

The background of the entire page is a faded, light blue image of a windmill. Overlaid on this are several white geometric shapes: a large square in the top left, a smaller square in the top right, and a large L-shaped frame on the right side. A dark teal square is positioned within the L-shaped frame, containing a white letter 'V'.

V

Soil, Land Capability and Strategic Agricultural Land Assessment



Soil, Land Capability and Strategic Agricultural Land Assessment

Bylong Coal Project

Report Number 630.11072.00000

24 March 2015

Hansen Bailey Pty Limited
6/127-129 John Street
Singleton NSW 2330

Version: Revision 1



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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 2

Soil, Land Capability and Strategic Agricultural Land Assessment

Bylong Coal Project

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
630.11072.00000	Revision 1	24 March 2015	Adele Calandra	Rod Masters	Rod Masters
630.11072.00000	Revision 0	13 February 2015	Adele Calandra/Adam Koppers	Rod Masters	Rod Masters

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 3

Table of Contents

1	INTRODUCTION	12
1.1	Project Background	12
1.2	Project Description	12
1.3	Study Area and Project Domains	16
1.4	Purpose of this Report	18
1.4.1	Secretary's Environmental Assessment Requirements	18
1.4.2	Strategic Regional Land Use Policy	19
1.5	Standards and Guidelines	20
2	BIOPHYSICAL ENVIRONMENT	22
2.1	Climate	22
2.2	Topography	22
2.3	Hydrology	26
2.4	Geology	26
2.5	Soil Landscape Units	27
2.6	Strategic Agricultural Land	29
2.7	Vegetation and Land Use	31
3	SOIL SURVEY	32
3.1	Methodology	32
3.1.1	Risk Assessment and Survey Scale	32
3.1.2	Reference Mapping	34
3.1.3	Field Survey	35
3.1.4	Laboratory Assessment	38
3.1.5	Soil Classification Nomenclature	39
3.2	Soil Results	39
3.2.1	Summary of Soil Units	39
3.2.2	Bald Hill Soil Unit Summary	43
3.2.3	Benjang Soil Unit Summary	44
3.2.4	Bylong Soil Unit Summary	45
3.2.5	Growee Soil Unit Summary	46
3.2.6	Lees Pinch Soil Unit Summary	47
3.2.7	Ogilvie Soil Unit Summary	48
3.2.8	Sandy Hollow Unit Summary	49

Table of Contents

4	LAND AND SOIL CAPABILITY ASSESSMENT	50
4.1	Methodology	50
4.2	Assessment Results	53
5	BSAL ASSESSMENT	57
5.1	Methodology	57
5.1.1	Phase 2 Assessment – Site Verification Criteria	57
5.1.2	Assessment Check List	59
5.2	Assessment Results	59
5.3	Differences in Regional Mapping to Verified Mapping within Study Area	67
6	REHABILITATION STRATEGY OVERVIEW	68
6.1	Overview of Decommissioning Strategy	68
6.2	Impact Types	69
6.3	Project Domain by Impact Type	69
6.4	Preliminary Rehabilitation Goals Overview	71
7	IMPACT ASSESSMENT	73
7.1	Impact on Soil Resources within Project Disturbance Footprint	73
7.2	Impact on LSC Classes within Project Disturbance Footprint	76
7.3	Impact on BSAL within Project Disturbance Footprint	79
7.3.1	Impact on BSAL within Project Disturbance Footprint by Soil Units	81
7.4	Post-mining LSC Class	83
7.4.1	Temporary Impacts	83
7.4.2	Permanent Impacts	83
7.4.3	Overall Change in LSC Classes in the Project Boundary	86
7.5	Post-mining Quantity of BSAL	87
7.6	Post-mining Land Use: Direct and Permanently Impacted Areas	87
8	DISTURBANCE MANAGEMENT	91
8.1	Soil Stability	91
8.1.1	Emerson Aggregate Test (EAT)	91
8.1.2	Soil Erodibility (K Factor)	91
8.1.3	Soil Stability Assessment Results	91

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 5

Table of Contents

8.2	Soil Suitability	96
8.2.1	Methodology	96
8.2.2	Soil Suitability Assessment	97
8.2.2.1	LSC Class 3/BSAL and Class 4 Rehabilitated Lands	97
8.2.2.2	LSC Class 5, 6 and 7 Rehabilitated Lands	98
8.2.3	Soil Volume Available for Conservation	103
8.3	Soil Volume Requirement	104
8.3.1	Sources of Soil	104
8.3.2	Soil Volume Required for Conservation	104
8.4	Soil Volume Mass Soil Balance	105
9	CONCLUSION	107
10	REFERENCES	109

TABLES

Table 1	Project Domains	18
Table 2	Summary of Secretary's Environmental Assessment Requirements	18
Table 3	Summary of Gateway Requirements	20
Table 4	Slope Classes	22
Table 5	Soil Landscape Units	27
Table 6	Agricultural Impact and Risk Ranking Matrix	32
Table 7	Project Domains	34
Table 8	Soil Survey Observation Types	36
Table 9	Soil Survey Observation Type and Density	36
Table 10	Detailed Soil Profile Description Parameters	38
Table 11	Laboratory Parameters and Analytes	39
Table 12	Soil Unit Distribution Summary	40
Table 13	LSC Class Definition	50
Table 14	LSC Class Summary	53
Table 15	LSC Class Assessment by Soil Unit	55
Table 16	Biophysical Strategic Agricultural Land Assessment Checklist	59
Table 17	BSAL: Interim Protocol Assessment - Summary	61
Table 18	Interim Protocol BSAL Assessment – per soil unit	63
Table 19	Preliminary Rehabilitation Objectives by Project Domain	68
Table 20	Preliminary Project Impact Category by Project Domain	69
Table 21	Impact Category: Project Disturbance Footprint	71
Table 22	Preliminary Post-Mining Goals	72
Table 23	Soil Types within Project Disturbance Footprint	73
Table 24	LSC Class within Project Disturbance Footprint	76
Table 25	Impact Category: LSC Class within Project Disturbance Footprint	78
Table 26	Total BSAL within Project Disturbance Footprint	79
Table 27	Impact Category: Biophysical Strategic Agricultural Land	81
Table 28	BSAL Soil Units by Impact Category	82
Table 29	Pre and Post-mining LSC Class for Permanently Disturbed Domains	86
Table 30	Pre and Post-mining LSC Class for Permanently Disturbed Domains	86
Table 31	Pre- and Post-mining LSC Class	87

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 6

Table of Contents

Table 32	Post-mining Land Use for Permanently Disturbed Domains	90
Table 33	Soil Stability Assessment	93
Table 34	Soil Suitability Criteria	96
Table 35	Soil Suitability Assessment	98
Table 36	Soil Resources to be Stripped and Salvaged	103
Table 37	Soil Volume Availability	103
Table 38	Area of Land Requiring Rehabilitation	104
Table 39	Soil Volume Requirements for the Permanently Impacted Landform	105
Table 40	Soil Volume Mass Balance	106
Table 41	Soil Volume Summary	106

FIGURES

Figure 1	Locality	13
Figure 2	Regional Locality	14
Figure 3	Conceptual Mine Layout	15
Figure 4	Project Domains	17
Figure 5	Elevation	23
Figure 6	Slope Analysis: All Categories	24
Figure 7	Slope Analysis: BSAL Categories	25
Figure 8	Soil Landscape Units	28
Figure 9	BSAL: Upper Hunter SRLUP	30
Figure 10	Risk Assessment and Survey Scale Map	33
Figure 11	Field Survey Observation Map	37
Figure 12	Soil Unit Map	42
Figure 13	LSC Classification (pre-mining)	54
Figure 14	BSAL Verification Assessment: Interim Protocol	60
Figure 15	BSAL Limitations	62
Figure 16	Impact Types	70
Figure 17	Soil Units and Project Footprint	74
Figure 18	LSC Classes and Project Footprint	77
Figure 19	BSAL and Project Footprint	80
Figure 20	Post-mining LSC Classes	84
Figure 21	Post-mining Slope Classes	85
Figure 22	Post-mining BSAL	88
Figure 23	Post-mining Land Use	89
Figure 24	Erosion Risk Ranking	92
Figure 25	Recommended Stripping Depths	102

APPENDICES

Appendix A	Topographic Base Maps 1:25,000 Scale
Appendix B	Field Survey Observation Maps 1:25,000 Scale
Appendix C	Soil Laboratory Results
Appendix D	Soil Unit Maps 1:25,000 Scale
Appendix E	Soil Units - Detailed Profile Descriptions

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 7

Abbreviations

Abbreviation	Term
A	Authorisation
ALS	Airborne Laser Scanning
ASC	Australian Soil Classification
BOM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
CEC	Cation Exchange Capacity
CIC	Critical Industry Cluster
CHPP	Coal Handling and Preparation Plant
Draft Interim Protocol – 1st Release	<i>Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – draft</i>
Draft Interim Protocol – 2 nd Release	<i>Interim protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – V7</i>
DP&I	Department of Planning & Infrastructure
DPI	Department of Primary Industries
DPI-OASFS	Department of Primary Industries - Office of Agricultural Sustainability and Food Security
EAT	Emerson Aggregate Test
EC	Electrical Conductivity
EIS	Environmental Impact Statement
ECe	Electrical Conductivity (saturated paste)
EP&A Act	<i>Environmental Planning & Assessment Act 1979</i>
EPA	Environmental Planning Agency
EPA Regulation.	<i>Environmental Planning and Assessment Regulation 2000</i>
GSSE	GSS Environmental
Hansen Bailey	Hansen Bailey Pty Limited
Interim Protocol	<i>Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land</i>
KEPCO	KEPCO Bylong Australia Pty Ltd
LGA	Local Government Area
LSC	Land and Soil Classification
LSC Guideline	<i>Land and Soil Capability Assessment Scheme</i>
Mtpa	million tonnes per annum



Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 8

Abbreviations

Abbreviation	Term
MCM	million cubic metres
Mining SEPP	<i>State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007</i>
MWRC	Mid-Western Regional Council
NCST	National Committee on Soil and Terrain
NATA	National Association of Testing Authority
NSW	New South Wales
OEA	Overburden Emplacement Area
OEH	Office of Environment & Heritage
Project, the	Bylong Coal Project
PSA	Particle Size Analysis
Rehabilitation Strategy	Rehabilitation and BSAL Reinstatement Strategy: Bylong Project
ROM	Run Of Mine
SAL	strategic agricultural land
SEARs	Secretary's Environmental Assessment Requirements
SLR	SLR Consulting Australia Pty Ltd
SRLUP	Strategic Regional Land Use Plan
OAS&FS	Office of Agricultural Sustainability and Food Security
WAF	Workforce Accommodation Facility
WorleyParsons	Worley Parsons Services Pty Ltd

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 9

Glossary of terms

Term	Definition
Acidity	A property expressed by the pH value when this is below 7.0 in a soil/water suspension.
Aggregate	A unit of soil structure usually formed by natural processes in contrast with natural processes, and generally <10 mm in diameter.
Alkalinity	A property expressed by the pH value when this exceeds 7.0 in a soil/water suspension.
Availability	General expression referring to the ease with which plants can absorb a particular nutrient from the soil.
Available Water Capacity	The amount of water in the soil, generally available to plants, which can be held between field capacity and the moisture content at which plant growth ceases. Sometimes also known as the <i>Plant Available Water Capacity</i> .
Cation	An element with a positive charge.
Cation Exchange	Process whereby cations interchange between the soil solution and the clay or organic matter complexes in the soil.
Cation Exchange Capacity	The total amount of exchangeable cations that a soil can adsorb, expressed in centimoles of positive charge per kilogram of soil
Clay	A soil separate consisting of particles <0.002 mm in equivalent diameter.
Consistence Force	Consistence force refers to the strength of cohesion and adhesion in the soil.
Course Fragments	Particles greater than 2mm
Electrical Conductivity	A measure of the conduction of electricity through water or a water extract of soil. It can be used to determine the soluble salts in the extract and hence soil salinity. The unit of electrical conductivity is the Siemens and soil salinity is normally expressed as decisiemens per meter at 25 °C (dS/m).
Emerson Aggregate Test	A classification of soil aggregates based on their coherence in water.
Exchangeable Cation	A positively charged ion held on or near the surface of a solid particle by a negative surface charge of a colloid and which may be replaced by other positively charged ions in the soil solution.
Exchangeable Sodium Percentage	Exchangeable sodium fraction expressed as a percentage.
Field Texture Grade	Field texture is a measure of the behaviour of a small handful of soil when moistened and kneaded into a ball and then passes out between thumb and forefinger. The recommended field texture grades are characterised by the behaviour of the moist bolus.
Field Colour	The colour of soil material is determined by comparison with a standard Munsell colour chart.
Gravel	A mixture of coarse mineral particles larger than 2mm, but less than 75mm in diameter.
Hydraulic Conductivity	The flow of water through soil per unit of energy gradient. For practical purposes, it may be taken as the steady state of percolation rate of a soil when infiltration and internal drainage are equal, measured as depth per unit time.
Infiltration	The downward entry of water into the soil through the soil surface.
Leaching	The removal of materials in solution from the soil.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 10

Glossary of terms

Term	Definition
Mottles	Spots, blotches or streaks of subdominant colours different from the matrix colour and also different from the colour of the ped surface.
Organic Carbon	Gives an estimate of the amount of organic matter in a soil as a percentage by weight.
Organic Matter	Is the sum of all natural and thermally altered biologically derived organic materials found in the soil. These materials, in various states of decay, include leaf litter, plant roots, branches, living, and dead organism, and excreta.
pH (soil)	A measure of the acidity or alkalinity of a soil. It represents the negative logarithm of the hydrogen ion concentration in a specified soil/water suspension on a scale of 0 to 14.
Parent Material	The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of soils is developed by pedogenic processes.
Particle Size Analysis	The laboratory determination of the amounts of the different separates in a soil sample such as clay, silt, fine sand, coarse sand and gravel. The amounts are normally expressed as percentages by weight of dry soil.
Ped	A unit of soil structure such as an aggregate, crumb, prism, block or granule, formed by natural processes (in contrast with a clod which is artificially formed).
Permeability (soil)	The ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or layer of soil.
Physical Properties (soil)	Those characteristics, processes or reactions of a soil which is caused by physical forces and which can be described by, or expressed in, physical terms or equations. These can be difficult to separate from chemical properties; hence terms, physical-chemical or physico-chemical.
Pores	The part of the bulk volume of the soil not occupied by soil particles.
Sampling Site	A georeferenced point within a monitoring unit where one or more samples are taken for analysis.
Sand	A soil particle that in the USDA soil texture system is of size 0.05 mm to 2.0 mm in diameter.
Silt	A soil particle that in the USDA soil texture system is of size 0.002 mm to 0.05 mm in diameter.
Sodicity	A property expressed by the amount of exchangeable sodium present relative to the cation capacity of a soil horizon.
Soil Classification	The systematic arrangement of soils into groups or categories on the basis of similarities and differences in their characteristics.
Soil Consistence	The resistance of soil material to deformation or rupture.
Soil Erodibility	The susceptibility of a soil to the detachment and transportation of soil particles by erosive agents.
Soil Horizon	A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, biological properties such as colour, structure, texture, consistency, kinds and number of organisms present, degrees of acidity or alkalinity.
Soil Profile	A vertical section of the soil through all its horizons.
Soil Salinity	The amount of soluble salts in a soil. The convention measure of soil salinity is the electrical conductivity of a saturation extract.
Soil Structure	Refers to the way soil particles are arranged and bound together to form aggregates or peds.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 11

Glossary of terms

Term	Definition
Soil Texture	The relative proportions of the various soil separates in as soil as described by the classes of soil texture. It is the general coarseness or fineness of soil material as it affects the behaviour of a moist ball (bolus) when pressed between the thumb and forefinger.
Solum	The upper part of a soil profile above the parent material, in which current processes of soil formation are active. The solum consists of either the A and B horizons or the A horizon alone when no B is present.
Structure Pedality Grade	Is the degree of development and distinction of ped.
Structure Ped and Size	Refers to the distinctness, size and shape of peds.
Subsoil	Refers to B soil horizons
Topsoil	Refers to A soil horizons.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 12

1 INTRODUCTION

Hansen Bailey Pty Limited (Hansen Bailey) engaged SLR on behalf of Worley Parsons Services Pty Ltd (WorleyParsons) to undertake a *Soil, Land Capability and Strategic Agricultural Land Assessment* for the Bylong Coal Project

1.1 Project Background

In December 2010 KEPCO Bylong Australia Pty Ltd (KEPCO) acquired Authorisations (A) 287 and 342. Since this time, extensive exploration and mine planning work has been undertaken to determine the most socially responsible and economically viable mine plan to recover the known coal resources within the two Authorisations.

In September 2014 KEPCO commissioned WorleyParsons to manage the Project exploration activities, mine feasibility study planning, environmental approvals and ongoing environmental monitoring for the Bylong Coal Project (the Project).

The Project is wholly located within A287 and A342 which are located within the Mid-Western Regional Council (MWRC) Local Government Area (LGA). The closest regional centre is Mudgee, located approximately 55 km south-west of the Project Boundary. The Project is approximately 230 km by rail from the Port of Newcastle. **Figure 1** illustrates the locality of the Project within New South Wales (NSW). **Figure 2** shows the regional locality of the Project in relation to the neighbouring town centres, mining authorities, major transport routes and reserves.

KEPCO is seeking State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the development and operation of the Project. The State Significant Development Application will be supported by an Environmental Impact Statement (EIS) which is being prepared by Hansen Bailey.

1.2 Project Description

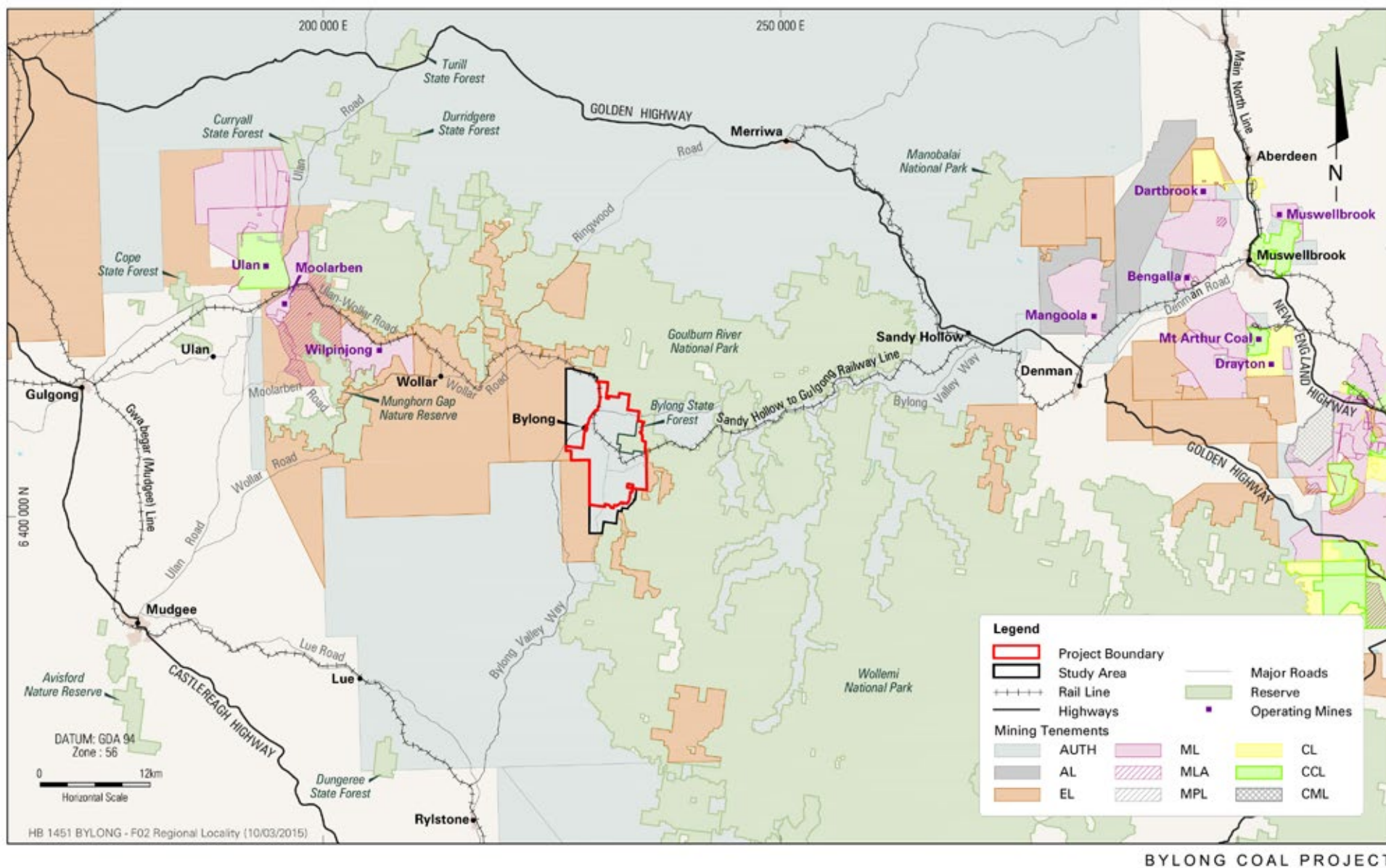
The Project life is anticipated to be approximately 25 years, comprising a two year construction period and a 23 year operational period, with underground mining operations commencing in Year 7. Various rehabilitation and decommissioning activities will be undertaken during both the course of, and following the 25 years of the Project. It is noted that further mineable coal resources exist within both A287 and A342.

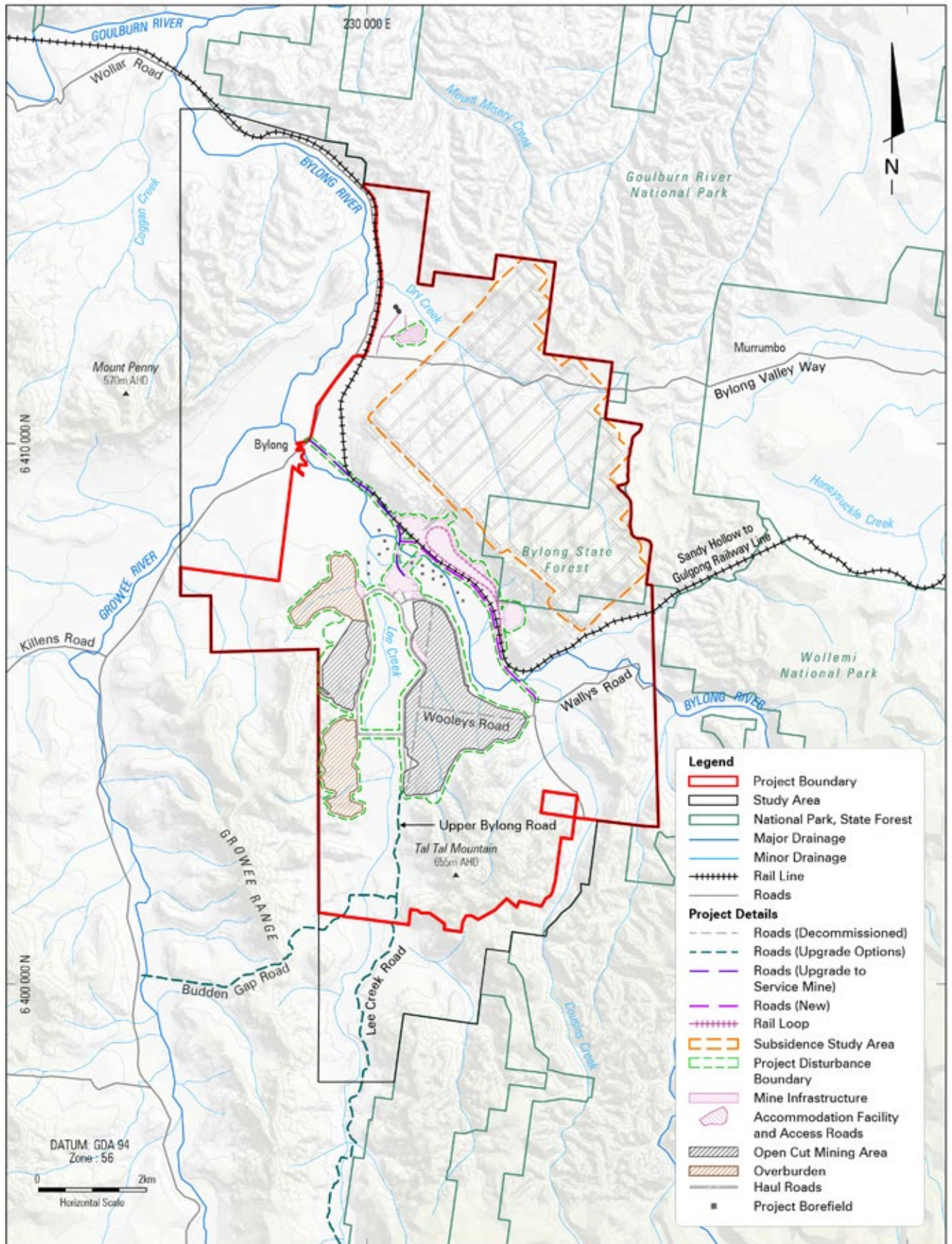
The Project is to be developed on land within the Project Boundary as illustrated on **Figure 3**. Key features of the Project are conceptually shown on **Figure 3** and include:

- The initial development of two open cut mining areas with associated Haul Roads and Overburden Emplacement Areas (OEAs), utilising a mining fleet of excavators and trucks and supporting ancillary equipment;
- The two open cut mining areas will be developed and operated 24 hours a day, 7 days a week over an approximate 10 year period and will ultimately provide for the storage of coal processing reject materials from the longer term underground mining activities;
- Construction and operation of administration, workshop, bathhouse, explosives magazine and other open cut mining related facilities;
- Construction and operation of an underground coal mine operating 24 hours a day, 7 days a week for a 20 year period, commencing mining in around year 7 of the Project;
- A combined maximum extraction rate of up to 6.5 Million tonnes per annum (Mtpa) Run of Mine (ROM) coal;
- A workforce of up to approximately 800 during the initial construction phase and a peak of 470 full-time equivalent operations employees at full production;



BYLONG COAL PROJECT





BYLONG COAL PROJECT

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 16

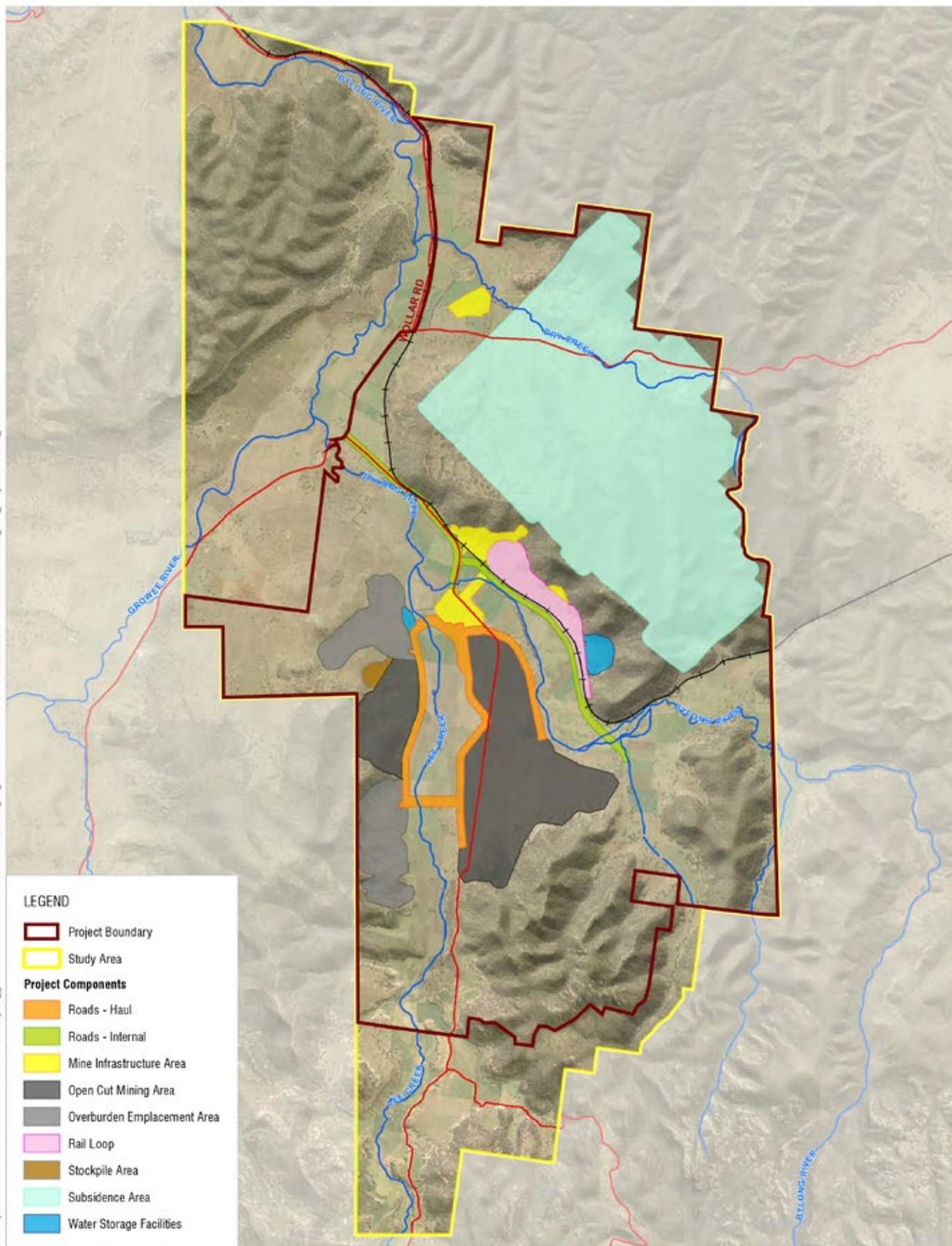
- Underground mining operations utilising longwall mining techniques with primary access provided via drifts constructed adjacent to the rail loop and Coal Handling and Preparation Plant (CHPP);
- The construction and operation of facilities to support underground mining operations including personnel and material access to the underground mining area, ventilation shafts, workshop, offices and employee amenities, fuel and gas management facilities;
- Construction and operation of a CHPP with a designed throughput of approximately 6 Mtpa of ROM coal, with capacity for peak fluctuations beyond this;
- The dewatering of fine reject materials through belt press filters within the CHPP and the co-disposal of dewatered fine and coarse reject materials within OEAs and final open cut voids (avoiding the need for a tailings dam);
- Construction and operation of a rail loop and associated rail load out facility and connection to the Sandy Hollow to Gulgong Railway Line to facilitate the transport of product coal;
- The construction and operation of surface and groundwater management and water reticulation infrastructure including diversion drains, dams (clean, dirty and raw water), pipelines and pumping stations;
- The installation of communications and electricity reticulation infrastructure;
- Construction and operation of a Workforce Accommodation Facility (WAF) and associated access road from the Bylong Valley Way;
- The upgrade of Upper Bylong Road and the construction and operation of a Mine Access Road to provide access to the site facilities;
- Relocation of sections of some existing public roads to enable alternate access routes for private landholders surrounding the Project; and
- Infilling of mining voids, progressive rehabilitation of disturbed areas, decommissioning of Project infrastructure and rehabilitation of the land progressively following mining operations.

1.3 Study Area and Project Domains

The Study Area for the Project has been defined as A287 and A342 and covers 10,317 ha (**Figure 4**). The Project Boundary covers an area of 6,957.7 ha within the Study Area and is also shown on **Figure 4**.

The various Project features have been categorised into eight major Project domains. Each Project domain has an impact on the existing land resource and the intensity of this impact differs between each domain. **Table 1** provides a summary of the domains. **Figure 4** shows their spatial location.

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Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 18

Table 1 Project Domains

Project Domain		Description
1	Open Cut Mining Area	- Western Open Cut - Eastern Open Cut
2	OEA	- South-western OEA - North-western OEA
3	Mine Infrastructure Area	- Employee & materials drift - CHPP - Overland Conveyor - ROM coal pad - Main access - Administration buildings - Accommodation village
4	Rail Loop	- Rail Loop and associated rail load out
5	Roads	- Haul Roads - Internal Roads
6	Water Storage Facilities	- Raw water storage - Dirty water storage
7	Subsidence Study Area	- Angle of draw for the Underground Extraction Area within the Study Area boundary
8	Stockpile Area	- Land nominated for storage and management of stripped soil

1.4 Purpose of this Report

1.4.1 Secretary's Environmental Assessment Requirements

This *Soil, Land Capability and Strategic Agricultural Land Assessment* has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the Project. **Table 2** provides a summary of the requirements under the SEARs that are relevant to this assessment and indicates where specific issues have been addressed in this document.

Table 2 Summary of Secretary's Environmental Assessment Requirements

Specific issues	Where addressed in this document
Secretary's Requirements	
Land – including:	
- an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds, paying particular attention to any biophysical strategic agricultural land (BSAL), having regard to the Mining & Petroleum Gateway Panel's and Department of Primary Industries' requirements;	Section 7
OASFS	
Specifically include: - ...detailed advice regarding rehabilitation, in particular the proposed rehabilitation of Biophysical Strategic Agricultural Land (BSAL), including the location of the activities, methodologies and time-frames for implementation.	<i>Rehabilitation and BSAL Reinstatement Strategy</i> (Rehabilitation Strategy; SLR, 2015)
DRE	

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 19

Specific issues	Where addressed in this document
The following are the key issues to be addressed in the EIS that are likely to have a bearing on rehabilitation and mine closure: - ...An evaluation of current land capability class and associated condition. The EIS should characterise soils across the proposed area of surface disturbance and assess their value and identify opportunities and constraints for use in rehabilitation.	Section 7
- Where an agricultural land use is proposed, the EIS should: - Demonstrate that the landscape will be returned to the Agricultural Suitability Class that existed before mining commenced or better; - Provide information on how soil would be developed in order to achieve the proposed stock capacity.	Rehabilitation Strategy
- Post Mining Land Use - the proponent must identify and assess post mining land use options and provide a statement of the preferred post mining land use outcome in the EIS. This should include a discussion of how the final land use(s) are aligned with relevant local and regional strategic land use objectives as well as the benefits of the post mining land to the surrounding environment, a subsequent landowner, the local community and the state of NSW.	Section 7; Rehabilitation Strategy
EPA	
Soils The EIS should include: 1. An assessment of potential impacts on soil and land resources should be undertaken, being guided by Soil and Landscape Issues in Environmental impact Assessment (DLWC 2000). The nature and extent of any significant impacts should be identified. Particular attention should be given to: - Soil erosion and sediment transport - in accordance with Managing urban stormwater: soils and construction, vol. 1 (Landcom 2004) and vol. 2 (A. Installation of services; B Waste landfills; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC 2008).	Section 8
2. A description of the mitigation and management options that Will be used to prevent, control, abate or minimise identified soil and land resource impacts associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Rehabilitation Strategy
3. Where required, add any specific assessment requirements relevant to the Project.	Section 7

1.4.2 Strategic Regional Land Use Policy

The NSW Strategic Regional Land Use Policy applies state-wide in areas where there is high value agricultural land and increasing activity in the coal and coal seam gas industries. The Project Boundary falls within the area covered under the Upper Hunter Region Strategic Regional Land Use Plan (SRLUP) which was released in September 2012.

A key component of the Upper Hunter Region SRLUP is the identification and mapping of Strategic Agricultural Land (SAL). One category of SAL is Biophysical Strategic Agricultural Land (BSAL), which is land containing "a rare combination of natural resources and is considered highly suitable for agriculture" (DP&I, 2012a).

State Significant Development proposals related to mining that are likely to impact on areas of BSAL are subject to the new BSAL Site Verification and Gateway Process. If areas of the Project Boundary are already mapped as BSAL under the relevant SRLUP, then applicants are required to ascertain whether to accept or challenge the respective mapping (via site verification).

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 20

The BSAL Site Verification and Gateway processes have been implemented through an amendment to, inter alia, *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) and the *Environmental Planning and Assessment Regulation 2000* (EPA Regulation). The amendment was gazetted in October 2013. A further amendment to *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* was gazetted in February 2014 with revised mapping of SAL.

The EP&A Regulation (section 50A) requires that:

“..a development application for consent to a mining or petroleum development on certain identified land (including land shown on the Strategic Agricultural Land Map) must be accompanied by:

(a) a gateway certificate, or

(b) a site verification certificate that certifies that the land on which the proposed development is to be carried out is not biophysical strategic agricultural land.

KEPCO identified that the Project will impact areas of BSAL and proceeded directly to the Gateway process that included details of the verification of BSAL within the application (SLR, 2013). The Gateway Panel issued a Conditional Gateway Certificate with conditions in April 2014.

Table 3 provides a summary of the requirements under the Conditional Gateway Certificate that are relevant to this assessment and indicates where specific issues have been addressed in this or affiliated Project documentation.

Table 3 Summary of Gateway Requirements

Specific issues	Where addressed
Mining Petroleum and Gateway Panel	
With regard to the removal and recreation of verified BSAL soils:	Rehabilitation Strategy
1. Undertake a risk assessment that identifies the hazards and proposes controls with respect to the movement of BSAL soils;	
2. Identify a final location for the verified BSAL soils within the Project Boundary area;	
3. Detail the methods proposed for the handling, storage and treatment of the verified BSAL soils;	
4. Propose alternate mitigation measures to be implemented in the event that the methodology selected results in the loss of verified BSAL soils post-implementation.	

1.5 Standards and Guidelines

This report has generally been prepared in accordance with the requirements of the following relevant strategic land use planning and resource management plans and policies:

- The soil taxonomic classification system utilised was the *Australian Soil Classification System* (Isbell, 1996);
- The soil survey system implemented with regard to survey unit type and scale was the *Guidelines for Surveying Soil and Land Resources* (NCST, 2008). This is the recognised guideline for Australian soil and land capability assessments;
- The soil survey system applied with regard to recording information from field soil survey observations was the *Australian Soil and Land Survey Field Handbook* (NCST, 2009). This is the recognised guideline for Australian soil and land capability assessments;

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 21

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- The *Land and Soil Capability Assessment Scheme* (OEH, 2012) was applied to assess the inherent physical capacity of the land to sustain a range of land uses and management practices. This scheme was recently introduced and builds upon the previously used *Systems Used to Classify Rural Lands in New South Wales* (Emery, 1986);
 - The *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* ((Office of Environment & Heritage (OEH) and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (DPI-OASFS), 2013a)). Hereafter referred to as the Interim Protocol was applied to Study Area to assess the presence of BSAL; and
 - The suitability of soil for conservation and use in the rehabilitation of land disturbed associated with mining construction and operations has been determined with reference to multiple rehabilitation guidelines including *Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas* (Elliot & Reynolds, 2007) and *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Part D: Growth Media Management* (QLD DME, 1995).

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 22

2 BIOPHYSICAL ENVIRONMENT

2.1 Climate

The Study Area typically has a cool temperate climate with moderately dry winters and wetter summers. Temperatures within the region range from an average daily maximum of 24.1°C in January to an average daily minimum of 2.5°C in July. The annual average maximum and minimum temperatures measured at Nullo Mountain Bureau of Meteorology (BOM) Station are 16.6°C and 8.0°C, respectively. The annual average rainfall is 930.4 mm with the majority of this rainfall falling in the summer months of November to February and an average of 89.9 rain days per year (BOM, 2014a; Nullo Mountain BOM station No. 062100). The annual average rainfall at Heatherbrae (Bylong) situated approximately 3 km from Bylong is 627.2 mm (BOM, 2014b; Bylong station No. 062080).

Given that the Study Area receives an annual average rainfall of greater than 350 mm per annum, this is deemed to be a reliable water supply, as defined by the Interim Protocol.

2.2 Topography

The Study Area contains steep sections and rocky escarpments associated with the Great Dividing Range, which surround the Bylong alluvial valley plains. The Bylong Valley is bisected by two broad valleys associated with each of the Bylong River and Growee River, which have been mainly cleared for agriculture. These valleys are surrounded by elevated, heavily wooded forests and escarpment-bounded plateaus ranging from 400-600 m above sea level. Some of these narrow plateaus have elevations of up to 700 m at the southern region fringed by the alluvial valleys as indicated in **Figure 5**.

Wider tablelands with elevations of up to about 450 m occur to the northwest of the Study Area. Mapping at a base scale of 1:25,000, illustrating the topography of the Study Area is provided in **Appendix A**.

