high

Attribute	Comment
ESP	Very low
Cu	medium
Zn	low
Mn	medium
Fe	medium
Total N	medium

Shell (1999) – Major Data Trends

- 3 sites underwent laboratory analysis.
- pH trends from neutral surface to alkaline with depth
- saline below 90cm and sodic below 100cm
- Ca:Mg favourable for sound structure
- Low dispersion indicated in surface layer but increasing with depth
- Moderate to high cation exchange capacity
- Moderate N, P and other major nutrients but adequate.
- PAWC assessed as 120mm (for 100cm plant root effective depth).

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 4		**Grazing native and improved pastures** **Class** : 2	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	4	▪ Water availability	2
▪ Susceptibility to erosion	3	▪ Susceptibility to erosion	2
▪ Soil physical factors	2	▪ Soil physical factors	1
▪ Salinity	3	▪ Salinity	1
▪ Nutrient deficiency	2	▪ Nutrient deficiency	1
▪ Rockiness	1		
▪ Wetness	1		
▪ Flooding	1		
▪ Workability	2		

F.4.9 Soil Type: B4

CONCEPT Thin red brown sandy clay loam or light clays on hard alkaline red brown clay subsoil on mixed sediments. Poplar Box and Belah Very limited cropping capability.	

MAJOR SOIL FEATURES

- Moderately deep uniform red brown clays or thin duplex soils.
- The surface is firm, often with ironstone gravels and usually non-cracking.
- The surface 20 – 30 cm layer has weak crumb or angular structure which overlies quite hard, coarse blocky red brown clay subsoils.
- Soil reaction is neutral becoming very alkaline with depth.
- Non- saline or sodic to at least 90cm depth.
- PAWC considered moderate (approx 90-100mm).
- Reasonable overall fertility but for low / medium cation exchange capacity.
- Decomposing sandstone or mixed sediments may be encountered from 60 cm or less on upper slope positions.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 12

LOCATION: 369950E 6977840N Z56

LANDFORM ELEMENT: Mid slope

LANDFORM PATTERN: Undulating plain

SLOPE: 1.5%

SURFACE COARSE FRAGMENTS: ironstone rounded 5-10mm

AUST. SOIL CLASSIFICATION: Red ferrosol

MAIN VEGETATION: Poplar Box, carissa

DISTURBANCE: Mostly cleared for grazing

MICRO RELIEF: Absent

PERMEABILITY: Slow

DRAINAGE: Imperfect

SURFACE CONDITION: Firm sandy

SUBSTRATE: Mixed sediments on sandstone

SOIL PROFILE MORPHOLOGY

	Horizon Depth (cm)	Description
	A1 0 – 20	Dark reddish brown (5YR3/2), clay loam, gravelly, granular, field pH 7.5, no inclusions, dry, abrupt change to,
	B21 20 –70	Dark red (2.5YR3/6), light clay, strong angular blocky, field pH 7.5, some small ironstone gravels, gradual change to,
	B22 70 -100	Yellowish red (5YR5/6), medium clay, strong sub-angular blocky, field pH 8.0, calcareous nodules increasing with depth, moist. Sandstone gravels increasing with depth

Laboratory Data Summary - Site 12

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 12 is non saline or sodic throughout.
- Soil reaction is neutral becoming moderately alkaline with depth.
- The entire soil profile is non sodic with calcium dominated cations however R1's range from 0.82 to 0.99 which indicates some dispersive tendency.
- Reasonable overall fertility but for low / medium cation exchange capacity.
- The profile has medium clay subsoils which are quite coarsely structured possibly as a result of quite high fine sand content with the clay dominated medium.
- Analytical data suggests that effective rooting depth is not restricted to 90cm however the hard impervious clay will inhibit root exploitation. Effective root depth is limited to about 60cm.
- Calculated plant available water content (PAWC) is in a range from 85 to 115 mm for soils > 0.9m deep.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	high
P (bicarb)	medium
Org. carbon	medium
Sulphate - S	Low medium
Ca	high
Mg	medium
K	high

Attribute	Comment
Na	Very low
Cation exchange capacity	Medium low
ESP	Very low
Cu	medium
Zn	high
Mn	high
Fe	medium
Total N	Very high

Shell (1999) – Major Data Trends

- 2 sites underwent laboratory analysis.
- pH trends from neutral surface to alkaline with depth
- non saline to 100cm but often sodic below 30cm
- Ca:Mg favourable for sound structure
- Low dispersion indicated in surface layer
- Moderate cation exchange capacity
- Low to moderate N, P but other major nutrients adequate

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 4/5		**Grazing native and improved pastures** **Class** : 3	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	4	▪ Water availability	3
▪ Susceptibility to erosion	4	▪ Susceptibility to erosion	3
▪ Soil physical factors	3	▪ Soil physical factors	2
▪ Salinity	2	▪ Salinity	1
▪ Nutrient deficiency	2	▪ Nutrient deficiency	1
▪ Rockiness	1		
▪ Wetness	1		
▪ Flooding	1		
▪ Workability	3		

F.4.10 Soil Type: Ba1

CONCEPT **Fine brown light clay over well structured red brown medium clays over hard brown clay or weathered basalt** Mountain Coolibah Productive cropping land	

MAJOR SOIL FEATURES

- Moderately deep uniform red brown clays or thin duplex soils.
- Well structured medium heavy clay with good drainage.
- The surface is sandy, often with ironstone gravels and usually non-cracking.
- The surface 20 – 30 cm layer has strong granular structure which overlies well structured and permeable red brown clay subsoils.
- Soil reaction is neutral becoming very alkaline with depth.
- Non saline or sodic throughout.
- PAWC considered very high (>140mm).
- Strong overall fertility. Fertiliser inputs likely.
- Decomposing basalt usually encountered from 70 to 90 cm.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 101

LOCATION: 367845E 6980937N Z56

LANDFORM ELEMENT: Mid upper slope

LANDFORM PATTERN: Undulating plain

SLOPE: 1.5%

SURFACE COARSE FRAGMENTS: Basalt and ironstone pebbles

AUST. SOIL CLASSIFICATION: Ferrosol

MAIN VEGETATION: Originally open Mountain Coolibah

DISTURBANCE: Mostly cleared for cropping

MICRO RELIEF: Absent

PERMEABILITY: moderate

DRAINAGE: well drained

SURFACE CONDITION: Soft. Non-cracking

SUBSTRATE: Basalt

SOIL PROFILE MORPHOLOGY

	Horizon	Depth (cm)	Description
	Ap	0 – 40	Dark reddish brown (5YR3/3), fine sandy clay, granular, field pH 7.5, no inclusions, dry, abrupt change to,
	B21	40 –70	Yellowish red (5YR4/6), medium clay, strong sub-angular blocky, field pH 8.5, moderate calcareous concretions and manganese, clear change to,
	BC	70 -120	Weathered basalt. Field pH 9.0

Laboratory Data Summary - Site 101

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 101 is non saline or sodic to 90cm depth.
- Soil reaction is neutral becoming highly alkaline with depth.
- The entire soil profile is non dispersive and R1's are <0.6 which indicates stable tendencies. However magnesium dominates calcium quite significantly which appears erroneous given the basalt derived medium.
- Surface fertility is very strong.
- The profile is a uniform clay with content about 70%.
- Effective rooting depth is not restricted to 90cm except in occasional shallow variants where bedrock is encountered from about 80 cm.
- Calculated plant available water content (PAWC) is >150 mm.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	high
P (bicarb)	Very high
Org. carbon	medium
Sulphate - S	high
Ca	medium
Mg	medium
K	high
Na	Very low
Cation exchange capacity	high

Attribute	Comment
ESP	Very low
Cu	medium
Zn	medium
Mn	medium
Fe	medium
Total N	medium

Shell (1999) – Major Data Trends

- 3 sites underwent laboratory analysis.
- pH trends from alkaline surface to highly alkaline with depth
- generally non saline or sodic
- Ca:Mg favourable for sound structure
- Low dispersion indicated in surface layer
- Very high cation exchange capacity
- Quite high N, P and other major nutrients
- PAWC assessed 150mm (for 90cm plant root effective depth).

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 3		**Grazing native and improved pastures** **Class** : 2	
Major Limitations and Severity:		**Major Limitations and Severity:**	
▪ Water availability	1	▪ Water availability	1
▪ Susceptibility to erosion	3	▪ Susceptibility to erosion	2
▪ Soil physical factors	2	▪ Soil physical factors	1
▪ Salinity	1	▪ Salinity	1
▪ Nutrient deficiency	1	▪ Nutrient deficiency	1
▪ Rockiness	1		
▪ Wetness	1		
▪ Flooding	1		
▪ Workability	1		

F.4.11 Soil Type: Ba2

CONCEPT **Thick black cracking and mulching medium clay on fresh and weathered basalt on uplands.** Good cropping soil	

MAJOR SOIL FEATURES

- Moderately deep and dark medium heavy clays on basalt.
- The surface is granular and deeply cracking.
- Soil reaction is slightly alkaline throughout.
- Non saline or sodic throughout.
- Effective rooting and PAWC only restricted by depth to basalt rock. (Normally 70 – 80 cm)
- Strong overall fertility
- Fresh and decomposing basalt encountered from 70 cm.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 96

LOCATION: 368313E 6980887N Z56

LANDFORM ELEMENT: Upper slope

LANDFORM PATTERN: Undulating plain

SLOPE: 0.5%

SURFACE COARSE FRAGMENTS: Some Basalt to 50mm

AUST. SOIL CLASSIFICATION: Self Mulching Black Vertosol

MAIN VEGETATION: Originally open Mountain Coolibah

DISTURBANCE: Cultivation

MICRO RELIEF: Absent

PERMEABILITY: moderate

DRAINAGE: well drained

SURFACE CONDITION: Soft. Cracking and self mulching

SUBSTRATE: Basalt

SOIL PROFILE MORPHOLOGY

	Horizon	Depth (cm)	Description
	Ap	0 – 40	Very dark grey (10YR3/1) medium clay, strong subangular blocky, field pH 8.0, some calcareous nodules to 3mm, moist, abrupt change to,
	B21	40 – 75	Dark greyish brown (10YR4/2 medium heavy clay, calcareous nodules common, strong lenticular structure, field pH 8.5, clear change to,
	BC	75 +	Basalt bedrock

Laboratory Data Summary - Site 96

A detailed assessment by Dennis Baker (Environmental Soil Solutions), together with data from chemical analysis is included as Attachment 2.

Major aspects from this report are reproduced below.

- Site 101 is non saline or sodic to weathered basalt.
- Soil reaction is slightly alkaline throughout.
- The entire soil profile is non dispersive and R1's are <0.4 which indicates stable tendencies. Calcium dominates the cations with a healthy ratio over magnesium.
- Surface fertility is strong.
- The profile is a uniform clay with content about 77% throughout. This is a medium heavy clay.
- Effective rooting depth is restricted only by the depth to basalt parent rock which is usually 65 to 75 cm.
- Calculated plant available water content (PAWC) is 125 mm for 80cm soil depth.

Fertility Summary of surface 10cm

(refer Attachment 2 for complete data)

Attribute	Comment
Nitrate -N	medium
P (bicarb)	medium
Org. carbon	medium
Sulphate - S	low
Ca	Very high
Mg	high
K	Very high
Na	Very low
Cation exchange capacity	Very high
ESP	Very low
Cu	medium
Zn	low

Attribute	Comment
Mn	low
Fe	medium
Total N	medium

Shell (1999) – Major Data Trends

- 3 sites underwent laboratory analysis.
- pH trends from alkaline surface to highly alkaline with depth
- non saline or sodic
- Ca:Mg favourable for sound structure
- Very low dispersion indicated throughout
- Very high cation exchange capacity
- Quite high N, P and other major nutrients
- PAWC assessed 120mm (for 70cm soil layer over weathered basalt).

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 2		**Grazing native and improved pastures** **Class** : 1	
Major Limitations and Severity:		**Major Limitations and Severity:**	
■ Water availability	2	■ Water availability	1
■ Susceptibility to erosion	2	■ Susceptibility to erosion	1
■ Soil physical factors	1	■ Soil physical factors	1
■ Salinity	1	■ Salinity	1
■ Nutrient deficiency	1	■ Nutrient deficiency	1
■ Rockiness	2		
■ Wetness	1		
■ Flooding	1		
■ Workability	1		

F.4.12 Soil Type: Ba3

CONCEPT	
Shallow generally basaltic rocky upland areas Basalt outcrops and ridge lines Very limited cropping suitability	

MAJOR SOIL FEATURES

- Shallow and very rocky red brown clays on fresh basalt.
- The surface is soft, often with extensive basalt rock and usually non-cracking.
- The surface 20 – 30 cm layer has granular structure
- Soil reaction is alkaline.
- Non saline or sodic.
- PAWC considered low (<70mm).
- Quit good fertility but major issue is lack of soil.

REPRESENTATIVE SOIL PROFILE

SITE NUMBER: 108

LOCATION: 368590E 6982015N Z56

LANDFORM ELEMENT: Hillslope

LANDFORM PATTERN: undulating rises

SLOPE: 10%

SURFACE COARSE FRAGMENTS: Extensive Basalt rock

AUST. SOIL CLASSIFICATION: Brown Dermosol

MAIN VEGETATION: Mountain Coolibah

DISTURBANCE: Grazing land

MICRO RELIEF: Absent

PERMEABILITY: moderate

DRAINAGE: well drained

SURFACE CONDITION: Very rocky. Soft

SUBSTRATE: Basalt

SOIL PROFILE MORPHOLOGY

	Horizon	Depth (cm)	Description
	A1	0 – 20	Dark reddish grey (5YR4/2) light medium clay, strong granular, field pH 8.0, some calcareous nodules to 3mm, moist,
	B21	20 – 60	Dark red brown (5YR3/2 medium clay, calcareous nodules common, strong blocky structure, field pH 8.5, clear change to,
	C	60+	Basalt bedrock

Note: nearby hilltop has skeletal soil on basalt only.

Laboratory Summary - Shell (1999) site 25

ITEMS	0-20 cm depth	30-40cm depth
ACIDITY (pH)	Neutral	mildly alkaline
MAJOR ELEMENTS	high Potassium, very low avail Nitrogen, Phosphorus, sodium	-
SECONDARY ELEMENTS	high Calcium, Magnesium, low Sulphur,	high Calcium, Magnesium
TRACE ELEMENTS	adequate Copper, Manganese, Iron, Boron. low Zinc	-
ORGANIC MATTER	low - moderate	-
SALINITY	Very low EC, sodium, chloride	Very low EC
CATION EXCHANGE CAPACITY	moderate	moderate
EXCHANGE SODIUM %	non-sodic	non-sodic
CATIONS	High Ca, Mg; moderate K; Low Na; Very Low Al.	High Ca, Mg; moderate K; Low Na; Very Low Al.
Ca/Mg RATIO	adequate	adequate
R1 Dispersion	low	low
PAWC	70mm for 40cm soil depth	

AGRICULTURAL LAND SUITABILITY

Dryland cropping **Class** : 5		**Grazing native and improved pastures** **Class** : 4	
Major Limitations and Severity:		**Major Limitations and Severity:**	
■ Water availability	5	■ Water availability	3
■ Susceptibility to erosion	4	■ Susceptibility to erosion	4
■ Soil physical factors	4	■ Soil physical factors	2
■ Salinity	1	■ Salinity	1
■ Nutrient deficiency	1	■ Nutrient deficiency	1
■ Rockiness	3		
■ Wetness	2		
■ Flooding	2		
■ Workability	5		

NEW HOPE GROUP

G.1.8 Final Landform Technical Report

NEW HOPE GROUP

FINAL LANDFORM TECHNICAL REPORT

New Acland Coal Mine Stage 3 Project

JANUARY 2014

Contents

1. Introduction

1.1. Project Description

New Acland Coal Pty Ltd (NAC) currently operates the Mine, as a 4.8 million tonnes (product coal) per annum (Mtpa) open cut coal mine on Mining Lease (ML) 50170 and ML 50216, adjacent to Mineral Development Licence (MDL) 244, under the approval of Environmental Authority (EA) No. EPML00335713. The Mine is forecasted to deplete its reserves by 2017. The revised Project involves the extension and operation of the Mine, increasing production from 4.8 Mtpa up to 7.5 Mtpa of thermal product coal.

The revised Project involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within MLA 50232. These resources areas are termed the Manning Vale and Willeroo resource areas. The revised Project will include mining in three new mine pits, namely, the Manning Vale West, Manning Vale East and Willeroo mine pits.

The key objectives of the revised Project are to:

- establish and operate a sustainable and profitable coal mine;
- construct and operate a mine that complies with all relevant statutory obligations and continues to improve operations to ensure best practice environmental management;
- construct, design and operate a mine that does not compromise environmental and social indicators and standards;
- make efficient use of current infrastructure, with upgrades and expansions for the required capacity increase;
- reduce the disturbance to environmental values by minimising the footprint requirements for road and rail construction and the use of areas already disturbed for laydown and storage and handling facilities; and
- use similar proven strategies to those adopted at the Mine, for example:
  - salvage and stockpiling of topsoil;
  - early and progressive rehabilitation of disturbed areas;
  - use of recycled water as the main water supply;
  - protection of water quality by appropriate management systems; and
  - adoption of appropriate landform designs to ensure sustainability and planning for a nominated final land use.

In addition, the key features of the revised Project will include the:

- development of a suitable 'off set' strategy to satisfy State and Federal requirements for clearance of significant vegetation within new operational areas (i.e. extent of surface rights areas) on MLA 50232;
- preservation of historical items within Acland;
- comprehensive progressive rehabilitation program involving continuous monitoring and reporting in line with the agreed post mining land use; and
- amendment of NAC's existing EA commensurate to the revised Project's size and scope.