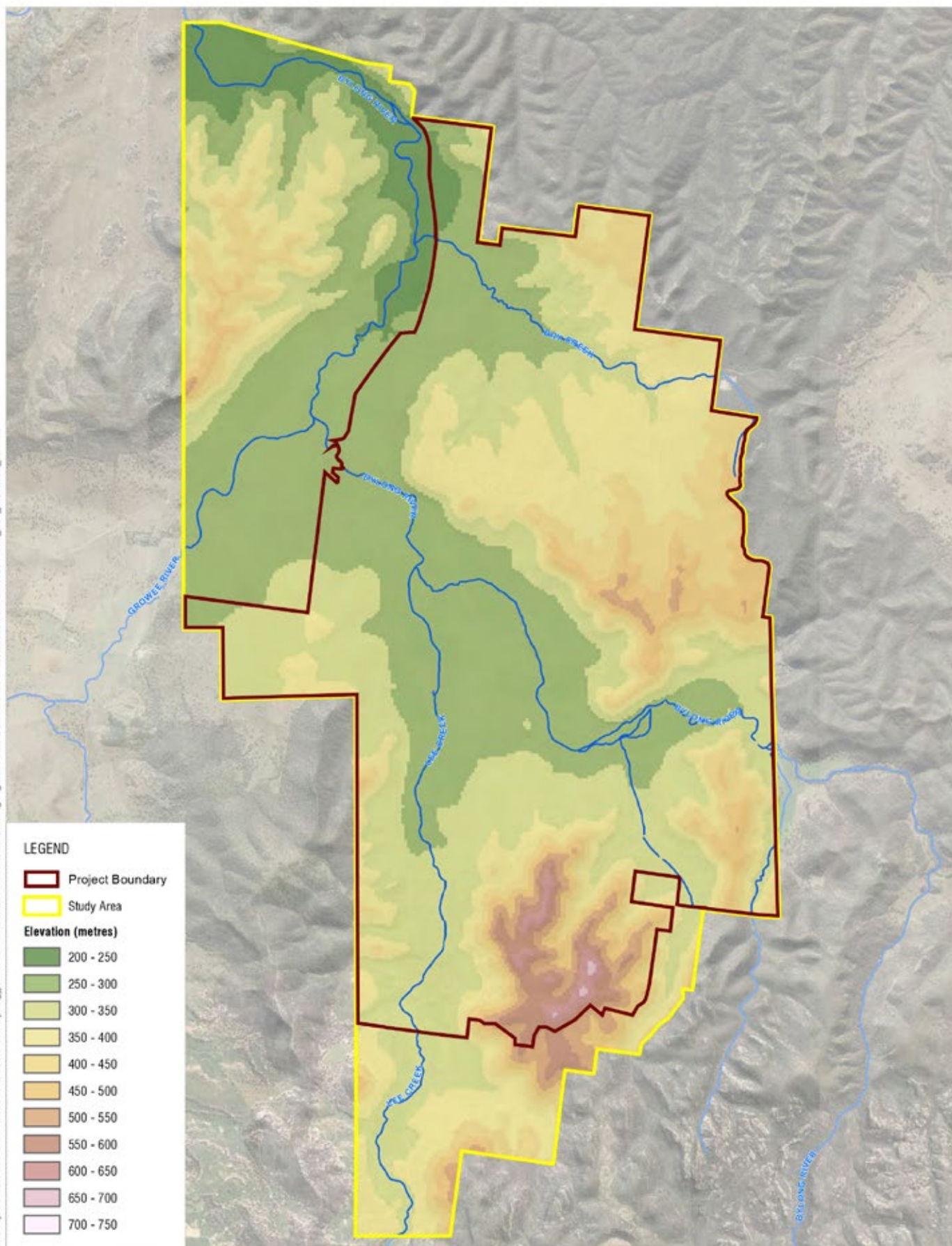
Figure 6 illustrates a slope analysis undertaken for the Study Area, using 0.25 m LIDAR information. Of particular relevance from this analysis is land with slope less than 10%, as this is one of the key BSAL criteria to be met in consideration of whether land is classified as BSAL or not. Land with slopes >10% is considered to be non-BSAL. Land with slopes of <10% may be considered BSAL if all other BSAL criteria are met. **Table 4** quantifies each slope class across the Study Area.

Figure 7 shows the distribution of the <10% and >10% land across the Study Area.

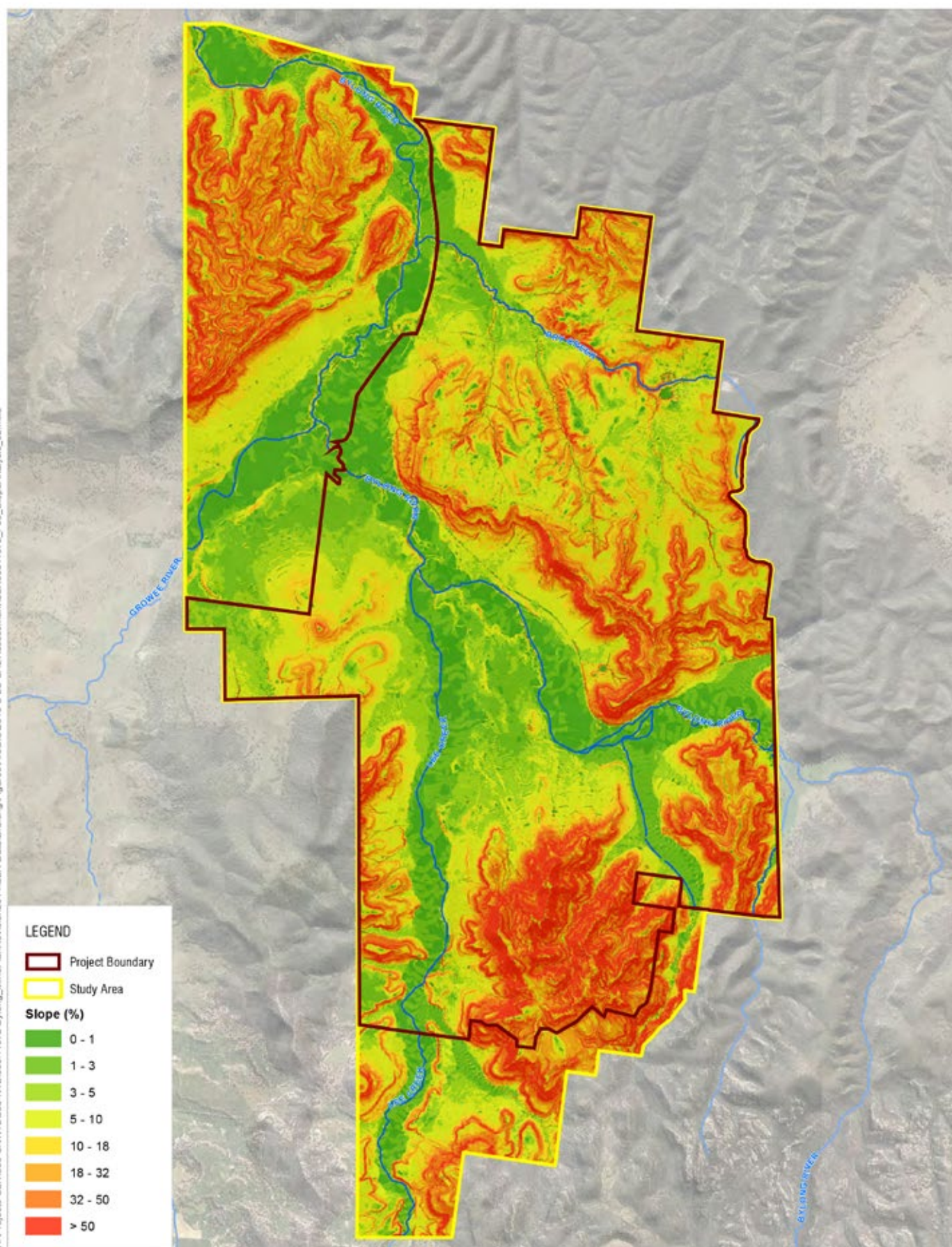
Table 4 Slope Classes

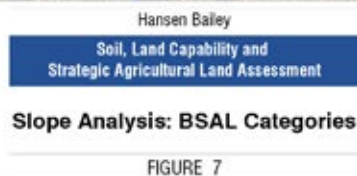
Slope		Potential BSAL	Study Area	
Class	% incline	Yes/No	ha	%
Level	0-1	Yes	1,203.0	11.7
Very gently inclined	1-3	Yes	1,142.9	11.1
Gently inclined	3-5	Yes	983.7	9.5
	5-10	Yes	1,930.1	18.7
Subtotal			5,259.70	51.0
Moderately inclined	10-32	No	2,646.1	25.6
Steeply inclined	32-50	No	1,326.3	12.9
Very steep to precipitous	>50	No	1,084.9	10.5
Subtotal			5,057.30	49.0
Total			10,317.0	100.0

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Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 26

2.3 Hydrology

The Bylong River flows through most of the valley plain within the Study Area continuing from the southeast in a northerly direction where it drains to the Goulburn River. It is an ephemeral (flows less than 95% of the time) unregulated river; however, represents a highly productive alluvial groundwater source. Given the characteristics of the Bylong River, it is deemed to be a reliable water supply, as defined by the Interim Protocol.

Other named ephemeral rivers and creeks within the Study Area (**Figure 5**) include:

- The Growee River flows from the southwest to northeast and its confluence with the Bylong River is located near the town of Bylong. The alluvium associated with this river also represents a highly productive groundwater source;
- Lee Creek flows from the southern portion of the Study Area in a northerly direction meeting the Bylong River southeast of the town of Bylong;
- Dry Creek, located in the northern portion of the Study Area, drains the elevated areas of the Bylong State Forest and flows in a northwesterly direction, meeting the Bylong River north of the town of Bylong; and
- Other smaller tributaries which drain into the Bylong River include the Cousin's, Crow's Nest and Wattle Creeks.

The Bylong valley features indicate that alluvial floodplains have developed through the subsequent erosion of river channels to their peak depth and width limits, followed by the gradual in-filling of alluvial sediments which make up the existing Bylong River valley plains.

Further details pertaining to water in relation to the Upper Hunter SRLUP and associated Interim Protocol and Aquifer Interference Policy (NSW, Office of Water, 2012) are provided in the Groundwater Impact Assessment prepared to support the EIS for the Project (AGE, 2015).

2.4 Geology

The Study Area is located within the Western Coalfield of the Sydney Basin, which forms part of the larger Sydney-Gunnedah-Bowen Basin.

At the northern end of the Study Area, shale, conglomerate and sandstone of the Shoalhaven Group (Early Permian) form the basement geology which is exposed within the Lee and Dry Creeks. This formation is overlain by the Illawarra Coal Measures which outcrop along the sides of the valleys. The coal measures in turn are overlain by the Triassic Narrabeen Group, and are present to the east, west and north of the Study Area where they form conglomeritic sandstone escarpments.

The Illawarra Coal Measures are of Late Permian Age, with an approximate thickness of 220 m within the Study Area, with the sequence becoming thicker towards the east. The Coal Measures regionally dip at around 2° towards the northeast.

The stratigraphic units forming the Illawarra Coal Measures are similarly presented as follows from the oldest to the youngest unit: Shoalhaven Group, Coggan Seam, Blackman's Flat Conglomerate, Ulan Seam, Long Swamp Formation, Irondale Coal, Newnes Formation, Glen Davis Formation, Denman Formation, Watts Sandstone, State Mine Creek Formation, Gap Sandstone and Farmer's Creek Formation. Members of this stratigraphic unit are present for the most parts of the Study Area, being relatively thin in the western half of the coalfield with a relatively uniform thickness of 100-200 m. To the east, the Coal Measures thicken from 200-900 m as they pass into the main trough of the Sydney Basin.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 27

2.5 Soil Landscape Units

The Study Area and Project Boundary consist of seven soil landscape units (Kovac & Lawrie, 1991). These are Bald Hill, Benjang, Bylong, Growee, Lees Pinch, Ogilvie and Sandy Hollow (**Figure 8**). The broad scale mapping shows that the major soil landscape units in the Study Area are Growee, Lees Pinch and Bylong (**Table 5**).

Table 5 Soil Landscape Units

Soil Landscape Unit	Study Area		Project Boundary	
	ha	%	ha	%
Bald Hill	688	6.7	630.6	9.0
Benjang	1,027	9.9	1,026.3	14.8
Bylong	1612	15.6	909.8	13.1
Growee	3,566	34.6	2,060.1	29.6
Lees Pinch	2,404	23.3	1,641.5	23.6
Ogilvie	565	5.5	234.1	3.4
Sandy Hollow	455	4.4	455.3	6.5
Total	10,317	100.0	6,957.7	100.0

Bald Hill

The Bald Hill Soil Landscape Unit is associated with low hillocks and basalt or dolerite caps and is present mainly in the northeast of the Study Area. It occurs on the Tertiary basalt geological unit and the parent rock is olivine basalt and dolerite. Elevations range from 240-1,000 m and slope gradients are between 5-50%. This soil landscape unit is typically suited to grazing enterprises.

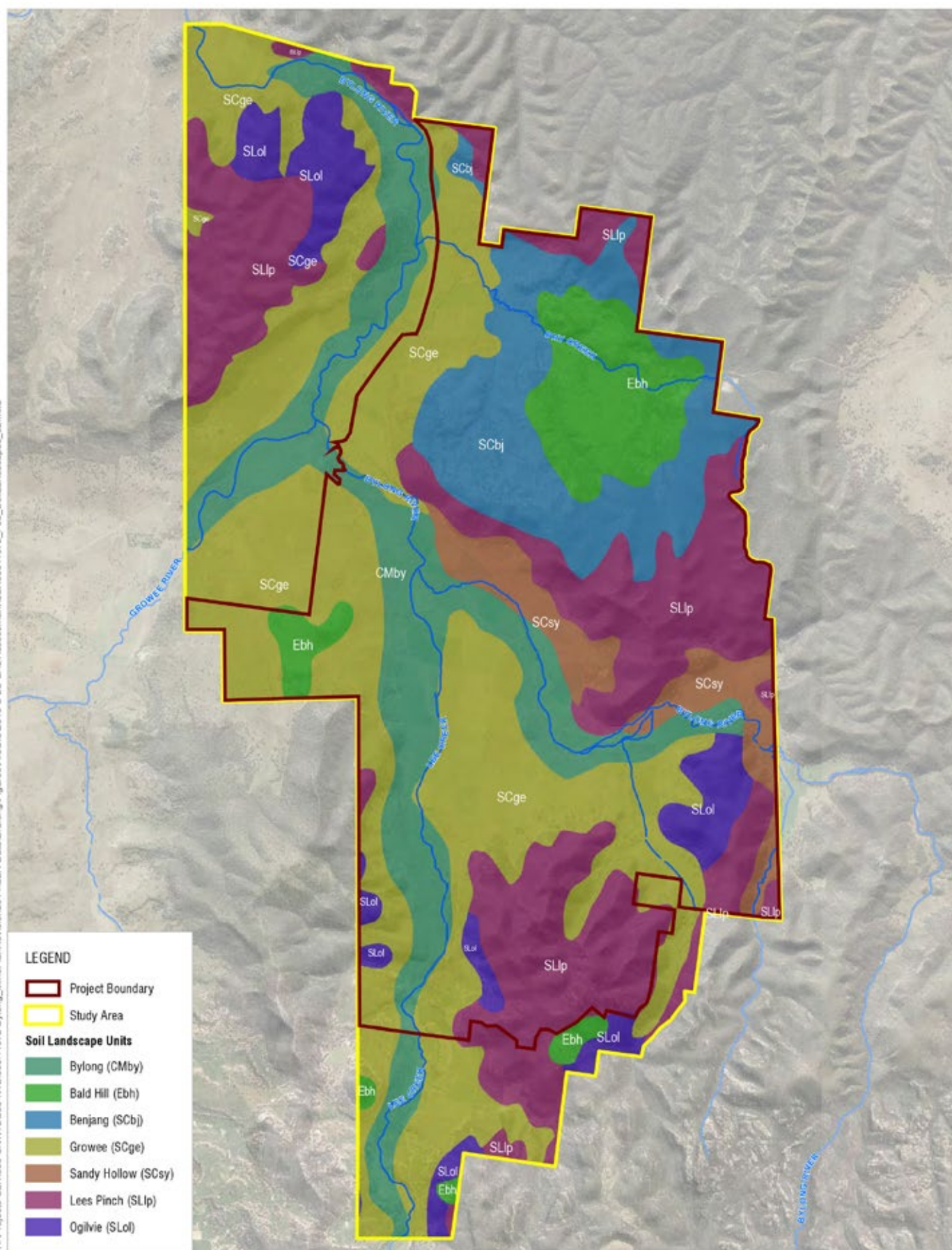
Benjang

The Benjang Soil Landscape Unit is associated with rounded rolling hills with large open valleys and some sandstone cliffs and occurs beside the more rugged Lees Pinch soil landscape in the east of the Study Area. It occurs on the Illawarra Coal Measures geological unit and the parent rock is shale, sandstone, conglomerate, mudstone, coal, tuff and some basalt. The rolling hills range in elevation from 240-440 m and are generally rounded with frequent outcrops of sandstone or conglomerate on the summits. The landform slopes are 10-25%. Soils on the steeper benched country have hard rocks and near horizontal bedding that has resulted in poor soil drainage. This soil landscape unit is typically suited to grazing enterprises.

Bylong

The Bylong Soil Landscape Unit is associated with alluvial flats and low terraces of the Bylong River and the Growee Creek in the vicinity of the Bylong Village. It occurs on the Quaternary alluvium geological unit and the parent material is alluvium. Elevations range from 260-320 m and the landform consists of low (<10 m) alluvial terraces with swampy hollows and abandoned channels. This soil landform provides a stable landscape with little erosion except for stream bank erosion along main drainage channels. This soil landscape unit is typically suited to cropping and grazing enterprises.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 29

Growee

The Growee Soil Landscape Unit is associated with undulating rises and low hills, with broad, widely spaced shallow valleys. The small, closely spaced valleys occur in the areas of undulating low rises. The main valleys often have terraced alluvium near the drainage lines. This unit occurs throughout the Study Area primarily adjacent to the Bylong soil landscape unit. It occurs on the Illawarra Coal Measures geological unit and parent rock is shale, sandstone, conglomerate, coal, tuff and clay. The slopes are generally less than 10% throughout the area and this soil landscape unit is typically suited to grazing enterprises.

Lees Pinch

The Lees Pinch Soil Landscape Unit is associated with rolling hills to steep mountains and generally covers the steep sections and rocky escarpments of the Great Dividing Range that surround the Bylong valley. Summits are rounded or edged by sandstone cliffs, large sandstone outcrops occur on many hills, with occasional small plateaus, and narrow inaccessible valleys and gorges are common. It occurs on the Narrabeen Group geological unit and parent rock is lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone. The slopes are up to 90%. This soil landscape unit is marginally suited to grazing enterprises or best left protected with green timber.

Ogilvie

The Ogilvie Soil Landscape Unit is associated with steep hills and escarpments with sandstone and conglomerate outcrops forming cliffs. The landscape is also characterised by deep ravines with sandstone rubble and is present as isolated pockets in the Study Area. It occurs on the Narrabeen Group geological unit and parent rock is sandstone, shale and conglomerate. The landform elevation ranges from 180-620 m, with slopes between 15-60%. This soil landscape unit is marginally suited to grazing enterprises or not suitable for agriculture.

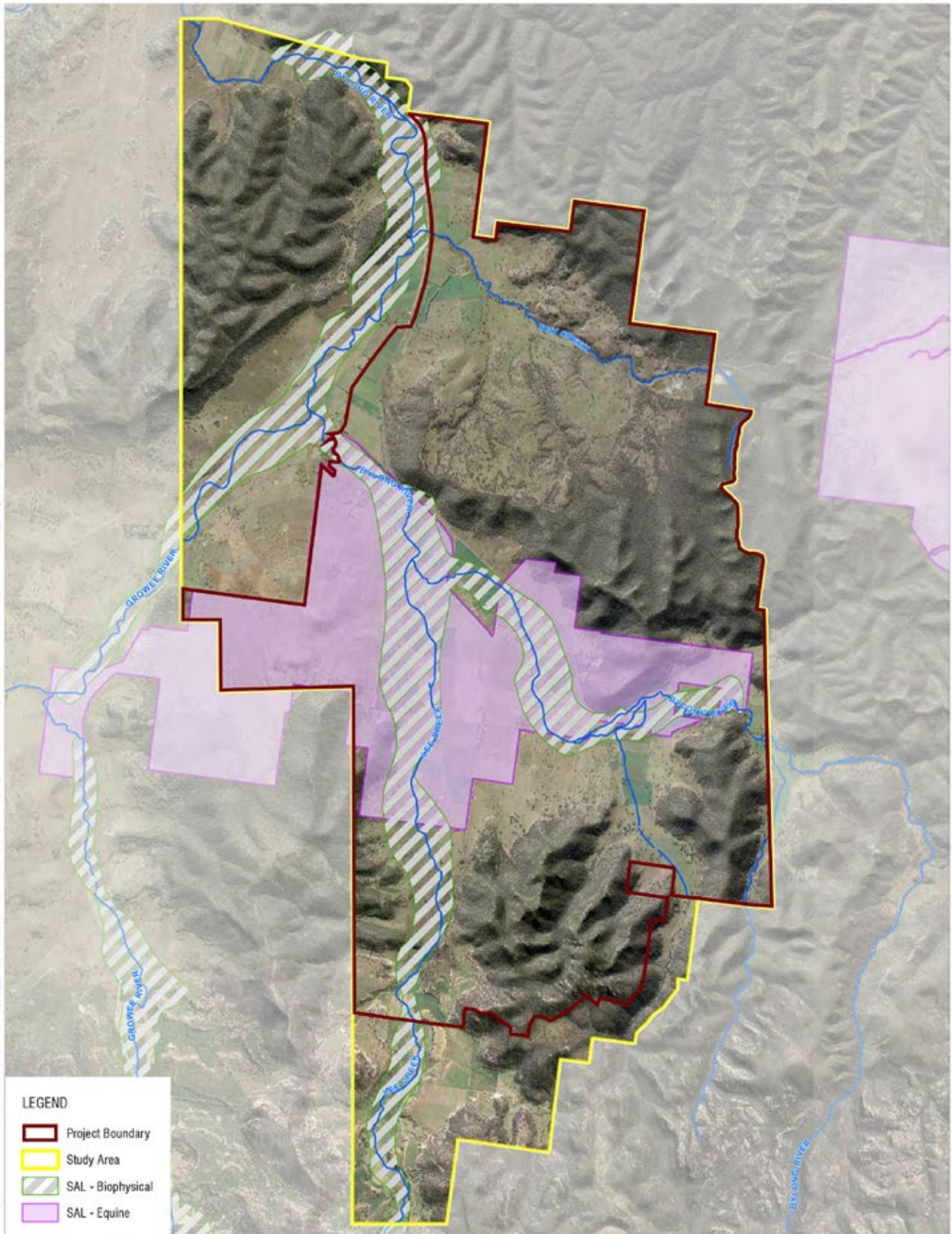
Sandy Hollow

The Sandy Hollow Soil Landscape Unit is associated with undulating terrain with smooth and gentle rises. It is associated with the Ogilvie and Lees Pinch soil landscape units as it grades into Lees Pinch on the steep slopes with cliffs and into Ogilvie on toeslopes. Within the Study Area, it is a minor unit and occurs primarily in the central-east and eastern parts. It is located on Quaternary colluvium derived from the Narrabeen Group and the parent rock is sandstone, shale and conglomerate. Slopes are generally less than 10% with lengths ranging from 100-250 m. There are some outcrops of sandstone and also narrow flat benches on the sandstone with small broken scarps. Shallow valleys 20-40 m deep are cut into adjacent hills. Terraces sandy or gravelly alluvium occurs in the major valleys along streams. There is moderate gully erosion (<1.5 m) in drainage lines and minor sheet and rill erosion on slopes. This soil landscape unit is typically suited to grazing enterprises.

2.6 Strategic Agricultural Land

The Study Area has been broadly mapped by the final Upper Hunter Region SRLUP as containing SAL. According to SAL maps within the Upper Hunter Region SRLUP, a total of 1,610 ha of the Study Area is potential BSAL and 6,603 ha is potential 'Critical Industry Cluster' (CIC). Within the Project Boundary a total of 936 ha is potential BSAL and 1,933 ha is potential CIC (**Figure 9**). The BSAL from the SRLUP correlates with the coverage of the broad scale mapping of the alluvial Bylong Soil Landscape Unit.

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**Upper Hunter Biophysical Strategic
Agricultural Land Mapping**

FIGURE 9

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 31

2.7 Vegetation and Land Use

The Study Area and land immediately adjacent consists of freehold land which has been extensively modified by historic clearing and ongoing agricultural activity. The remaining areas are constituted by native vegetation, predominately within the Bylong State Forest, Goulburn River National Park and the Wollemi National Park (refer **Figure 2**). Native vegetation has been cleared (by historic clearing and ongoing agricultural activity) along the floodplains and lower slopes of the Bylong River, Growee River and Dry Creek, which occur within the Study Area. Vegetation communities include intact patches of native woodland and forest, partially disturbed woodland remnants, derived native grassland with remnant trees, exotic grassland and cropland.

The rural village of Bylong is located within the Study Area. A small quarry is also located within the Study Area which is currently in operation.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 32

3 SOIL SURVEY

3.1 Methodology

3.1.1 Risk Assessment and Survey Scale

Each Project domain has an impact on the existing land resource and the intensity of this impact differs between each domain. A risk assessment was undertaken to evaluate the risk of the Project to soil resources (and consequently agricultural activities) and to assign an appropriate soil sampling density (survey scale) to land potentially affected by the Project.

The risk assessment was undertaken in February 2013, prior to the release of the Interim Protocol, and was initially undertaken in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – V7* (OEH & DPI-OASFS, 2013b; hereafter referred to as the Draft Interim Protocol – 2nd Release). This approach was confirmed during a meeting with OEH and DPI-OASFS prior to the field works commencing.

The risk assessment applied to the Study Area is commensurate with the risk assessment requirements of the Interim Protocol. Accordingly, the risk assessment initially completed has been utilised. The risk assessment ranking guide is reproduced below in **Table 6** where the likelihood of a risk to occur is A - almost certain occur, B - likely, C - possible, D - unlikely and E - rare.

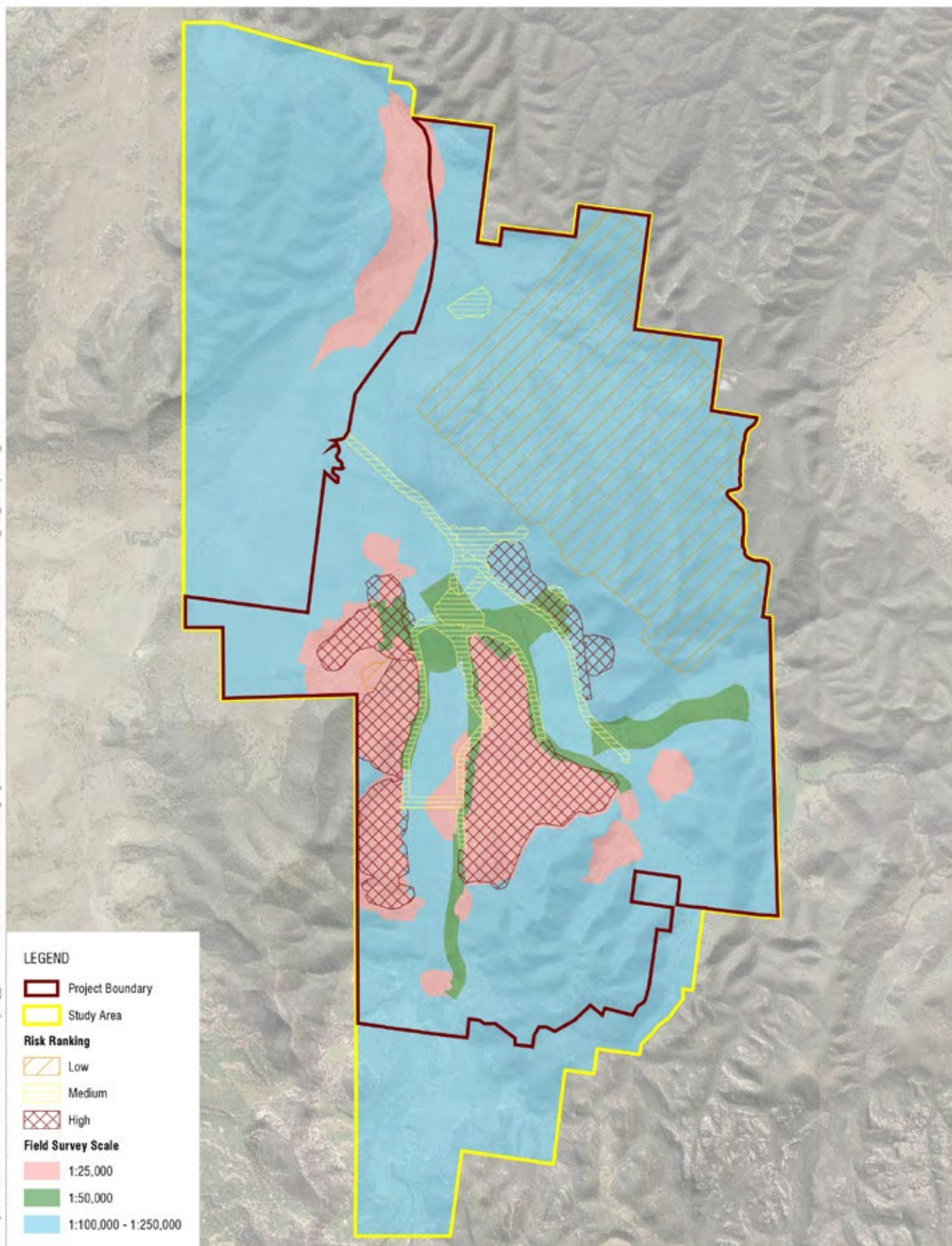
Table 6 Agricultural Impact and Risk Ranking Matrix

Probability Consequence	A Almost Certain	B Likely	C Possible	D Unlikely	E Rare
1. Severe and/or permanent damage. Irreversible impacts	A1 High	B1 High	C1 High	D1 High	E1 Medium
2. Significant and /or long term damage. Long term mgt implications. Impacts difficult or impractical to reverse.	A2 High	B2 High	C2 High	D2 Medium	E2 Medium
3. Moderate damage and/or medium-term impact to agricultural resources or industries. Some ongoing mgt implications which may be expensive to implement. Minor damage or impacts over the long term.	A3 High	B3 High	C3 Medium	D3 Medium	E3 Medium
4. Minor damage and/or short-term impact to agricultural resources or industries. Can be managed as part of routine operations.	A4 Medium	B4 Medium	C4 Low	D4 Low	E4 Low
5. Very minor damage and minor impact to agricultural resources or industries. Can be effectively managed as part of normal.	A5 Low	B5 Low	C5 Low	D5 Low	E5 Low

Source: DPI-OASFS, 2013

The risk ranking associated with major Project domains on soil resources ranges from low to high (**Table 7**). **Figure 10** shows the risk rating of proposed Project domains across the Study Area.

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**Risk Assessment &
Field Survey Scale**

FIGURE 10

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 34

Table 7 Project Domains

Project Domain		Risk Rating	Survey Scale
No.	Unit	Rating	-
1	Open Cut Mining Areas	A1-A3 – High	1:25,000
2	OEAs	A1-A3 – High	
4	Rail Loop	A3 – High ¹	
6	Water Storage Facilities	A3 – High ²	
3	Mine Infrastructure Area	A4 – Medium	1:50,000
5	Roads	A4 – Medium	1:50,000
7	Subsidence Study Areas - on non-SRLUP mapped BSAL	B5 - Low	1:100,000
	- on non-alluvial influenced BSAL	C4 - Low ³	
8	Stockpile Area	C4- Low	
	Nil Disturbance	Nil ⁴	1:100,000 – 1:250,000

- 1 Project domains will be left in place for future use
- 2 Area of land is small and impact on agricultural industries is minimal; however, as topsoil and subsoil will be significantly disturbed it has been assigned a high rating.
- 3 BSAL on elevated land is not predicted to be impacted by subsidence
- 4 No survey required for BSAL verification. Survey scale nominated to satisfy typical project SEARs

As per the Interim Protocol, sampling density is to be undertaken at a scale of 1:25,000 unless it can be demonstrated that the land will be subject to a lower risk of impact. **Table 7** details the assigned rankings per major Project domain and in accordance with the Interim Protocol has nominated multiple survey scales commensurate with the assessed level of risk.

For the majority of the Project domains identified as having a high risk of impacting soil resources, the associated land was subject to a sampling density scale of 1:25,000. For the remaining key Project domains identified as having a medium to low risk of impacting soil resources, the associated land was subject to a sampling density scale of 1:50,000 to 1:250,000. **Figure 10** shows the risk rating of proposed Project domains across the Study Area and the commensurate survey scale as specified in **Table 7**.

Some access was limited and therefore survey scale has been amended in localised areas to reflect this. In addition, mine plan refinements over time have led to parts of some high risk ranked domains being surveyed at a lower intensity scale and vice versa. These areas have been clearly shown on **Figure 10**.

3.1.2 Reference Mapping

An initial soil map (reference map) was developed using the following resources and techniques.

Aerial photographs and topographic maps

Aerial photos and topographic maps were analysed using remote sensing techniques which enabled a detailed analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the Study Area.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 35

Reference information

Source materials were used to obtain correlations between pattern elements and soil properties that may be observable in the field. These source materials included:

- Cadastral data;
- Prior and current physiographic, geological, vegetation, water resources studies; and
- Soil Landscapes *Maps of the Singleton 1:250 000 Sheet* (Kovac & Lawrie, 1991).

3.1.3 Field Survey

Background

Extensive fieldwork has been conducted across the Study Area over a one and a half year period, commencing in November 2011 and finishing in April 2013. Work was initiated in 2011 in response to the incoming NSW Liberal government adopting the proposed Strategic Regional Land Use Policy. Soil survey work commenced prior to the release of the first draft of the Interim Protocol and its intent was to identify the better classes of agricultural land, specifically Rural Land Capability Classes I, II and III land, to assist the mine planning design process. This phase of the fieldwork covered the period of 2011-2012 with surveys undertaken in November 2011, February 2012, May 2012 and August 2012 as land access became available. The first draft of the Interim Protocol released in November 2012 was titled *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – draft* (OEH & DPI-OASFS, 2013c); hereafter referred to as the Draft Interim Protocol – 1st Release.

Further survey works commenced in February 2013 post the release of the Draft Interim Protocol – 1st Release. This work built upon the 2011-2012 survey effort with the intent to ground-truth land proposed to be impacted by the Project in accordance with the survey scales described in **Table 7**. This fieldwork phase was also designed to collect information to satisfy the typical SEARs and therefore included a survey of the nil disturbance land.

This second phase of the fieldwork was largely conducted in the first quarter of 2013, prior to the finalisation of the Interim Protocol, with surveys undertaken in February, March and mid-April 2013 as land access to privately owned land became available. Some land proposed to be impacted by the Project was not accessible due to land access constraints. This land has been mapped using a model of soil distribution in line with the Interim Protocol.

Survey Techniques

The initial field surveys of 2011 and 2012 were an integrated qualitative survey conducted in accordance with the Guidelines for Surveying Soil and Land Resources (NCST, 2008). The second phase of field survey conducted in 2013 was revised to be in line with the Draft Interim Protocol – 1st Release and – 2nd Release, as appropriate, and was a random grid sampling survey with some points repositioned to allow for site access. Stratification of known soil landscape units was also taken into account.

For a general soil survey and a BSAL survey several types of observation sites were used. These are listed in **Table 8**. Observation types between the systems are equivalent with the exception of the BSAL Exclusion Site. Exclusion zones are zones that fail the BSAL criteria on landform aspects other than soil profile variables. For the Study Area this type of observation was limited to land with slope inclines of >10% (**Figure 7**). Slope measurement for exclusion zones used Airborne Laser Scanning (ALS) data collected from a 2011 LiDAR survey. The ALS data was collected by AAM Pty Limited in 2011 on behalf of the client from a fixed wing aircraft. Slope measurements were also recorded in the field, to accompany ALS data using the Theodolite IPAD software application.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 36

Table 8 Soil Survey Observation Types

General Soil Survey	BSAL Survey	Comparison
Detailed profile descriptions (Class I observations)	Detailed Sites	Equivalent
Laboratory assessed profiles (Class III observations)	A subset of the Detailed Sites ¹	Equivalent
Mapping observations (Class IV observations)	Check Sites	Equivalent
-	Exclusion Sites	No Equivalent; unique to BSAL verification process

1 Previously termed Analysed site in the Draft Interim Protocol – 1st Release and – 2nd Release.

The type and density of survey observations across the Study Area is shown in **Figure 11**. Mapping at a base scale of 1:25,000 illustrating the distribution of the observation points is in **Appendix B**.

Table 9 Soil Survey Observation Type and Density

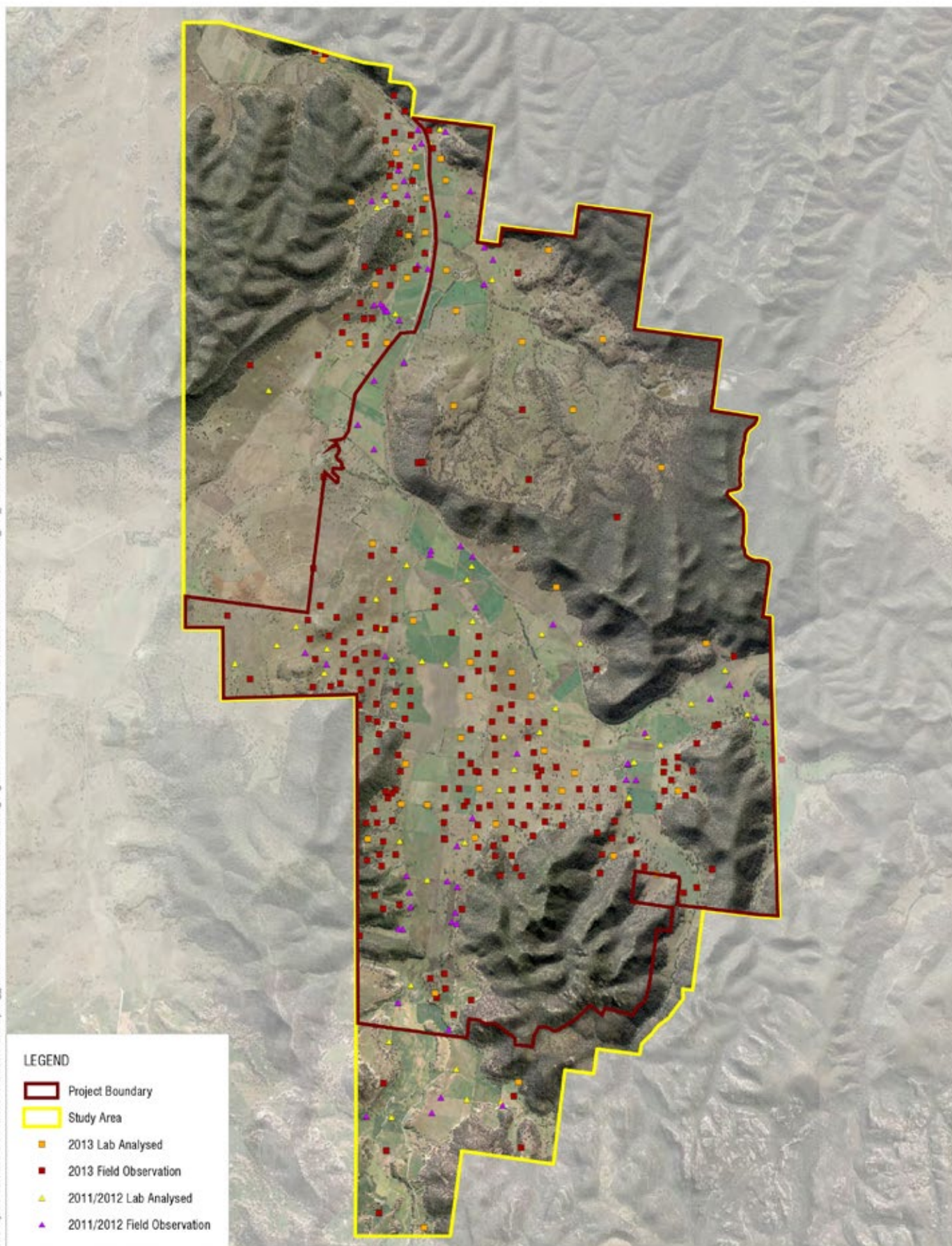
Fieldwork Phase	Number and Types of Observation			
	Detailed profile Descriptions	Laboratory Assessed profiles	Mapping observations	Total
2011-2012	72	48	47	167
2012-2013	185	50	255	490
			Total	657

Detailed Profile Description / Detailed Sites

Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST, 2009). Each soil-profile exposure was excavated by a soil corer to the required depth of 1.2 m, or to bedrock. After assessment was completed, soil cores were backfilled with the remaining excavated soil.