The revised Project will allow the New Hope Group (NHG) to expand its production capacity at the Mine to meet current and future market demands for its thermal coal products. The revised Project is particularly important considering the NHG's West Moreton Operations near Ipswich will exhaust current coal reserves in the near future.

The revised Project offers an opportunity for the NHG to expand its business base, improve profitability and increase its return to shareholders. The revised Project's thermal coal products are a highly valued energy resource that possesses lower sulphur content, produces less greenhouse emissions and provides a higher energy output than many alternative thermal coal sources. The revised Project will boost economic activity within the Darling Downs region through direct and indirect employment, investment and business opportunities for the life of the revised Project and beyond.

1.2. Project Life

The revised Project involves the continued development of the Mine by the progressive commissioning of two additional resource areas within MLA 50232. The two resource areas will be developed sequentially and combined with the current operations will supply up to 7.5 Mtpa of saleable product coal until approximately 2029 for export and domestic markets.

Following the successful grant of MLA 50232 in around 2015, NAC estimate approximately 2.5 years to undertake design, construction and other related activities to facilitate the continuation of mining. The proposed length of the construction period is governed by external rail developments which influence the rate of product coal transportation off-site. An indicative schedule for mining related activities on MLA 50232 is provided in **Table 1-1**. The construction phase for the revised Project involves the increase in the mining fleet and workforce, construction of supporting infrastructure and development of the new resource areas.

Table 1-1 Indicative Schedule for Mining related activities on MLA 50232

Year	Activity
2015	Environmental and mining approvals (Federal & State)
2015-2017	Cultural Heritage clearance Road closure applications Construction of the rail spur from Jondaryan and a balloon loop within the mining lease Construction of site access and roads (including re-alignments) Construction of water management structures Construction of the additional supporting infrastructure Gradual employment of additional workers
2016	Mining commences within the Manning Vale reserve area (box-cut and out-of-pit dump construction)
2016	Mining commences within the Willeroo reserve area (box-cut and out-of-pit dump construction)
2017-2029	Mining achieves the targeted production rate of 7.5 Mtpa and continues within the Manning Vale and Willeroo reserve areas until depletion of the coal reserves currently delineated for mining purposes
2029-2039	Final rehabilitation and mine closure activities

NAC will be responsible for all mining activities within the revised Project site. In line with current practices, NAC will employ contractors for specialist mining activities, such as blasting. All mining and construction activities will be conducted in compliance with the *Coal Mining Safety and Health Act 1999*.

NAC's Life of Mine Plan (LoM Plan) for the revised Project has been developed to minimise equipment capital expenditure and operational mining costs, particularly at start-up, and to maximise the net project value over the life of the revised Project. The production rate of 7.5 Mtpa is targeted to be reached after 2017. The LoM Plan allows sufficient time for the mining lease to be granted and the upgrades to the CHPP to be completed. More importantly, it also coincides with the depletion of the Glen Roslyn mining reserves. **Table 1-2** describes NAC's planned increase in production rates for the life of the revised Project.

Table 1-2 Planned Production Rates

Date from	Date to	Planned production rate
2013	2017	4.8 Mtpa
2017	2029	7.5 Mtpa

The revised Project's production rate will be closely governed by available road, rail and port capacities. Although the ability to increase production up to a 7.5 Mtpa rate occurs from 2017, NAC's current mine plan is to gradually increase production up to the proposed maximum level over a two year period. The multiple thin seam mining technique to be employed for the revised Project relies on highly experienced operators with the relevant experience required to mine the coal in an efficient and effective manner. In addition, there are physical mining constraints, statutory environmental considerations and economic consequences to rapidly increasing production.

NAC will progressively rehabilitate the active mine areas over the life of the revised Project to advance the mine closure process. Rehabilitation and full mine closure is expected to be completed in total to a standard for regulatory approval for surrender of the revised Project's mining leases by about 2039. It should be noted that these dates are subject to variation and can be significantly influenced by factors that affect the rate of mining, fluctuations in the global economic environment, legislative and regulatory changes, future business decisions by the NHCL's Board and Senior Management, and/or change of company ownership.

1.3. Purpose of the Report

This Report has been compiled to outline the methodology to be applied by NAC to ensure that the revised Project creates safe, stable and non-polluting landforms that allow the proposed final land uses to be conducted in a sustainable manner. This Report supports NAC's Final Land Use and Rehabilitation Plan (FLURP) located in **Appendix J.2** and relies on the application of a number of associated plans, for example, the Topsoil Management Plan as presented in **Appendix J.3**. NAC will continue to ensure the principles of this Report are integrated into the revised Project's general mine planning process and rehabilitation activities.

2. Environmental Characterisation

2.1. Overview

The revised Project is located within the Darling Downs area of Queensland, and as a consequence, has been exposed to a long history of agricultural production in the form of grazing (beef production) and dryland cropping. In the past prior to deregulation of the dairy industry, dairy farming was also a common form of agriculture production within the Acland area.

The topography of the revised Project area consists of gentle slopes with elevation ranging from 430 m above sea level at Lagoon Creek in the south east of the revised Project site, to 525 m above sea level on the basaltic ridge that occurs across the revised Project site. The revised Project site is located within the Lagoon Creek catchment. The majority of the terrain within the catchment is undulating and land use is predominantly grazing. Lagoon Creek is grazed and cultivated up to and within the creek channel. In the upper reaches of the catchment, the terrain becomes steeper and possesses tracts of remnant vegetation. Higher, localised peaks in the Lagoon Creek catchment are vegetated with native tree species. The Lagoon Creek channel includes a number of in-stream farm dams which disrupt the natural flow regime. The main channel of both creeks is poorly defined with significant erosion along the creek banks as described in **Chapter 5**.

In general, the long history of agricultural production within the Study area has impacted heavily upon the native vegetation with isolated patches of remnant and non-remnant status remaining mainly on rocky elevated landforms, along certain water courses, and within a number of road reserves. From an agricultural perspective, areas of 'good quality agricultural land' and more recently 'strategic cropping land' (SCL) have been delineated within the Study area from topsoil mapping and land capability studies. During late 2011, new legislative requirements for SCL were introduced by the Queensland government. The revised Project has been deemed to be in a 'transitional' phase under the new legislation, and therefore, must address the new requirements.

NAC will continue to consult with the Department of Natural Resources and Mines (DNRM) in the future to ensure compliance with the SCL legislation. As a preliminary task, NAC will lodge a validation application for the revised Project with the DNRM to delineate those areas that are not SCL, and therefore, will not require specific management to ensure statutory compliance.

2.2. Pre-Mining Land Suitability and Use

The Study area has a range of fertile soils with a desirable climate which is capable of growing a wide variety of crops and producing quality livestock. A summary of historical land use patterns within the Study area is outlined as follows. A detailed soil assessment for the revised Project is presented in **Chapter 4**.

2.2.1. Cropping Lands

An area planted for crop production is driven by market demand and the likely on-farm price of the produce. The soil type of an area is also an influencing factor in the determination of a particular enterprise selection. The main risks to sustainable long-term cropping enterprises are decreasing soil fertility, the risk of soil structure degradation, soil erosion and the security of good quality irrigation water supplies. Main summer crops in the Central Darling Downs region are cotton and sorghum followed by mung beans, millet, sunflowers, maize and soybeans. Wheat and barley are the main winter crops along with chickpeas. Summer and winter forage crops are also grown for grazing and/or harvesting as hay or silage.

Grain and forage production has introduced intensive livestock enterprises. A number of year-round cattle feedlots and poultry farms exist within the region. The Study area also

supports grazing industries for beef and dairy production. Grazing is predominately based on native pastures and also occurs on mixed farming enterprises combining grain and fodder production. A number of other minor industries including piggeries, horticulture and animal studs are present within the Study area due to the diversity of soils, proximity to markets and a favorable climate.

Cropping for grain production is one of the largest agricultural land uses and industries within the Study area cultivation for cropping and/or sown pasture carried out to some extent within the Study area. While both summer and winter crops are grown, summer crops are preferred due to higher economic returns and the summer dominant rainfall patterns within the Central Darling Downs region. Certain soil types with in the Eastern Uplands (which include the Study area) depend largely on seasonal soil moisture or, in limited areas, irrigation, where it is available.

2.2.2. Livestock production

Pasture lands occur throughout the Study area. Most of these areas carry native or sown grasses supporting grazing livestock. These pasture lands are (or were) the basis for a number of beef enterprises and to a lesser extent, dairy enterprises of the Study area. The greatest proportion of these pasture lands is under native pasture.

A detailed assessment of the pre-mining land suitability and use is presented in **Chapter 4**.