Detailed soil profile descriptions were developed recording parameters generally in accordance with the Interim Protocol (**Table 10**). Fieldwork undertaken during the first fieldwork phase, prior to the release of the verification guidelines excluded field pH. These observations were supplemented with laboratory data from surrounding soil cores undertaken at a later date.

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LEGEND

- Project Boundary
- Study Area
- 2013 Lab Analysed
- ◆ 2013 Field Observation
- ▲ 2011/2012 Lab Analysed
- ▲ 2011/2012 Field Observation



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Field Survey Observations

FIGURE 11

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 38

Table 10 Detailed Soil Profile Description Parameters

Parameter Descriptor	Parameter Descriptor
Unique identification and meaningful location description	Soil surface condition
Location provided as GPS recorded coordinates	Lower depth and type of each soil horizon or described layer
Identity of person describing the detailed site and date of description	Colour of the soil matrix and abundance, size, contrast and colour of any mottles for each soil horizon or described layer
Current land use and/or land cover	Field pH of each soil horizon or described layer
Landform	Boundary distinctiveness between soil horizons
Surface rock	Horizon name and notations for all layers
Outcropping bedrock	Abundance, nature, form and size of segregations (mineral and organic accumulations that have formed in the soil) for each layer
Gilgai microrelief	Abundance and size of coarse fragments (loose pebbles, cobbles, stones and boulders) for each layer
Slope %, direction and method of measurement	

Mapping Observations/Check Sites

Mapping observations consisted of exposed cuttings (such as cut slopes), topsoil exposures of up to 0.4 m (using a spade), vegetation cover associations, and rock outcrops. These were utilised to confirm mapping boundaries, soil unit distributions and any other characteristics being mapped in the survey.

3.1.4 Laboratory Assessment

Soil samples from representative sites were included in the laboratory testing program. Samples were analysed to assist with:

- Classification of soil taxonomic classes and soil suitability for re-use in rehabilitation activities;
- Assessment of LSC Class Classification; and
- Assessment of BSAL.

Soil samples were collected from each major soil horizon and analysed for the standard suite of parameters as listed in **Table 11**. Samples were collected where mixing of soil horizons would not occur and were taken across a span no greater than 30 cm where appropriate. Fieldwork in late 2012/early 2013 referenced the Draft Interim Protocol – 1st Release and sampling procedures used the following standard sampling depths where practicable: 0-10 cm, 25-35 cm, 55-65 cm and 90-100 cm. Sampling procedures were adjusted upon the release of the Draft Interim Protocol – 2nd Release (released late February, 2013), which required chemical data at a depth of 50 cm and samples were generally collected, where appropriate, from the standard sampling depths of: 0-10 cm, 25-35 cm, 45-55 cm and 85-95 cm.

In total approximately 350 samples were laboratory analysed and sent to the Australian Laboratory Services Brisbane (Qld, Australia) or Scone Research Centre (NSW, Australia) as applicable for the required analysis. These laboratories are both accredited by the National Association of Testing Authority (NATA). Mapping at a base scale of 1:25,000 and illustrating the distribution of the laboratory analysed sites is provided in **Appendix B**. Relevant laboratory certificates of analysis are provided in **Appendix C**.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 39

Table 11 Laboratory Parameters and Analytes

Laboratory Suite	Sampling Frequency	Laboratory Analysis
Soil taxonomic class	Major soil horizon and/or standard sampling depth	- Electrical conductivity 1: 5 water (EC)¹ - pH - Exchangeable cations - Cation exchange capacity (CEC) - Colour - Emerson Aggregate Test² - Particle size Analysis²
Land & Soil Classification Class (Section 4)	Major soil horizon and/or standard sampling depth	As above. No additional analytes required
BSAL (Section 5)	Major soil horizon and/or standard sampling depth	- As above; and - Chloride if gypsum is present to replace EC analytical test³.

1 Electrical conductivity from a saturated paste (ECe) was converted from the EC value using the approximate conversion factor as per the Interim Protocol

2 Undertaken for approximately 65% of laboratory analyses samples.

3 Not required as soil units exhibiting a chemical limitation of salinity were not observed to have gypsum present.

3.1.5 Soil Classification Nomenclature

The applicable technical standard for naming the units of soil identified is the *Australian Soil Classification* (ASC) system (Isbell, 1996).

3.2 Soil Results

3.2.1 Summary of Soil Units

Forty soil units and 14 soil-phases were identified within the Study Area. These were classified broadly into seven ASC orders: Chromosols, Dermosols, Kandosols, Rudosols, Sodosols, Tenosols and Vertosols. The key findings are:

- The major ASC order associated with the basaltic derived Bald Hill Soil Landscape Unit is a fine textured Red Dermosol followed by a Red Chromosol. Chromosols are soils with strong texture contrast between the A and B horizons that do not have strongly acidic or sodic B horizons;
- The major ASC order associated with the sedimentary derived Benjang Soil Landscape Unit is a medium textured (loam) Brown Chromosol;
- The major ASC order associated with the alluvial influenced Bylong Soil landscape Unit is a Black Dermosol. Dermosols are soils with structured B2 horizons and lack strong texture contrast between the A and B horizons. In the Bylong Soil Landscape Unit, the Dermosol was observed as a full profile or as a shallow Dermosol overlying an alluvial sandy soil;
- The major ASC order associated with the sedimentary derived Growee Soil Landscape Unit is a Red Chromosol. The Growee soil units are generally associated with gently to moderately inclined land and contain larger mineral particle content than the Bald Hill influenced Chromosol. Minor soil units in this soil landscape also include Tenosols, Kandosols, Sodosols and Rudosols; and
- The major ASC order associated with the sedimentary derived Lees Pinch Soil Landscape Unit is a Rudosol. Rudosols are soils that have negligible pedological organisation. This soil unit is highly siliceous and shallow.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 40

The major ASC order associated with the sedimentary derived Ogilvie Soil Landscape Unit is a Brown Sodosol. Sodosols are soils with strong texture contrast between the A and B horizons that have sodic B horizons. **Figure 12** illustrates the spatial distribution of soil units. Soil unit maps at a 1:25,000 scale are provided in **Appendix D**. **Table 12** provides the area covered by each soil unit. Full soil profile descriptions are provided in **Appendix E**.

Table 12 Soil Unit Distribution Summary

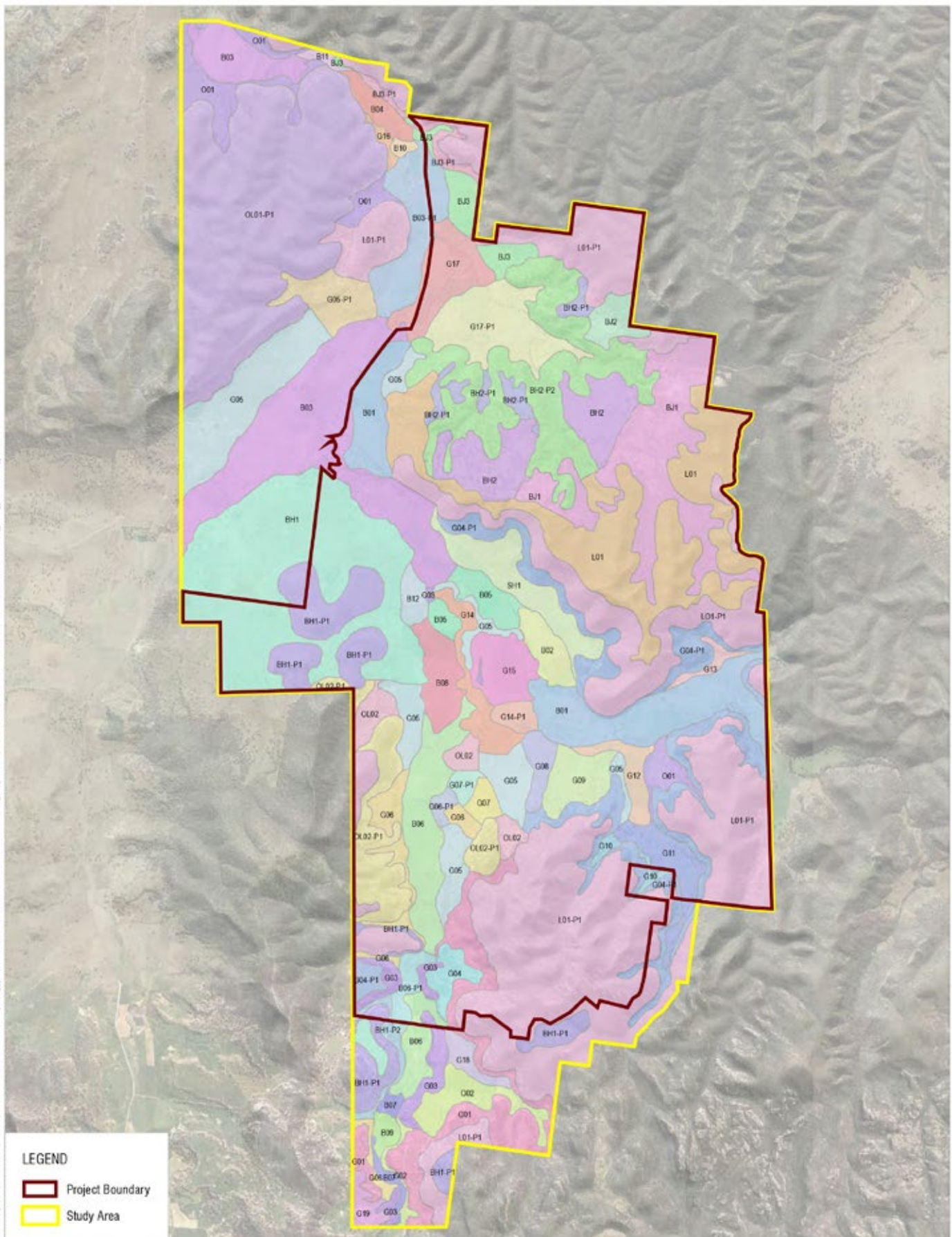
Soil Unit		Study Area		Project Boundary	
		ha	%	ha	%
Bald Hill Soil Landscape					
BH1	Eutrophic Red Dermosol; deep	729.6	7.1	443.4	6.3
BH1-P1: Shallow Phase	Red Chromosol; shallow	317.1	3.1	191.4	2.8
BH1-P2: Moderate Phase	Eutrophic Red Chromosol; moderate	24.6	0.2	6.4	0.1
BH2	Eutrophic Red Dermosol; deep	211.1	2.0	211.1	3.1
BH2-P1: Moderate Phase	Red Dermosol; moderate	62.6	0.6	62.5	0.9
BH2-P2: Shallow Phase	Red Chromosol; shallow	436.8	4.2	436.7	6.3
Benjang Soil Landscape					
BJ1	Eutrophic Brown Chromosol; deep	354.9	3.4	355.4	5.1
BJ2	Self-mulching Brown Vertosol; shallow	47.1	0.5	47.0	0.7
BJ3	Subnatric Yellow Sodosol; deep	80.8	0.8	75.3	1.1
BJ3-P1: Shallow Phase	Subnatric Yellow Sodosol; shallow	34.7	0.3	24.0	0.3
Bylong Soil Landscape					
B01	Eutrophic Black Dermosol overlying Stratic Rudosol	341.9	3.3	341.9	4.9
B02	Eutrophic Black Dermosol; deep	54.8	0.5	54.7	0.8
B03	Eutrophic Black Dermosol; deep	149.6	1.5	148.8	2.1
B03-P1: Saline Phase	Eutrophic Black Dermosol; saline	574.4	5.6	31.3	0.5
B04	Black Dermosol; moderate	39.9	0.4	Nil	Nil
B05	Brown-Orthic Tenosol	71.0	0.7	70.9	0.9
B06	Eutrophic Black Dermosol overlying Stratic Rudosol	228.2	2.2	187.4	2.7
B06-P1: Saline Phase	Eutrophic Black Dermosol overlying Stratic Rudosol; saline	34.7	0.3	32.4	0.5
B07	Chernic-leptic Tenosol	24.8	0.2	Nil	Nil
B08	Eutrophic Grey Dermosol overlying Stratic Rudosol	78.4	0.8	78.3	1.1
B09	Black Dermosol	19.9	0.2	Nil	Nil
B10	Leptic Tenosol	7.9	0.1	Nil	Nil
B11	Eutrophic Brown Kandosol	10.0	0.1	Nil	Nil
B12	Stratic Rudosol overlying Black Dermosol	28.7	0.3	28.8	0.5
Growee Soil Landscape					
G01	Eutrophic Red Chromosol; moderate	249.8	2.4	77.1	1.1
G02	Eutrophic Red Chromosol; deep	89.7	0.9	Nil	Nil
G03	Lithic Rudosol	86.9	0.8	39.5	0.5

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 41

Soil Unit		Study Area		Project Boundary	
		ha	%	ha	%
G04	Mesotrophic Brown Chromosol; moderate	40.2	0.4	40.2	0.6
G04-P1	Mesotrophic Red Chromosol; shallow	368.3	3.6	325.8	4.7
G05	Eutrophic Red Chromosol; moderate	419.3	4.1	208.9	3.1
G05-P1: Shallow Phase	Red Chromosol; shallow	82.8	0.8	Nil	Nil
G06	Eutrophic Red Chromosol; moderate	90.8	0.9	76.8	1.1
G06-P1: Shallow Phase	Red Chromosol; shallow	14.1	0.1	14.1	0.2
G07	Eutrophic Red Chromosol; deep	23.2	0.2	23.2	0.3
G07-P1: Gravelly Phase	Eutrophic Red Chromosol; gravelly	17.1	0.2	17.2	0.3
G08	Eutrophic Red Dermosol; shallow	37.1	0.4	37.1	0.5
G09	Eutrophic Brown Chromosol; moderate	76.5	0.7	76.5	1.1
G10	Eutrophic Black Kandosol	16.9	0.2	10.9	0.1
G11	Stratic Rudosol	80.7	0.8	66.3	1.0
G12	Black Dermosol; deep	47.8	0.5	47.8	0.6
G13	Black-Orthic Tenosol; light sandy textured	17.8	0.2	17.8	0.2
G14	Eutrophic Brown Chromosol; deep	72.6	0.7	72.4	1.1
G14-P1	Brown Chromosol; shallow	25.9	0.2	25.9	0.4
G15	Subnatric Brown Sodosol	84.2	0.8	84.1	1.1
G16	Stratic Rudosol	9.9	0.1	Nil	Nil
G17	Eutrophic Red Chromosol; deep	117.7	1.1	102.4	1.5
G17-P1: Moderate Phase	Eutrophic Red Chromosol; moderate	171.3	1.7	171.3	2.4
G18	Mesonatric Yellow Sodosol; deep	29.4	0.3	0.4	<0.1
G19	Brown Chromsol*; moderate	28.0	0.3	Nil	Nil
Lees Pinch Soil Landscape					
L1	Clastic Rudosol	577.0	5.6	578.7	8.4
L1-P1: Shallow Phase	Clastic Rudosol; very shallow	1964.2	19.0	1,577.5	22.7
Ogilvie Soil Landscape					
O1	Mesonatric Brown Sodosol; moderate	159.4	1.5	35.7	0.5
O1-P1: Shallow Phase	Subnatric Brown Sodosol; shallow	950.8	9.2	Nil	Nil
O2	Clastic Rudosol; deep	77.0	0.7	76.7	1.2
O2-P1: Moderate Phase	Clastic Rudosol; moderate	195.0	1.9	193.6	2.8
Sandy Hollow Soil Landscape					
SH1	Subnatric Red Sodosol; deep	132.1	1.3	132.1	1.8
Total		10,371.0	100.0	6,957.7	100.0

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LEGEND

- Project Boundary
- Study Area



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Soil Units

FIGURE 12

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Report Number 630.11072.00000
24 March 2015
Revision 1
Page 43

3.2.2 Bald Hill Soil Unit Summary

The Bald Hill Soil Landscape Unit covers low hillocks and basalt or dolerite caps. It occurs on the Tertiary basalt geological unit and the parent rock is olivine basalt and dolerite. Elevations typically range from 240-1000 m and slope gradients are between 5-50%.



Plate 1 – Bald Hill Soil Landscape

In the Study Area, the Bald Hill Soil Landscape Unit is a major unit covering a large area of elevated land in the north-east, and smaller pockets of land in the western and southern parts of the Study Area. The major soil unit is a Red Dermosol, it typically has deep to moderate soil depth, is non-sodic and non-saline. The minor soil unit is a Red Chromosol, with shallow soil depth.



Plate 2 – Red Dermosol



Plate 3 – Red Chromosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 44

3.2.3 Benjang Soil Unit Summary

The Benjang Soil Landscape Unit occurs on rounded rolling hills with large open valleys and some sandstone cliffs and occurs beside the more rugged Lees Pinch soil landscape in the east of the Study Area. It occurs on the Illawarra Coal Measures geological unit and the parent rock is shale, sandstone, conglomerate, mudstone, coal, tuff and some basalt. The rolling hills range in elevation from 240-440 m and are generally rounded with frequent outcrops of sandstone or conglomerate on the summits. The landform slopes are 10-25%.



Plate 4 – Benjang Soil Landscape Unit

The Benjang Soil Landscape Unit is a minor unit covering the lower slopes surrounding the Bald Hill Soil Landscape Unit in the north-eastern part of the Study Area. The major soil unit is a Brown Chromosol that typically has deep soil depth, is non-saline in the top soil, moderately saline in the subsoil and non-sodic. The minor soil units are a Brown Vertosol with shallow soil depth, slight sodic and saline trends, and a Yellow Sodosol with deep to shallow soil depth.



Plate 5 – Brown Chromosol



Plate 6 – Brown Vertosol



Plate 7 – Yellow Sodosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 45

3.2.4 Bylong Soil Unit Summary

The Bylong Soil Landscape Unit covers alluvial flats and low terraces of the Bylong River and the Growee Creek at Bylong. It occurs on the Quaternary alluvium geological unit and the parent material is alluvium. Elevations range from 260-320 m and the landform consists of low (<10m) alluvial terraces with swampy hollows and abandoned channels.



Plate 8 – Bylong Soil Landscape Unit

The Bylong Soil Landscape Unit in the Study Area is a major unit covering the alluvial flats around the two main watercourses, which run in a north-south and east-west direction through the centre of the Study Area. It is represented by 12 soil units and 1 phase. There are two major soil units, a Black Dermosol with deep soil depth that is generally slightly to moderately saline with depth. The other major soil unit is a Black Dermosol overlying a sandy Stratic Rudosol with deep soil depth and variable salinity. The minor soil units include Brown-Orthic Tenosol, Chernic-Leptic Tenosol, Leptic Tenosol, Grey Dermosol overlying Stratic Rudosol, Brown Kandosol and Stratic Rudosol overlying Black Dermosol.



Plate 9 - Black Dermosol



Plate 10 – Black Dermosol overlying Stratic Rudosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 46

3.2.5 Growee Soil Unit Summary

The Growee Soil Landscape Unit covers undulating rises and low hills, with broad, widely spaced shallow valleys. The small, closely spaced valleys occur in the areas of undulating low rises. The main valleys often have terraced alluvium near the drainage lines. This unit occurs throughout the Study Area primarily in association with the Bylong soil landscape unit. It occurs on the Illawarra Coal Measures geological unit and parent rock is shale, sandstone, conglomerate, coal, tuff and clay. The slopes are generally less than 10% throughout the area.



Plate 11 – Growee Soil Landscape Unit

The Growee Soil Landscape Unit is a major unit within the Study Area covering the low hills and valleys surrounding the alluvial flats and is associated with the Bylong soil landscape unit. It is represented by 19 soil units and 4 soil phases. There are two major soil units, a Red Chromosol with shallow to deep soil depth and is typically non-saline and non-sodic, although some units are slightly saline. The other major soil unit is a Brown Chromosol with shallow to deep soil depth and is typically non-saline and non-sodic, although some units are slightly saline. The minor soil units are Lithic Rudosols, Red Dermosols, Black Kandosols, Stratic Rudosols, Black Dermosols, Black-Orthic Tenosols and Yellow Sodosols.



Plate 12 – Red Chromosol



Plate 13 – Brown Chromosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 47

3.2.6 Lees Pinch Soil Unit Summary

The Lees Pinch Soil Landscape Unit is characterised by rolling hills to steep mountains and covers the steep sections and rocky escarpments of the Great Dividing Range that surround the Bylong valley. Summits are rounded or edged by sandstone cliffs, large sandstone outcrops occur on many hills, with occasional small plateaus, and narrow inaccessible valleys and gorges are common. It occurs on the Narrabeen Group geological unit and parent rock is lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone. Elevation ranges from 180-800 m, with slopes up to 90%.



Plate 14 – Lees Pinch Soil Landscape Unit

The Lees Pinch Soil Landscape Unit is the dominant unit in the Study Area covering elevated regions with steeper slopes in the north-west, eastern and southern parts of the Study Area. It is represented by one dominant soil unit, a Clastic Rudosol with shallow to very shallow soil depth, it is generally sodic and slightly to moderately saline throughout the profile.



Plate 15 – Clastic Rudosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 48

3.2.7 Ogilvie Soil Unit Summary

The Ogilvie Soil Landscape Unit covers steep hills and escarpments with sandstone and conglomerate outcrops forming cliffs. The landscape is also characterised by deep ravines with sandstone rubble and is present as isolated pockets in the Study Area. It occurs on the Narrabeen Group geological unit and parent rock is sandstone, shale and conglomerate. The landform elevation ranges from 180-620 m, with slopes between 15-60%.



Plate 16 – Ogilvie Soil Landscape Unit

The Ogilvie Soil Landscape Unit is a minor unit covering smaller areas of land in the north-west, eastern and southern parts of the Study Area and is usually associated with the Lees Pinch soil landscape unit. There are two major soil units, a Brown Sodosol with moderate to shallow soil depth, and typically increasing salinity with depth. The other major soil unit is and Clastic Rudosol with moderate to deep soil depth.



Plate 17 – Brown Sodosol



Plate 18 – Clastic Rudosol

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 49

3.2.8 Sandy Hollow Unit Summary

The Sandy Hollow Soil Landscape Unit covers undulating terrain with smooth and gentle rises. It is associated with the Ogilvie and Lees Pinch Soil Landscape Units as it grades into Lees Pinch on the steep slopes with cliffs and into Ogilvie on foot slopes. It is located on Quaternary colluvium derived from the Narrabeen Group and the parent rock is sandstone, shale and conglomerate. Slopes are generally less than 10% with lengths ranging from 100-250 m. There are some outcrops of sandstone and also narrow flat benches on the sandstone with small broken scarps.



Plate 19 – Sandy Hollow Soil Landscape Unit



Plate 20 – Red Sodosol

The Sandy Hollow Soil Landscape Unit is a very minor unit covering a small area in the central and eastern part of the Study Area that's grades into the Lees Pinch soil landscape unit. It is typically a slightly saline and sodic soil landscape. It is represented by one soil unit, a Red Sodosol with deep soil depth and moderate salinity at depth.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 50

4 LAND AND SOIL CAPABILITY ASSESSMENT

4.1 Methodology

Land and Soil Capability Classes

A new LSC assessment scheme has been developed for NSW: *The land and soil capability assessment scheme: second approximation – A general rural land evaluation system for NSW* (OEH, 2012; hereafter referred to as the LSC Guideline). The LSC Guideline builds on the former *Rural Land Capability* system (Emery, 1986). The LSC Guideline retains the eight class system presented in Emery (1986) but places additional emphasis on specific soil limitations and their management.

The LSC classes from the LSC Guideline are reproduced in **Table 13** and are based on two main considerations:

- The biophysical features of the land to derive the LSC classes associated with various hazards; and
- The management of the hazards including the level of inputs, expertise and investment required to manage the land sustainably.

Table 13 LSC Class Definition

LSC Class	General Definition	
Land capable of a wide variety of land uses (cropping, grazing, horticulture forestry, conservation, nature conservation)		
1	<i>Extremely high capability land</i> No limitations	No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land Slight limitations	Limitations can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	<i>High capability land</i> Moderate limitations	Is capable of sustaining high-impact land uses, such as cropping with cultivation using more intensive and widely accepted management practices. However careful management of the limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture forestry, nature conservation)		
4	<i>Moderate capability land</i> Moderate to high limitations for high-impact land uses	Limitations will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	<i>Moderate-low capability land</i> High limitations for high-impact land uses	Limitations will restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable of a for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	<i>Low capability land</i> Very high limitations for high-impact land uses	Land restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 51

LSC Class	General Definition	
Land generally incapable of agricultural land use (selective forestry and nature conservation)		
7	<i>Very low capability land</i> Severe limitations that restrict most land uses	Limitations generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations are not managed. There should be minimal disturbance of native vegetation.
8	<i>Extremely low capability land</i>	Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Calculating LSC Classes

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform and more specifically: slope, landform position, acidity, salinity, drainage, rockiness; and climate.

The eight hazards associated with these biophysical features that are assessed by the scheme are:

1. Water erosion
2. Wind erosion
3. Soil structure decline
4. Soil acidification
5. Salinity
6. Water logging
7. Shallow soils and rockiness
8. Mass movement

Each hazard is assessed against set criteria tables, as described in the LSC Guideline; each hazard for the land is ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

Hazard 1: Water Erosion

The Study Area lies within the Eastern and Central NSW Division, and the appropriate criteria for this division were used in the assessment. Assessment of water erosion hazard is almost solely dependent on the slope percentage of the land. The only exception is land which falls within the slope range of 10-20%, which may be designated LSC Class 4 or 5 depending on the presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess the wind erosion hazard for each soil unit:

- Wind erosive power - has been mapped in the Study Area as 'Low' (Figure 6 in the LSC Guideline);
- Capacity of the land to maintain surface cover - determined by the average rainfall. For the Bylong locality the average annual rainfall is 627.2 mm (**Section 3.1**) and therefore the Study Area lies within the "greater than 500 mm rainfall" (Table 6 of the LSC Guideline);

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 52

- Erodibility of the soil to wind - determined by surface texture in accordance with Table 5 of the LSC guideline; and
- Exposure of the land to wind - determined by site inspection of location and exposure within the Study Area.

Hazard 3: Soil Structure Decline

Soil structure decline is assessed on soil characteristics, including surface soil texture, sodicity (laboratory tested) and degree of self-mulching (field tested). These parameters assess the soil structure, stability and resilience of the soil.

Hazard 4: Soil Acidification

The soil acidification hazard is assessed using three criteria, being soil buffering capacity, pH and mean annual rainfall. In this assessment, soil buffering capacity was based on soil Great Soil Group; surface soil pH and a regional mean annual rainfall range of 550-700 mm.

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The overall recharge potential for the site was determined based on an average annual rainfall of 627.2 mm, with annual evaporation of 1600-1800 mm (BOM, 2006). This suggests low recharge potential, however, recharge potential also relates to landform position with elevated sites having a high recharge potential.

Based on the annual rainfall data and an average annual evapotranspiration of 600-700 mm minor discharge potential for the site is likely. As above, discharge potential also relates to landform position with sites low in the landscape position having a greater potential to discharge.

The Study Area, according to the Salt Store Map of NSW (Figure 7 in the LSC Guideline) is located in area of low-moderate salt store. Due the current available scale of this mapping, laboratory tested ECe values were used to determine salt store.

Hazard 6: Water Logging

Water logging was determined by the soils drainage characteristics, specifically field sample evidence of mottling, soil texture attributes as well as slope and climate.

Hazard 7: Shallow Soils and Rockiness

The shallow soils and rockiness hazard is determined by an estimated exposure of rocky outcrops and average soil depth.

Hazard 8: Mass Movement

The mass movement hazard is assessed through a combination of three criteria; mean annual rainfall, presence of mass movement and slope class. The mean annual rainfall is greater than 500 mm.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 53

4.2 Assessment Results

The overall LSC Classes for the Study Area ranged from 3 to 7 as illustrated in **Figure 13**. The key findings from the LSC assessment include:

- Almost half of the Study Area (47.9%) and Project Boundary (47.5%) is suited to low - very low impact agricultural land uses. This consists of Class 6 land, which is suitable for a limited set of land uses and is restricted to low-impact land uses such as grazing, forestry and nature conservation and Class 7 land, which is very-low capability land generally incapable of agricultural use;.
- Approximately a quarter of the Study Area (24.9%) and Project Boundary (24.6%) is suited to moderate to moderate-low impact agricultural uses. This consists of Class 4 land, which is suitable for cropping with restricted cultivation. Strict land management is required for regular high-impact and uses such as cropping, high-intensity grazing or horticulture. Class 5 land makes up the remainder and is moderate-low capable land that is largely restricted to grazing, some horticulture and forestry; and
- Just over a quarter of the Study Area (27.2%) and Project Boundary (27.9%) is capable of high intensity land uses and is suitable for a range of agricultural uses including high-impact land uses such as cropping with cultivation.

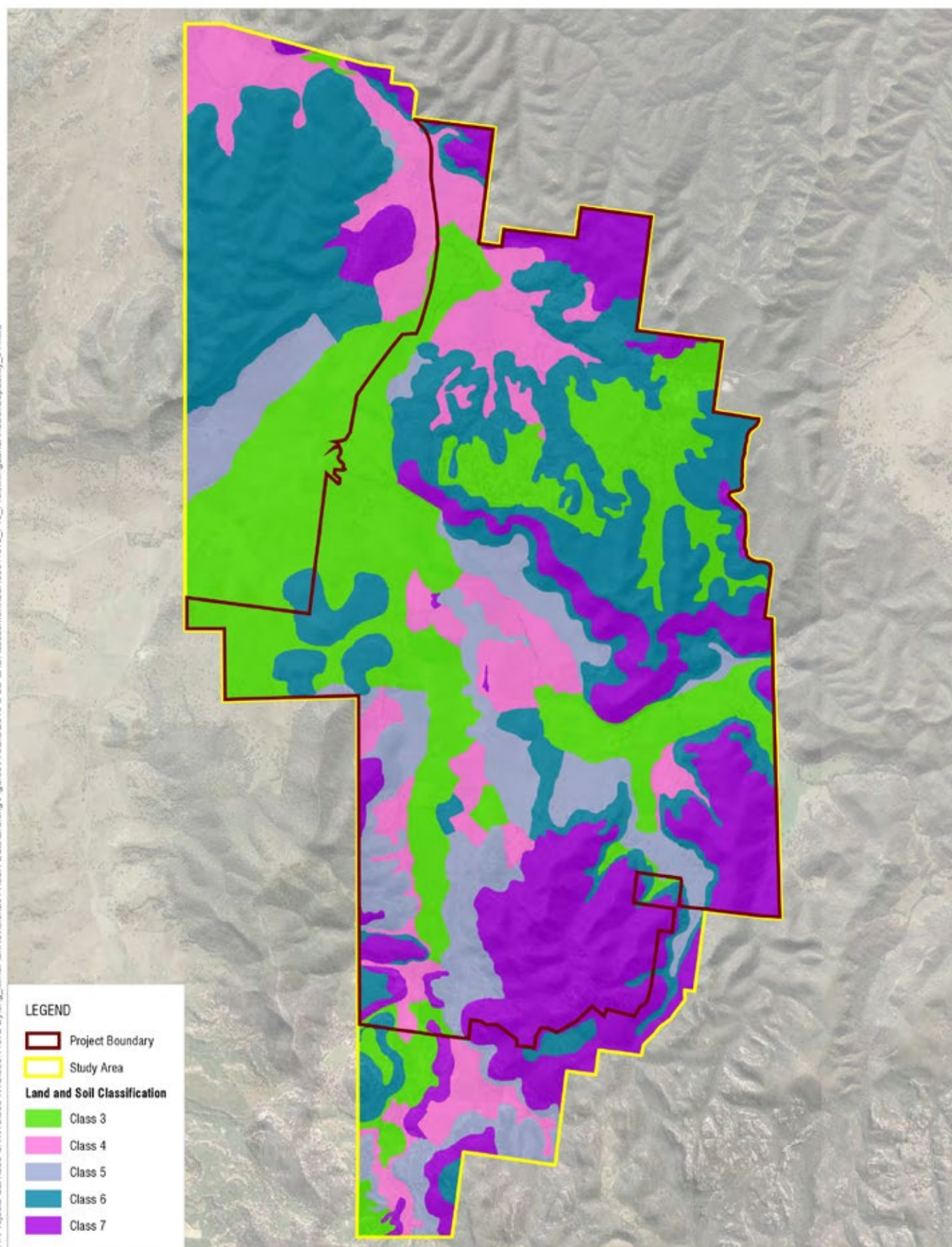
Table 14 summarises the LSC classes in the Study Area below.

Table 14 LSC Class Summary

LSC	Study Area		Project Boundary	
	ha	%	ha	%
Low to Very Low Capable Land	4943.5	47.9	3,297.7	47.5
Class 6	2,891.7	28.1	1,680.7	24.30
Class 7	2,051.8	19.8	1,617.0	23.20
Moderate to Moderate-Low Capable Land	2,567.3	24.9	1,703.0	24.6
Class 4	1,273.5	12.3	818.1	11.80
Class 5	1,293.8	12.6	884.9	12.80
Highly Capable Land	2,806.2	27.2	1,957.0	27.9
Class 3	2,806.2	27.2	1,957.0	27.90
Total	10,317.0	100.0	6,957.7	100.0

Table 15 provides the LSC classification per soil unit and soil phase.

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Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 55

Table 15 LSC Class Assessment by Soil Unit

Soil Units		Hazard Criteria								
No.	Site	1	2	3	4	5	6	7	8	Final
		Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Move-ment	Class
BH1	126	3	1	3	2	1	2	2	1	3
BH1-P1	139	4	3	3	3	-	2	6	1	6
BH1-P2	31 (GSSE, 2012)	3	2	3	3	1	2	3	1	3
BH2	1	3	1	1	2	1	2	1	1	3
BH2-P1	7	3	1	3	2	1	2	4	1	4
BH2-P2	28	6	-	-	-	-	-	6	-	6
BJ1	22	3	2	3	3	3	3	1	1	3
BJ2	33	3	1	1	1	1	2	6	1	6
BJ3	14 (GSSE, 2012)	3	2	3	4	1	3	1	1	4
BJ3-P1	51	5	2	3	4	1	3	6	1	6
B1	Core 33; Site 52 (GSSE, 2012)	1	1	3	1	1	2	1	1	3
B2	3 (GSSE, 2012)	1	1	1	2	4	2	1	1	4
B3	278	2	1	3	2	3	2	1	1	3
B3-P1	295	2	1	3	2	4	2	1	1	4
B4	251	2	1	3	2	**	2	4	1	4
B5	131	1	1	3	4	**	2	1	1	4
B6	2 (GSSE, 2012)	1	1	3	2	1	2	1	1	3
B7	Core 30; Site 81 (GSSE, 2012)	1	1	3	4	1	2	1	1	4
B8	72 (GSSE, 2012)	1	1	3	2	1	2	1	1	3
B9	60	1	1	3	n/a	**	**	**	1	3
B10	11 (GSSE, 2012)	1	1	3	3	4	**	**	1	4
B11	305	2	1	3	3	1	2	1	1	3
B12	132	1	1	3	4	1	1	1	1	4
G1	58	5	1	1	3	1	2	1	1	5
G2	26 (GSSE, 2012)	3	3	3	4	1	3	3	1	4
G3	93	4	3	3	5	**	2	7	1	7

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 56

Soil Units		Hazard Criteria								
No.	Site	1	2	3	4	5	6	7	8	Final
		Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Move-ment	Class
G4	90	3	2	3	5	1	3	4	1	5
G4-P1	82	6	3	3	5	**	2	4	1	6
G5	47 (GSSE, 2012)	3	2	3	5	1	2	3	1	5
G5-P1	283	3	1	3	4	**	2	6	1	6
G6	110	3	1	3	3	1	2	4	1	4
G6-P1	238	3	2	3	3	**	3	6	1	6
G7	106	3	1	3	3	3	2	1	1	3
G7-P1	156	3	1	3	3	4	2	1	1	4
G8	147	3	1	3	2	1	3	6	1	6
G9	145	3	1	3	3	5	4	4	1	5
G10	195	3	2	3	3	1	1	1	1	3
G11	208	3	2	3	5	**	2	4	1	5
G12	67 (GSSE, 2012)	1	2	3	2	1	2	1	1	3
G13	77	3	1	3	5	1	2	3	1	5
G14	50 (GSSE, 2012)	2	1	3	3	1	5	1	1	5
G14-P1	100	3	1	3	3	**	2	6	1	6
G15	104	2	3	3	4	1	3	4	1	4
G16	252	3	1	3	5	**	2	3	1	5
G17	43	2	1	3	3	1	2	1	1	3
G17-P1	42	3	1	3	3	1	3	4	1	4
G18	25 (GSSE, 2012)	2	2	3	4	1	4	1	1	4
G19	61	3	1	3	3	**	**	**	1	3
L1	31	6	5	1	5	5	1	6	6	6
L1-P1	N/A	7	5	1	5	5	1	7	7	7
O1	8 (GSSE, 2012)	3	1	3	4	3	4	1	1	4
O1-P1	54	5	2	3	4	3	3	6	1	6
O2	173	3	2	3	4	**	2	1	1	4
O2-P1	231	5	2	3	5	**	2	4	1	5
SH1	5 (GSSE, 2012)	3	1	3	5	1	2	3	1	5

Correlated with Soil Landscapes of the Singleton 1:250 000 Sheet (Kovac & Lawrie, 1991)

** Observation; no laboratory data or constraints to field data

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 57

5 BSAL ASSESSMENT

5.1 Methodology

The published mapping of BSAL, released with the Upper Hunter SRLUP, indicates broadly where it occurs throughout the region. The mapping within the Upper Hunter SRLUP has been undertaken at a regional scale and cannot be used for property-level assessments. This regional scale mapping should be used to provide an indication of areas that potentially have strategically significant agricultural value. Therefore, it is important that land within the Study Area is verified against the BSAL criteria. BSAL within the Study Area was therefore verified using the Interim Protocol.

This methodology uses a two-phase verification assessment:

- Phase 1 – Confirm access to reliable water supply; and
- Phase 2 – 12 step site verification criteria

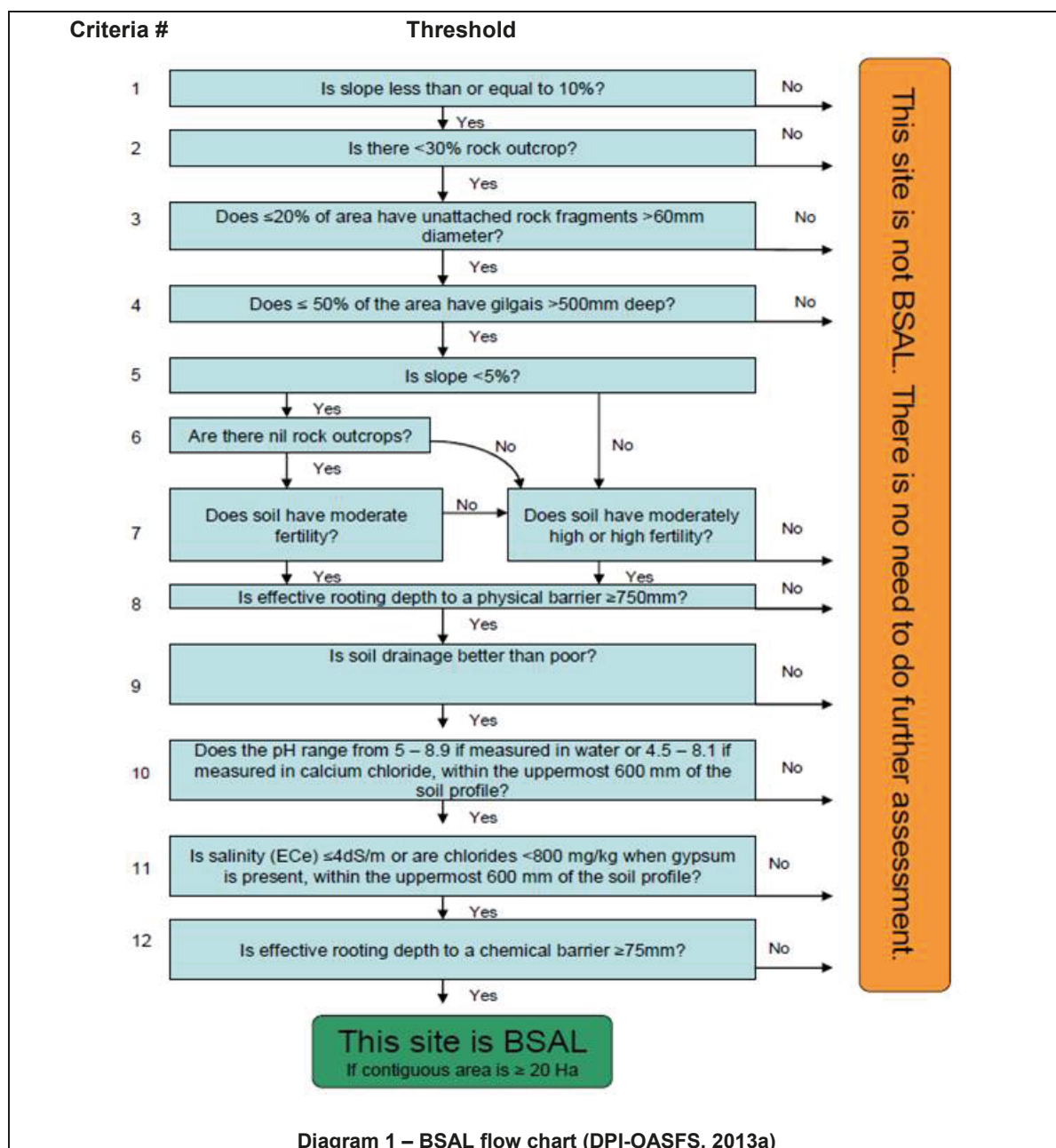
For the Upper Hunter SRLUP, the Interim Protocol states that reliable water supply has been verified for the area and as such only Phase 2 is applicable to the BSAL verification assessment.