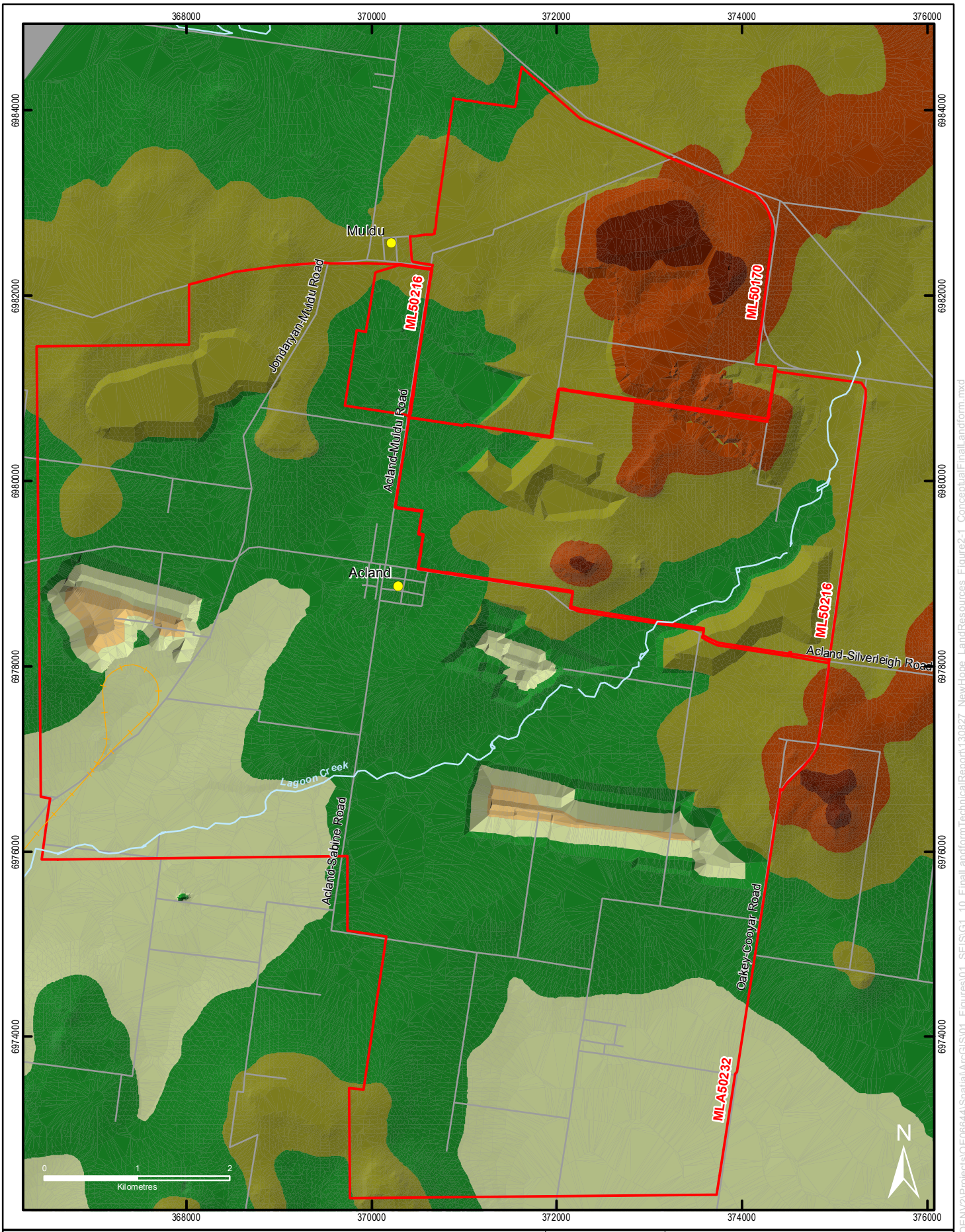
2.3. Post Mining Land Use

The conceptual final landform for the revised Project is presented in **Figure 2-1**. In summary, NAC intends to progressively rehabilitate the majority of the land disturbed by mining back to grazing (beef production), which is a common land use practice in the Acland area. This form of agricultural production will be incorporated into the Acland Pastoral Company (APC)'s farming business and longer term will be managed in a sustainable and economically beneficial manner. The APC is also a subsidiary company of the NHG, and therefore, NAC possesses a strong business imperative to ensure the revised Project's rehabilitation performance is maximised, particularly for the return of land to farming practices.

To maximise rehabilitation success, the APC is actively involved in the Mine's rehabilitation process providing agricultural advice and support through management of the current grazing trials within the Mine's rehabilitation areas. NAC and the APC will expand its grazing trials into the revised Project's rehabilitation areas in the future. The grazing trials are designed to compare the carrying capacity of the rehabilitated land with nearby undisturbed analogue sites to assess the rehabilitation process and to establish a long term sustainable grazing regime.

The revised Project's conservation zones will comprise managed natural regeneration, managed natural regeneration with supplementary tree plantings or complete rehabilitation of areas devoid of trees using specific tree planting strategies. A Conservation Zone Management Plan for revised Project is located in **Appendix J.6**. NAC's long term goal for the revised Project is to establish a net gain in its conservation status.

A detailed assessment of the post mining land use is presented in **Chapter 4**.



LEGEND

- Towns and Localities
- Rail Spur
- Roads
- Creeks
- Mining Tenements

Elevation

- 604 - 636
- 573 - 604
- 542 - 573
- 511 - 542
- 480 - 511
- 449 - 480
- 417 - 449
- 386 - 417
- 355

NEW HOPE GROUP

SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2-1 - Conceptual Final Landform

Scale 1:54,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 27/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\G1_10_FinalLandformTechnicalReport130827_NewHope_LandResources_Figure2-1_ConceptualFinalLandform.mxd

2.4. Closure Planning

As part of the initial phase of the revised Project's mine closure planning process, NAC has developed a LoM Plan and defined sustainable post mine land use goals. Over the life of the revised Project, NAC's LoM Plan will remain dynamic and will require periodic amendments to address influencing factors, such as economic changes (e.g. coal price variations), geological changes (e.g. coal resource variations) and regulatory requirements (e.g. legislative changes).

NAC will continue to investigate other possible innovative final land uses for the revised Project. NAC will ensure the applicable government authorities and the community are appropriately consulted in relation to any proposed future changes for the revised Project's final land uses. NAC will also be required to seek regulatory approval, provide satisfactory scientific evidence and ensure community expectations are satisfied for all proposed future changes to the revised Project's final land uses. NAC will ensure all consultation undertaken for the revised Project is consistent with the Local Stakeholder Management Plan and the Stakeholder Engagement Plan located in **Appendices J.18** and **K.1** respectively.

The final phase of the revised Project's mine closure planning process will commence a minimum of five years from the end of the revised Project's life and will involve the development of a dedicated Mine Closure Plan. NAC will ensure the applicable government authorities, its workforce and the community are appropriately consulted during the development of the revised Project's Mine Closure Plan and that a risk based management approach is adopted to address all relevant environmental, social, economic and safety issues/matters at the end of the revised Project's life.

NAC is committed to a mine closure process that ensures at the end of the revised Project's life (including final rehabilitation) that:

- future public health and safety are not compromised;
- environmental resources are not subject to physical and chemical deterioration;
- the post-mining use of the site is beneficial and sustainable in the long term;
- any adverse socio-economic impacts are minimised; and
- the opportunity is taken to maximise socio-economic benefits.

2.5. General Rehabilitation Goals

NAC's main rehabilitation goal is the development of a progressive rehabilitation plan for the revised Project which ensures:

- the post-mined landscape is safe and is stable from physical, geochemical and ecological perspectives;
- the quality of the surrounding water resources is protected;
- the agreed sustainable post-mining land use is established and clearly defined to the satisfaction of the community and government; and
- success criteria are agreed with the relevant stakeholders, monitored, and as required, reported to the applicable stakeholders.

2.6. Rehabilitation Hierarchy

NAC's rehabilitation hierarchy for the revised Project is based on:

- industry accepted rehabilitation practices;
- integration of those rehabilitation practices into the short, medium and long term mine plans;
- ensuring progressive rehabilitation of disturbed areas as they become available;
- creating safe, stable and non-polluting landforms; and
- allowing the proposed final land use to be achieved in a sustainable manner.

2.7. Industry Standards and Guidelines

NAC is committed to delivering 'leading practice' rehabilitation management practices for the revised Project where they are prudent, economically feasible and will deliver beneficial outcomes. NAC continues to support and/or use the services of organisations, such as the Australian Coal Research Program and the Sustainable Minerals Institute (University of Queensland) to improve its environmental management.

NAC relies on environmental information and guidelines provided by the Department of Environment and Heritage Protection; the Department of Natural Resources and Mines; the Commonwealth Department of Industry, Tourism and Resources; and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities.

NAC will continue to seek support from specialist consultancies and qualified professionals to address specific issues as they arise in relation to environmental management of the revised Project's mining operations. NAC is focussed on continuous improvement of its environmental management practices for its mining operations and possesses an Environmental Management System (EMS) to help achieve this outcome.

3. Project's Mining Process

3.1. Overview

NAC will continue to employ an open cut strip mining process for the revised Project's coal extraction. This form of open cut mining facilitates the removal of coal in a progressive manner across the revised Project's defined coal resources and is common practice for the Australian coal industry (i.e. for shallow coal deposits). The rate of progression of each of the revised Project's active mine pits will be governed by a range of factors, in particular the overall rate of production and the nature of the geological environment (e.g. coal seam thickness and faults).

To achieve the maximum rate of production, the revised Project will employ three active mine pits at any one time over its mine life. **Section 3.2** explains how each of the revised Project's active mine pits will progress on an individual basis. **Section 3.3** details how the revised Project's final void areas are generated at the cessation of economic coal extraction within each active mine pit.

The advantage of this form of mining is that it facilitates progressive rehabilitation behind the active mine path, which ensures that a defined level of active mining disturbance is basically maintained over the revised Project's life. NAC expects that through the method of progressive rehabilitation, minimal disturbance areas will be open at any one time over the life of the revised Project.

3.2. Out-of-Pit Dump Formation and Active Mine Pit Progression

In general, new mining areas require the development of a box-cut (initial mine pit) and an out-of-pit (or rock waste) dump. This requirement is unavoidable unless there is an adjacent final void to backfill. The construction of an out-of-pit dump normally lasts about 18 months. At this stage of development, the active mine pit has progressed sufficiently to allow in-pit dumping. The strip mining process then progresses in an ordered manner or 'steady state' across the resource area. The in-pit dumping continues behind the active mine pit normally reducing in elevation as the active mine pit progresses away from the original box-cut area. The development and operation of in-pit tailings storage facilities can influence the dumping process through the displacement of dump space for tailings storage purposes.

Error! Reference source not found. provides a typical cross section of an active mine pit at a steady state of production, showing the high-wall (un-mined area ahead of the mine path), the current mining strip (coal extraction), along with the in-pit dumps located on the low wall (mined area behind the active mine pit). Progression of the active mine pits is facilitated by the previously mined strips which are on the pit floor being utilised as the in-pit waste dump, with the overburden and partings material being used to progressively backfill the void as mining progresses across the coal resource Therefore, the amount of open void space at any one time, does not change significantly for each active mine pit, rather the void area moves with the progression of mining as the backfilling of previously mined void space takes place.

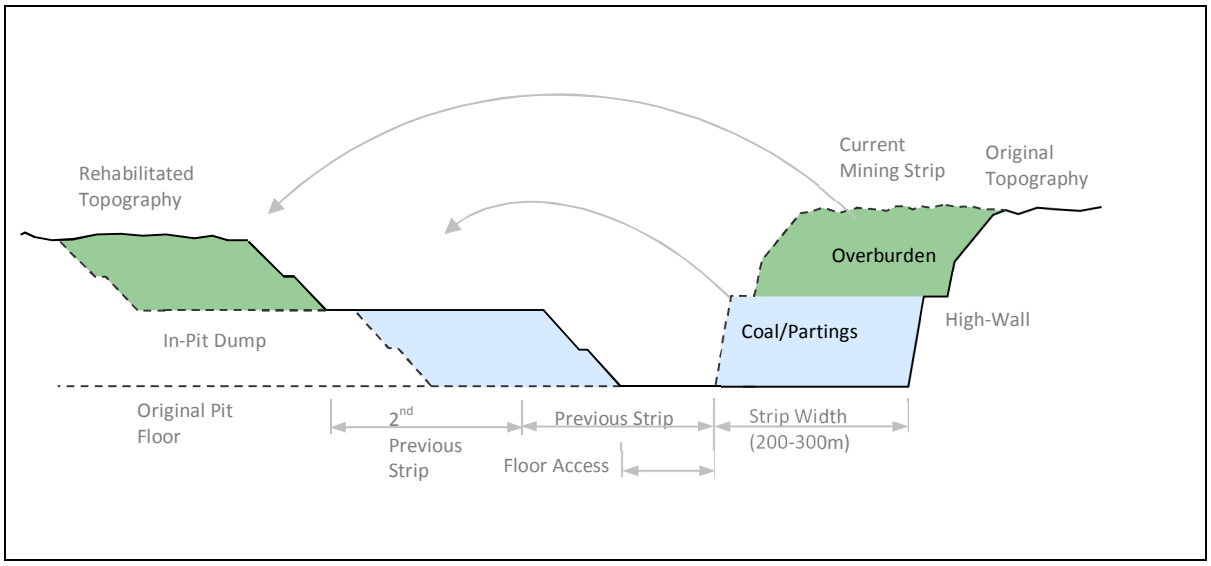


Figure 3-1 Typical cross section of an active mine pit

The revised Project will result in the progressive development of three new mining pits within the Manning Vale West, Manning Vale East and Willeroo resource areas as the Glen Roslyn reserves (Centre and South Pits) are depleted as presented in , the revised Project overview.

The Manning Vale West Pit will require the development of an out-of-pit dump due to the fact that there are no voids adjacent to this resource area that can be backfilled. The closest void that will exist when the Manning Vale West Pit is developed is the Centre Pit void, which is unavailable as it is planned to be used as a future in-pit tailings storage facility.

The Manning Vale East Pit will be sequenced as a progression of the South Pit. The waste material mined from the Manning Vale East Pit's box cut will be used to backfill the South Pit void. This arrangement is facilitated by the close proximity of both mine pits to each other and the fact both mine pits are located on the same side of Lagoon Creek.

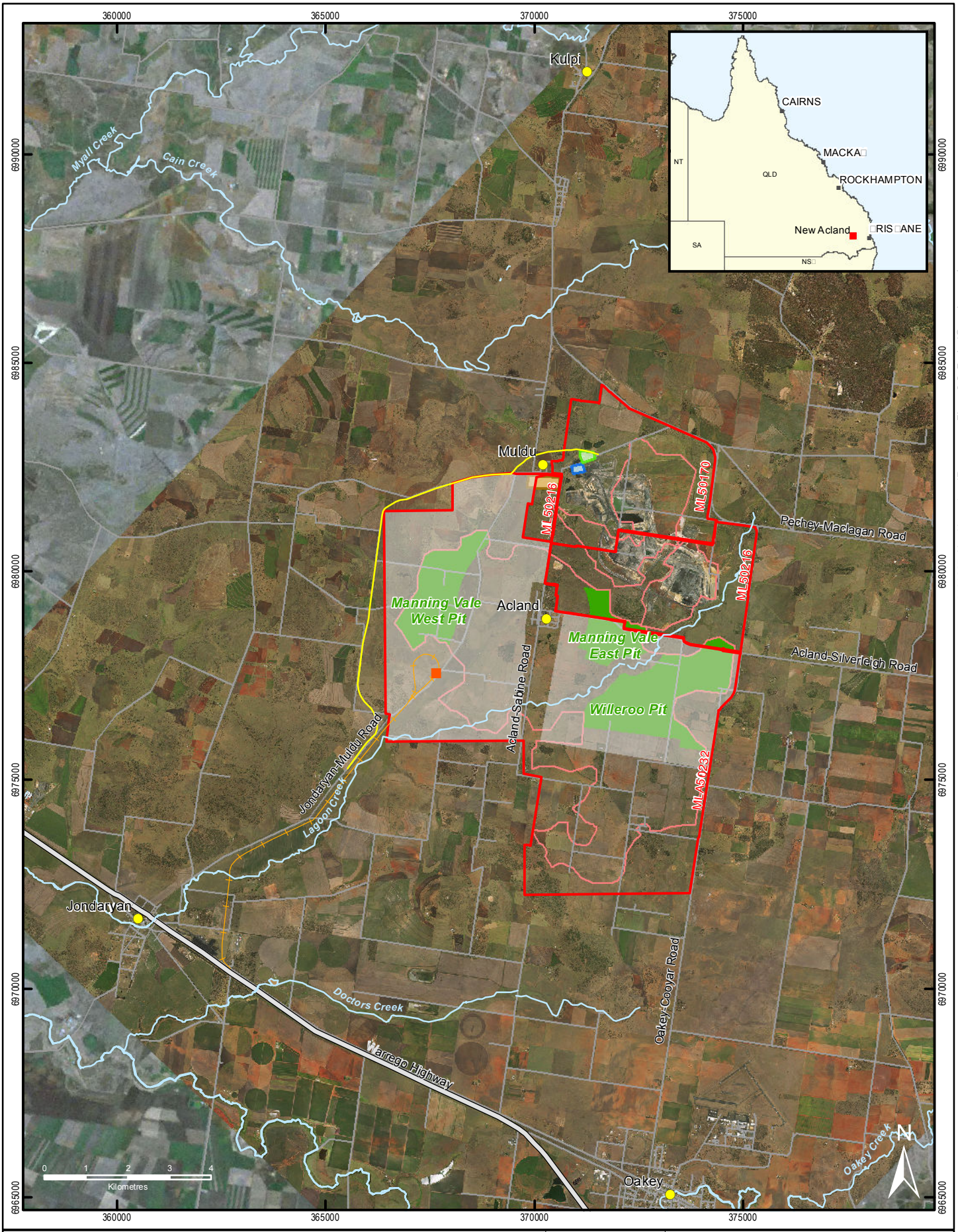
The Willaroo Pit may also be sequenced as a progression of the South Pit. However, the use of the Willaroo Pit's box-cut material to backfill the South Pit void is not optimal because both mine pits are located on opposite sides of Lagoon Creek and are separated by a distance of up to 1.5 km. As a result, the most efficient mine plan requires the development of a new out-of-pit dump using the Willaroo Pit's box-cut material.