5.1.1 Phase 2 Assessment – Site Verification Criteria

The 12 step site verification criteria from the Interim Protocol are summarised in **Diagram 1**. If a criterion fails to meet any of the BSAL conditions (except step 5 or step 6), the site is rejected as BSAL and the remaining conditions are not assessed.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 58



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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 59

5.1.2 Assessment Check List

The BSAL assessment has been conducted in accordance with the Interim Protocol and other relevant guidelines. A check list is provided in **Table 16** to assist the reader with the location of the information.

Table 16 Biophysical Strategic Agricultural Land Assessment Checklist

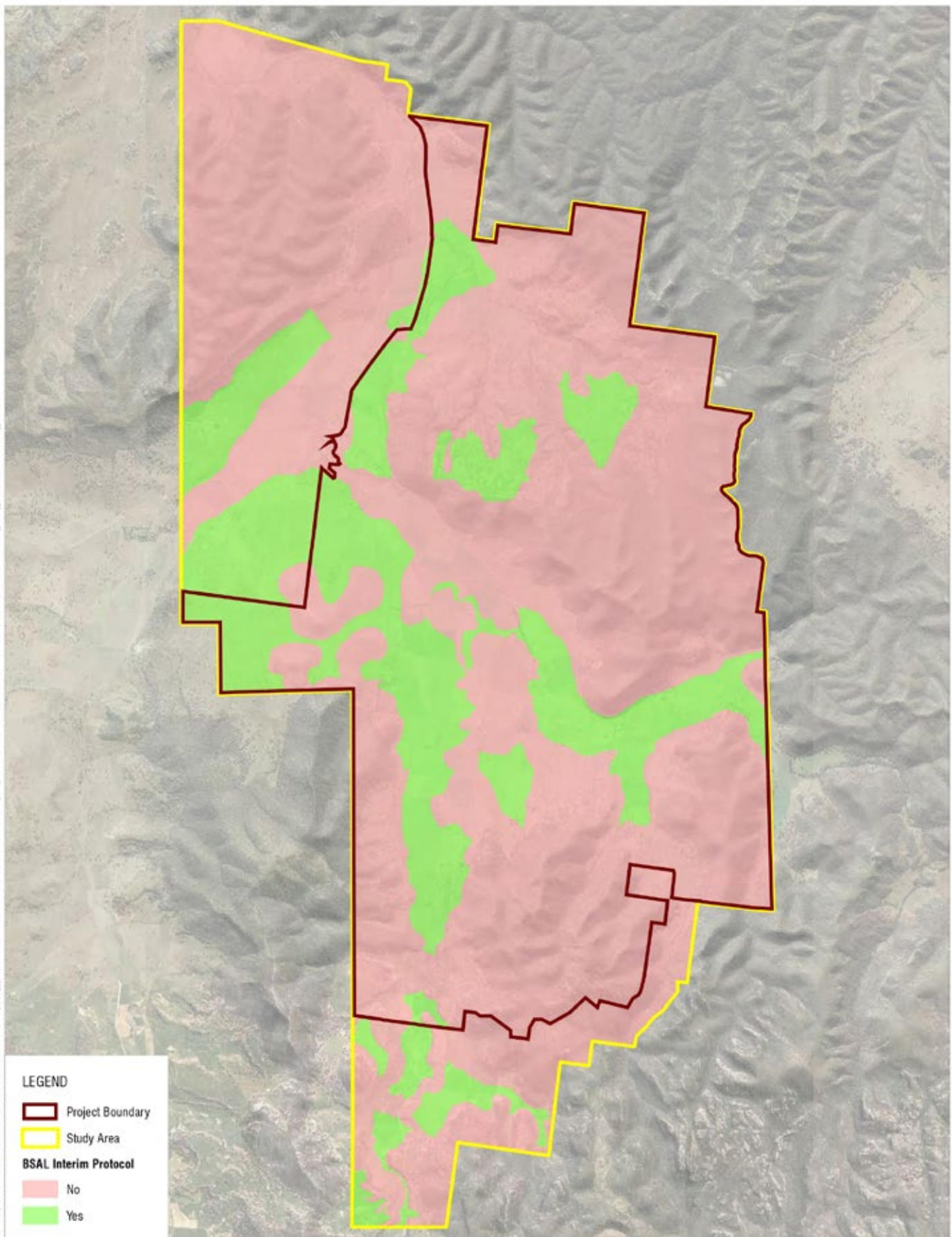
Required	Satisfied	Where in document
Qualified Soil Scientist	Yes	Section 1.6
Laboratories are compliant with ISO/IEC17025	Yes	Appendix C; NATA accredited
Results within 15% of threshold levels are analysed in a laboratory	Yes	All reference profiles laboratory analysed
All soil profile descriptions and observations are recorded and submitted to SALIS	No	Not required as client proceeded directly to gateway
Laboratory data is supplied to OEH using their standard spread sheet templates	No	Not required as client proceeded directly to gateway. Laboratory certificates provided for transparency; Appendix C
Three 1:25,000 maps showing base level information, soil units and BSAL	Yes	Appendix A, Appendix D
Laboratory report	Yes	Appendix C
Reporting requirements for site verification as described in Appendix 1		
1. Slope: Used LIDAR methodology and IPAD technology	Yes	Section 3
2. Rock outcrop and surface rockiness	Yes	Section 3
3. Gilgai microrelief	N/A	No gilgai relief observed
4. ASC and determination of fertility	Yes	Fertility as per Table 6 in Appendix 2 of the Interim Protocol
5. Drainage	Yes	Drainage assessed using Munsell chart – refer
6. Soil pH	Yes	Refer Laboratory certificates; Appendix C
7. Salinity	Yes	Refer Laboratory certificates; Appendix C
8. Effective Rooting Depth	Yes	Assessed as per Section 8 of Appendix 1 of the Interim Protocol
9. Minimum Area	Yes	All BSAL units greater than 20 ha

5.2 Assessment Results

The assessment found 2,366 ha of land within the Study Area and 1,675.9 ha of land within the Project Boundary to be verified BSAL (**Figure 14**). The key findings from this assessment are:

- Approximately one quarter of the Study Area (23.0%) and Project Boundary (24.1%) was determined to be BSAL in that it meets all the relevant site verification criteria;
- Generally BSAL in the Study Area is associated with the alluvial influenced deep non-saline Black Dermosol soil units on very gently inclined land. Some basaltic influenced Red Dermosols on elevated gently inclined land were also assessed as BSAL, as well as some deep Red Chromosols on the sedimentary derived Growee Soil Landscape Unit;

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0 1,000 2,000 3,000 m

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BSAL Verification Assessment

FIGURE 14

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 61

- The remainder of the Study Area has been assessed as non-BSAL. This included moderately to steeply inclined land, poorly developed or shallow soils, low fertility soils and soils with subsoil constraints such as sodicity and salinity; and
- Of the area identified as non-BSAL, approximately half of the Study Area and Project Boundary had unfavourable slope inclines; one-tenth contained unfavorable chemical limitations; and fertility and physical limitations largely composed the bulk of the remaining limitations.

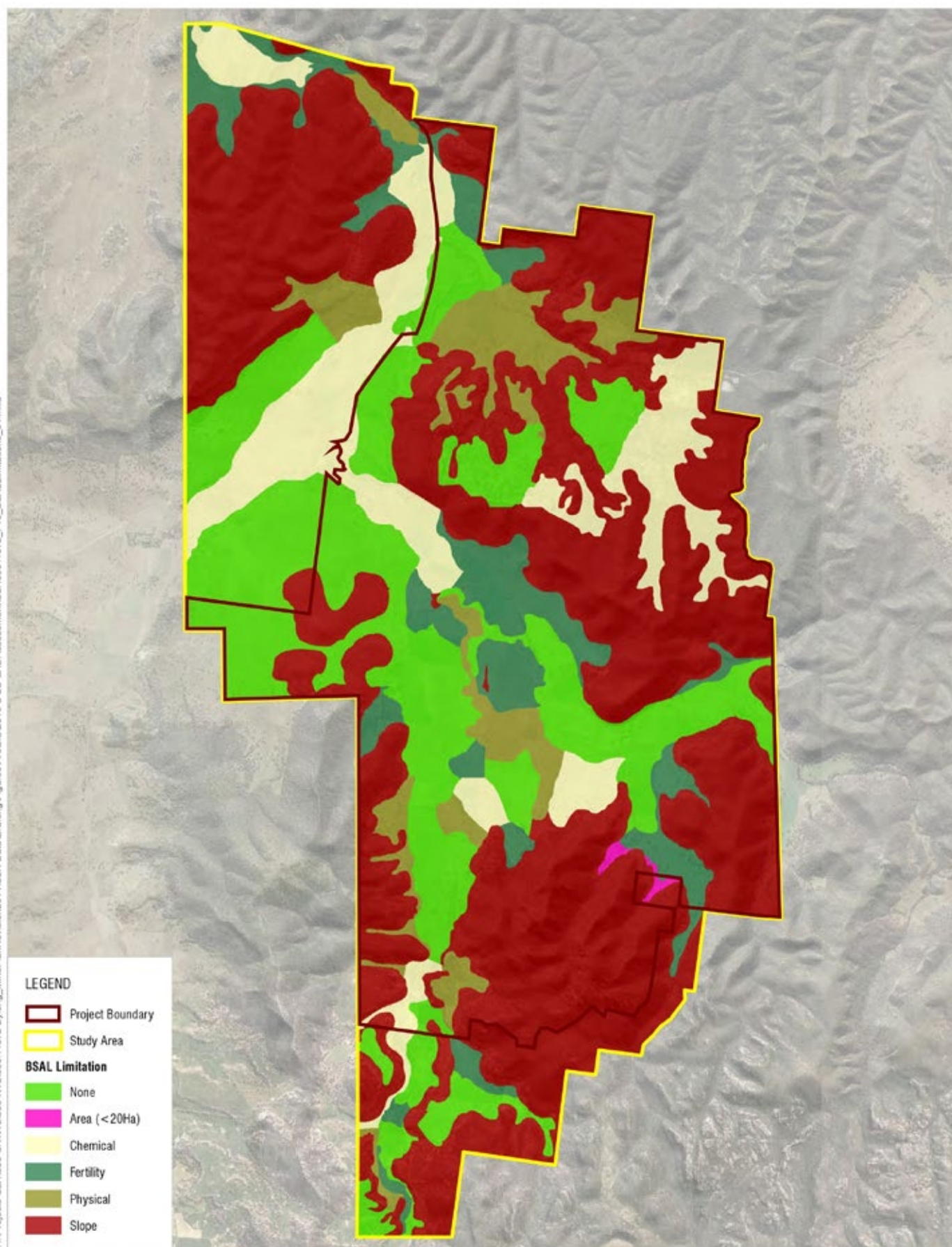
Table 17 summarises the BSAL coverage in the Study Area below and the main limitations across the Study Area. **Figure 15** shows the distribution of BSAL limitations across the Study Area.

Table 17 BSAL: Interim Protocol Assessment - Summary

BSAL by limitation	Study Area		Project Boundary	
	ha	%	ha	%
No	7,951.0	77.0	5,281.8	75.9
Land Area (<20 ha)	16.9	0.2	10.9	0.1
Chemical	1,255.0	12.0	691.2	10.0
Fertility	813.6	8.0	588.1	8.3
Physical	684.2	6.7	547.3	7.9
Slope	5,181.3	50.1	3,444.3	49.6
Yes	2,366.0	23.0	1,675.9	24.1
Nil	2,366.0	23.0	1,675.9	24.1
Total	10,317.0	100.0	6,957.7	100.0

The BSAL assessment of the 12 site verification criteria for each major soil unit is shown below in **Table 18** and, where relevant, lists the major BSAL limitation per soil unit.

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BSAL Limitations

FIGURE 15

Table 18 Interim Protocol BSAL Assessment – per soil unit

Soil Unit		1	2	3	4	5	6	7	8	9	10	11	12	BSAL / Limitation
No.	Site	Slope	Rock Outcrop (30%)	Rockine ss	Gilgai	Slope (5%)	Nil Rock Outcrop	Fertility	Physical Barrier	Drain- age	pH	Salinity	Chemical barrier	
Bald Hill Soil Landscape Unit														
BH1	126	✓	✓	✓	✓	✕	-	✓	✓	✓	✓	✓	✓	BSAL
BH1-P1	139	✕	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
BH1-P2	31 (GSSE, 2012)	✓	✓	✓	✓	✕	-	✓	✓	✓	✕	-	-	pH >8.9 at 0.5 m
BH2	1	✓	✓	✓	✓	✕	-	✓	✓	✓	✓	✓	✓	BSAL
BH2-P1	7	✓	✓	✓	✓	✕	-	✓	✕	-	-	-	-	Bedrock at 0.65 m
BH2-P2	28	✕	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
Benjang Soil Landscape Unit														
BJ1	22	✓	✓	✓	✓	✕	-	✓	✓	✓	✓	✓	✕	ECe >4 at 0.6 m
BJ2	33	✓	✓	✓	✓	✕	-	✓	✕	-	-	-	-	Bedrock at 0.5 m
BJ3	14 (GSSE, 2012)	✓	✓	✓	✓	✕	-	✕	-	-	-	-	-	Moderately low inherent fertility
BJ3-P1	51	✕	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
Bylong Soil Landscape Unit														
B1	52 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
B2	3 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
B3	278	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕	-	-	pH >8.9 at 0.45 m
B3-P1	295	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕	-	ECe > 4 at 0.3 m

Soil Unit		1	2	3	4	5	6	7	8	9	10	11	12	BSAL / Limitation
No.	Site	Slope	Rock Outcrop (30%)	Rockiness	Gilgai	Slope (5%)	Nil Rock Outcrop	Fertility	Physical Barrier	Drainage	pH	Salinity	Chemical barrier	
B4	251	✓	✓	✓	✓	✓	✓	✓	x	-	-	-	-	Bedrock, sandstone at 0.75 m
B5	131	✓	✓	✓	✓	✓	✓	*	-	-	-	-	-	Moderately low inherent fertility
B6	2 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
B7	81 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	x	-	-	-	-	-	Moderately low inherent fertility
B8	72 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
B9	60	✓	✓	✓	✓	✓	✓	✓	^	^	^	^	^	BSAL*
B10	11 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	x	-	-	-	-	-	Moderately low inherent fertility
B11	305	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Moderately low inherent fertility
B12	132	✓	✓	✓	✓	✓	✓	x	-	-	-	-	-	Moderately low inherent fertility
Growee Soil Landscape Unit														
G1	58	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
G2	26 (GSSE, 2012)	✓	✓	✓	✓	x	-	✓	✓	✓	✓	✓	✓	BSAL
G3	93	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
G4	90	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Bedrock at 0.6 m
G4-P1	82	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%

Soil Unit		1	2	3	4	5	6	7	8	9	10	11	12	BSAL / Limitation
No.	Site	Slope	Rock Outcrop (30%)	Rockiness	Gilgai	Slope (5%)	Nil Rock Outcrop	Fertility	Physical Barrier	Drainage	pH	Salinity	Chemical barrier	
G5	47 (GSSE, 2012)	✓	✓	✓	✓	x	-	✓	✓	✓	✓	✓	✓	BSAL
G5-P1	283	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Weathering parent material at 0.4 m
G6	110	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Bedrock at 0.75 m
G6-P1	238	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Bedrock at 0.5 m
G7	106	✓	✓	✓	✓	x	-	✓	✓	✓	✓	✓	x	ECe >4 at 0.6 m
G7-P	156	✓	✓	✓	✓	x	-	✓	✓	✓	✓	x	-	ECe >4 at 0.15 m
G8	147	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Bedrock at 0.5 m
G9	145	✓	✓	✓	✓	x	-	✓	✓	✓	✓	✓	x	ECe >4 at 0.7 m
G10	195	✓	✓	✓	✓	x	-	x	-	-	-	-	-	None but less than 20 ha
G11	208	✓	✓	✓	✓	x	-	x	-	-	-	-	-	Moderately low inherent fertility
G12	67 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
G13	77	✓	✓	✓	✓	x	-	x	-	-	-	-	-	Moderately low inherent fertility
G14	50 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	✓	✓	x	-	-	-	Fails drainage criteria
G14-P1	100	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Weathering sandstone at 0.5 m

Soil Unit		1	2	3	4	5	6	7	8	9	10	11	12	BSAL / Limitation
No.	Site	Slope	Rock Outcrop (30%)	Rockine ss	Gilgai	Slope (5%)	Nil Rock Outcrop	Fertility	Physical Barrier	Drain- age	pH	Salinity	Chemical barrier	
G15	104	✓	✓	✓	✓	✓	✓	x	-	-	-	-	-	Moderately low inherent fertility
G16	252	✓	✓	✓	✓	x	-	x	-	-	-	-	-	Moderately low inherent fertility
G17	43	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	BSAL
G17-P1	42	✓	✓	✓	✓	x	-	✓	x	-	-	-	-	Weathering bedrock at 0.65 m
G18	25 (GSSE, 2012)	✓	✓	✓	✓	✓	✓	x	-	-	-	-	-	Moderately low inherent fertility
G19	61	✓	✓	✓	✓	x	-	^	^	^	^	^	^	BSAL *
Lees Pinch Soil Landscape Unit														
L1	31	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
L1-P1	N/A	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
Olgivie Soil Landscape Unit														
O1	8 (GSSE, 2012)	✓	✓	✓	✓	x	-	x	-	-	-	-	-	Moderately low inherent fertility
O1-P1	54	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
O2	173	✓	✓	✓	✓	x	-	x						Low inherent fertility
O2-P1	231	x	-	-	-	-	-	-	-	-	-	-	-	Slope >10%
Sandy Hollow Soil Landscape Unit														
SH1	5 (GSSE, 2012)	✓	✓	✓	✓	x	-	x	-	-	-	-	-	Moderately low inherent fertility

* Further laboratory data required; conservative assessment is that the soil units may be BSAL

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 67

5.3 Differences in Regional Mapping to Verified Mapping within Study Area

The Upper Hunter SRLUP BSAL mapped in the Study Area is 1,610 ha. The property scale field verification assessment has shown that there is a larger amount of BSAL present, with over 2,366 ha conforming to the BSAL criteria (**Table 16**). The verified BSAL does not completely mirror the Upper Hunter SRLUP BSAL mapping as this was regional mapping largely covering the Bylong Soil Landscape Unit at a publication scale of 1:250,000.

The local field verification assessments found that some soil units associated with the Bylong Soil Landscape Unit contained physical or chemical limitations, which preclude them from being verified BSAL. These included alkaline soil pH, saline soil or insufficient fertility characteristics (refer to **Table 15**). However, the site inspection identified further land beyond the soil associated with the Bylong Soil Landscape Unit that is good quality agricultural land associated with igneous parent material. This land occurs in the east and in the west of the Study Area, therefore increasing the overall quantity of BSAL in the Study Area.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 68

6 REHABILITATION STRATEGY OVERVIEW

The long and short-term rehabilitation objectives for the Project have been considered in detail by KEPSCO in the Project's Rehabilitation Strategy. An overview of the strategy is provided in this section as it feeds into the long-term impact assessment on agricultural resources (**Section 7**).

Development of the Project will disturb land which is termed the Project disturbance footprint. This land is associated with the construction and operation of infrastructure domains and mining activities proposed for the Project. Each domain of the Project has a construction and operational disturbance footprint with some parts of the disturbance footprint being progressively rehabilitated immediately after construction and the remainder being rehabilitated following operational use.

6.1 Overview of Decommissioning Strategy

The Project's rehabilitation strategy seeks to minimise risks to agricultural resources and minimise long-term impacts. A summary of the strategy is provided below in **Table 19**.

Table 19 Preliminary Rehabilitation Objectives by Project Domain

Project Domain		Rehabilitation Objectives
1	Open Cut Mining Area	Shape overburden to provide a stable landform consistent with the surrounding environment and proposed post-mining land use. Any carbonaceous material emplaced within the Open Cut Mining Areas will be capped with suitable inert material.
		Final void within the Eastern Open Cut Mining Area will be progressively backfilled with the southern end remaining open for tailings and reject emplacement for the remaining mine life. Following closure of the mine, the area will be capped and rehabilitated as per the conceptual final landform.
2	OEA	Shape overburden to provide a stable landform consistent with the surrounding environment and proposed post-mining land use and minimise final void areas.
3	Mine Infrastructure Area	Remove all aboveground infrastructure and seal and recover underground infrastructure. Regrade embankments and cuttings where required and reshape landform to be similar to pre-mining landform. Drift to be rehabilitated by emplacement of a concentrate plug with topdressing material for rehabilitation.
4	Rail Loop	Rail Loop to remain at closure.
5	Roads	
	Haul Roads	Haul roads will have fill and road base material removed. Roads will be re-shaped to blend with the surrounding landform and revegetated with appropriate species. Buffer of 50 m
	Internal Roads	Internal roads will be left insitu as they form part of the road realignment.
6	Water Storage Facilities	
	Raw water storage dam	Dams will be drained and de-silted with dam walls re-shaped to blend in with surrounding environment.
	Mine water dam	
7	Subsidence Study Area	Monitor erosion, ponding and surface cracking during operations and post closure.
8	Stockpile Area	Stockpiles will be removed and rehabilitated.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 69

6.2 Impact Types

Three impact types have been identified for the Project's impact on agricultural resources after consideration of the Project's rehabilitation strategy. The three impact types are:

- Indirect and temporary,
- Direct and temporary; and
- Direct and permanent.

Indirect and temporary impacts are defined as impacts that do not directly disturb the land's surface and are temporary.

Direct and temporary impacts are defined as impacts which directly disturb the land's surface, however, are short-term by nature with the area to be rehabilitated to pre-mining status.

Direct and permanent impacts are defined as impacts which will directly disturb the land's surface and the area will not be rehabilitated to pre-mining status.

Figure 16 shows the distribution of impact types across the Project disturbance footprint.

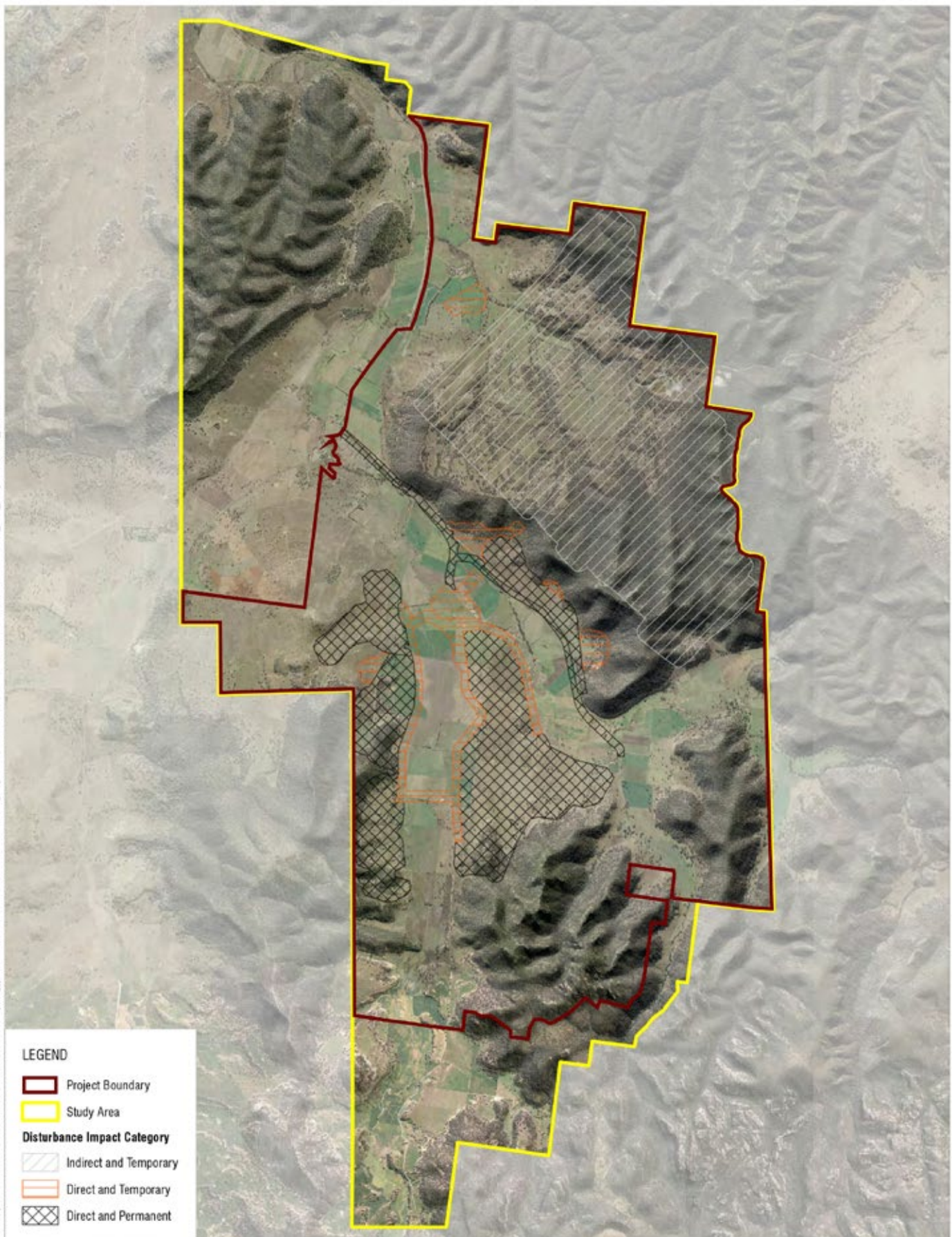
6.3 Project Domain by Impact Type

The long-term impact category for each of the eight major Project domains is provided in **Table 20**. For clarity, the agricultural soil resource risk ratings have been provided for comparison (refer **Section 3**). There is a difference between the two assessments (risk versus impact) for some Project domains as the rehabilitation commitments have been taken into account. For example, the Interim Protocol considers Haul Roads as high risk activity to soil resources, however, as KEPCO has committed to the complete rehabilitation of the land (refer **Table 19**), the impact type is direct and temporary. Should KEPCO have elected to not remove fill and road base, shape to landform and re-profile soil resources the impact would have been considered direct and permanent.

Table 20 Preliminary Project Impact Category by Project Domain

	Project Domain	Soil Risk Category	Impact Category
1	Open Cut Mining Area	High	Direct and permanent
2	OEAs	High	
3	Mine Infrastructure Area: - Employee & materials drift; - CHPP; - Overland Conveyor; - ROM coal pad; - Main access; - Administration buildings; and - Accommodation village	Medium	Direct and temporary
4	Rail Loop	High	Direct and permanent
5a	Roads: Haul	Medium	Direct and temporary
5b	Roads: Internal	Medium	Direct and permanent
6	Water Storage Facilities: raw water and mine water dam	High	Direct and temporary
7	Subsidence Study Area	Low	Indirect and temporary
8	Stockpile Area	Low	Direct and temporary

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LEGEND

- Project Boundary
- Study Area
- Disturbance Impact Category**
- Indirect and Temporary
- Direct and Temporary
- Direct and Permanent



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Disturbance Impact Category

FIGURE 16

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 71

The amount of land in each impact category is summarised in **Table 21** and the key findings are:

- Indirect and temporary impacts cover 1,714.3 ha and comprise 59.6% of the Project disturbance footprint. This area is entirely covered by the Subsidence Study Area;
- Direct and temporary impacts cover 240.9 ha and comprise 8.4% of the Project disturbance footprint. This area is largely covered by the Haul Roads, Mine Infrastructure Area, Stockpile Area and Water Storage Facilities; and
- Direct and permanent impacts cover 919.5 ha and comprise 32.0% of the Project disturbance footprint. This area is impacted upon by the Internal Roads, Rail Loop, Open Cut Mining Area and the OEAs.

Table 21 Impact Category: Project Disturbance Footprint

Impact Category by Project Domain	ha	%
Indirect and Temporary Impacts	1,714.3	59.6
Subsidence Study Area	1,714.3	59.6
Direct and Temporary Impacts	240.9	8.4
Haul Roads	118.3	4.1
Mine Infrastructure Area	85.0	3.0
Stockpile Area	11.1	0.4
Water Storage Facilities	26.5	0.9
Direct and Permanent Impacts	919.5	32.0
Internal Roads	73.5	2.6
Open Cut Mining Area	532.7	18.5
OEAs	225.0	7.8
Rail Loop	88.3	3.1
Total	2,874.7	100.0

6.4 Preliminary Rehabilitation Goals Overview

The Project disturbance footprint covers approximately 2,874.7 ha of land within the Project Boundary, of which 440.8 is verified BSAL (refer **Section 7**). The Project's risk to long-term impacts on agricultural soil resources has been considered by KEPCO in the Projects Rehabilitation Strategy.

A summary of the strategy's goals is provided **Table 22** and the overarching post-mining land use goals include:

- Where practical, return the land to its pre-mining land capability and land use;
- Limit impacts on BSAL and minimise the total quantity of BSAL foregone within the Project Boundary;
- Return land subject to temporary disturbance to pre-mining condition; and
- Return a similar quantity of good quality land, (including BSAL) for land directly and permanently impacted by mining related activities.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 72

Table 22 Preliminary Post-Mining Goals

Project Domain	Post-mining Goal
Indirect and Temporary Impact	
Subsidence Study Area	Return to: - Pre-mining land use - Pre-mining LSC Class - Pre-mining soil and landscape characteristics
Direct and Temporary Impact	
Mine Infrastructure Area Haul Roads Stockpile Area	Return to: - Pre-mining Land use - Pre-mining LSC Class - Pre-mining soil and landscape characteristics
Direct and Permanent Impact	
Open Cut Mining Area OEA	Return to: - Pre-mining land use as appropriate Instate: - Equivalent quantity of LSC Class 4 land Soil and landscape characteristics to be commensurate with LSC Class 4 hazard criteria - Equivalent quantity of LSC Class 3 land Soil and landscape characteristics to be commensurate with LSC Class 3 hazard criteria Instate: - Equivalent quantity of BSAL located on land with a target LSC of Class 3 to offset the impact on BSAL - Soil and landscape characteristics to be commensurate with the BSAL criteria and where appropriate the LSC Class 3 hazard criteria
Internal Roads Rail Loop	Retain infrastructure: - Pre-mining land use changed from agricultural to transport (road and rail) infrastructure - Pre-mining LSC changed to an agricultural classification of Urban (U)

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 73

7 IMPACT ASSESSMENT

This assessment of the Project impacts on the proposed disturbance footprint has been completed in accordance with the Mining & Petroleum Gateway Panel's and DPI's requirements and includes:

- Long-term impact assessment on soil, LSC and BSAL resources within the Project Boundary; and
- Predicted post-mining LSC classes.

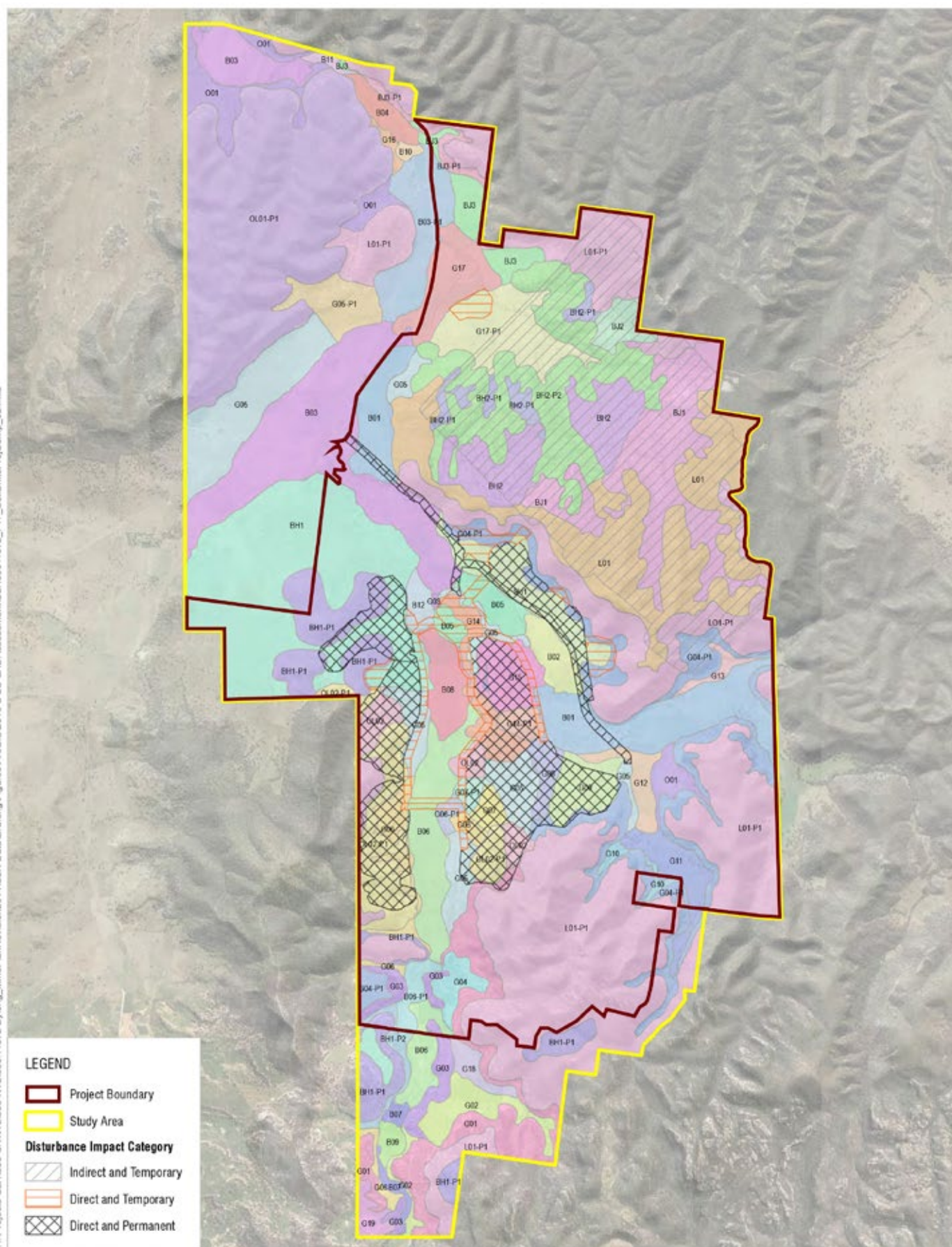
7.1 Impact on Soil Resources within Project Disturbance Footprint

Within the Project disturbance footprint there are six soil type ASC orders (**Table 23; Figure 17**). The dominant ASC orders within the footprint are Chromosols covering 46.1% (1,321.1 ha) and Rudosols covering 29.8% (860.2 ha). The other ASC orders that cover the remainder of the Project disturbance footprint include Dermosols (14.9%), Sodosols (6.7%), Vertosols (1.5%) and Tenosols (1.0%).

Table 23 Soil Types within Project Disturbance Footprint

ASC Order	ha	%
Chromosols	1,321.1	46.1
Brown Chromosols	572.2	20.0
Red Chromosols	748.9	26.1
Dermosols	427.8	14.9
Black Dermosol	20.6	0.8
Black Dermosol overlying Rudosol	33.3	1.1
Grey Dermosol overlying Rudosol	4.8	0.2
Red Dermosol	369.1	12.8
Rudosols	860.2	29.8
Clastic Rudosol	851.0	29.5
Lithic Rudosol	2.0	0.1
Stratic Rudosol overlying Dermosol	7.2	0.2
Sodosols	195.5	6.7
Brown Sodosol	74.3	2.5
Red Sodosol	121.2	4.2
Tenosols	27.3	1.0
Black-Orthic Tenosol	0.9	<0.1
Brown-Orthic Tenosol	26.4	1.0
Vertosols	42.8	1.5
Brown Vertosol	42.8	1.5
Total	2,874.7	100.0

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 75

The key soil and landscape characteristics are slope, surface rockiness, land surface micro-relief, soil fertility, effective rooting depth, soil drainage, soil pH and soil salinity. KEPSCO's post-mining rehabilitation goals commit to minimising the impacts on soil and landscape characteristics, in particular that associated with BSAL.

Indirect and Temporary Impacts

WRM Water & Environment Pty (2015) modelled the impact of direct rainfall on the Subsidence Study Area with regards to ponding effects across the landscape. The modelling found that "there is only very minor ponding in overland flow areas. This is due to the steep slopes in the Dry Creek catchment and indicates that the catchment is generally free-draining with the exception of farm dams and small water bodies located throughout the catchment area".

Therefore it is predicted that land indirectly and temporarily impacted by the Subsidence Study Area will experience localised short-term changes in soil and landscape characteristics by means of minor surface cracking and localised topographical depressions. Minor cracks may facilitate erosion and localised depressions may result in ponding which can affect chemical soil characteristics (e.g. soil pH) and physical characteristics (e.g. drainage). Where such issues may occur, surface remediation will be investigated to ensure soil and landscape characteristics are not significantly impacted from its pre-mining condition.

Direct and Temporary Impacts

Land directly and temporarily impacted by Mine Infrastructure Area and Haul Roads will experience a short-term change in soil and landscape characteristics as a result of the removal of topsoil/subsoil, soil compaction and from the re-grading of localised slopes for engineering purposes.

Post-mining, or during the operational phase as is appropriate, the impacted land will be rehabilitated to pre-mining condition, which includes all key soil and landscape characteristics. This will be undertaken through the (i) careful stockpiling and management of soil resources during the operational period to maintain soil integrity, (ii) re-grading of slopes commensurate with pre-mining condition, and (iii) execution of an approved BSAL Reinstatement Plan to ensure that key soil and landscape characteristics specific to the soil unit are reinstated (SLR, 2015). In this regard, soil and landscape characteristics will not be significantly impacted in the long-term as a result of the Project's operations.

Direct and Permanent Impacts

Land directly and permanently impacted (919.5 ha) by the Open Cut Mining Areas, OEAs, Internal Roads and Rail Loop will experience a long-term change in soil and landscape characteristics as a result of the complete removal of the soil profile and underlying rock strata during coal extraction activities and the emplacement of overburden material.

Impacts for the Open Cut Mining Areas and OEAs will be mitigated and offset through reinstatement of an equivalent amount of impacted LSC Class 3 and 4 lands within the Project Boundary. The Internal Roads and Rail Loop will not be decommissioned and will be retained for future use at closure.

Further details on how impacts will be mitigated are contained in the Project's Rehabilitation Strategy.

7.2 Impact on LSC Classes within Project Disturbance Footprint

Within the Project disturbance footprint there are five LSC Classes (**Table 24; Figure 18**). The dominant land capability category within the footprint is low capability land (LSC Classes 6 and 7; 43.4%), followed by moderate capability land (LSC Classes 4 and 5; 32.7%) and then high capability land (LSC Class 3; 23.9%).

Table 24 LSC Class within Project Disturbance Footprint

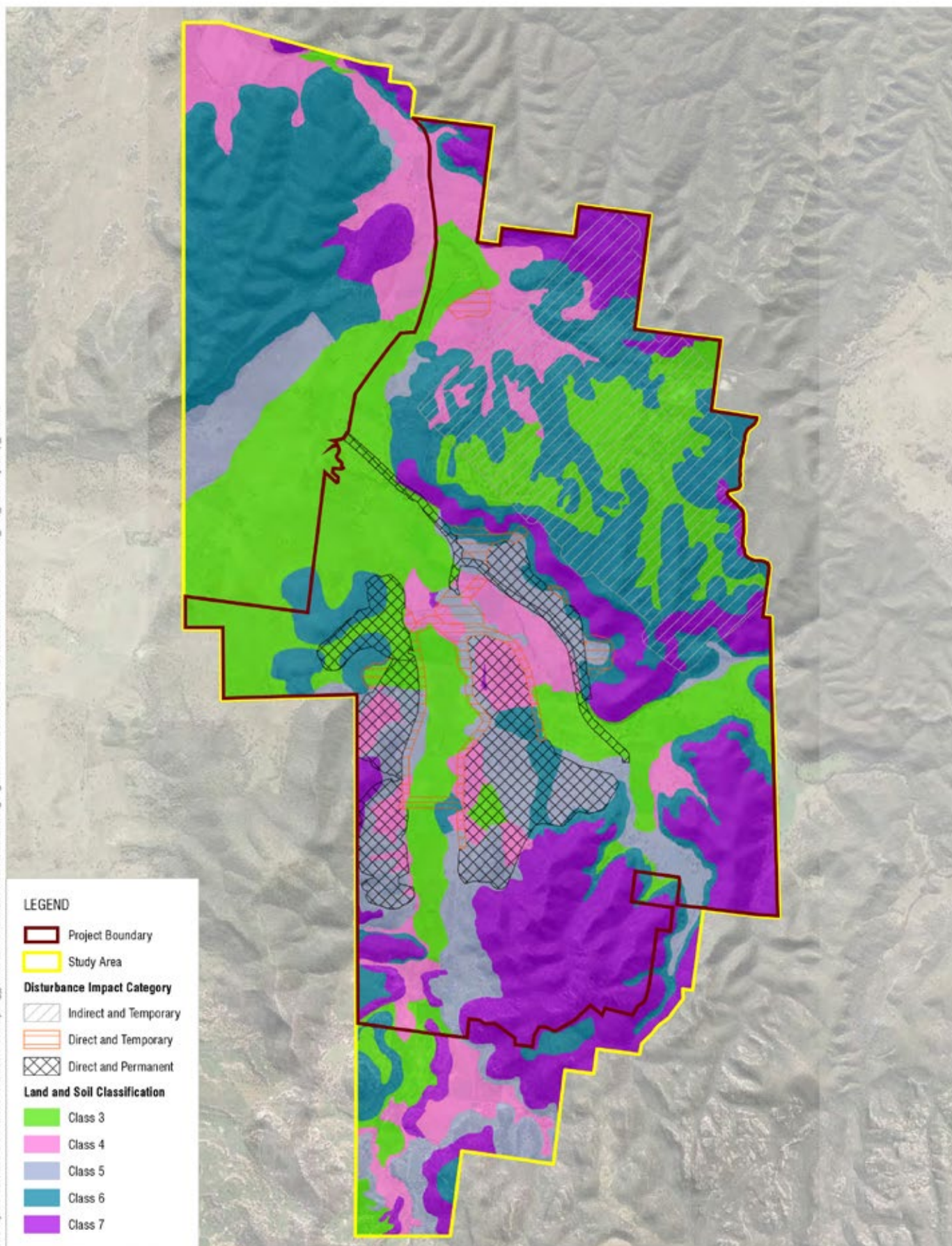
LSC	ha	%
High Capability Land	688.1	23.9
Class 3	688.1	23.9
Moderate Capability Land	945.5	32.7
Class 4	418.1	14.4
Class 5	527.4	18.3
Low Capability Land	1,241.1	43.4
Class 6	1,029.8	36.1
Class 7	211.3	7.3
Total	2,874.7	100.0

Class 3 lands are capable of high intensity land uses and are suitable for a range of agricultural uses including high-impact land uses such as cropping with cultivation. Class 4 land is moderately capable land suitable for some rotational cropping and good quality grazing. Class 5 land is moderate-low capable land that is largely restricted to grazing, some horticulture and forestry. Classes 6 and 7 are low to very low capability land suited to light grazing.

Based on the previously defined impact categories, the type of LSC within each Project domain has been quantified. **Table 25** provides a summary and the key findings are:

- Indirect and temporary impacts that cover 1,714.3 ha (59.6%) of the Project disturbance footprint are largely associated with low capability land (Class 6) followed by high capability land (Class 3) with the remainder covered by very low capability land;
- Direct and temporary impacts cover 240.9 ha (8.4%) of the Project disturbance footprint are largely associated with moderate capability land (Classes 4 and 5); and
- Direct and permanent impacts cover 919.5 ha (32.0%) of the Project disturbance footprint are mainly associated with moderate capability land (Classes 4 and 5), followed by high (Class 3) and low capability (Class 6) land distributions.

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FIGURE 18

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Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 78

Table 25 Impact Category: LSC Class within Project Disturbance Footprint

LSC	ha	%
Direct and Permanent Impacts	919.5	32.0
Class 3	141.9	4.9
Internal Roads	36.4	1.3
Open Cut Mining Area	43.3	1.5
OEAs	62.2	2.1
Class 4	194.7	6.6
Internal Roads	5.3	0.2
Open Cut Mining Area	151.3	5.1
OEAs	38.1	1.3
Class 5	440.9	15.3
Internal Roads	28.2	0.9
Open Cut Mining Area	268.1	9.4
OEAs	74.9	2.6
Rail Loop	69.7	2.4
Class 6	127.8	4.7
Internal Roads	1.9	0.1
Open Cut Mining Area	65.3	2.3
OEAs	42.9	1.6
Rail Loop	17.7	0.7
Class 7	14.2	0.5
Internal Roads	1.7	0.1
Open Cut Mining Area	4.7	0.2
OEAs	6.9	0.2
Rail Loop	0.9	>0.1
Direct and Temporary Impacts	240.9	8.4
Class 3	37.0	1.3
Haul Roads	26.9	0.9
Mine Infrastructure Area	0.6	<0.1
Stockpile Area	8.1	0.3
Water Storage Facilities	1.4	0.1
Class 4	76.9	2.7
Haul Roads	40.4	1.4
Mine Infrastructure Area	33.0	1.2
Water Storage Facilities	3.5	0.1
Class 5	85.6	3.0
Haul Roads	41.6	1.5
Mine Infrastructure Area	32.2	1.1
Stockpile Area	0.4	<0.1
Water Storage Facilities	11.4	0.4
Class 6	40.0	1.4

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 79

LSC	ha	%
Haul Roads	9.4	0.3
Mine Infrastructure Area	19.0	0.7
Stockpile Area	2.6	0.1
Water Storage Facilities	9.0	0.3
Class 7	1.4	<0.1
Mine Infrastructure Area	0.2	<0.1
Water Storage Facilities	1.2	<0.1
Indirect and Temporary Impacts	1,714.3	59.6
Class 3	509.2	17.7
Subsidence Study Area	509.2	17.7
Class 4	146.5	5.1
Subsidence Study Area	146.5	5.1
Class 5	0.9	<0.1
Subsidence Study Area	0.9	<0.1
Class 6	862.0	30.0
Subsidence Study Area	862.0	30.0
Class 7	195.7	6.8
Subsidence Study Area	195.7	6.8
Total	2,874.7	100.0

7.3 Impact on BSAL within Project Disturbance Footprint

There is 440.8 ha of verified BSAL within the Project disturbance footprint and this represents 26.3% of the total verified BSAL within the Project Boundary (1,675.9 ha) (**Figure 19**). The Project has been designed to avoid BSAL where possible. Of the potential 2,874.7 ha of land to be impacted by the Project, approximately 84.6% is situated on non-BSAL and approximately 15.4% (440.8 ha) is located on land verified as BSAL according to the Interim Protocol (**Table 26**).

Table 26 Total BSAL within Project Disturbance Footprint

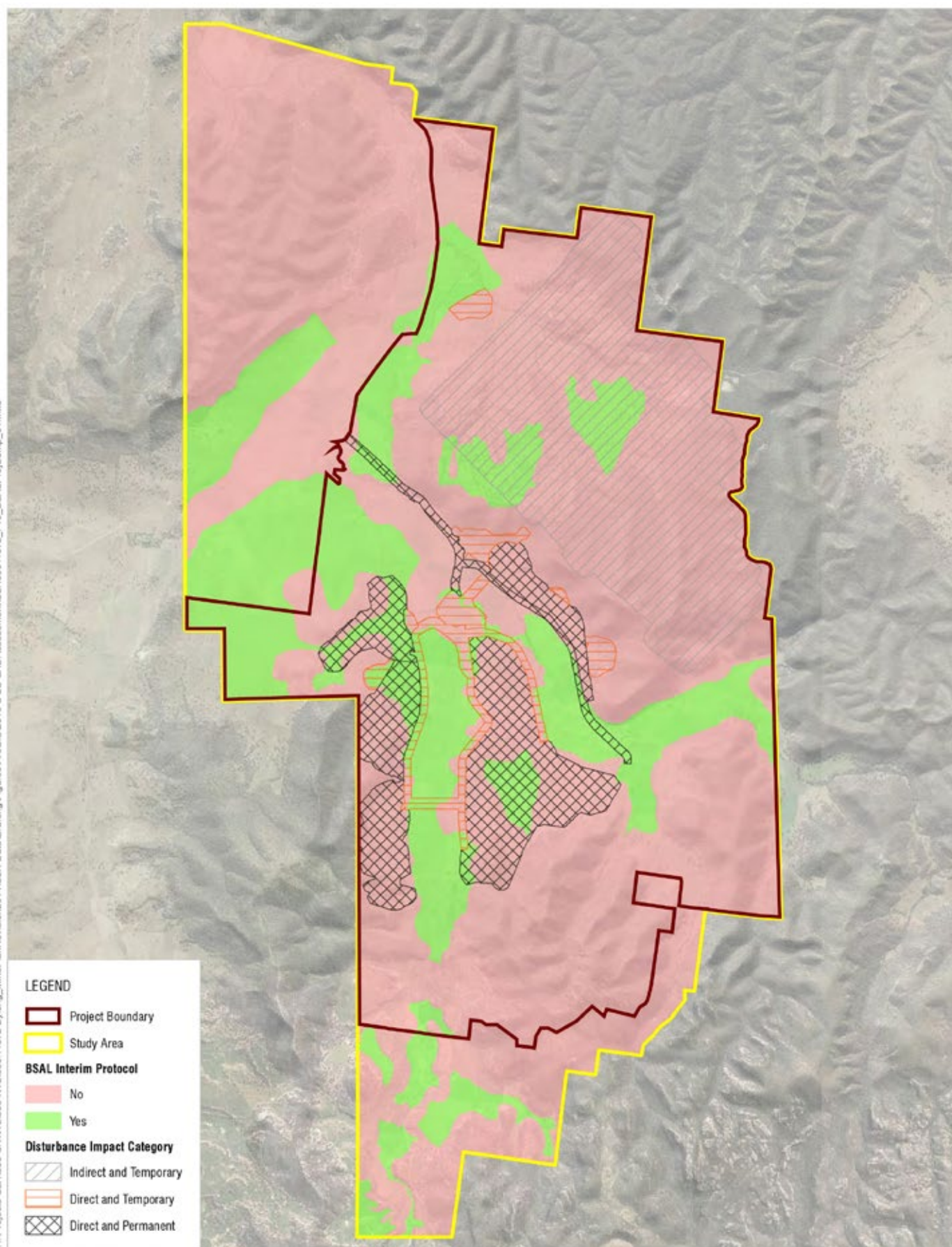
BSAL	ha	%
No	2,433.9	84.6
Yes	440.8	15.4
Total	2,874.7	100.0

The amount of BSAL in each impact category is summarised in **Table 27** and the key findings are:

- 39.0% (171.8 ha) of the verified BSAL within the Project disturbance footprint will be indirectly and temporarily impacted by the Subsidence Study Area;
- 14.2% (62.7 ha) of the verified BSAL within the Project disturbance footprint will be directly; however, temporarily impacted by the development of Hauls Roads, Mine Infrastructure, Stockpile Area and Water Storage Facilities; and
- 46.8% (206.3 ha) of the verified BSAL within the Project disturbance footprint will be directly and permanently impacted by Internal Roads, Rail Loop, Open Cut Mining Areas and OEAs.

There are no impacts on verified BSAL resulting from the Rail Loop.

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BSAL & Project Footprint

FIGURE 19

Table 27 Impact Category: Biophysical Strategic Agricultural Land

Project Domain and Impact Category	ha	%
Indirect and Temporary Impacts	171.8	39.0
Subsidence Study Area	171.8	39.0
Direct and Temporary Impacts	62.7	14.2
Haul Roads	48.5	11.0
Mine Infrastructure Area	4.7	1.1
Stockpile Area	8.1	1.8
Water Storage Facilities	1.4	0.3
Direct and Permanent Impacts	206.3	46.8
Internal Roads	27.9	6.3
Open Cut Mining Area	116.2	26.4
OEA's	62.2	14.1
Total	440.8	100.0

7.3.1 Impact on BSAL within Project Disturbance Footprint by Soil Units

The BSAL to be impacted upon is underlain by nine soil units. This is largely comprised of three soil units; two from the Bald Hill Soil Landscape Unit (which cover 61.8% of the Project disturbance footprint on BSAL) and three from the Growee Soil Landscape Unit (which covers 28.7% of the Project disturbance footprint on BSAL) (**Table 28**). Collectively, these soil units account for 90.5% of the Project disturbance footprint on BSAL. The four soil units that make up the remaining area are associated with the Bylong Soil Landscape Unit. The key factors of each of the impacted soil types is summarised below:

- The soils associated with the Bylong Soil Landscape Unit are alluvial influenced soils and are considered to have the highest productivity, relative to other soil units assessed as BSAL. The Project will impact 42.1 ha of BSAL within the Bylong soil units. The impact is largely direct and permanent through the development of Internal Roads. However, 0.7 ha of the Bylong Soil Landscape Unit is located within the OEA and open cut mining, which is associated with a direct and permanent impact. Where practical, this land will be avoided during mining operations;
- The soils associated with the Bald Hill Soil Landscape Unit are igneous influenced and are considered to be the second most productive category of soil assessed as BSAL. The Project will impact 272.2 ha of BSAL within the Bald Hill soil units. Of this a large proportion, 171.8 ha, will be indirectly and temporarily impacted upon by the Subsidence Study Area. The remaining 100.4 ha will largely be directly and permanently impacted upon by Open Cut Mining Areas and OEA's; and
- The sedimentary derived soils from the Growee Soil Landscape Unit are considered to be the least productive of the soil units assessed as BSAL. The Project will impact 126.5 ha of BSAL within the Growee soil unit. A large proportion (100.2 ha) will be directly and permanently impacted upon by Internal Roads, Open Cut Mining Area and OEA's with the remaining directly and temporarily impacted upon by Haul Roads and Mine Infrastructure Area.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 82

Table 28 BSAL Soil Units by Impact Category

Soil Unit by Impact Category	ha	%
Bylong Soil Landscape Unit	42.1	9.5
B01	22.4	5.0
<i>Direct and Temporary Impacts</i>	2.5	0.5
Haul Roads	2.5	0.5
<i>Direct and Permanent Impacts</i>	19.9	4.5
Internal Roads	19.7	4.5
Open Cut Mining Area	0.1	<0.1
B02	4.0	0.9
<i>Direct and Permanent Impacts</i>	4.0	0.9
Internal Roads	4.0	0.9
B06	10.9	2.5
<i>Direct and Temporary Impacts</i>	10.3	2.4
Haul Roads	10.3	2.4
<i>Direct and Permanent Impacts</i>	0.6	0.1
OEAs	0.6	0.1
B08	4.8	1.1
<i>Direct and Temporary Impacts</i>	4.8	1.1
Haul Roads	4.8	1.1
Bald Hill Soil Landscape Unit	272.2	61.8
BH1	100.4	22.8
<i>Direct and Temporary Impacts</i>	18.8	4.2
Haul Roads	9.3	2.1
Stockpile Area	8.1	1.8
Water Storage Facilities	1.4	0.3
<i>Direct and Permanent Impacts</i>	81.6	18.6
Open Cut Mining Area	20.0	4.6
OEAs	61.6	14.0
BH2	171.8	39.0
<i>Indirect and Temporary Impacts</i>	171.8	39.0
Subsidence Study Area	171.8	39.0
Growee Soil Landscape Unit	126.5	28.7
G05	123.1	27.9
<i>Direct and Temporary Impacts</i>	25.7	5.8
Haul Road	21.6	4.9
Mine Infrastructure Area	4.1	0.9
<i>Direct and Permanent Impacts</i>	97.4	22.1
Internal Roads	1.3	0.3
Open Cut Mining Area	96.1	21.8
G12	2.8	0.6
<i>Direct and Permanent Impacts</i>	2.8	0.6
Internal Road	2.8	0.6

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 83

Soil Unit by Impact Category	ha	%
G17	0.6	0.2
<i>Direct and Temporary Impacts</i>	<i>0.6</i>	<i>0.2</i>
Mine Infrastructure Area	0.6	0.2
Total	440.8	100.0

7.4 Post-mining LSC Class

7.4.1 Temporary Impacts

Land temporarily impacted upon, both directly and indirectly, will be returned to pre-mining condition. Therefore, there is no change in LSC classes for temporary impacts.

7.4.2 Permanent Impacts

The Project will permanently impact upon approximately 142 ha of Class 3 land, 195 ha of Class 4 land, 441 ha of Class 5 land, 128 ha of Class 6 land and 14 ha of Class 7 land (refer **Section 7.2**). Of this, approximately 206 ha is BSAL land. KEPCO has committed to re-instating a similar quantity of BSAL and a similar quantity of the better agricultural LSC classes, i.e. Classes 3 and 4 on the rehabilitated landform.

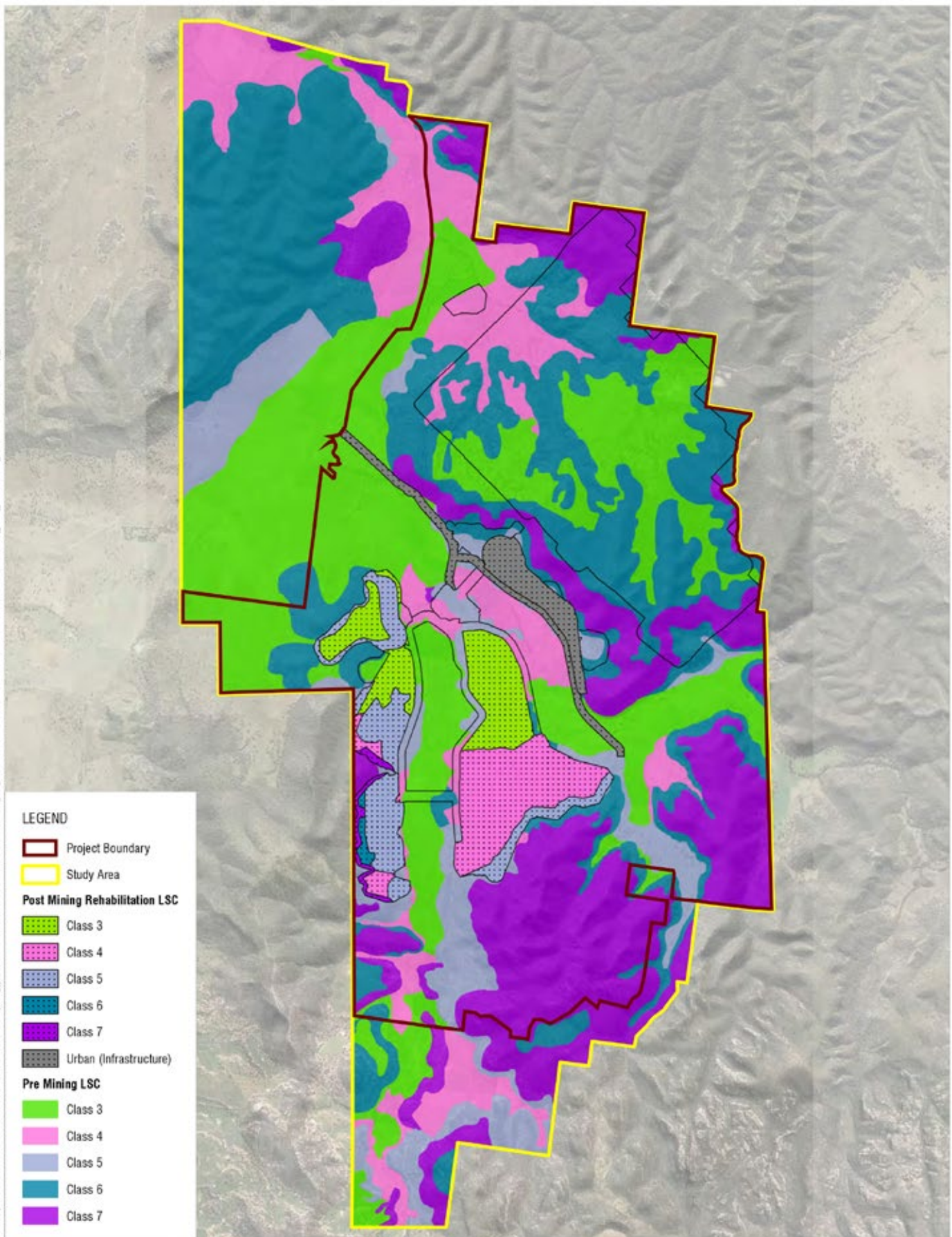
The post-mining landform LSC Classes differ from the pre-mining landform as follows:

- The land associated with road realignment networks and the rail loop will remain as an active network at closure (Class U land);
- All infrastructure elements contained within the Mine Infrastructure Area, Water Storage Facilities and Haul Roads domains will be removed and the pre-mining landform and LSC class reinstated; and
- The land within the Open Cut Mining Area and OEA will contain a similar mix of LSC classes.

The rehabilitated Project disturbance footprint will support LSC classes ranging from Class 3 to Class 7 (**Figure 20**). This will provide a post-mining landform capable of both cropping (Class 3) and grazing (Classes 4 and 5) enterprises along with some land that can be lightly grazed but is best revegetated with trees and shrubs for erosion control (Classes 6 and 7). The post-mining landform will also contain areas not suitable for any agricultural enterprise (Class U) as the infrastructure will be retained for future use (i.e. the road realignment and rail loop).

Selection of post-mining LSC classes is strongly associated with the slope incline of the rehabilitated landform and characteristics of the surrounding landform. **Table 29** describes this association. **Figure 21** shows the slopes of the post-mining landform.

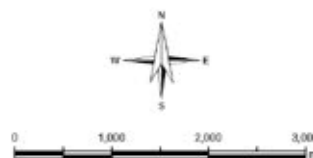
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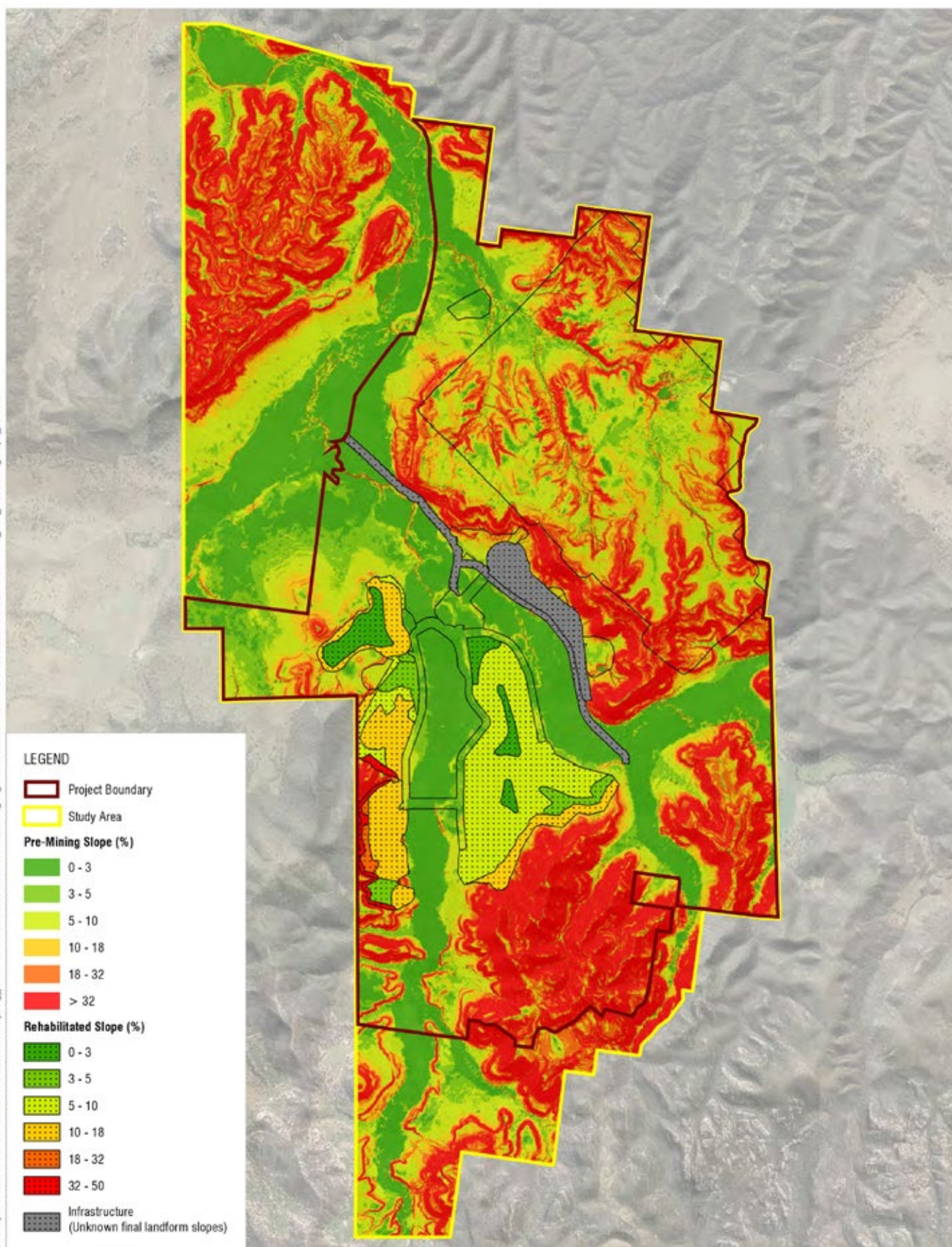
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**Land and Soil Capability
(Post-Mining)**

FIGURE 20

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**Slopes
(Post-Mining)**

FIGURE 21

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Report Number 630.11072.00000
24 March 2015
Revision 1
Page 86

Table 29 Pre and Post-mining LSC Class for Permanently Disturbed Domains

LSC Class	Associated features
Rehabilitated Landform	
3	Slopes <10%. Slopes with inclines of <less 5% have been preferentially targeted with slopes of 5-10% utilised where appropriate. Proximity to existing LSC Class 3 has been considered.
4	Slopes <10%, with the majority being comprised of slopes inclines of 5-10%.
5	Slope inclines of 10-18%
6	Slope inclines of 18-32%
7	Slope inclines of 32-50%
Non-Rehabilitated Infrastructure	
Urban (U)	Infrastructure that will not be decommissioned and removed

Within the area of land to be directly and permanently disturbed there will be:

- A reduction in LSC Class 5 (208.7 ha; 22.8%) and LSC Class 6 (116.7 ha; 12.7%) lands which will be offset by the reinstatement of a greater area of land LSC Class 3 (85.1 ha; 9.3%) and LSC Class 4 (70.1 ha; 7.7%);
- There is also an increase in the area of LSC Class 7 (8.4 ha; 0.8%); and
- Land covered by infrastructure that will be retained at closure (161.8 ha; 17.6%) has not designated a LSC Class rather it has been designated a state land capability code of U for Urban.

Table 30 Pre and Post-mining LSC Class for Permanently Disturbed Domains

LSC	Pre-mining		Post-mining		Difference	
Class	ha	%	ha	%	ha	%
Rehabilitated Landform						
3	141.9	15.5	227.0	24.8	85.1	9.3
4	194.7	21.1	264.8	28.8	70.1	7.7
5	441.0	48.0	232.3	25.2	-208.7	-22.8
6	127.7	13.9	11.0	1.2	-116.7	-12.7
7	14.2	1.6	22.6	2.4	8.4	0.8
Non-Rehabilitated Infrastructure						
Urban	Nil	Nil	161.8	2.3	161.8	17.6
Total	919.5	100.0	919.5	100.0	-	-

7.4.3 Overall Change in LSC Classes in the Project Boundary

The amount of land in each LSC Class in the Project Boundary (pre and post-mining) is summarised in **Table 31** and the key findings are:

- The predicted permanent reduction in LSC Class 5 (208.7 ha; 3.3%) and LSC Class 6 (116.7 ha; 1.7%) lands within the Project Boundary will be offset by the reinstatement of a greater area of land LSC Class 3 (85.1 ha; 1.4%) and LSC Class 4 (70.1 ha; 1.1%);
- There are also increase in the area of LSC Class 7 (8.4 ha; 0.2%);
- A total of 161.8 ha (2.3%) of infrastructure including Internal Roads and the Rail Loop will remain post-mining and therefore is not designated a LSC Class; and

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 87

- Overall, the spatial distribution of LSC classes will change; however, the quality of LSC will improve overall due to the increase in LSC Class 3 and 4 lands.

Table 31 Pre- and Post-mining LSC Class

LSC	Pre-mining		Post-mining		Difference	
Class	ha	%	ha	%	ha	%
Rehabilitated Landform						
3	1,957.0	27.9	2,042.1	29.3	85.1	1.4
4	818.1	11.8	888.2	12.9	70.1	1.1
5	884.9	12.8	676.2	9.5	-208.7	-3.3
6	1,680.7	24.3	1564	22.6	-116.7	-1.7
7	1,617.0	23.2	1,625.4	23.4	8.4	0.2
Non-Rehabilitated Infrastructure						
Urban	Nil	Nil	161.8	2.3	161.8	2.3
Total	6,957.7	100.0	6,957.7	100.0	-	-

7.5 Post-mining Quantity of BSAL

KEPCO has committed to avoiding (where practicable) and minimising the impacts on BSAL. The quantity of BSAL that will be directly and permanently impacted is proposed to be offset to mitigate Project impacts. There will be no reduction in the quantity of BSAL, however, as per the LSC classes, the spatial distribution of BSAL will differ from the pre-mining landscape. Additionally, KEPCO will aim to reinstate 10% greater area of BSAL than is predicted to be disturbed as a conservative and practical objective for rehabilitation.

BSAL will be reinstated on land which also meets LSC Class 3 criteria with slopes preferably less than 3%, but may be reinstated on land up to 10% slope. Where practical, reinstated BSAL will be located adjacent to or nearby to existing and undisturbed BSAL. **Figure 22** shows the spatial distribution of reinstated BSAL.

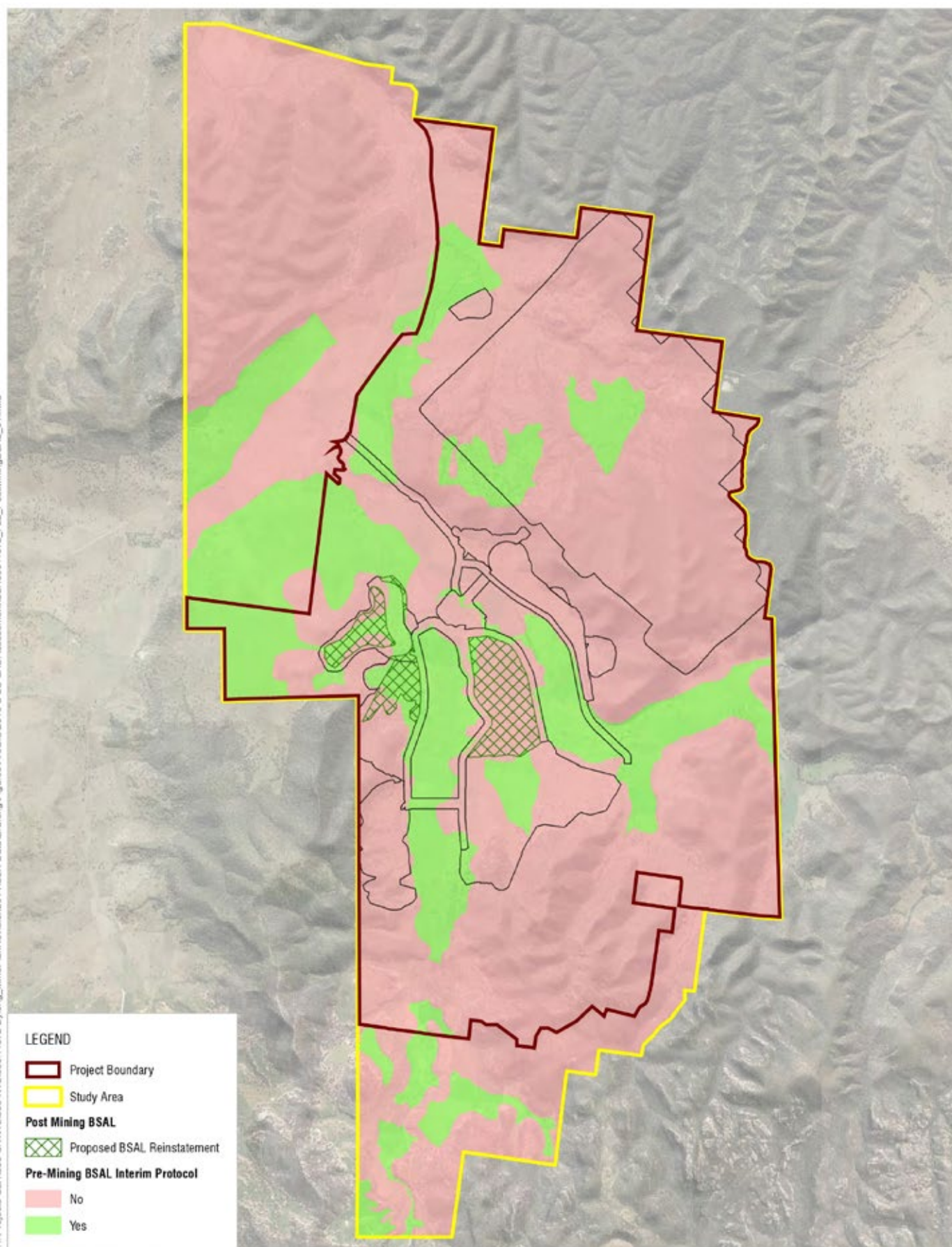
Further details regarding the rehabilitation of this land and compensatory measures are provided in Project's Rehabilitation Strategy.

7.6 Post-mining Land Use: Direct and Permanently Impacted Areas

Within the Project disturbance footprint all land within areas to be temporarily disturbed, whether indirectly or directly, will be returned to their pre-mining land use.

Of the 919.5 ha to be directly and permanently disturbed, land associated with Internal Roads and the Rail Loop (161.8 ha) will not be returned to a pre-mining land use and will remain as non-rehabilitated infrastructure. For the remaining land, cropping land will be established on LSC Class 3 and will cover 227.0 ha. Grazing land will be established on land associated with LSC Classes 4 and 5, covering 497.1 ha. Woodland will be used for the remaining land which is LSC Class 6 and 7 due to their association with moderately steep to steep land (**Figure 23**).

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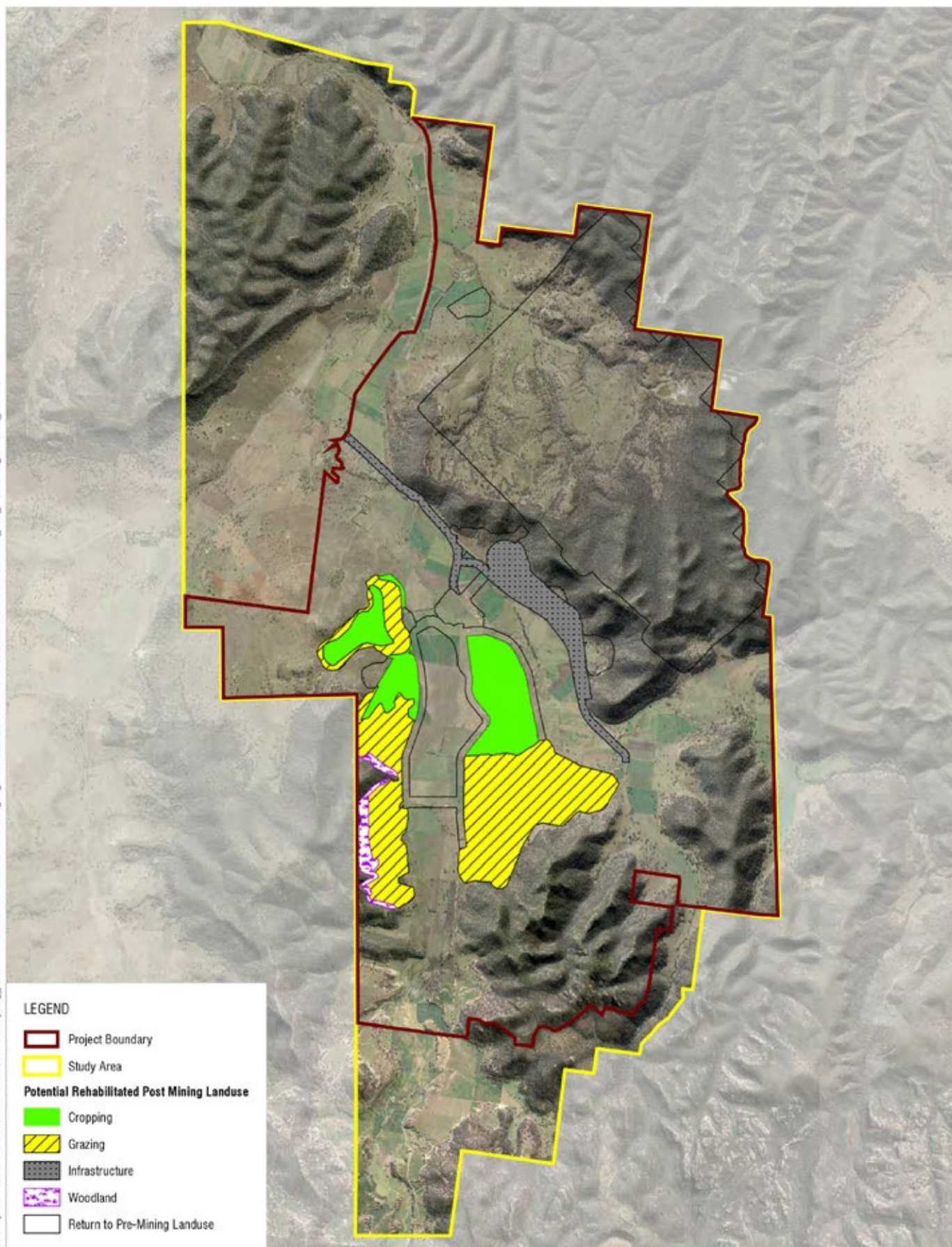
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BSAL (Post-Mining)

FIGURE 22

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 90

Table 32 Post-mining Land Use for Permanently Disturbed Domains

Land Use	Associated LSC Class	ha	%
Rehabilitated Landform			
Cropping	Class 3	227.0	24.8
Grazing	Class 4 and 5	497.1	54.0
Woodland	Class 6 and 7	33.6	3.6
Non-Rehabilitated Infrastructure			
Urban	N/A	161.8	17.6
Total		919.5	100.0

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 91

8 DISTURBANCE MANAGEMENT

Development of the Project will disturb approximately 2,874.7 ha of land. The two aspects of disturbance addressed in this report are inherent soil erodibility and suitability of disturbed soils for re-use in rehabilitation activities.

8.1 Soil Stability

Soil stability can be a significant hazard within and downstream of the Study Area when vegetative cover is disturbed and the soil is subject to the erosive agents of water and wind. Inherent stability characteristics also impact on the suitability of the material for use in civil engineering works (e.g. earthworks). Soil erosion occurs when soil particles detach and are transported off site. The key parameters used for this soil stability assessment are the Emerson Aggregate Test and the K factor.