In addition, the design volume required for the out-of-pit dumps and associated box-cut volumes have been based on the following criteria.

- 100 % of the waste rock within the first strip which lies adjacent with the edge of the mine pit boundary is dumped out-of-pit.
- Due to the disparity between the low wall angles of the dump, and the angle of the highwall for the first strip, not all of the waste volume mined within Strip 2, can fit within the mine pit. Based on approximate geometries, 50 % of the waste material mined in Strip 2, will also be required to be dumped out-of-pit. This is consistent with previous out-of-pit dump volumes.

- The waste volume mined from the subsequent strips will be dumped within the confines of the previous strip. The volume of the product coal and tailings extracted will on average be similar to the level of swell that is achieved. Hence long term, the final in-pit dump profile will be on a comparative basis, similar to original topography. Depending on the interaction of the different yields achieved, material properties and their swell, along with the change in-pit floor heights, the final dump height will typically swing up and down between slightly surcharging the dump and dumping to a level slightly below that of the original topography.

- The swell factor used for out-of-pit dump design volumes is 15 %. Based on previous work conducted at a similar operation, the swell was identified as being potentially less than 10 % on average. As a result, 15 % is a conservative number whilst using the truck and loader mining method with minimal dump heights.



LEGEND

- Towns and Localities
- Train Loadout Facility
- Rail Spur
- Roads
- Creeks
- Jondaryan-Muldu Road Diversion
- Proposed Extent of Surface Rights Area
- Coal Resource Area
- Mining Tenements
- Stage 3 Pit Areas
- CHPP Precinct
- Material Handling Facility
- Mine Industrial Area

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 3-2 - Revised Project Overview

Scale 1:120,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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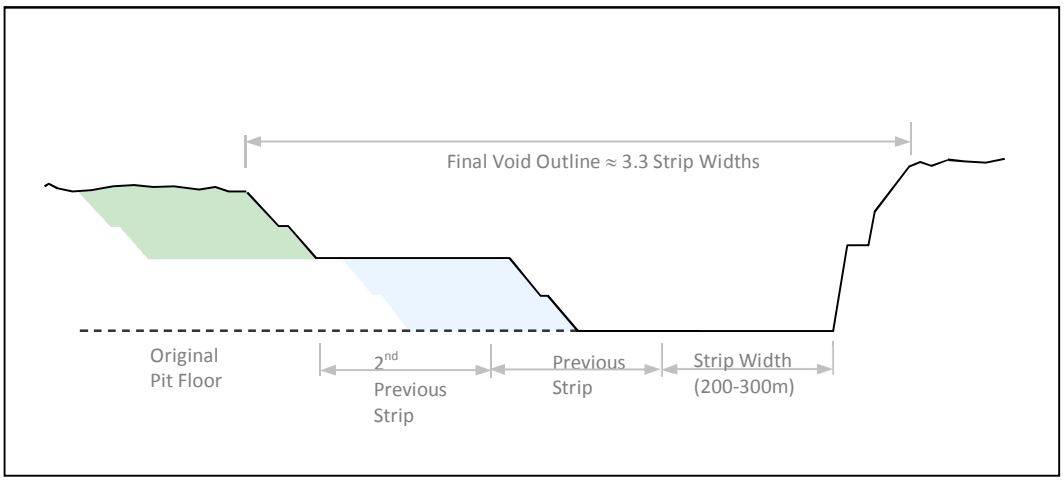
3.3. Final Void Formation

As mining progresses to the final strip, the final void extends in width by approximately 3.3 strip widths and comprises:

- the highwall batter;
- the end wall batters;
- the last strip completed being mined;
- a percentage of the previous strip which has been used for access to the pit floor and ramps; and
- the in-pit dump which has not been completely backfilled.

The void area is affected by the necessary requirement for access ramps from the floor to the top of the dump, which further increasing the working void area. The typical outline of the final void is presented in **Figure 3-2**. The revised Project's final void sizes have been estimated to be in the order of approximately three strip widths wide from the pit highwall to the top of the low wall dump and extending the full length of the pit.

Figure 3-2 Typical Final Void Outline



4. Final Landform Design and Planning

4.1. Overview

As an important component of the planning phase for the revised Project, NAC's has developed a feasible mining methodology to eliminate unusable post-mined land for the revised Project. The main driver for this approach was to ensure the final out-of-pit dumps (elevated landforms) and final voids (depressed landforms) are battered down to a safe and stable angle to allow the sustainable application of the revised Project's proposed final land use. While this design scenario will add a significant operational cost to the revised Project, NAC acknowledges the importance of addressing government and public concerns in relation to this issue to earn its 'social licence' to operate.

4.2. Location and Extent of Depressed and Elevated Landforms

The number of depressed landforms (former final voids) and elevated landforms (out-of-pit dumps) and their respective locations within the revised Project's final landform design have been influenced by the mining sequence and the number of pits operating at any moment in time. The location and extent of the depressed and elevated landforms is presented in **Figure 2-1**. The Acland resource areas comprise a large number of thin coal seams inter-bedded with claystone, and as a result, the mining method employed by the revised Project is quite unique. Importantly, multiple thin seam mining requires a large working area to enable the coal resource to be extracted in an efficient manner with a high level of productivity. Therefore, NAC's ability to achieve the revised Project's desired target mining rate is dependent upon the strike length of the active mine pit and the number of blocks available in-pit for coal production at any moment in time.

Another influential factor determining the size and location of the revised Project's depressed landforms and elevated landforms is the planned sequencing of mining proposed for each resource area. A large amount of mine planning work has been applied to the revised Project's mine sequence to satisfy a number of constraining factors whilst optimising the LoM schedule. The main constraining factors influencing the revised Project's mining schedule are the:

- coal haulage distances to the CHPPs;
- stripping ratios of the individual resource areas;
- interaction between active mining pits and target production rates; and
- product coal blending capability to obtain a consistent marketable product.

Consequently, optimisation of the mining schedule and satisfying the main constraints whilst operating three mine pits has largely defined the size and location of the revised Project's depressed landforms and elevated landforms. The revised Project's elevated landforms have been designed to ensure the angle on the face of the dumps is 8.5 to 17 degrees. This slope is based on the current out-of-pit dump angles that have successfully been constructed within the existing ML 50170 (Stage 1) and ML 50216 (Stage 2) areas. A 8.5 to 17 degree dump batter is considered to be safe and sustainable for the revised Project, and is supported by current evidence from the Mine that suggests that this batter design works efficiently and possesses a low risk of gross geotechnical failure (slumping).

NAC has maximised the number of final voids to be back filled by the revised Project. The feasibility of backfilling the final voids is limited because of the haulage distances required and the sequencing constraints placed on the active mining pits. In addition, the only material normally available in the required volume for back filling operations is contained within the non-adjacent elevated landform, and as a result of progressive rehabilitation, the

re-disturbance of these areas would be inefficient and costly because they are normally well established in terms of stability and vegetation cover.

Therefore, in order to effectively rehabilitate the revised Project's remaining voids, it is proposed that the highwalls, and low walls be battered down to a suitable angle, such that they are no longer classified as final voids, but rather 'depressed landforms'. The slope angle that these depressed landforms will be pushed to 8.5 to 17 degrees, which matches the rehabilitated design angle of the elevated landforms. Importantly, at 8.5 to 17 degrees the slopes can be efficiently topsoiled and seeded and cattle can safely graze the slopes.

To form the revised Project's depressed landforms, the total surface area (footprint) of each void will increase as part of the cut and fill process to achieve the required slope angles of 8.5 to 17 degrees. **Table 4-1** outlines the change in surface area that occurs as a result of the construction of each of the revised Project's depressed landforms. **Table 4-2** outlines the rehabilitation volumes required to be moved to construct each of the revised Project's depressed landforms.

Table 4-1 Void and Depressed Landform Area Changes

Resource area	Void area 2029	Depressed landform area
Manning Vale West Pit	124	184
Manning Vale East Pit	111	130
Willeroo Pit	222	307
Total	457	621

Note: Depressed Landform Area is the area of the void after reshaping has occurred (from the crest).

Table 4-2 Rehabilitation Volumes for the Depressed Landforms

Depressed Landform Area	Approx Rehab Cut/Fill Volume
ITSF 4 + ITSF 5	0.35 Mm^3
Manningvale West Pit	7.4 Mm^3
Manningvale East Pit	2.0 Mm^3
Willeroo Pit	10.4 Mm^3
Total	20.15 Mm^3

In summary, there will be a total of three depressed landforms left at the end of the revised Project's mining phase comprising a total area of approximately 621 ha and an average depth 40 m to 70 m deep – Manning Vale West, Manning Vale East and Willeroo Pits. Importantly, the rehabilitation goal for these depressed landforms is to have their internal slopes battered down to a profile that will allow grazing to be performed in a safe and sustainable manner as the nominated final land use.