8.1.1 Emerson Aggregate Test (EAT)

The EAT is a measure of the soil dispersibility or structural stability, which is often an indicator for its suitability for rehabilitation as well as earthworks. Soils with a low EAT class (e.g. Class 1 and 2) are highly dispersive soils and often unsuitable for rehabilitation or earthworks due to their erodibility during rainfall events.

8.1.2 Soil Erodibility (K Factor)

Soil erodibility is quantified using the soil erodibility factor known as the 'K factor'. Soil texture is the principal component affecting K factor; however, other factors such as soil structure, soil organic matter content and soil profile permeability also contribute to the soil's inherent erodibility. Soils that have the highest erodibility are those that have weak bonds between soil particles and contain an abundance of easily transportable soil particles.

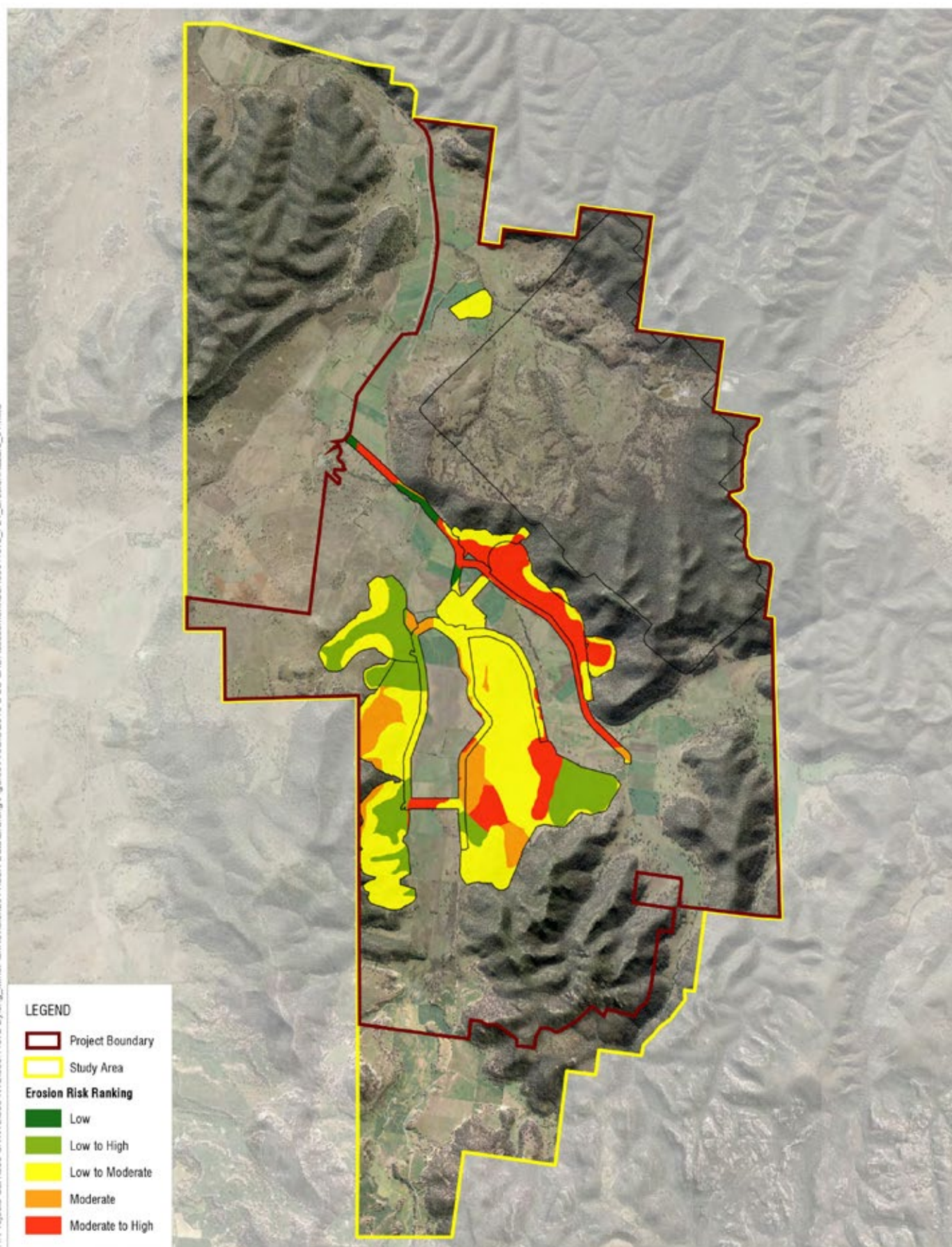
8.1.3 Soil Stability Assessment Results

Overall, the majority of soil units were categorised as having a low to moderate or moderate soil erodibility ranking (**Table 33**). These soils units commonly displayed negligible to slight dispersibility (EAT), with only low to moderate erodibility according to their K factor.

Soils that displayed high erodibility rankings were usually associated with soils determined to have a high K Factor and/or moderate to very high dispersibility. Soils with high dispersibility were commonly associated with sodic subsoils of Sodosols and some Chromosols which resulted in high soil erodibility rankings.

Figure 24 illustrates the overall soil erodibility ranking across the Project disturbance footprint.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 93

Table 33 Soil Stability Assessment

Soil Unit		Depth	Soil Stability Indicators				Soil Erodibility
#	ASC	m	EAT	Dispersibility	K Factor^	Erodibility	Ranking
B01	Eutrophic Black Dermosol overlying Stratic Rudosol	0 – 0.2	4	Negligible	0.040	High	Moderate to High
		0.2 – 0.4	5	Slight	0.030	Moderate	
		0.4 – 0.6	4	Negligible	0.030	Moderate	
		0.6 – 1.0	3(1)	Slight	0.020	Moderate	
B02	Eutrophic Black Dermosol (deep)	0 – 0.1	5	Slight	0.055	High	Moderate to High
		0.1 – 0.3	3(1)	Slight	0.040	High	
		0.3 – 0.6	3(1)	Slight	0.030	Moderate	
		0.6 – 0.9	3(1)	Slight	0.030	Moderate	
B03	Eutrophic Black Dermosol (deep)	0 – 0.3	4	Negligible	0.025	Moderate	Low
		0.3 – 0.45	4	Negligible	0.012	Low	
		0.45 – 0.8	4	Negligible	0.030	Moderate	
		0.8 – 1.0	4	Negligible	0.030	Moderate	
B05	Brown-Orthic Tenosol	0 – 0.2	N/A		0.030	Moderate	Low to Moderate
		0.2 – 0.4			0.020	Moderate	
		0.4 – 0.7			0.015	Low	
		0.7 – 1.0			0.015	Low	
B06	Eutrophic Black Dermosol overlying Stratic Rudosol	0 – 0.1	3(1)	Slight	0.040	High	Moderate to High
		0.1 – 0.6	3(1)	Slight	0.040	High	
		0.6 – 0.8	3(1)	Slight	0.040	High	
		0.8 – 1.0	3(1)	Slight	0.030	Moderate	
		1.0 – 1.2	3(1)	Slight	0.030	Moderate	
B08	Eutrophic Grey Dermosol overlying Stratic Rudosol	0 – 0.25	N/A		0.030	Moderate	Moderate
		0.25 – 0.5			0.025	Moderate	
		0.5 – 0.9			0.025	Moderate	
		0.9+			0.020	Moderate	
B12	Stratic Rudosol overlying Black Dermosol	0 – 0.1	3(1)	Slight	0.030	Moderate	Moderate
		0.1 – 0.35	3(1)	Slight	0.025	Moderate	
		0.35 – 0.75	3(1)	Slight	0.030	Moderate	
		0.75 – 1.1	5	Slight	0.025	Moderate	
BH1	Eutrophic Red Dermosol (deep)	0 – 0.1	3(1)	Slight	0.040	High	Low to High
		0.1 – 0.25	3(2)	Slight	0.030	Moderate	
		0.25 – 0.6	5	Slight	0.012	Low	
		0.6 – 0.85	5	Slight	0.012	Low	
		0.85 – 1.0	2(1)	High to moderate	0.012	Low	
BH1-P1	Red Chromosol (shallow)	0 – 0.15	N/A		0.020	Moderate	Low to Moderate
		0.15 – 0.4			0.017	Low	
		0.4 – 0.55			0.012	Low	
G01	Eutrophic Red Chromosol (moderate)	0 – 0.15	3(1)	Slight	0.030	Moderate	Low to Moderate
		0.15 – 0.4	2(1)	High to moderate	0.012	Low	
		0.4 – 0.6	2(2)	High	0.012	Low	

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 94

Soil Unit		Depth	Soil Stability Indicators				Soil Erodibility
#	ASC	m	EAT	Dispersibility	K Factor^	Erodibility	Ranking
		0.6 – 1.0+	2(1)	High to moderate	0.012	Low	
G03	Lithic Rudosol	0 – 0.15	N/A		0.020	Moderate	Moderate
G04-P1	Brown Chromosol (shallow)	0 – 0.15	N/A		0.030	Moderate	Low to Moderate
		0.15 – 0.35			0.017	Low	
		0.35 – 0.5			0.017	Low	
		0.5 – 0.65			0.017	Low	
G05	Eutrophic Red Chromosol (moderate)	0 – 0.2	N/A		0.030	Moderate	Low to Moderate
		0.2 – 0.6			0.025	Moderate	
		0.6 – 0.9			0.015	Low	
G06	Eutrophic Red Chromosol (moderate)	0 – 0.15	8	Negligible	0.040	High	Low to High
		0.15 – 0.35	2(1)	High to Moderate	0.040	High	
		0.35 – 0.6	5	Slight	0.015	Low	
		0.6 – 0.75	3(1)	Slight	0.015	Low	
G06-P1	Red Chromosol (shallow)	0 – 0.05	N/A		0.030	Moderate	Low to Moderate
		0.05 – 0.15			0.030	Moderate	
		0.15 – 0.3			0.025	Moderate	
		0.3 – 0.5			0.015	Low	
G07	Eutrophic Red Chromosol (deep)	0 – 0.1	8	Negligible	0.040	High	Moderate to High
		0.1 – 0.3	3(1)	Slight	0.040	High	
		0.3 – 0.6	3(2)	Slight	0.040	High	
		0.6 – 1.0	5	Slight	0.030	Moderate	
G07-P1	Eutrophic Red Chromosol (gravelly)	0 – 0.15	8	Negligible	0.040	High	Moderate
		0.15 – 0.4	3(2)	Slight	0.030	Moderate	
		0.4 – 0.6	5	Slight	0.030	Moderate	
		0.6 – 1.0	4	Negligible	0.030	Moderate	
G08	Eutrophic Red Dermosol (shallow)	0 – 0.1	8	Negligible	0.040	High	Moderate to High
		0.1 – 0.3	3(1)	Slight	0.025	Moderate	
		0.3 – 0.5	4	Negligible	0.025	Moderate	
G09	Eutrophic Brown Chromosol (moderate)	0 – 0.1	8	Negligible	0.040	High	Low to High
		0.1 – 0.35	2(2)	High	0.025	Moderate	
		0.35 – 0.7	2(2)	High	0.018	Low	
		0.7 – 1.0	2(3)	Very High	0.018	Low	
G12	Black Dermosol	0 – 0.15	N/A		0.025	Moderate	Moderate
		0.15 – 0.3			0.025	Moderate	
		0.3 – 0.6			0.015	Low	
		0.6 – 1.0			0.025	Moderate	
G14	Eutrophic Brown Chromosol (deep)	0 – 0.1	N/A		0.025	Moderate	Low to Moderate
		0.1 – 0.5			0.025	Moderate	
		0.5 – 0.85			0.015	Low	
		0.85 – 1.0			0.015	Low	
G14-	Brown	0 – 0.1	N/A		0.030	Moderate	Low to

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 95

Soil Unit		Depth	Soil Stability Indicators				Soil Erodibility
#	ASC	m	EAT	Dispersibility	K Factor^	Erodibility	Ranking
P1	Chromosol (shallow)	0.1 – 0.2			0.020	Moderate	Moderate
		0.2 – 0.5			0.015	Low	
G15	Subnatric Brown Sodosol	0 – 0.03	8	Negligible	0.020	Moderate	Low to Moderate
		0.03 – 0.3	8	Negligible	0.030	Low	
		0.3 – 0.55	2(1)	High to Moderate	0.012	Low	
G17	Eutrophic Red Chromosol (deep)	0 – 0.15	3(1)	Slight	0.040	High	Low to High
		0.15 – 0.35	3(1)	Slight	0.012	Low	
		0.35 – 0.75	2(1)	High to Moderate	0.012	Low	
		0.75 – 1.0	2(1)	High to Moderate	0.018	Low	
G17-P1	Eutrophic Red Chromosol (moderate)	0 – 0.15	8	Negligible	0.040	High	Low to Moderate
		0.15 – 0.3	4	Negligible	0.012	Low	
		0.3 – 0.65	4	Negligible	0.012	Low	
L01-P1	Clastic Rudosol (very shallow)	N/A	N/A		0.018*	Moderate	Moderate
OL02	Clastic Rudosol (deep)	0 – 0.15	N/A		0.030	Moderate	Moderate
		0.15 – 0.3			0.020	Moderate	
		0.3 – 0.5			0.020	Moderate	
		0.5 – 1.0			0.025	Moderate	
OL02-P1	Clastic Rudosol (moderate)	0 – 0.1	N/A		0.030	Moderate	Low to Moderate
		0.1 – 0.3			0.030	Moderate	
		0.3 – 0.6			0.017	Low	
SH1	Subnatric Red Sodosol (deep)	0 – 0.1	5	Slight	0.040	High	Moderate to High
		0.1 – 0.3	2(1)	High to Moderate	0.018	Low	
		0.3 – 0.5	2(2)	High	0.025	Moderate	
		0.5 – 0.8	2(3)	Very High	0.025	Moderate	

^ K-Factor correlated based on soil texture (Hazelton & Murphy, 2007)

* Soil texture correlated according to Soil Landscape Unit (Kovac & Lawrie, 1991)

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 96

8.2 Soil Suitability

Rehabilitation of disturbed mining land requires adequate soil resources be available for rehabilitation works. This section provides an assessment of suitability of relevant soils for re-use as a topsoil resource (primary growth media) or subsoil resource (secondary growth media). The assessment specifically targets the:

- Growth media for LSC Class 3 and BSAL reinstatement;
- Growth media for LSC Class 4 reinstatement; and
- Secondary growth media.

The Project's Rehabilitation Strategy provides recommendation on salvage, erosion stability assessment and storage techniques.

8.2.1 Methodology

The suitability of soil for conservation and use in the rehabilitation of land disturbed associated with mining construction and operations has been determined with reference multiple rehabilitation guidelines including:

- *Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas* (Elliot & Reynolds, 2007); and
- *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Part D: Growth Media Management* (QLD DME, 1995)

As well as consideration to NSW land capability guidelines:

- LSC Guideline; and
- Interim Protocol

This selection procedure determines the appropriate stripping depths of soil material to be removed and their ideal rehabilitation suitability, and is based on soil physical and chemical parameters. **Table 34** summarises the procedure to determine suitability of soil materials for re-use on areas that are to be disturbed by the Project. Soil management protocols are contained in the Project's Rehabilitation Strategy.

Table 34 Soil Suitability Criteria

Criteria	Primary - BSAL / Class 3	Primary - Class 4	Secondary
Physical			
Pedality	>30% peds	>30% peds	N/A
Macrostructure	<100 mm (or greater if ameliorated)	<100 mm (or greater if ameliorated)	N/A
Structure	Unsuitable if single-grained sands or massive block-like structure	Unsuitable if single-grained sands or massive block-like structure	Single-grained sands or massive block-like structure are suitable if mixed with other material
Boulders (dia. 60 cm to 2 m)	<2% rock fragments greater than 60 mm diameter	<2% rock fragments greater than 60 mm diameter	<50%
Stones, cobbles and gravels (diameter 0.2 to 60 cm)			<20%

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 97

Criteria	Primary - BSAL / Class 3	Primary - Class 4	Secondary
Texture	Loamy Sands; Loams; Friable clays (i.e not sands, or strong structured clays)	Loamy Sands; Loams; Friable clays (i.e not sands, or strong structured clays)	Cracking/non-cracking clays are suitable if they meet chemical criteria
PSA	<60% silt and fine sand content	N/A	N/A
	<60% gravel & sand content	<60% gravel & sand content	<90% sand
Mottling	Negligible mottling with value-chroma Class 2 mottles	Negligible mottling with value-chroma Class 2 mottles	N/A
Chemical			
pH	5.5 - 8.4* if loam or greater	5.5 - 8.4* if fine sandy loam or greater	N/A
	6.7 - 8.4* if fine sandy loam or greater	6.7 - 8.4* if sandy loam or greater	N/A
ESP	<5%	<8%	8-10% for loams; 8-30% clays
Ca:Mg	0.1 or greater	N/A	N/A
Salinity	ECe < 1 dS/m*	ECe < 1.5 dS/m*	ECe < 2 dS/m*
CEC	>12 cmol/kg (moderate or greater)	>6 cmol/kg (low or greater)	N/A

* Denotes 1:5 (soil:water)

8.2.2 Soil Suitability Assessment

8.2.2.1 LSC Class 3/BSAL and Class 4 Rehabilitated Lands

Soil units to be subject to surface activities are associated with the Project domains that have a direct impact. Direct and temporary and direct and permanent impacts cover 240.9 ha and 919.5 ha, respectively, collectively totalling 1,160.4 ha. The proposed Subsidence Study Area is not subject to surface activities.

The soils to be assessed for stripping and salvage suitability for re-use in rehabilitation activities are listed in **Table 35**. Soil units listed in this table but not direct and permanently impacted include B08, G06-P1, G17 and G17-P1; whilst Soil units listed that are not direct and temporarily impacted include B01, B02, B03, G01, G07, G09 and G12.

The limitations of each soil unit are also summarised in **Table 35** and the key elements are:

- Soil unit horizons most commonly excluded for use as a Primary BSAL/Class 3 growth media was due to:
 - Single-grained apedal soil structure;
 - pH,
 - Salinity; and/or
 - Low CEC.
- Soil unit horizons which failed BSAL/Class 3 criteria, but were able to meet Class 4 criteria, were able to do so due to the lower CEC threshold required;

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 98

- Some soil unit horizons suitable for use as a secondary growth media require amelioration due to their single-grained apedal soil structure. Amelioration involves mixing with other suitable soil material to improve structure; and
- Soil unit horizons unsuitable for use as either a primary or secondary growth media were commonly excluded due to soil salinity ($EC_e > 2 \text{ dS/m}$) or high stone content.

Figure 25 illustrates the recommended stripping depths across the Study Area.

8.2.2.2 LSC Class 5, 6 and 7 Rehabilitated Lands

Some soil material which failed to meet the criteria required for primary media use in LSC Class 3 or Class 4 reinstatement was also evaluated for re-use as primary media for LSC Class 6 and 7 using the same criteria, with the exception of pH. A pH range of 4.7 to 8.9 was deemed suitable for topsoil use for LSC Class 6 and 7 reinstatement.

Additionally, some soil material which failed to meet the criteria required for secondary media use in reinstatement was also evaluated for re-use as secondary media for LSC Class 5, 6 and 7. Soil originally excluded due to stone content was assessed as suitable for subsoil use for LSC Class 5, 6 and 7 reinstatement.

Table 35 Soil Suitability Assessment

Soil Unit		Depth	Limitations			Overall Growth Suitability
#	ASC	m	Primary LSC 3 / BSAL	Primary LSC 4	Secondary All LSC	
B01	Eutrophic Black Dermosol overlying Stratic Rudosol	0 – 0.2	EC_e	EC_e	EC_e	None
		0.2 – 0.4	pH	pH	None	Primary LSC 6 and 7
		0.4 – 0.6	pH; CEC	pH	None	Primary LSC 6 and 7
		0.6 – 1.0	pH; Apedal; CEC	pH; Apedal	Apedal*	Secondary*
B02	Eutrophic Black Dermosol (deep)	0 – 0.1	EC_e	EC_e	EC_e	None
		0.1 – 0.3	None	None	None	Primary LSC 3/BSAL
		0.3 – 0.6	pH; EC_e ; ESP	pH; EC_e ; ESP	None	Secondary
		0.6 – 0.9	pH; ESP	pH	None	Secondary
B03	Eutrophic Black Dermosol (deep)	0 - 0.3	None	None		Primary LSC 3/BSAL
		0.3 - 0.45	Texture; pH	Texture; pH	None	Secondary
		0.45 - 0.8	pH; EC_e	pH; EC_e	EC_e	None
		0.8 - 1.0	pH; EC_e	pH; EC_e	EC_e	None
B05	Brown-Orthic Tenosol	0 – 0.2	CEC ^{^^}	None	None	Primary LSC 4
		0.2 – 0.4	CEC ^{^^}	None	None	Primary LSC 4
		0.4 – 0.7	Apedal; pH	Apedal; pH	Apedal*	Secondary*
		0.7 - 1.0	Apedal; pH	Apedal; pH	Apedal*	Secondary*
B06	Eutrophic Black Dermosol overlying Stratic Rudosol	0 – 0.1	None	None	None	Primary LSC 3/BSAL
		0.1 – 0.6	None	None	None	Primary LSC 3/BSAL

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 99

Soil Unit		Depth	Limitations			Overall Growth Suitability
#	ASC	m	Primary LSC 3 / BSAL	Primary LSC 4	Secondary All LSC	
		0.6 – 0.8	None	None	None	Primary LSC 3/BSAL
		0.8 – 1.0	Apedal; CEC	Apedal	Apedal	Secondary*
		1.0 – 1.2	None	None	None	Primary LSC 3/BSAL
B08	Eutrophic Grey Dermosol overlying Stratic Rudosol	0 – 0.25	None	None	None	Primary LSC 3/BSAL
		0.25 – 0.5	Mottling	Mottling	None	Secondary
		0.5 – 0.9	None	None	None	Primary LSC 3/BSAL
		0.9+	pH	pH	None	Secondary
B12	Stratic Rudosol overlying Black Dermosol	0 – 0.1	None	None	None	Primary LSC 3/BSAL
		0.1 – 0.35	None	None	None	Primary LSC 3/BSAL
		0.35 – 0.75	Apedal; CEC	Apedal; CEC	Apedal*	Secondary*
		0.75 – 1.1	None	None	None	Primary LSC 3/BSAL
BH1	Eutrophic Red Dermosol (deep)	0 – 0.1	CEC	None	None	Primary LSC 4
		0.1 – 0.25	CEC	None	None	Primary LSC 4
		0.25 – 0.6	Texture; CEC	Texture	None	Secondary
		0.6 – 0.85	Texture; CEC	Texture	None	Secondary
		0.85 – 1.0	Texture; CEC	Texture	None	Secondary
BH1-P1	Red Chromosol (shallow)	0 – 0.15	CEC^	None	None	Primary LSC 4
		0.15 – 0.4	CEC^	None	None	Primary LSC 4
		0.4 – 0.55	Texture	Texture	None	Secondary
G01	Eutrophic Red Chromosol (moderate)	0 – 0.15	CEC	None	None	Primary LSC 4
		0.15 – 0.4	Texture; CEC	Texture	None	Secondary
		0.4 – 0.6	Texture; CEC; Mottling	Texture; Mottling	None	Secondary
		0.6 – 1.0+	Texture; CEC; ECe; Mottling	Texture; ECe; Mottling	ECe	None
G03	Lithic Rudosol	0 – 0.15	Apedal	Apedal	Apedal*	Secondary*
G04-P1	Brown Chromosol (shallow)	0 – 0.15	pH	pH	None	Secondary
		0.15 – 0.35	None	None	None	Primary LSC 3/BSAL
		0.35 – 0.5	None	None	None	Primary LSC 3/BSAL
		0.5 – 0.65	pH	pH	None	Secondary

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 100

Soil Unit		Depth	Limitations			Overall Growth Suitability
#	ASC	m	Primary LSC 3 / BSAL	Primary LSC 4	Secondary All LSC	
G05	Eutrophic Red Chromosol (moderate)	0 – 0.2	Stone content; pH; CEC	Stone content; pH; CEC	Stone content	Secondary LSC 5, 6 and 7
		0.2 – 0.6	Stone content	Stone content	Stone content	Secondary LSC 5, 6 and 7
		0.6 – 0.9	Texture; CEC; Stone content	Texture; stone content	Stone content	Secondary LSC 5, 6 and 7
G06	Eutrophic Red Chromosol (moderate)	0 – 0.15	CEC	None	None	Primary LSC 4
		0.15 – 0.35	CEC	CEC	None	Secondary
		0.35 – 0.6	Texture; CEC	Texture	None	Secondary
		0.6 – 0.75	Texture; CEC	Texture	None	Secondary
G06-P1	Red Chromosol (shallow)	0 – 0.05	pH	pH	None	Secondary
		0.05 – 0.15	Apedal; pH	Apedal; pH	Apedal*	Secondary*
		0.15 – 0.3	CEC^	None	None	Primary LSC 4
		0.3 – 0.5	Texture	Texture	None	Secondary
G07	Eutrophic Red Chromosol (deep)	0 – 0.1	None	None	None	Primary BSAL
		0.1 – 0.3	CEC; ECe	ECe	None	Secondary
		0.3 – 0.6	CEC	None	None	Primary LSC 4
		0.6 – 1.0	ECe	ECe	ECe	Secondary
G07-P1	Eutrophic Red Chromosol (gravelly)	0 – 0.15	CEC; ECe	CEC; ECe	ECe	None
		0.15 – 0.4	CEC; ECe	CEC; ECe	ECe	
		0.4 – 0.6	CEC; ECe	CEC; ECe	ECe	
		0.6 – 1.0	Stone content	Stone content	Stone content	
G08	Eutrophic Red Dermosol (shallow)	0 – 0.1	None	None	None	Primary LSC 3/BSAL
		0.1 – 0.3	None	None	None	Primary LSC 3/BSAL
		0.3 – 0.5	Stone content	Stone content	Stone content	None
G09	Eutrophic Brown Chromosol (moderate)	0 – 0.1	CEC	None	None	Primary LSC 4
		0.1 – 0.35	CEC; pH	pH	None	Primary LSC 6 and 7
		0.35 – 0.7	ECe; pH	ECe; pH	ECe	None
		0.7 – 1.0	ECe; pH	ECe; pH	ECe	None
G12	Black Dermosol	0 – 0.15	ECe	ECe	None	Secondary
		0.15 – 0.3	None	None	None	Primary LSC 3/BSAL
		0.3 – 0.6	Texture	Texture	None	Secondary
		0.6 – 1.0	CEC	None	None	Primary LSC 4

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 101

Soil Unit		Depth	Limitations			Overall Growth Suitability
#	ASC	m	Primary LSC 3 / BSAL	Primary LSC 4	Secondary All LSC	
G14	Eutrophic Brown Chromosol (deep)	0 – 0.1	CEC	CEC	None	Secondary
		0.1 – 0.5	CEC	CEC	None	Secondary
		0.5 – 0.85	Texture; Mottling; CEC	Texture; Mottling	None	Secondary
		0.85 – 1.0	Texture; Mottling; CEC	Texture; Mottling	None	Secondary
G14-P1	Brown Chromosol (shallow)	0 – 0.1	Apedal; CEC^	Apedal; CEC^	Apedal;*	Secondary*
		0.1 – 0.2	Apedal; CEC^	Apedal; CEC^	Apedal;*	Secondary*
		0.2 – 0.5	Texture; CEC^	Texture	None	Secondary
G15	Subnatic Brown Sodosol	0 – 0.03	Apedal; CEC	Apedal; CEC	Apedal;*	Secondary*
		0.03 – 0.3	Apedal; CEC; ECe	Apedal; CEC; ECe	Apedal;*	Secondary*
		0.3 – 0.55	Mottling; CEC	Mottling; CEC	None	Secondary
G17	Eutrophic Red Chromosol (deep)	0 – 0.15	CEC	CEC	None	Secondary
		0.15 – 0.35	Texture	Texture	None	Secondary
		0.35 – 0.75	Texture	Texture	None	Secondary
		0.75 – 1.0	Texture	Texture	None	Secondary
G17-P1	Eutrophic Red Chromosol (moderate)	0 – 0.15	None	None	None	Primary LSC 3/BSAL
		0.15 – 0.3	Texture	Texture	None	Secondary
		0.3 – 0.65	Texture; pH; Mottling	Texture; pH; Mottling	None	Secondary
L01-P1	Clastic Rudosol (very shallow)	N/A	Not sampled #			None
OL02	Clastic Rudosol (deep)	0 – 0.15	Apedal	Apedal	Apedal;*	Secondary*
		0.15 – 0.3	Apedal	Apedal	Apedal;*	Secondary*
		0.3 – 0.5	Apedal; Stone content	Apedal; Stone content	Apedal;* ; Stone content	None
		0.5 – 1.0	None	None	None	Primary LSC 3/BSAL
OL02-P1	Clastic Rudosol (moderate)	0 – 0.1	Apedal; pH	Apedal; pH	Apedal;*	Secondary
		0.1 – 0.3	Apedal	Apedal	Apedal;*	Secondary
		0.3 – 0.6	Stone content	Stone content	Stone content	None
SH1	Subnatic Red Sodosol (deep)	0 – 0.1	pH; ECe; CEC	pH; ECe	pH; ECe	None
		0.1 – 0.3	ESP	None	None	Primary LSC 4
		0.3 – 0.5	ESP	ESP	None	Secondary
		0.5 – 0.8	ESP; ECe	ESP; ECe	ECe	None

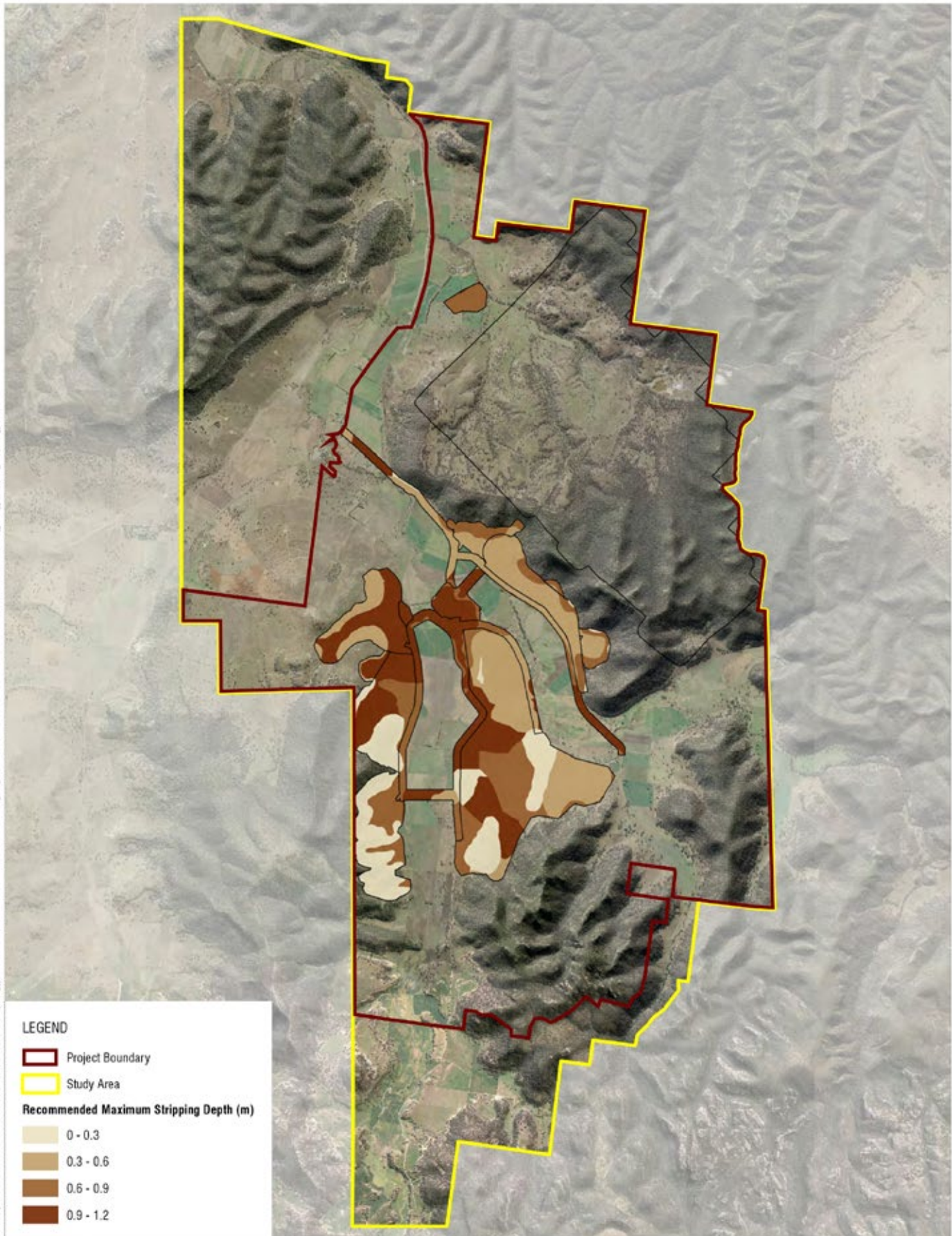
* Indicates only suitable if mixed with other material

^ Indicates chemical data for soil unit phase is correlated with main soil unit

^^ Indicates chemical data for soil unit has been related to inherent soil fertility

Not sampled and assumed unsuitable

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Recommended Stripping Depths

FIGURE 24

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 103

8.2.3 Soil Volume Available for Conservation

Land that will be subject to stripping activities includes land directly impacted upon, both temporarily and permanently (1,160.4 ha; **Table 36**). Land indirectly impacted upon is not subject to stripping activities.

Table 36 Soil Resources to be Stripped and Salvaged

Soil Resources	Area (ha)	Percentage (%)
Direct and Temporary Impacts	240.9	8.4
Haul Roads	118.3	4.1
Mine Infrastructure Area	85.0	3.0
Stockpile Area	11.1	0.4
Water Storage Facilities	26.5	0.9
Direct and Permanent Impacts	919.5	32.0
Internal Roads	73.5	2.6
Open Cut Mining Area	532.7	18.5
OEAs	225.0	7.8
Rail Loop	88.3	3.1
Total	1,160.40	40.4

The quantity of soil that can be salvaged from the disturbance footprint for re-use in rehabilitation works as a primary or secondary media is based on the recommended soil stripping depths per soil unit horizon and the area of land that will be disturbed. The estimated total volume of soil available from areas to be disturbed is approximately 7.42 million cubic metres (MCM) (**Table 37**).

The total volume breakdowns for primary and secondary media use are as follows:

- Primary media capable for BSAL reinstatement: 0.96 MCM;
- Primary media capable for LSC Class 4 (also used for Class 5) reinstatement: 1.03 MCM;
- Primary media capable for LSC Class 6 and 7 reinstatement: 0.25 MCM;
- Secondary media for all LSC Classes 3, 4 and 5: 4.07 MCM (including 0.79 MCM that required amelioration); and
- Secondary media for all LSC Classes 6 and 7: 1.11 MCM.

The available soil volumes, calculated for land to be directly and permanently disturbed compared to directly and temporary, are shown in **Table 37**.

Table 37 Soil Volume Availability

Soil Suitability	Direct and Permanent Impact	Direct and Temporary Impact	Total
By Media and LSC Class	MCM	MCM	MCM
Primary LSC Class 3 / BSAL	0.61	0.35	0.96
Primary LSC Class 4 and 5	0.80	0.23	1.03
Primary LSC Class 6 and 7	0.24	0.01	0.25
Secondary LSC Class 3 and 4	2.98	1.09	4.07
Secondary LSC Class 5, 6 and 7	0.88	0.23	1.11
Total	5.51	1.91	7.42

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 104

It is recommended that the detailed Topsoil Management Plan (which is to be developed prior to the commencement of construction works) provides strategies on how to minimise topsoil losses during stripping to ensure that topsoil resources are preserved.

8.3 Soil Volume Requirement

8.3.1 Sources of Soil

Land that is to be rehabilitated includes all land being directly impacted upon with the exclusion of the Internal Roads and Rail Loop which will remain as infrastructure at closure (refer **Section 6.1; Table 38**).

Land to be directly but temporally impacted upon is proposed to be rehabilitated, where practical, using the same soil as that which was disturbed for project This has been termed 'existing soil resources' (refer **Table 38**).

For land that will be permanently impacted upon and is to be rehabilitated, soil will be sourced from various stripped sources including the land where rehabilitation is not required. This has been termed 'other soil resources' (refer **Table 38**).

Table 38 Area of Land Requiring Rehabilitation

Rehabilitation Strategy	ha	%
Rehabilitation Required		
Using Existing Soil resources	240.9	8.4
Haul Roads	118.3	4.1
Mine Infrastructure Area	85.0	3.0
Stockpile Area	11.1	0.4
Water Storage Facilities	26.5	0.9
Using Other Soil resources	757.7	65.2
Open Cut Mining Area	532.7	45.8
OEAs	225	19.4
Rehabilitation not Required		
Soil Resources can be used elsewhere	161.8	8.6
Internal Roads	73.5	2.6
Rail Loop	88.3	3.1
Total	1,160.40	40.4

8.3.2 Soil Volume Required for Conservation

Land to be directly but temporally impacted upon is proposed to be rehabilitated to the pre-mining LSC class using the same soil as that which was disturbed for project Therefore it is reasonable to assume that that sufficient soil resources are available for rehabilitation as it is 'like for like' and no further soil volume calculation is required..

For land that will be permanently impacted upon and is to be rehabilitated (i.e. 757.7 ha), the post-mining LSC class differs from the pre-mining land class. As such the soil volume required to rehabilitate this land is required to be calculated. This is based on the soil media placement depths for each LSC class and the quantity of each LSC class to be instated.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 105

The Rehabilitation Strategy details the soil media placement depth requirements for both topsoil (primary media) and subsoil (secondary media) for each LSC class re-instated on the permanently impacted landform. These depths are as follows:

- LSC Class 3 and BSAL landform will have a minimum of 0.6 m subsoil overlain by 0.25 m of topsoil (total profile depth 0.85 m);
- LSC Class 4 landform will have a minimum of 0.4 m subsoil (secondary media) overlain by 0.2 m of topsoil (total profile depth 0.6);
- LSC Class 5 land will have a minimum of 0.4 m subsoil (secondary media) overlain by 0.1 m of topsoil (total profile depth 0.5 m);
- LSC Class 6 land will have a minimum of 0.2 m subsoil (secondary media) overlain by 0.1 m of topsoil (total profile depth 0.3 m); and
- LSC Class 7 land will have 0.1 m of topsoil (total profile depth 0.1 m)

Table 39 details the soil volume requirements per LSC Class.

Table 39 Soil Volume Requirements for the Permanently Impacted Landform

LSC	Area	Soil Volume Required (MCM)		
Class/BSAL Status	ha	Topsoil (Primary)	Subsoil (Secondary)	Total
3 / BSAL	227.0	0.57	1.36	1.93
4	264.8	0.53	1.06	1.59
5	232.3	0.23	0.93	1.16
6	11.0	0.01	0.02	0.03
7	22.6	0.02	0.00	0.02
Total	757.7	1.36	3.37	4.73

8.4 Soil Volume Mass Soil Balance

Following the assessment of the quantity of soil required for rehabilitation for land to be directly and permanently impacted upon (see **Section 8.3.1**), it has been determined that the Project has sufficient soil volumes available for conservation and re-use to achieve the post-mining LSC classes.

Soil suitability assessment determined that a total of 5.51 MCM of soil was available for conservation across the three growth media categories from land to be directly and permanently impacted. This exceeds the 4.73 MCM required for rehabilitation (refer **Table 39**).

The Project has sufficient topsoil for reinstatement of all LSC Classes including LSC Class 3/BSAL (**Table 40**). The Project has sufficient subsoil for reinstatement of LSC Class 3/BSAL and Class 4. There is inadequate subsoil for the reinstalment of LSC Classes 5, 6 and 7; however, the surplus soil volume suitable for secondary growth media LSC Class 3/BSAL and Class 4 can also be used. Therefore overall there are adequate soil resources to reinstate soil depth for each LSC Class as described in **Section 8.3.2**.

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 106

Table 40 Soil Volume Mass Balance

Growth Media Class	Soil Volume Mass Balance		
	Volume Available (MCM)	Volume Required (MCM)	Difference (MCM)
Topsoil (Primary LSC 3/BSAL)	0.61	0.57	0.04
Topsoil(Primary LSC 4 and 5)	0.80	0.76	0.04
Topsoil (Primary LSC 6 and 7)	0.24	0.03	0.21
Subsoil (Secondary LSC 3 and 4)	2.98	2.42	0.56
Subsoil (Secondary LSC 5, 6 and 7)	0.88	0.95	-0.07
Total	5.51	4.73	-

Table 41 summarises the strategy to use the different soil medias to ensure sufficient supply.

Table 41 Soil Volume Summary

Growth Media Class	Placement Media Summary		
	Sufficient Primary media	Sufficient Secondary Media	Comment
Topsoil (Primary LSC 3/BSAL)	✓	✓	Sufficient supply using soil resources suitable for LSC Class 3/BSAL instatement Surplus of 0.04 MCM
Topsoil (Primary LSC 4 and 5)	✓	✓	Sufficient supply using soil resources suitable for LSC Classes 4 & 5. Surplus of 0.04 MCM
Topsoil (Primary LSC 6 and 7)	✓	✓	Sufficient supply using soil resources suitable for LSC Classes 6 & 7. Surplus of 0.21 MCM
Subsoil (Secondary LSC 3 and 4)	✓	✓	Sufficient supply using soil resources suitable for LSC Class 3/BSAL instatement Surplus of 0.56 MCM
Subsoil (Secondary LSC 5, 6 and 7)	✓	✓	Sufficient supply using soil resources suitable for LSC Class 5, 6 and 7 <i>in conjunction</i> with surplus LSC Class 3 and 4 soil resources

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 107

9 CONCLUSION

This report has been prepared in accordance with contemporary Government requirements and in consultation with relevant government agencies.

The development of the Project is within an area that the NSW Strategic Regional Land Use Policy applies. According to the published regional SAL maps, a total of 1,610 ha of the Study Area is mapped as BSAL.

Extensive field survey and laboratory analyses have been undertaken to characterise and map the soil units and land capability of the Study Area and to verify the regional BSAL mapping to a local scale. Field surveys were conducted across the Study Area commencing in November 2011 and finishing in April 2013. Work was initiated in 2011 in response to the incoming NSW Liberal government adopting the proposed Strategic Regional Land Use Policy with the intent to identify the better classes of agricultural land, specifically Rural Land Capability Classes I, II and III land, to assist the mine planning design process. This phase of the fieldwork covered the period of 2011-2012 with surveys undertaken in November 2011, February 2012, May 2012 and August 2012 as land access became available.

Further survey works commenced in February 2013 post the release of the Draft Interim Protocol – 1st Release. This work built upon the 2011-2012 survey effort with the intent to ground-truth land proposed to be impacted by the Project for BSAL. This fieldwork phase was designed to collect information to satisfy the Director-General's Requirements (no referred to as SEARs) and therefore included a survey of the nil disturbance land. This second phase of the fieldwork was largely conducted in the first quarter of 2013 with surveys undertaken in February, March and mid-April 2013 as land access became available.

The overarching post-mining land use goals (rehabilitation goal) include:

- Where practical, return the land to its pre-mining land capability and land use;
- Limit impacts on BSAL and minimise the total quantity of BSAL foregone within the Project Boundary;
- Return land subject to temporary disturbance to pre-mining condition; and
- Return a similar quantity of good quality land, (including BSAL) for land directly and permanently impacted by mining related activities.

The key findings of this assessment are:

- This Soil, Land Capability and Strategic Agricultural Land Assessment has been prepared in accordance with the *Guidelines for Surveying Soil and Land Resources* (NCST, 2008), the contemporary Government requirements, particularly the Interim Protocol, as they have become available, and consultation with the DPI – OASFS and OEH in January 2013;
- The Study Area is 10,317 ha and covered by 40 different soil units. These cover seven ASC orders: Chromosols, Dermosols, Kandosols, Rudosols, Sodosols, Tenosols and Vertosols
- Almost half of the Project Boundary is suited to low - very low impact agricultural land uses (47.5%). Approximately a quarter (24.6%) is capable of moderate to moderate-low intensity land uses and is suited to grazing and restricted cultivation. Just over a quarter (27.9%) of the Project Boundary is Class 3, which describes land suitable for a range of agricultural uses, including high-impact land uses such as cropping with cultivation;
- Within the Project Boundary, 24.1% (1,675.9 ha) of the assessed land is considered to be BSAL and approximately 75.9% (5,281.8 ha) is considered not BSAL. Approximately half of the Study Area had unfavourable slope inclines; 10% contained unfavourable chemical limitations; and fertility and physical limitations largely composed the bulk of the remaining limitations;

Hansen Bailey Pty Limited
Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 108

- A total of 1,675.9 ha of land within the Project Boundary has been verified as BSAL, which differs from the broad scale Upper Hunter SRLUP mapping that indicated only 936 ha of BSAL within the Project Boundary. The distribution of the BSAL predominately occurs within the Bylong Soil Landscape Unit and the Bald Hill Soil Landscape Unit. The verified mapping differs to the regional mapping due to physical and chemical limitations largely associated with the Bylong Soil Landscape Unit and the mapping an inclusion of soil associated with the Bald Hill Soil Landscape Unit;
- The proposed Project has a disturbance footprint that covers approximately 2,874.7 ha. The footprint includes eight major project domains (1) Open Cut Mining Area, (2) OEA, (3) Mine Infrastructure Area, (4) Rail Loop, (5) Roads, (6) Water Storage Facilities, (7) Subsidence Study Area, and (8) Stockpile Area;
- The Subsidence Study Area has the largest footprint covering 1,714.3 ha of land and comprising 59.6% of the total Project disturbance footprint. It has been assessed as having low potential to adversely directly impact the soil resources. Other low risk disturbance activities include stockpile areas covering 11.1 ha (0.4%) of the Project disturbance footprint. Medium risk domains include the Mine Infrastructure Area, Internal Roads and the Haul Roads with a disturbance footprint covering 276.8 ha or 9.7% of the Project disturbance footprint. High risk domains include the Open Cut Mining Area, OEAs, Rail Loop and Water Storage Facilities. Collectively the high risk domains cover 872.5 ha or 30.3% of the Project disturbance footprint;
- The Project disturbance footprint includes 84.6% of non-BSAL and 15.4% (440.8 ha) of BSAL. The 440.8 ha of BSAL within the Project disturbance footprint represents 26.3% of the total verified BSAL within the Study Area (1,675.9 ha);
- Of the verified BSAL (440.8 ha), 206.3 ha (46.8%) is associated with the direct and permanent impacts; 171.8 ha (39.0%) with the indirect and temporary impact from the Subsidence Study Area and the remaining 62.7 ha with the direct and temporary impact activities;
- Overall, the majority of soil units were categorised as having a low to moderate or moderate soil erodibility ranking. These soils units commonly displayed negligible to slight dispersibility (EAT), with only low to moderate erodibility according to their K factor. Soils that displayed high erodibility rankings were usually associated with sodic subsoils of Sodosols and some Chromosols which resulted in high soil erodibility rankings; and

The estimated total volume of soil available from areas to be disturbed is approximately 5.51 MCM, in comparison to the 4.73 MCM required for rehabilitation. Overall there are adequate soil resources to reinstate soil depth for each LSC Class.

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Soil, Land Capability and Strategic Agricultural Land Assessment
Bylong Coal Project

Report Number 630.11072.00000
24 March 2015
Revision 1
Page 109

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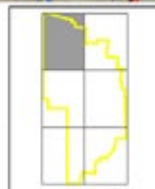
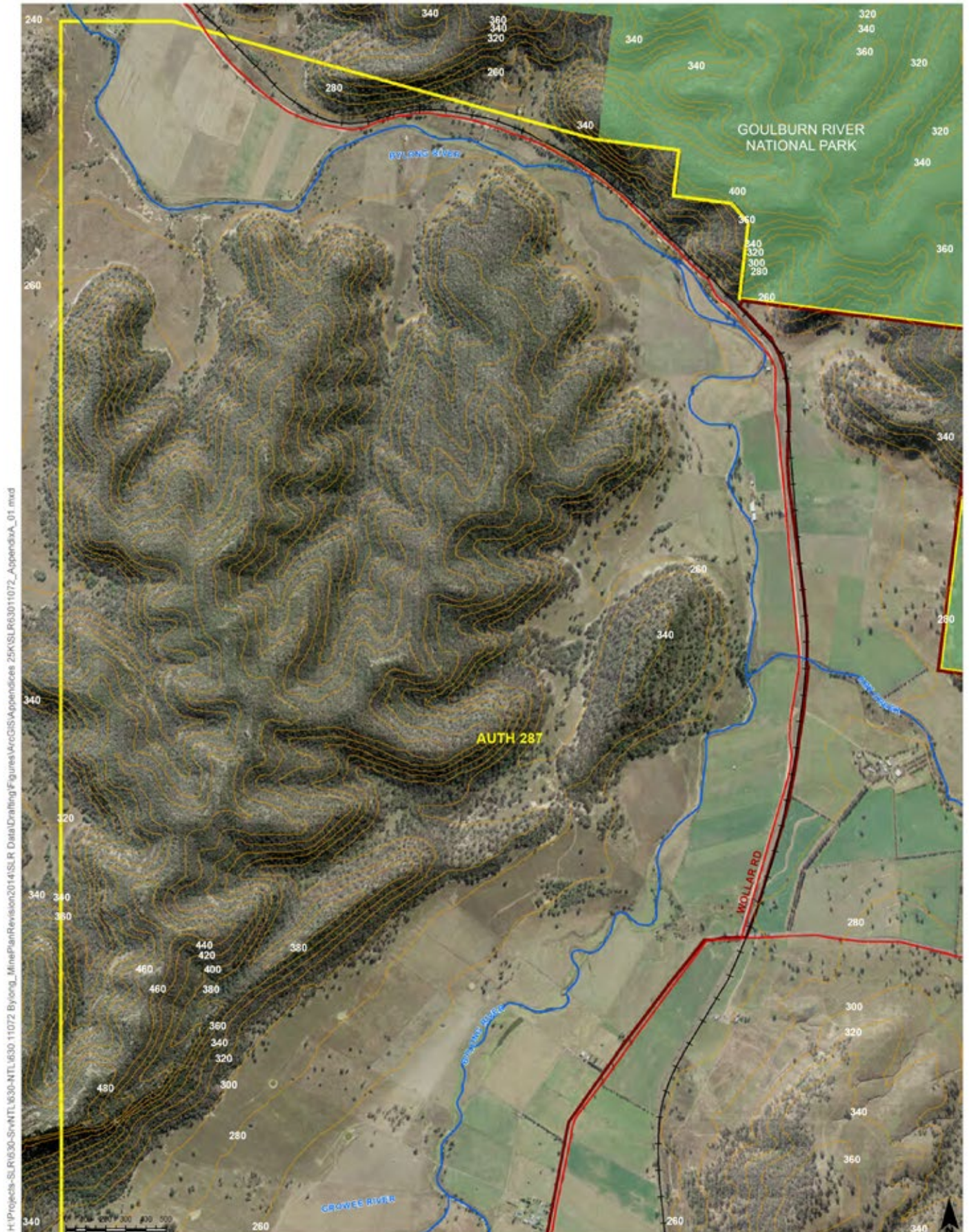
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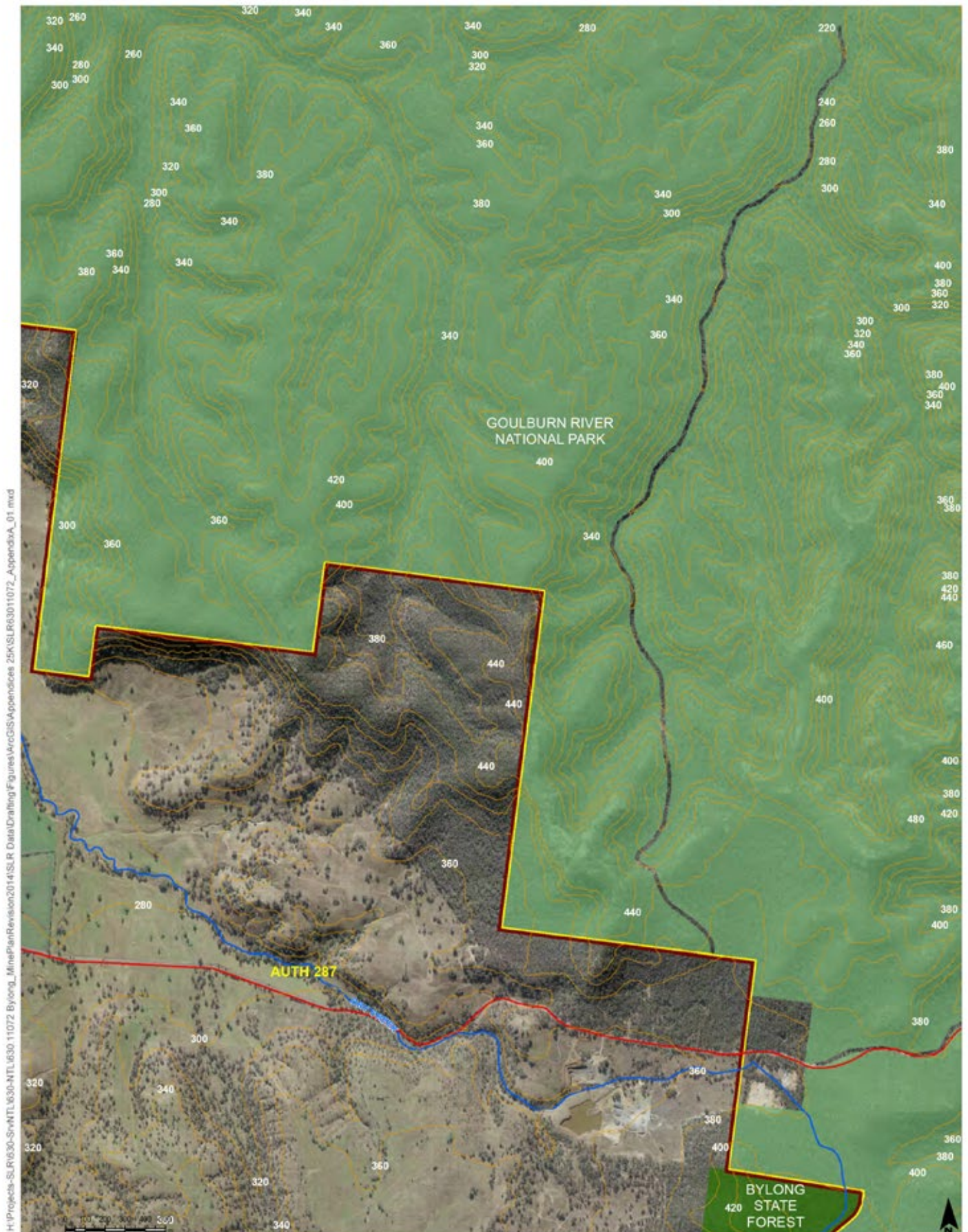


Appendix A

Report Number 630.11072.00000

Topographic Base Maps 1:25,000 Scale



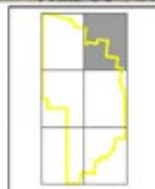


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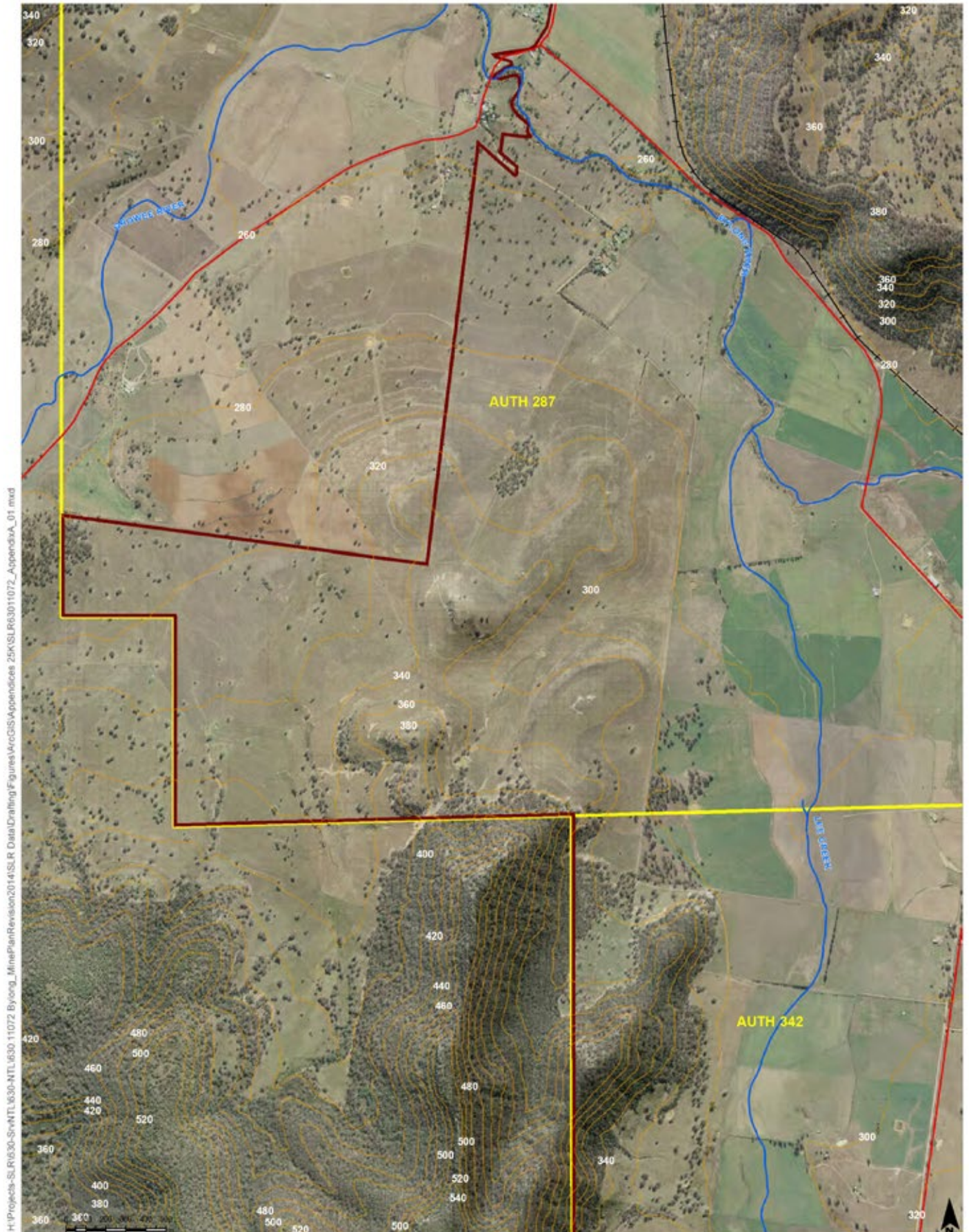
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Contours (20m)
NSW NPWS Reserves
NSW State Forests
Project Boundary
Coal Authorizations

Hansen Bailey

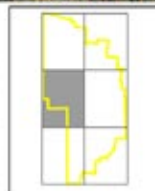
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Topography & Hydrology

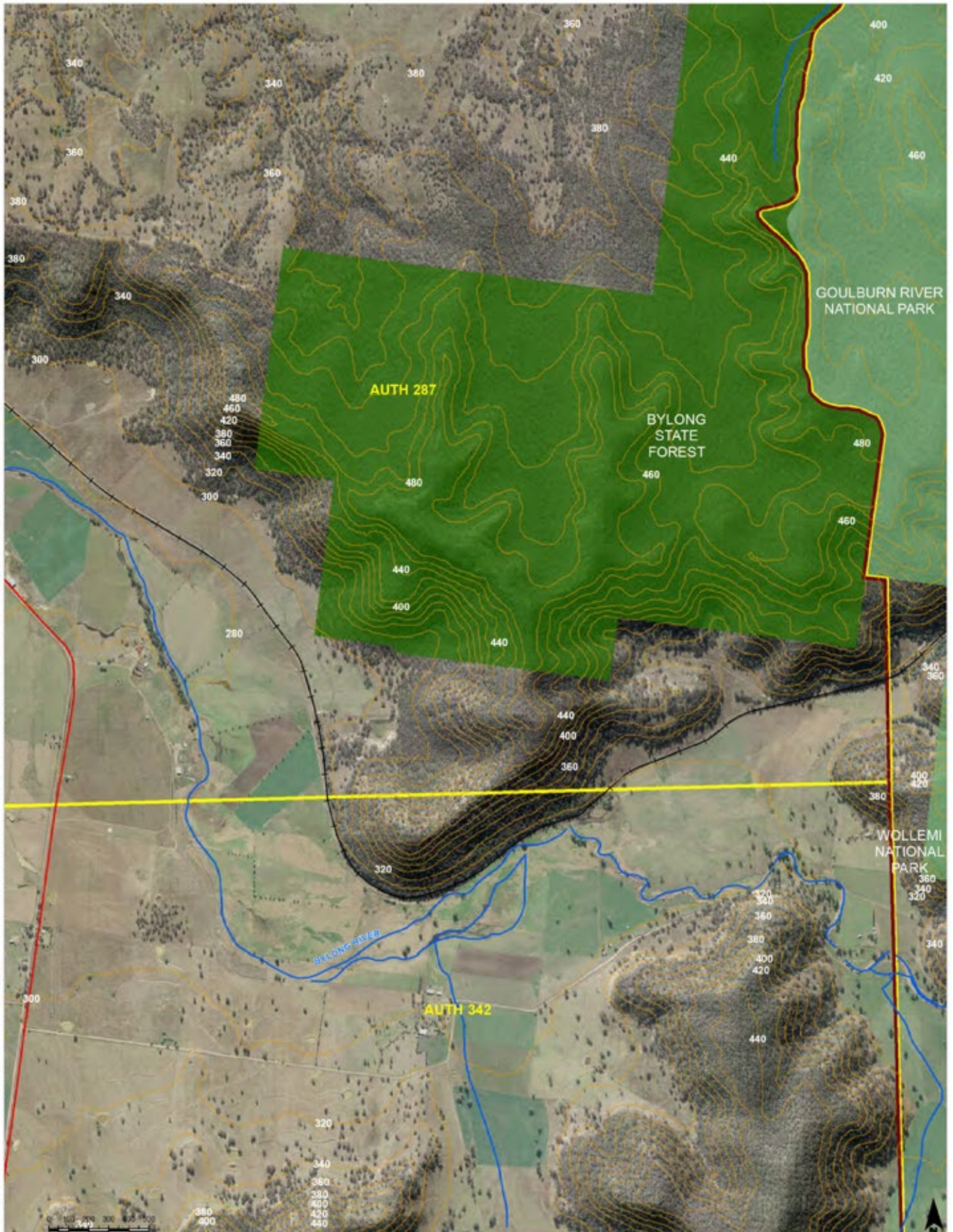
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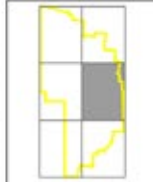
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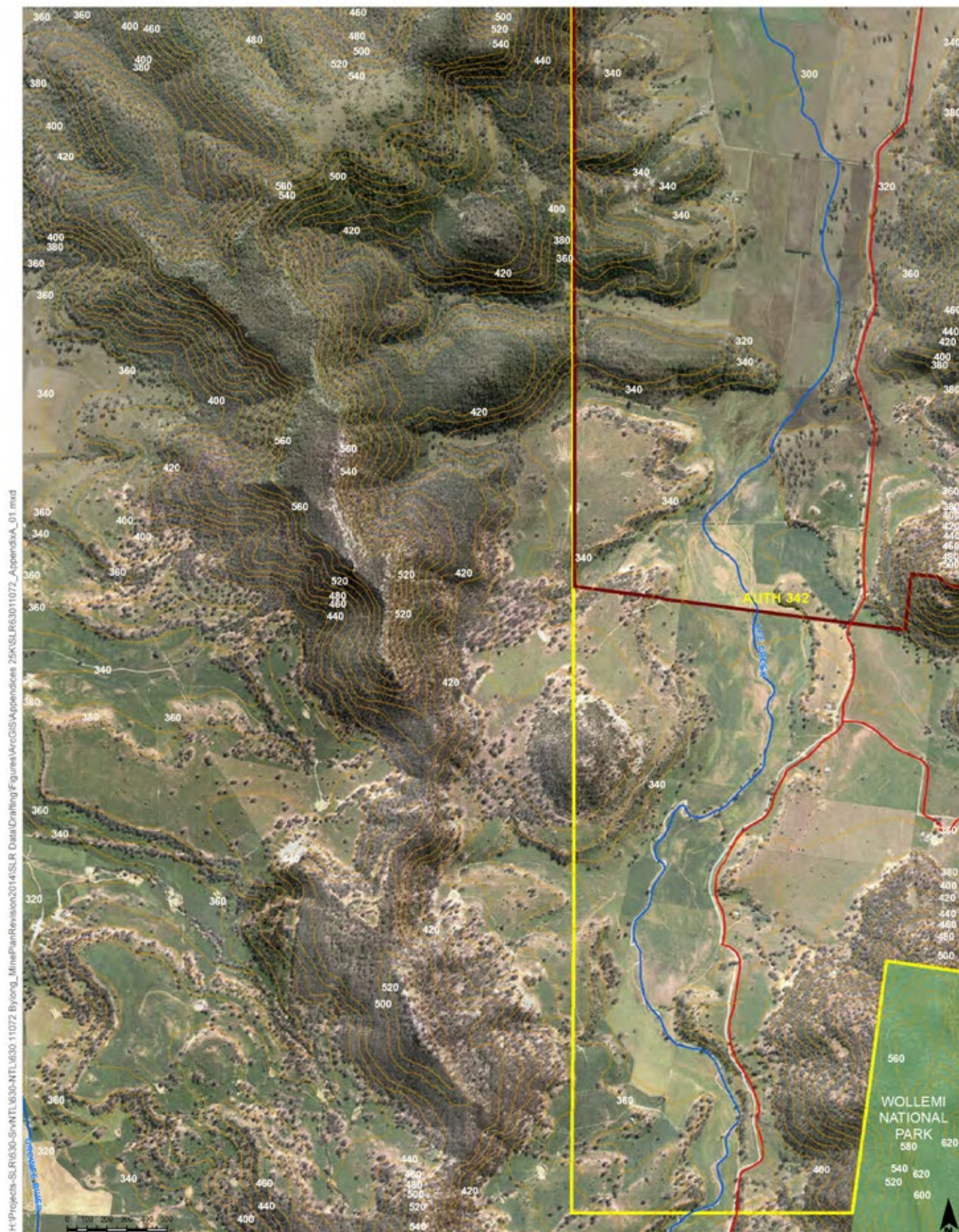
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Contours (20m)
NSW NPWS Reserves
NSW State Forests
Project Boundary
Coal Authorizations

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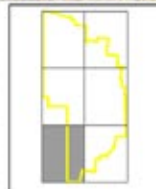
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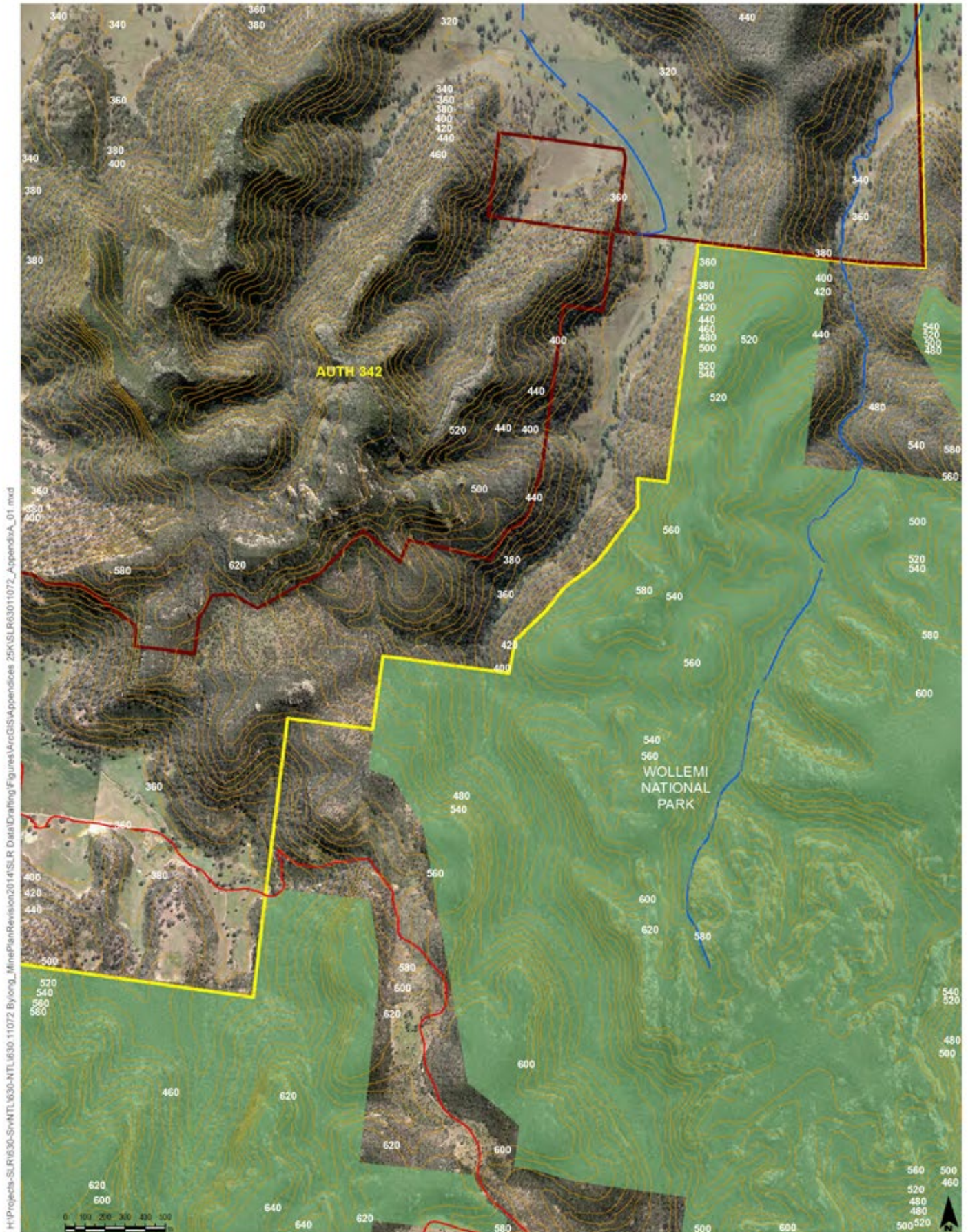
Topography & Hydrology

FIGURE A1.4



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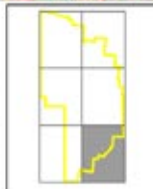
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LEGEND

- Contours (20m)
- NSW NPWS Reserves
- NSW State Forests
- Project Boundary
- Coal Authorizations

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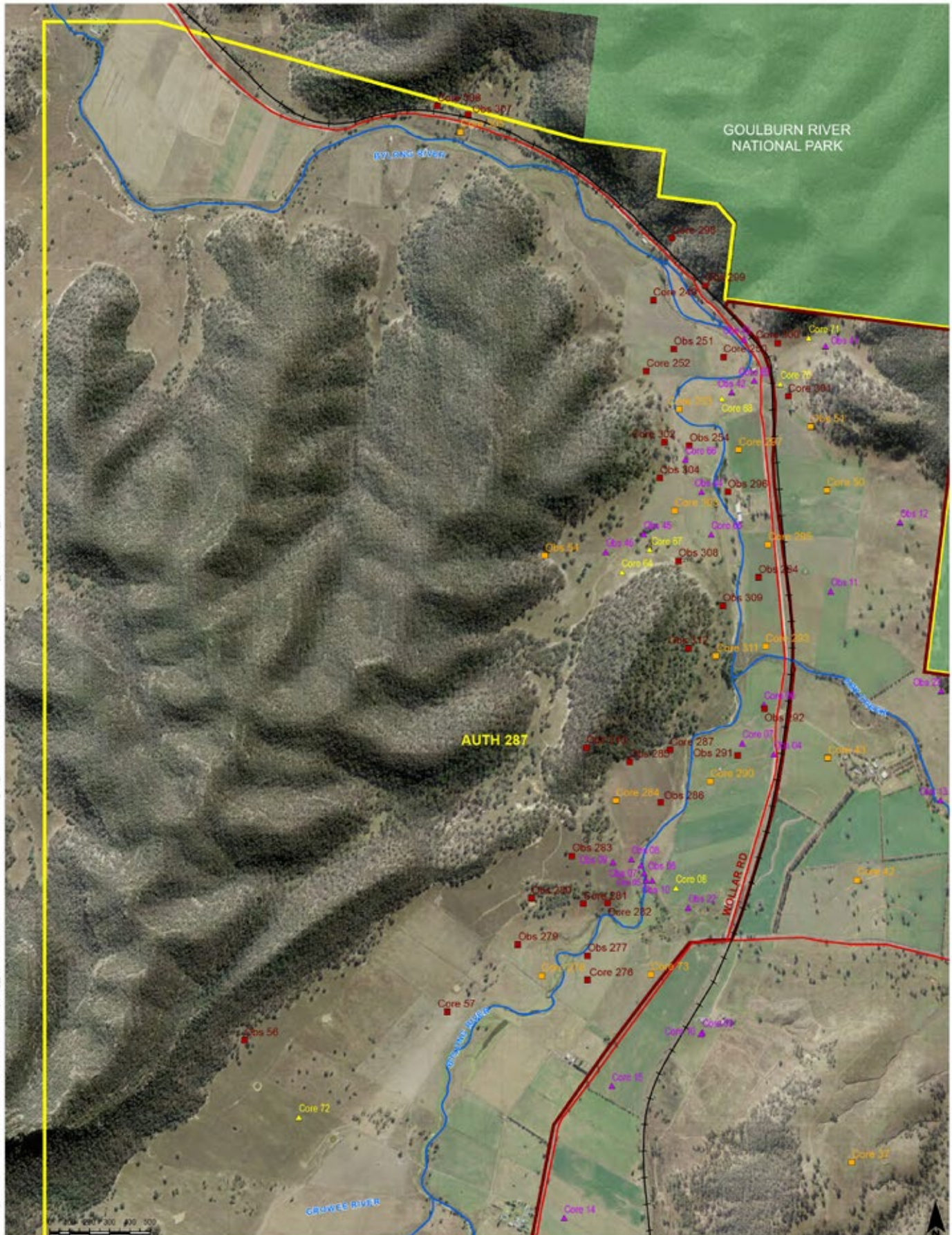
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FIGURE A1.6



Field Survey Observation Maps 1:25.000 Scale

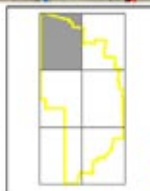
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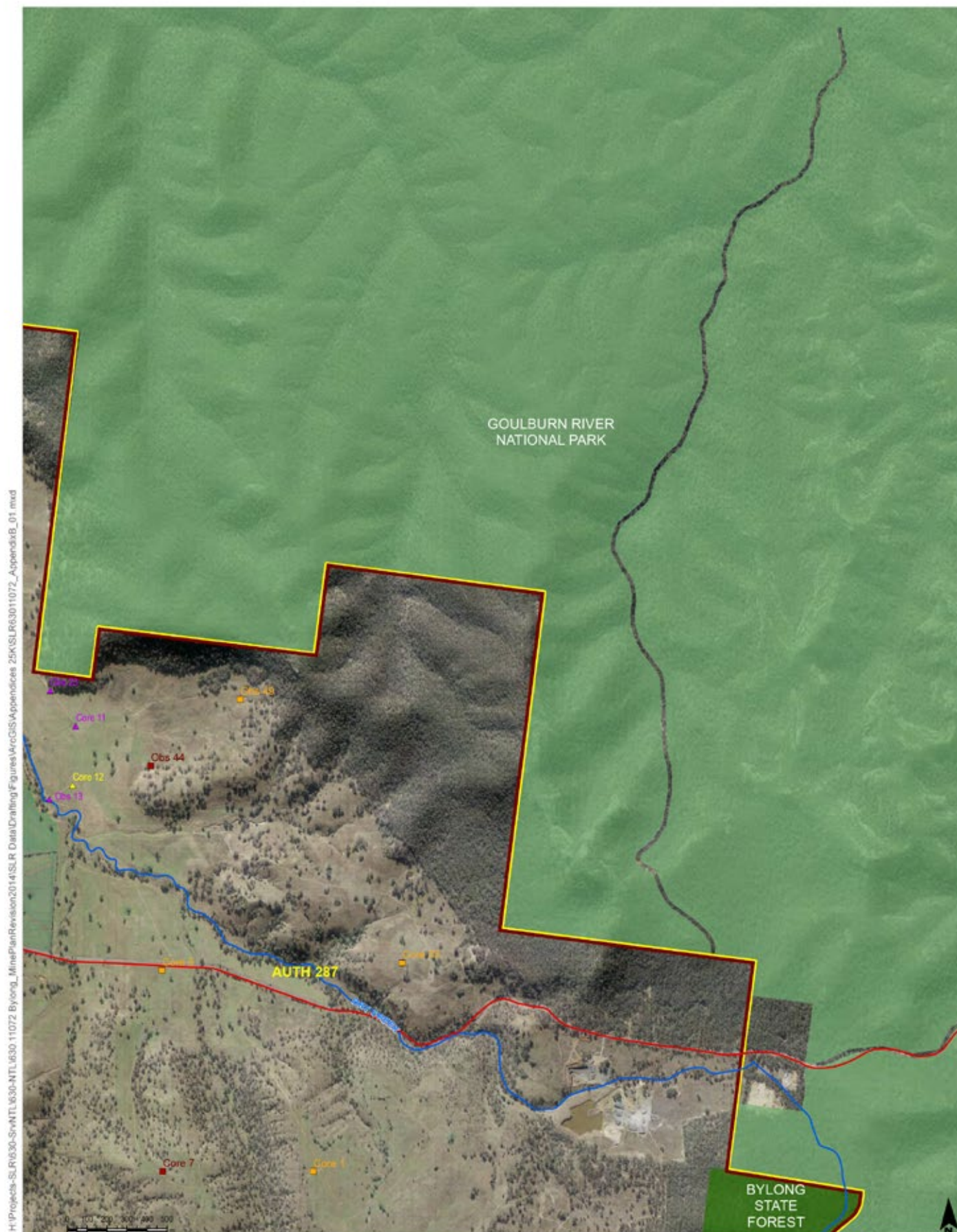
- LEGEND**
- 2013 Lab Analysed
 - 2013 Field Observation
 - ▲ 2011/2012 Lab Analysed
 - ▲ 2011/2012 Field Observation
 - Project Boundary
 - Study Area

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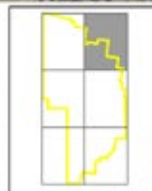
Soil, Land Capability and Strategic
Agricultural Land Assessment

Field Survey Observations

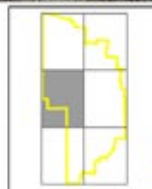
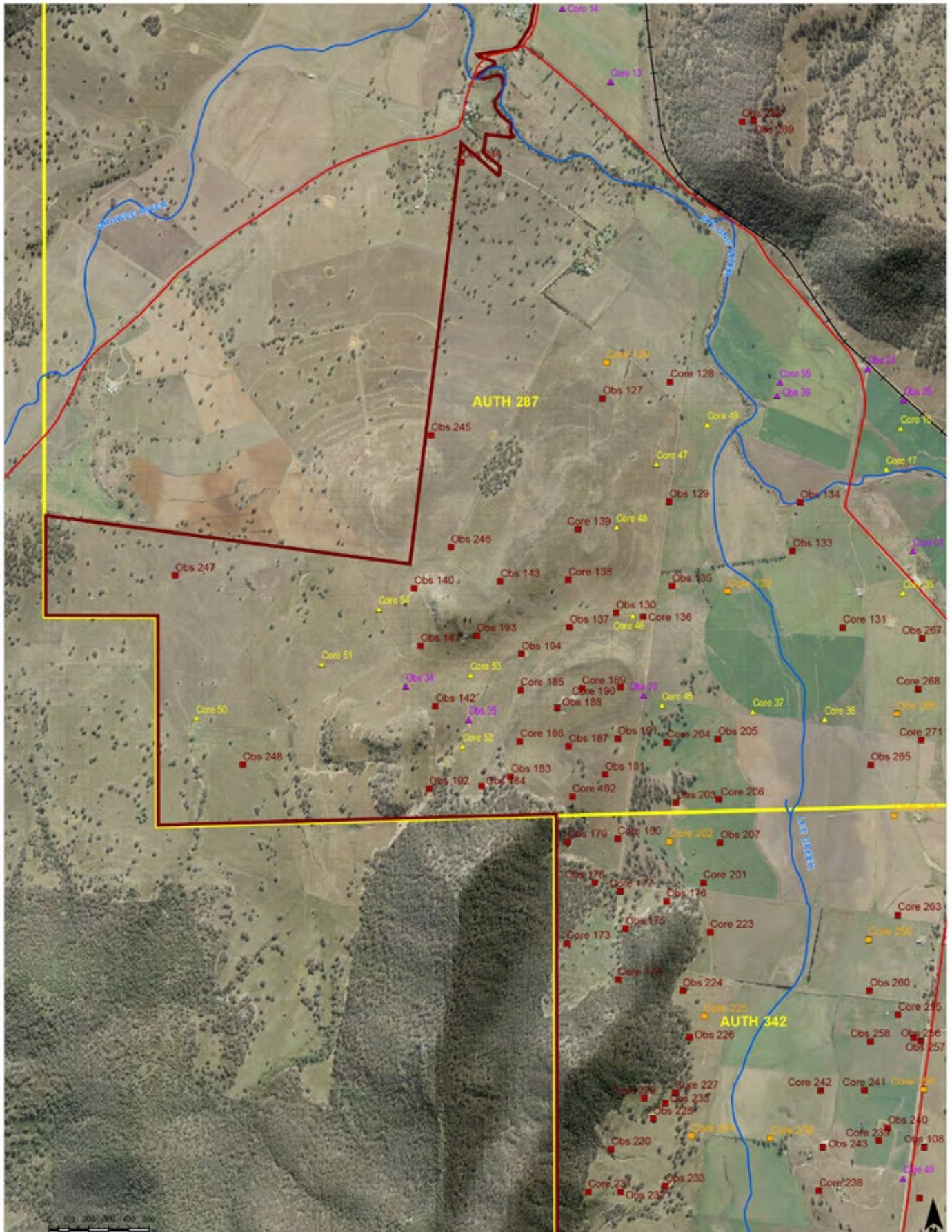
FIGURE B 2.1