Two other final voids will be completely backfilled at the end of the revised Project's mining phase – Centre and South Pits (Stage 2). The Centre Pit will be beneficially used for the revised Project's tailings management, which is the preferred method of long term tailings storage. The South Pit will be backfilled with spoil from the Manning Vale East and Centre Pits. Therefore, the revised Project will not possess any actual final voids with 'un-useable

land' at the end of its operational life. NAC is committed to achieving this rehabilitation outcome for the revised Project.

4.3. Rehabilitation Objectives for Depressed Landforms

4.3.1. Overview

NAC has developed a feasible rehabilitation strategy to ensure that all the revised Project's remaining final voids are developed (re-shaped) into depressed land forms that are able to support grazing (beef production). While this rehabilitation strategy possesses a significant cost for the revised Project, NAC believes it demonstrates a strong corporate commitment to government and the community.

4.3.2. Depressed Landforms – Rehabilitation Commitment

NAC is committed to ensuring all the revised Project's former final void areas are either:

1) rehabilitated to a depressed final landform that is safe, stable, non-polluting and able to support the proposed final land use, grazing, in a sustainable manner; or
2) backfilled to a suitable final landform that is safe, stable, non-polluting and able to be rehabilitated to support the proposed final land use, grazing, in a sustainable manner.

4.3.3. Depressed Landforms – Low Wall Slopes

NAC has identified that dump slopes would be stable up to 50 m high at the natural rill angle which equates to approximately 35 degrees. To increase the factor of safety in relation to slope failure, it is normally recommended that 10 m catch berms be incorporated into the dump design every 20 m in dump height. An overall dump angle of 27.4 degrees is achieved through the use of berms in this manner.

Additional geotechnical analysis conducted at the NHCL's West Moreton operations, which mine the same geological sequence (rock types), indicates that a long term stable dump slope, even when fully saturated, is in the order of 17 to 21 degrees. Current active in-pit dump/low wall angles at the Mine are generally no shallower than 25 degrees. Nine years of field observations by NAC have failed to identify any specific issues with the current slope design parameters.

For the revised Project, NAC intends to apply a far more conservative approach by proposing that in-pit dump/low wall slopes for the final voids be battered down to an angle of 8.5 to 17 degrees. This slope from all current available geotechnical information is well below that previously identified as being safe and stable long term at the Mine. The proposed slope will allow the establishment of grass and legume species to stabilise the surface layer from erosion and to allow the future use of the land for grazing (beef production) purposes.

4.3.4. Depressed Landforms – Highwall Slopes

To achieve the proposed depressed landform design for the revised Project, NAC intends to re-grade the final void highwalls to the more conservative slope of 8.5 to 17 degrees depending on final geotechnical recommendations obtained during mine closure. This new approach goes should provide a safe and stable profile. Importantly, a final angle of 8.5 to 17 degrees is sufficiently shallow to allow grazing (beef production) to be conducted in a sustainable and productive manner.

4.3.5. Depressed Landforms – Proposed Design Criteria

NAC commits to the following final landform design criteria for the revised Project to ensure the creation of a safe and stable landform.

- Depressed landform low wall dump slopes will not exceed 8.5 to 17 degrees.

- Depressed landform highwall slopes will not exceed 8.5 to 17 degrees.
- The proposed depressed landforms, as former final voids, will be on average 50 m to 70 m deep.

The recommended slopes for the depressed landform will allow safe access for humans, stock and native wildlife and will not compromise rehabilitation activities. NAC will ensure that the internal slopes of the depressed landform possess a suitable vegetative groundcover of 70 % or greater to minimise the potential for erosion. The general rehabilitation success criteria for grazing as the revised Project's proposed final land use for the depressed landforms are defined in the Final Land Use and Rehabilitation Plan located in **Appendix J.2**.

4.3.6. Depressed Landforms – Long Term Water Storage and Quality

Surface Water

A comprehensive surface water assessment has been carried out for the revised Project and is located **Chapter 5**. In addition, the revised Project's Water Resource Management Plan is presented in **Appendix J.4**.

Groundwater

A comprehensive groundwater assessment has been carried out for the revised Project and is located **Chapter 6**. In addition, the revised Project's Ground Monitoring and Impact Management Plan is presented in **Appendix J.5**.

4.4. Rehabilitation Objectives for the Elevated Landforms

4.4.1. Overview

NAC has applied conservative slopes to its elevated landform designs and has provided the most efficient LoM Plan for the revised Project's proposed maximum rate of production of up to 7.5 Mtpa. Therefore, NAC believes it has delivered the best possible scenario in relation to the design of the revised Project's elevated landforms. Importantly, the proposed elevated landform designs will support the revised Project's planned final land use for these areas (i.e. grazing).

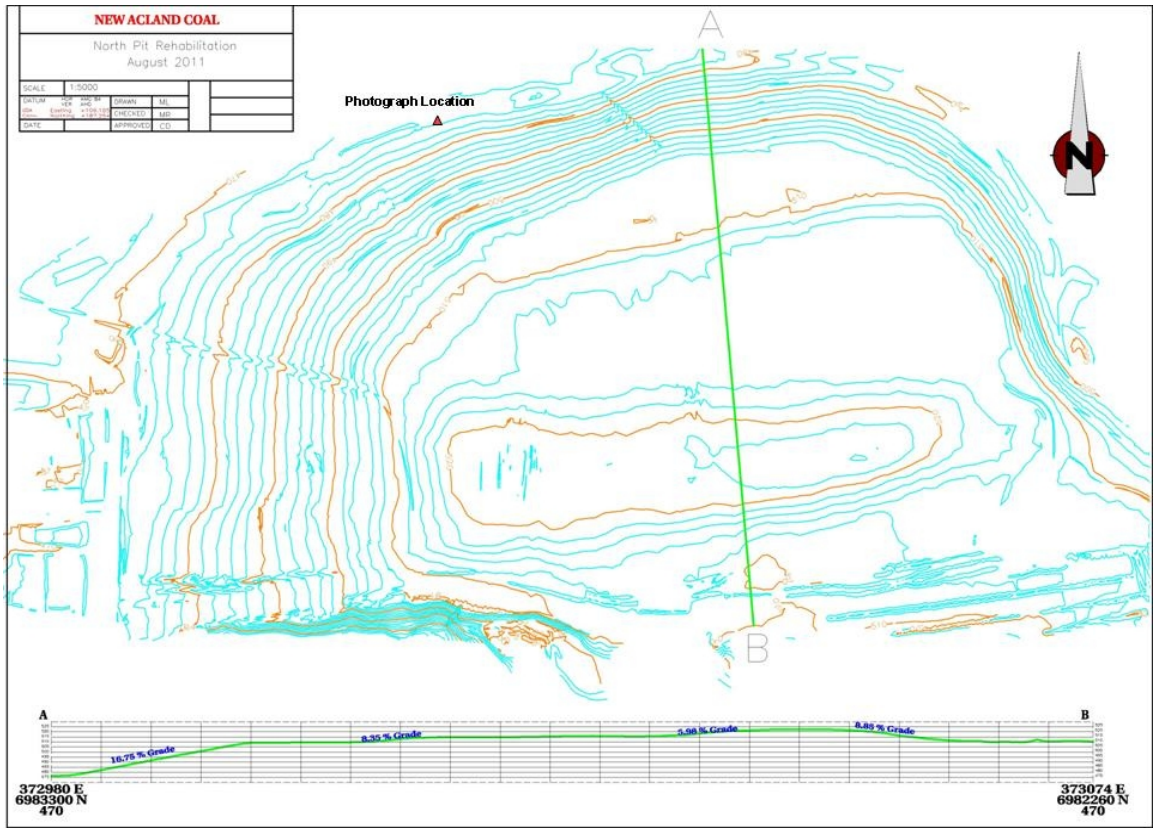
4.4.2. Elevated Landforms – Rehabilitation Commitment

NAC is committed to ensuring all the revised Project's elevated landforms are rehabilitated to a safe, stable and non-polluting landform that is able to support the proposed final land use, grazing (beef production), in a sustainable manner.

4.4.3. Elevated Landforms – Slopes

The revised Project's elevated landforms have been designed such that the angle on the face of the dumps will be 8.5 to 17 degrees. This slope is based on the current out of pit dumps angles that have successfully been constructed within the existing ML50170 (Stage 1) and ML50216 (Stage 2). A 8.5 to 17 degree batter is believed to be safe and sustainable, and there is evidence on-site currently to suggest that this batter is geotechnically stable. **Figure 4-1** depicts a cross section of the North Pit's out of pit dump. **Photograph 4-1** illustrates the slope of the North Pit's out of pit dump. The North Pit's out of pit dump has been established for over five years and has experienced prolonged drought conditions and extreme rainfall events. No evidence of geotechnical failure or significant erosion is present.

Figure 4-1 North Pit's Elevated Landform



Photograph 4-1 Slope of the North Pit's out of pit dump

NAC has reviewed the current gradient of land (natural topography) within the vicinity of the revised Project and identified slopes up to 13 degrees. Therefore, NAC believes the revised

Project's elevated landform slopes are sufficiently comparable to the surrounding landscape and over time will be difficult to distinguish from the natural topography without prior knowledge of the original mining activities.

4.4.4. Elevated Landforms – Proposed Design Criteria

The general design parameters for the revised Project's elevated landforms are provided in **Table 4-3**. Three examples of natural local landforms have been included for comparison purposes as presented in **Table 4-4**. In general, the revised Project's elevated landforms (in terms of physical dimensions) are relatively commensurate with the surrounding local topography. NAC believes with sustainable rehabilitation outcomes for the revised Project's elevated landforms, these structures will be compatible with the natural topography.

NAC will employ a range of recognised water management structures to control rainfall run off to minimise the risk of significant erosion. In general, contour banks and rock-lined water ways are the main water management structures incorporated into the slopes of the elevated landforms. These structures normally report to a sediment dam via a defined flow path, and then on to an environmental dam via a defined flow path, before water discharge of- site is possible. NAC's elevated landforms, water flow pathways and other water management structures (e.g. diversion banks) normally possess a good vegetative cover once properly established (i.e. >70% ground cover), which significantly reduces the potential for erosion. As required, NAC will use other protective measures at points of flow concentration (e.g. rock armouring). NAC will ensure all dedicated water management structures possess a suitable hydraulic design fit-for-purpose. NAC preferentially uses water captured in its sediment and environmental dams for dust suppression and other uses on-site to reduce the likelihood of off-site water discharges. The Water Resource Management Plan for the revised Project is presented in **Appendix J.4**.

Table 4-3 Elevated Landforms - General design parameters

Elevated landforms	Height (m)	Volume (Mm^3)	Area (footprint) (ha)	Proposed slope (degrees)	Longest slope length (m)
Manning Vale East Pit	45	23.4	67	8.5-17	300
Manning Vale West Pit	45	25.6	155	8.5-17	300
Willeroo Pit	45	23.5	129	8.5-17	300

Willeroo pit has 102 ha on ML50216 and 26ha on MLA50232

Table 4-4 Local topographic features, Acland area

Local topographic features	Height (m)	Area (footprint) (Ha)	Proposed Slope (degrees)	Longest Slope Length (m)
Bottle Tree Hill	56	150	11	700
Radar Hill	65+	450+	7	1,000
Surrounding Ridgeline	80+	NA	>20	>2,000

In summary, NAC will apply the following erosion and sediment control principles to all areas as general practice for the revised Project.

1) Erosion and sediment control planning will be incorporated into the mine planning process prior to commencing disturbance works in new mining areas. The erosion and sediment control planning will be amended as required to keep pace with the dynamic nature of the mining process, to ensure statutory compliance with discharge limits, and to minimise the potential for environmental harm to the downstream receiving environment.
2) Disturbance at the revised Project will be kept to an operational minimum. New disturbance areas will be carefully planned and controlled by the mine planning process. A 'permit to disturb' process will be applied to non-mining areas to prevent accidental disturbance by contractors.
3) Clean water from undisturbed areas at the revised Project will be diverted around disturbed areas.
4) Where possible, top soil at the revised Project will be protected against erosion initiated by raindrops, wind, or concentrated flows. The revised Project's Topsoil Management Plan is located in **Appendix J.3**.
5) Dirty water from disturbed areas at the revised Project will be captured preferentially for re-use on site or treated prior to discharge.
6) Sediment control measures will be implemented for the revised Project to prevent off-site impacts (e.g. contour banks, rock lined water ways, grassed diversion drains, etc.).
7) Disturbed areas at the revised Project will be progressively rehabilitated as soon as operationally possible to ensure a groundcover of >70% is established as a surface stabilisation and erosion control measure.
8) An inspection, monitoring, and corrective action maintenance regime will be applied to the revised Project to ensure erosion and sediment control measures and water management structures are functioning efficiently.

NAC will continue to explore innovative erosion and sediment control measures and use recognised industry standards for general practices, for example, "Sediment Control Engineering Guidelines for Queensland Construction Sites (IEA Qld 1996)".

4.5. Rehabilitation Success Criteria

The vegetation rehabilitation success criteria for the revised Project's depressed and elevated landforms are defined in the FLURP (Refer to **Appendix J.2**) and are based on a comparison with an analogue site in the Acland area that possesses similar biophysical features. For the revised Project's depressed and elevated landforms, NAC will expand its current monitoring programs and grazing trials to incorporate the applicable rehabilitation success criteria to guide its rehabilitation management (e.g. performance and maintenance regime) and to collect the necessary data to demonstrate:

- the geotechnical stability of the constructed landform;
- the successful establishment of a suitable vegetative cover to support the final land use and minimise the potential for erosion; and
- the productivity of the vegetative cover from a grazing (beef production) perspective.

NAC will be required to demonstrate in a scientifically rigorous manner the success of the revised Project's rehabilitation, including the revised Project's depressed and elevated landforms, to allow future surrender of the associated mining leases. In addition, NAC will consult with government and community on a regular basis over the life of the revised Project to report on the progress of rehabilitation and other matters.

In general, NAC's rehabilitation program is administered through a Plan of Operations and various supporting documentation (e.g. FLURP and Topsoil Management Plan). Importantly, NAC is required as part of the Plan of Operations to maintain a financial assurance with the State government to cover its rehabilitation liability.

NAC as part of its EMS also conducts internal and third party audits to assess environmental management (including rehabilitation) for continuous improvement purposes and ensures that environmental management responsibilities are clearly defined on the mine site. Finally, NAC is committed to maximising the revised Project's rehabilitation success to ensure the APC can function as a competitive agribusiness. NAC will also continue to draw on the APC's expertise to assist and enhance rehabilitation management.

A comprehensive land resource assessment outlining the rehabilitation success criteria has been conducted for the revised Project and is located in **Chapter 4**.

4.6. Slope Stability Monitoring Parameters

While conservative slopes have been selected for the revised Project's final landform design criteria, NAC will ensure that the following additional monitoring parameters are established or expanded to demonstrate the long term geotechnical stability of the depressed and elevated landforms for future mine closure and mining lease surrender requirements.

- NAC will select several typical profiles normal to the slope contours for each of the revised Project's depressed and elevated landform areas. Sufficient monitoring points will be established at each constructed landform to allow proper scientific evaluation;
- NAC will establish permanent survey points along each profile;
- NAC will undertake photographic monitoring and surveying at each of the profiles once or twice a year (e.g. at the start and finish of the wet season);
- NAC will progressively review and maintain its slope stability monitoring data as a long term performance measure for the geotechnical stability of the revised Project's depressed and elevated landforms; and
- NAC will expand its general site inspection regime to include all constructed slope areas. This inspection regime will be conducted monthly during the wet season and possess a formal corrective action process.

4.7. Final Land Use Capability

NAC is currently undertaking a formal long term grazing trial within a rehabilitate area of the North Pit's Elevated Landform on ML 50170 at the Mine as presented in **Photograph 4-2**. This grazing trial includes slope areas and will involve a comparison process with an analogue site in the vicinity of the Mine. The grazing trial program is being managed by the APC and will involve a formal study and report by a professional third party agricultural consultancy and local university. This grazing trial program will be a continuous process with new areas progressively added to the original trial area each year. The grazing trial program will be expanded to include the revised Project's rehabilitation areas designated for grazing. NAC believes the grazing trial program will be a critical assessment tool for demonstrating long term success of its grazing based rehabilitation for the revised Project's future mine closure and mining lease surrender requirements.

From an operational perspective, NAC will use the grazing trial:

- to assess the success of the current rehabilitated area in relation to the performance of cattle growth (beef production);
- to evaluate current rehabilitation practices from a final land use perspective; and
- as required, to develop new rehabilitation strategies to improve rehabilitation and long term grazing performance.

Longer term, the APC will also use this information to develop appropriate land management plans for NAC's former mined land within both the current Mine and the revised Project areas.

NAC is confident from the current grazing trial process and the grazing activities conducted at the NHCL's West Moreton mining operation that it can demonstrate with full scientific rigor that the revised Project's constructed landforms will be able to support grazing (beef production) as the proposed final land use in a long term sustainable manner. The current grazing trials are presented in **Photograph 4-3**.

Photograph 4-2 Grazing trial – North Pit's elevated landform, New Acland Coal Mine

Photograph 4-3 Long term grazing – Elevated landform on ML 4710, West Moreton Operations

5. References

New Hope Group (2012) New Acland Continuation Plan (NACP) 17 Year Mine Plan Input for EIS v2, October 2012.