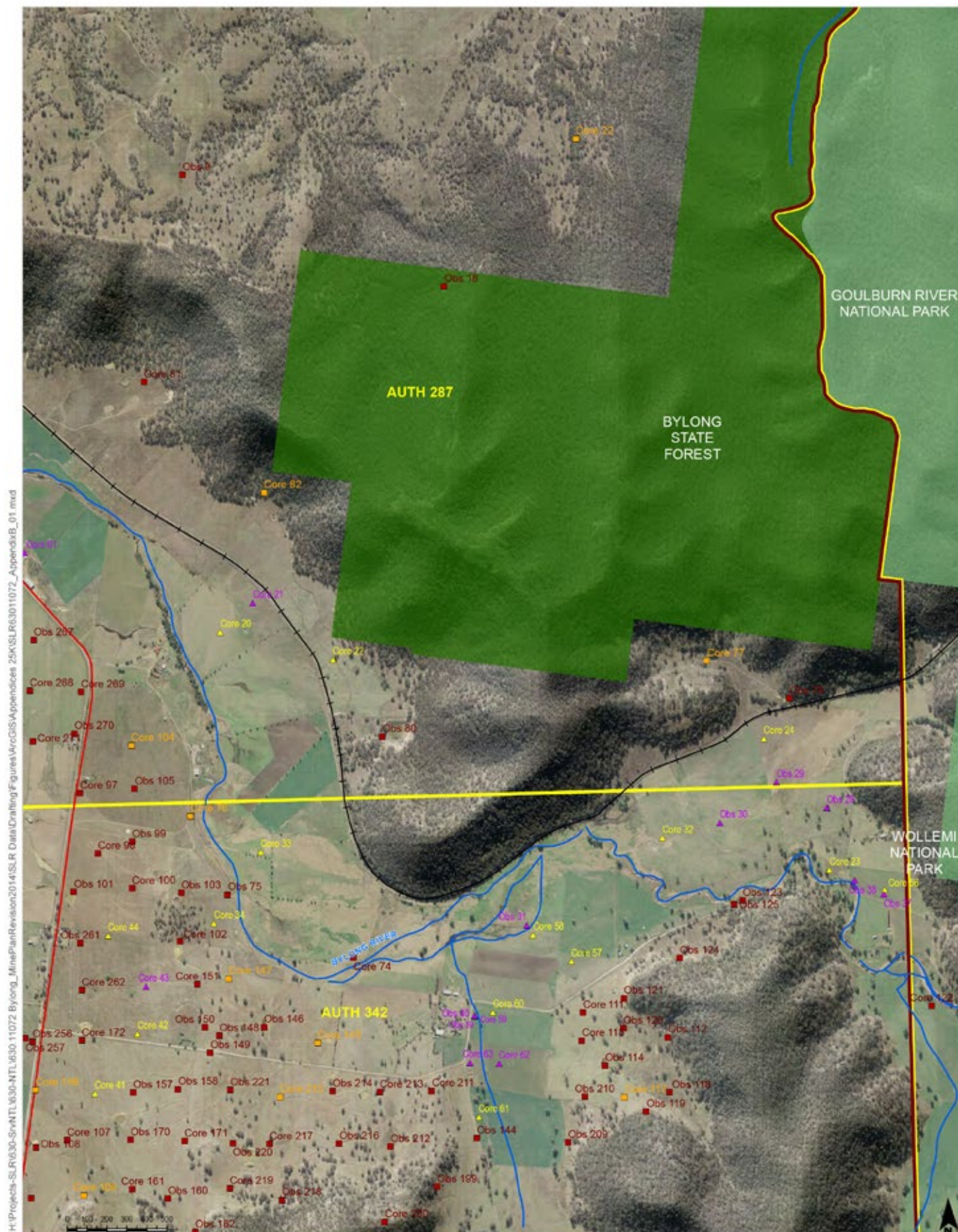


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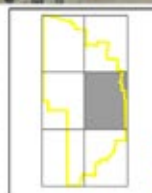


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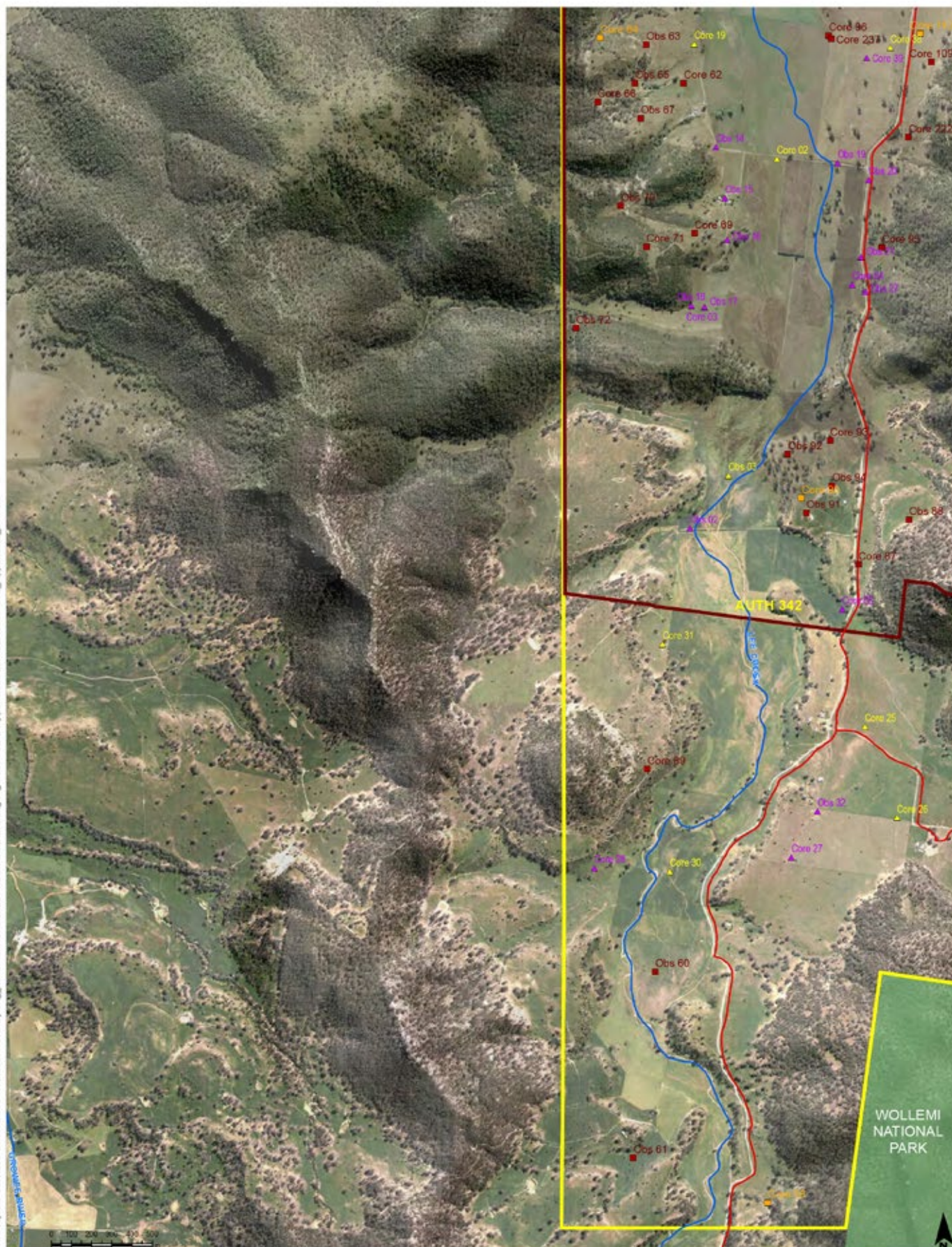




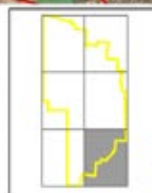
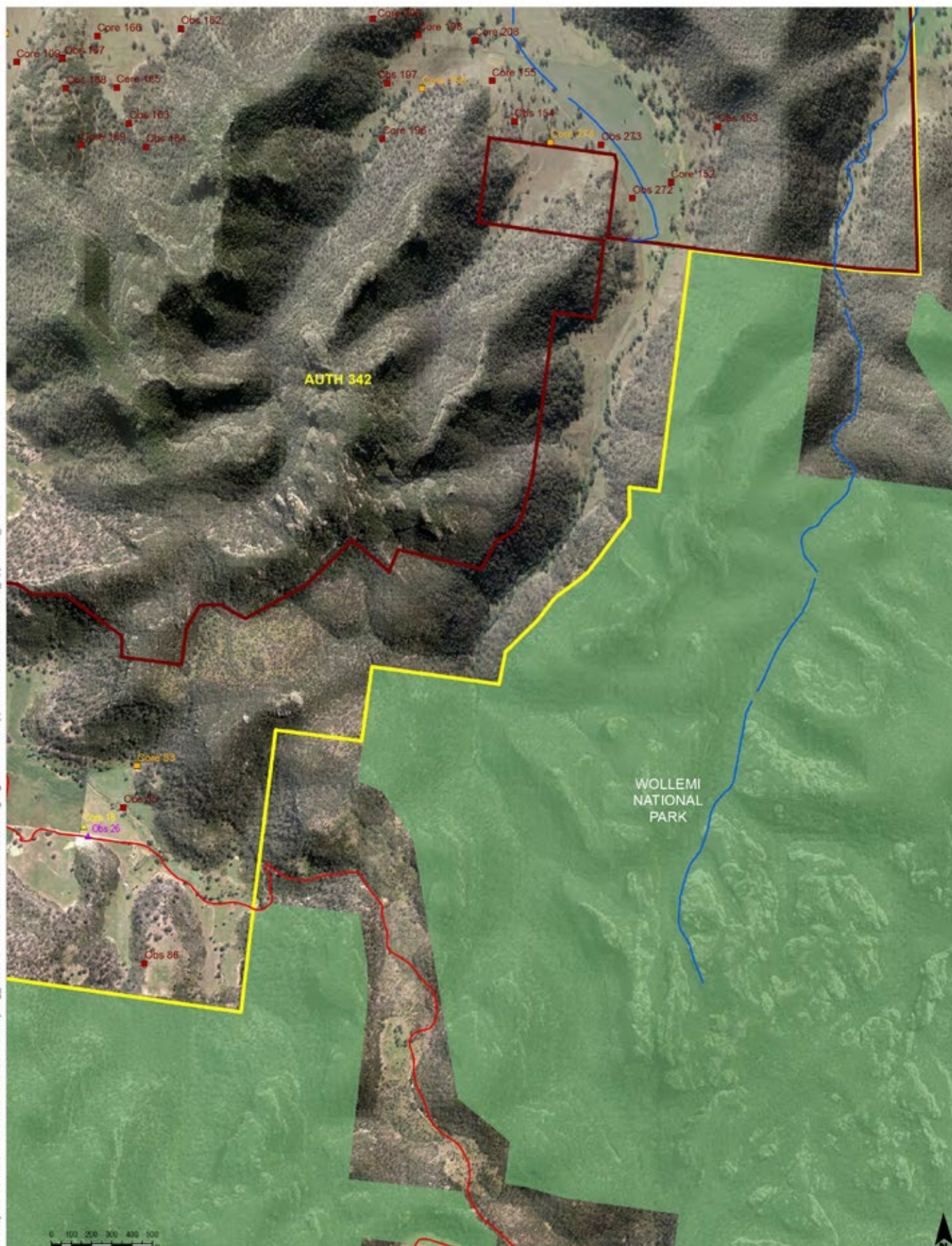
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Appendix C
Report Number 630.11072.00000

Soil Laboratory Results: Certificates of Analysis

Table A1: 2011-12 Sample Name Correlation Table

Laboratory Sample Name	Report Sample Name	Analysed In the Lab
Obs 1	Core 1	N
Core 2	Core 02	Y
Core 3	Core 03	N
Core 4	Core 04	N
Core 5	Core 05	N
Core 6	Core 06	N
Core 7	Core 07	N
Core 8	Core 08	Y
Core 9	Core 09	N
Core 10	Core 10	N
Core 11	Core 11	N
Core 12	Core 12	Y
Core 13	Core 13	N
Core 14	Core 14	N
Core 15	Core 15	N
Core 16	Core 16	Y
Core 17	Core 17	Y
Feb Core 1	Core 18	Y
Feb Core 1	Core 19	Y
Feb Core 1	Core 20	Y
Feb Core 1	Core 21	N
Feb Core 1	Core 22	Y
Feb Core 1	Core 23	Y
Feb Core 1	Core 24	Y
Core 82	Core 25	Y
Core 77	Core 26	Y
Core 76	Core 27	N
Core 79	Core 28	N
Core 80	Core 29	Y
Core 81	Core 30	Y
Core 83	Core 31	Y
Core 61	Core 32	Y
Core 52	Core 33	Y
Core 51	Core 34	Y
Core 73	Core 35	Y
Core 72	Core 36	Y
Core 71	Core 37	Y
Core 45	Core 38	Y
Core 44	Core 39	N
Core 46	Core 40	N
Core 47	Core 41	Y
Core 48	Core 42	Y
Core 49	Core 43	N
Core 50	Core 44	Y
Core 70	Core 45	Y
Core 57	Core 46	Y
Core 36	Core 47	Y
Core 35	Core 48	Y
Core 37	Core 49	Y

Laboratory Sample Name	Report Sample Name	Analysed In the Lab
Core 23	Core 50	Y
Core 24	Core 51	Y
Core 59	Core 52	Y
Core 58	Core 53	Y
Core 25	Core 54	Y
Core 40	Core 55	N
Core 64	Core 56	Y
Core 74	Core 57	Y
Core 75	Core 58	Y
Core 68	Core 59	N
Core 67	Core 60	Y
Core 65	Core 61	Y
Core 66	Core 62	N
Core 69	Core 63	N
Core 7	Core 64	Y
Core 6	Core 65	N
Core 5	Core 66	N
Core 8	Core 67	Y
Core 4	Core 68	Y
Core 3	Core 69	N
Core 1	Core 70	Y
Core 2	Core 71	Y
Core 9	Core 72	Y
Obs 2	Obs 02	-



Soil Conservation Service

SOIL TEST REPORT

Page 1 of 5

Scone Research Centre

REPORT NO: SCO11/403R1

REPORT TO: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

REPORT ON: Seventeen soil samples

PRELIMINARY RESULTS

ISSUED: Not issued

REPORT STATUS: Final

DATE REPORTED: 22 December 2011

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

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

A handwritten signature in cursive script, appearing to read "SR Young".

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO11/403R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
1	Obs 2 0-10	18	22	32	28	0	8	10YR4/3	10YR2/1
2	Obs 2 10-30	17	16	33	33	1	3(1)	10YR4/3	10YR2/1
3	Obs 2 30-50	5	0	24	68	3	3(1)	10YR5/3	10YR4/2
4	Core 2 0-10	24	21	30	25	<1	3(1)	10YR4/2	10YR2/2
5	Core 2 20-60	19	12	23	41	5	3(1)	10YR4/2	10YR2/1
6	Core 2 60-80	21	20	24	35	0	3(1)	10YR4/2	10YR2/1
7	Core 2 80-110	12	5	42	40	1	3(1)	10YR5/3	10YR4/2
8	Core 2 110-130	17	12	46	22	3	3(1)	10YR5/2	10YR2/1
9	Core 12 0-20	22	29	32	16	1	3(1)	7.5YR5/3	7.5YR3/2
10	Core 12 40-50	32	12	29	24	3	3(1)	7.5YR5/3	7.5YR3/2



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 3 of 5

Report No: SCO11/403R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

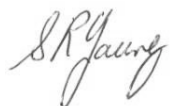
Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
11	Core 16 30-50	45	12	25	15	3	2(3)	7.5YR6/4	7.5YR4/4
12	Core 8 0-20	14	15	43	28	0	3(1)	10YR4/2	10YR2/2
13	Core 8 30-60	19	11	38	32	0	3(1)	10YR4/2	10YR3/2
14	Core 8 80-90	45	29	21	5	0	3(2)	10YR4/2	10YR2/2
15	Core 17 0-20	19	17	37	26	1	3(1)	10YR4/2	10YR2/2
16	Core 17 20-40	14	10	41	34	1	3(1)	10YR4/2	10YR2/2
17	Core 17 70-80	9	4	17	60	10	3(1)	10YR4/2	10YR2/2

SR Young

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Scone Research Service Centre

Report No: SCO11/403R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/3 CEC & exchangeable cations (me/100g)					
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al
1	Obs 2 0-10	0.24	7.4	6.7	40.1	0.8	1.6	20.9	11.4	nt
2	Obs 2 10-30	0.12	6.7	6.2	31.6	0.7	0.9	18.8	8.5	nt
3	Obs 2 30-50	0.02	7.1	6.2	5.2	0.3	0.1	2.7	1.3	nt
4	Core 2 0-10	0.16	6.0	5.4	23.4	0.4	2.8	14.1	3.3	<0.1
5	Core 2 20-60	0.05	6.7	5.5	20.5	0.3	1.5	13.0	3.0	<0.1
6	Core 2 60-80	0.04	8.0	6.6	21.2	0.5	0.3	13.5	5.1	nt
7	Core 2 80-110	0.03	8.3	6.9	11.2	0.5	0.2	5.9	3.1	nt
8	Core 2 110-130	0.11	8.2	7.0	17.7	0.8	0.2	9.3	5.0	nt
9	Core 12 0-20	0.08	6.4	5.8	19.4	0.2	1.6	11.9	3.6	<0.1
10	Core 12 40-50	<0.01	7.7	6.2	21.0	0.3	1.0	11.4	5.5	nt



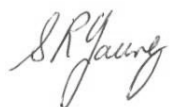
SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 5 of 5

Report No: SCO11/403R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/3 CEC & exchangeable cations (me/100g)					
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al
11	Core 16 30-50	0.65	9.4	8.3	25.2	6.8	0.7	4.9	11.8	nt
12	Core 8 0-20	0.10	7.4	7.0	18.5	0.3	0.9	10.1	5.6	nt
13	Core 8 30-60	0.04	8.5	7.7	14.7	0.4	0.3	7.4	5.3	nt
14	Core 8 80-90	0.47	8.1	7.1	37.0	3.3	0.8	17.6	13.5	nt
15	Core 17 0-20	0.10	7.1	6.4	23.9	0.3	2.8	12.7	5.3	nt
16	Core 17 20-40	0.04	8.2	6.8	16.7	0.4	0.9	9.3	4.7	nt
17	Core 17 70-80	0.02	8.4	6.8	9.3	0.4	0.3	4.3	2.9	nt

nt = not tested



END OF TEST REPORT

CERTIFICATE OF ANALYSIS

Work Order	: EB1223946	Page	: 1 of 22
Amendment	: 1		
Client	: GSS ENVIRONMENTAL	Laboratory	: Environmental Division Brisbane
Contact	: MS ADELE CALANDRA	Contact	: Customer Services
Address	: LEVEL 1, 241 DENISON ST BROADMEADOW NSW, AUSTRALIA 2292	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: Calandra@gssenvironmental.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 02 4920 3062	Telephone	: +61 7 3243 7222
Facsimile	: +61 02 4961 3360	Facsimile	: +61 7 3243 7218
Project	: CKC00-003	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 07-SEP-2012
Sampler	: Adele Calandra	Issue Date	: 26-SEP-2012
Site	: ----		
Quote number	: BN/355/12	No. of samples received	: 98
		No. of samples analysed	: 98

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



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

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
Andrew Epps	Metals Production Chemist	Brisbane Inorganics
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Stafford Minerals - AY
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics



Page : 2 of 22
Work Order : EB1223946 Amendment 1
Client : GSS ENVIRONMENTAL
Project : CKC00-003

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

- Subcontracted analysis reported in this work order is conducted by Soil Conservation Service. Soil Conservation Service does not hold NATA Accreditation for these parameters.
- This report has been amended and re-released to allow the reporting of additional analytical data. Additional data includes pH (EA002) & Conductivity (EA010) on EB1223946-001.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				Bylong 73 0-10	Bylong 73 25-35	Bylong 73 55-65	Bylong 73 90-100	Bylong 72 0-10
				[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit	EB1223946-001	EB1223946-002	EB1223946-003	EB1223946-004	EB1223946-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.7	6.3	6.8	8.6	5.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	44	34	44	104	53
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	1.6	2.3	----	----	9.7
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.5	1.0	3.4	2.5	13.9
Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.4	5.4	6.6	5.0
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	1.3	0.7	0.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.2	0.3	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.2	1.6	10.2	10.2	19.4
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.06	----	----	----	0.37
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	----	22.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	820	----	----	----	2870
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	820	----	----	----	2890
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	211	----	----	----	640



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 72 25-35	Bylong 72 55-65	Bylong 71 0-10	Bylong 71 25-35	Bylong 71 55-65
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-006	EB1223946-007	EB1223946-008	EB1223946-009	EB1223946-010
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		5.9	7.7	6.0	6.3	7.4
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		29	64	37	23	60
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	----	2.8	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		9.2	12.1	2.0	1.6	3.1
Exchangeable Magnesium	----	0.1	meq/100g		4.1	9.6	0.7	1.0	4.9
Exchangeable Potassium	----	0.1	meq/100g		0.2	0.2	0.6	0.4	0.6
Exchangeable Sodium	----	0.1	meq/100g		<0.1	0.2	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		13.6	22.1	3.3	3.1	8.7
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	----	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	----	9.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	790	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	----	800	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	----	270	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 71 90-100	Bylong 45 0-10	Bylong 45 20-30	Bylong 45 55-65	Bylong 45 90-100
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-011	EB1223946-012	EB1223946-013	EB1223946-014	EB1223946-015
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.0	5.6	6.2	7.2	7.1
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		156	67	14	33	42
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	5.3	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.9	2.9	1.9	5.2	4.2
Exchangeable Magnesium	----	0.1	meq/100g		6.0	0.7	0.5	3.8	4.4
Exchangeable Potassium	----	0.1	meq/100g		0.5	0.5	0.3	0.5	0.4
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		9.5	4.0	2.7	9.6	9.1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	0.07	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	26.4	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	1400	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	1430	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	277	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 47 0-10	Bylong 47 25-35	Bylong 47 60-70	Bylong 48 0-10	Bylong 48 25-35
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-016	EB1223946-017	EB1223946-018	EB1223946-019	EB1223946-020
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.2	7.9	8.8	5.8	6.8
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		43	28	72	25	53
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		1.6	----	----	9.1	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.1	4.7	3.1	2.9	4.5
Exchangeable Magnesium	----	0.1	meq/100g		1.3	9.1	5.9	0.7	5.7
Exchangeable Potassium	----	0.1	meq/100g		0.6	1.2	0.7	0.4	0.6
Exchangeable Sodium	----	0.1	meq/100g		<0.1	0.4	0.3	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g		5.0	15.4	10.0	4.0	11.1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	0.02	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		10.0	----	----	3.7	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1830	----	----	1040	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		1840	----	----	1040	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		292	----	----	243	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 48 55-65	Bylong 50 0-10	Bylong 50 25-35	Bylong 50 55-65	Bylong 50 90-100
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-021	EB1223946-022	EB1223946-023	EB1223946-024	EB1223946-025
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.7	5.6	6.4	7.2	7.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		29	36	16	40	39
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	6.1	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		13.9	3.7	2.7	5.4	5.7
Exchangeable Magnesium	----	0.1	meq/100g		8.1	0.8	0.9	3.6	4.1
Exchangeable Potassium	----	0.1	meq/100g		0.6	0.5	0.3	0.5	0.5
Exchangeable Sodium	----	0.1	meq/100g		0.2	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		22.9	5.1	3.9	9.5	10.4
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	17.7	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	1380	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	1400	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	243	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 70 0-10	Bylong 70 25-35	Bylong 70 90-100	Bylong 57 0-10	Bylong 57 30-40
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-026	EB1223946-027	EB1223946-028	EB1223946-029	EB1223946-030
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		5.9	8.0	8.9	8.1	8.2
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		54	51	324	105	155
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		9.2	----	----	12.6	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		4.8	3.2	6.4	23.4	34.6
Exchangeable Magnesium	----	0.1	meq/100g		2.2	5.5	10.8	4.1	9.1
Exchangeable Potassium	----	0.1	meq/100g		0.9	0.3	0.5	0.9	0.5
Exchangeable Sodium	----	0.1	meq/100g		<0.1	0.5	0.7	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		7.8	9.5	18.4	28.4	44.3
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.02	----	----	0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		16.1	----	----	6.6	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1320	----	----	1800	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		1340	----	----	1810	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		341	----	----	503	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 57 90-100	Bylong 36 0-10	Bylong 36 50-60	Bylong 35 0-10	Bylong 35 20-30
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-031	EB1223946-032	EB1223946-033	EB1223946-034	EB1223946-035
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.4	7.4	8.4	6.9	7.3
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		153	67	125	42	27
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	12.4	----	9.9	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		32.2	11.1	25.9	14.0	16.2
Exchangeable Magnesium	----	0.1	meq/100g		8.4	3.2	5.0	4.0	4.5
Exchangeable Potassium	----	0.1	meq/100g		0.4	1.4	0.6	0.9	0.5
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		41.1	15.7	31.6	18.9	21.2
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	<0.01	----	0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	8.6	----	5.5	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	1350	----	2190	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	1360	----	2200	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	300	----	407	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 37 0-10	Bylong 37 25-35	Bylong 37 55-65	Bylong 23 0-10	Bylong 23 55-65
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-036	EB1223946-037	EB1223946-038	EB1223946-039	EB1223946-040
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		5.4	7.8	8.6	7.0	8.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		48	46	92	46	92
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		4.4	----	----	9.3	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.0	5.3	4.8	7.9	15.2
Exchangeable Magnesium	----	0.1	meq/100g		0.8	8.0	10.5	1.2	1.9
Exchangeable Potassium	----	0.1	meq/100g		0.5	0.7	0.8	0.9	0.6
Exchangeable Sodium	----	0.1	meq/100g		<0.1	0.7	1.2	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		3.3	14.8	17.2	10.0	17.8
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		13.0	----	----	8.5	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		640	----	----	840	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		650	----	----	850	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		210	----	----	247	----





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 23 90-100	Bylong 24 0-10	Bylong 24 25-35	Bylong 24 55-65	Bylong 24 90-100
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-041	EB1223946-042	EB1223946-043	EB1223946-044	EB1223946-045
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.6	8.1	8.6	8.7	8.7
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		151	179	125	127	167
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	16.3	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		14.7	24.0	32.4	28.8	28.9
Exchangeable Magnesium	----	0.1	meq/100g		6.5	5.1	5.9	7.6	15.3
Exchangeable Potassium	----	0.1	meq/100g		0.6	1.9	0.7	0.4	0.4
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		21.8	31.1	39.1	36.8	44.7
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	10.7	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	2110	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	2120	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	528	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 59 0-10	Bylong 59 25-35	Bylong 59 55-65	Bylong 59 80-90	Bylong 58 0-10
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-046	EB1223946-047	EB1223946-048	EB1223946-049	EB1223946-050
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.1	6.8	7.2	7.6	5.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		77	13	14	21	63
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		8.1	----	----	----	7.7
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.8	3.7	4.8	5.0	5.1
Exchangeable Magnesium	----	0.1	meq/100g		1.1	1.0	2.4	2.4	1.4
Exchangeable Potassium	----	0.1	meq/100g		0.6	0.3	0.3	0.4	1.0
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		5.4	5.0	7.6	7.8	7.5
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	----	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		32.5	----	----	----	21.7
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1140	----	----	----	1210
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		1170	----	----	----	1230
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		230	----	----	----	507



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 58 25-35	Bylong 58 55-65	Bylong 58 80-90	Bylong 25 0-10	Bylong 25 25-35
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-051	EB1223946-052	EB1223946-053	EB1223946-054	EB1223946-055
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.0	6.7	6.5	6.0	8.0
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		17	29	34	62	53
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	----	----	6.4	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.1	5.9	4.9	4.5	7.2
Exchangeable Magnesium	----	0.1	meq/100g		1.2	3.9	3.6	1.8	7.4
Exchangeable Potassium	----	0.1	meq/100g		0.4	0.4	0.4	0.9	0.7
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g		4.7	10.4	8.9	7.2	15.4
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	----	----	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	----	----	11.5	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	----	1160	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	----	----	1170	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	----	----	271	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 25 50-60	Bylong 25 80-90	Bylong 64 0-10	Bylong 64 30-40	Bylong 64 80-90
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-056	EB1223946-057	EB1223946-058	EB1223946-059	EB1223946-060
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.4	8.5	5.8	7.7	7.4
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		321	497	124	21	32
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	----	4.2	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.6	6.2	2.6	12.4	9.5
Exchangeable Magnesium	----	0.1	meq/100g		3.5	9.1	0.4	2.7	3.2
Exchangeable Potassium	----	0.1	meq/100g		0.3	0.7	0.5	0.4	0.3
Exchangeable Sodium	----	0.1	meq/100g		0.2	0.2	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		6.6	16.3	3.5	15.6	13.1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	----	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	----	54.9	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	750	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	----	800	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	----	331	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 74 0-10	Bylong 74 25-35	Bylong 74 80-90	Bylong 75 0-10	Bylong 75 25-35
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-061	EB1223946-062	EB1223946-063	EB1223946-064	EB1223946-065
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.2	6.6	7.1	7.8	7.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		86	49	32	236	75
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		6.3	----	----	28.8	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		4.8	3.9	1.7	14.7	10.3
Exchangeable Magnesium	----	0.1	meq/100g		1.3	1.3	0.8	7.0	6.5
Exchangeable Potassium	----	0.1	meq/100g		0.5	0.4	<0.1	1.2	0.3
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	0.6	1.6
Cation Exchange Capacity	----	0.1	meq/100g		6.6	5.5	2.6	23.5	18.8
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	0.02	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		34.8	----	----	71.6	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1280	----	----	2460	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		1310	----	----	2530	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		393	----	----	455	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 75 60-70	Bylong 67 0-10	Bylong 67 20-30	Bylong 67 50-60	Bylong 67 90-100
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]	[16-MAY-2012]
Compound	CAS Number	LOR	Unit		EB1223946-066	EB1223946-067	EB1223946-068	EB1223946-069	EB1223946-070
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.4	5.9	6.9	7.2	8.3
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		27	167	22	21	103
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	14.2	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.8	20.2	19.1	13.6	6.7
Exchangeable Magnesium	----	0.1	meq/100g		1.5	5.6	5.9	4.1	1.9
Exchangeable Potassium	----	0.1	meq/100g		0.1	1.3	0.7	0.4	0.2
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		4.4	27.2	25.8	18.2	8.8
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	89.7	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	4180	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	4270	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	796	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 65 0-10	Bylong 65 25-35	Bylong 65 55-65	Bylong 13 0-10	Bylong 13 25-35
Client sampling date / time					[16-MAY-2012]	[16-MAY-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]
Compound	CAS Number	LOR	Unit		EB1223946-071	EB1223946-072	EB1223946-073	EB1223946-074	EB1223946-075
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.0	7.4	8.5	6.8	6.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		49	30	116	101	75
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		6.4	----	----	21.4	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		5.8	10.4	24.8	9.4	10.4
Exchangeable Magnesium	----	0.1	meq/100g		1.5	4.5	7.9	4.2	4.8
Exchangeable Potassium	----	0.1	meq/100g		0.9	1.0	0.9	1.0	0.8
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g		8.2	16.0	33.8	14.8	16.1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	----	----	0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		17.3	----	----	45.4	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1820	----	----	3020	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		1840	----	----	3060	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		419	----	----	389	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 13 55-65	Bylong 13 80-90	Bylong 14 0-10	Bylong 14 25-35	Bylong 14 50-60
Client sampling date / time					[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]
Compound	CAS Number	LOR	Unit		EB1223946-076	EB1223946-077	EB1223946-078	EB1223946-079	EB1223946-080
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.7	9.2	6.6	7.3	8.1
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		226	735	62	24	29
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	----	15.4	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		8.4	2.3	4.8	3.2	3.2
Exchangeable Magnesium	----	0.1	meq/100g		9.8	3.7	2.5	2.2	1.2
Exchangeable Potassium	----	0.1	meq/100g		0.8	0.4	0.6	0.3	0.3
Exchangeable Sodium	----	0.1	meq/100g		2.3	1.3	<0.1	<0.1	0.5
Cation Exchange Capacity	----	0.1	meq/100g		21.3	7.8	8.0	5.6	5.2
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	----	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	----	26.0	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	1620	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	----	1650	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	----	306	----	----





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 14 70-80	Bylong 11 0-25	Bylong 11 25-50	Bylong 10 0-10	Bylong 10 20-30
Client sampling date / time					[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]
Compound	CAS Number	LOR	Unit		EB1223946-081	EB1223946-082	EB1223946-083	EB1223946-084	EB1223946-085
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.2	8.0	8.7	6.7	7.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		33	492	181	49	36
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	25.4	----	17.2	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.7	16.8	4.8	11.1	12.9
Exchangeable Magnesium	----	0.1	meq/100g		1.8	8.7	2.4	3.9	8.3
Exchangeable Potassium	----	0.1	meq/100g		0.4	1.3	<0.1	2.2	1.4
Exchangeable Sodium	----	0.1	meq/100g		0.7	0.2	<0.1	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g		6.5	27.0	7.3	17.3	22.8
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	0.03	----	0.02	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	22.0	----	11.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	3200	----	3040	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	3220	----	3050	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	596	----	624	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 10 50-60	Bylong 10 80-90	Bylong 8 0-10	Bylong 8 25-35	Bylong 8 50-60
Client sampling date / time					[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]
Compound	CAS Number	LOR	Unit		EB1223946-086	EB1223946-087	EB1223946-088	EB1223946-089	EB1223946-090
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.9	8.9	6.2	8.5	9.1
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		222	553	85	226	668
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	----	12.9	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.6	7.6	6.7	10.4	10.5
Exchangeable Magnesium	----	0.1	meq/100g		4.3	8.6	2.7	5.9	7.3
Exchangeable Potassium	----	0.1	meq/100g		0.2	0.2	1.2	0.8	0.4
Exchangeable Sodium	----	0.1	meq/100g		0.5	0.8	0.1	1.7	3.1
Cation Exchange Capacity	----	0.1	meq/100g		7.5	17.2	10.7	18.8	21.3
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	----	0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	----	28.0	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	----	2240	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		----	----	2270	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	----	394	----	----





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 8 70-80	Bylong 7 0-10	Bylong 7 25-35	Bylong 7 55-65	Bylong 7 80-90
Client sampling date / time					[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]
Compound	CAS Number	LOR	Unit		EB1223946-091	EB1223946-092	EB1223946-093	EB1223946-094	EB1223946-095
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		9.1	6.4	8.4	9.2	9.4
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		745	47	182	914	850
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		----	10.3	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		9.2	4.2	6.2	23.5	27.9
Exchangeable Magnesium	----	0.1	meq/100g		7.0	3.1	12.6	12.7	11.4
Exchangeable Potassium	----	0.1	meq/100g		0.4	0.6	0.4	0.3	0.3
Exchangeable Sodium	----	0.1	meq/100g		3.3	<0.1	2.8	1.9	1.9
Cation Exchange Capacity	----	0.1	meq/100g		19.8	7.9	22.0	38.4	41.5
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		----	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		----	12.3	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		----	1750	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		----	1760	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		----	262	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Bylong 34 0-10	Bylong 34 25-35	Bylong 34 55-65	----	----
Client sampling date / time					[14-AUG-2012]	[14-AUG-2012]	[14-AUG-2012]	----	----
Compound	CAS Number	LOR	Unit		EB1223946-096	EB1223946-097	EB1223946-098	----	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.2	8.0	8.5	----	----
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		51	106	94	----	----
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		4.9	----	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		5.9	8.9	7.0	----	----
Exchangeable Magnesium	----	0.1	meq/100g		1.7	3.6	5.7	----	----
Exchangeable Potassium	----	0.1	meq/100g		0.9	1.1	0.6	----	----
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g		8.6	13.6	13.4	----	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		16.5	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		3150	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
Total Nitrogen as N	----	20	mg/kg		3170	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		330	----	----	----	----



SOIL TEST REPORT

Page 1 of 11

Scone Research Centre

REPORT NO: SCO12/232R2

REPORT TO: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

REPORT ON: Fifty five soil samples
Ref: CKC00-003

PRELIMINARY RESULTS
ISSUED: Not issued

REPORT STATUS: Final

DATE REPORTED: 12 October 2012

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

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

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

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Centre

Page 2 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al	OC (%)
1	Feb Core 1 0-10	0.24	6.3	5.8	11.1	0.1	1.2	7.7	1.9	0.4	1.79
2	Feb Core 1 20-30	0.03	6.8	5.7	12.3	0.2	0.9	7.0	3.7	0.1	0.47
3	Feb Core 1 50-60	0.02	6.6	5.5	17.4	0.2	0.8	9.4	6.2	0.3	0.42
4	Feb Core 2 0-10	0.61	5.8	5.5	18.9	0.3	1.2	15.4	3.4	0.4	5.49
5	Feb Core 2 10-20	0.05	6.6	5.6	4.6	0.1	1.1	3.3	1.0	0.3	0.40
6	Feb Core 2 30-40	0.06	6.6	5.7	4.9	0.1	1.1	3.6	0.9	0.2	0.27
7	Feb Core 3 0-10	0.42	6.6	6.2	40.4	0.9	2.8	19.6	13.0	0.1	6.98
8	Feb Core 3 20-30	0.11	7.6	6.6	38.5	1.5	1.0	17.5	14.3	nt	3.62
9	Feb Core 3 50-60	0.23	8.8	7.9	29.0	2.6	0.5	14.9	13.0	nt	1.42
10	Feb Core 3 80-90	0.12	8.8	7.8	22.1	1.4	0.5	10.0	10.3	nt	nt



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 3 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al	OC (%)
11	Feb Core 5 0-10	0.35	5.2	4.9	11.5	0.3	1.4	5.1	2.5	0.8	2.09
12	Feb Core 5 20-30	0.07	7.3	6.1	15.4	1.1	1.1	5.2	7.4	0.7	0.33
13	Feb Core 5 40-50	0.14	8.2	7.0	16.6	2.1	1.0	4.3	8.6	nt	0.17
14	Feb Core 5 70-80	0.59	8.5	7.6	21.9	3.3	1.1	4.1	11.1	nt	nt
15	Feb Core 6 0-10	0.30	5.9	5.5	25.7	0.7	1.5	14.9	7.5	0.3	5.30
16	Feb Core 6 20-30	0.03	7.1	6.2	20.5	0.2	0.4	12.1	6.4	0.3	3.00
17	Feb Core 6 30-40	0.01	7.7	6.7	12.6	0.2	0.3	6.3	5.1	nt	1.41
18	Feb Core 6 60-70	0.01	8.1	7.0	12.8	0.3	0.3	5.1	6.4	nt	nt
19	Feb Core 6 90	0.02	8.1	7.1	12.7	0.3	0.3	5.0	6.0	nt	nt
20	Feb Core 7 0-10	0.23	6.1	5.5	15.9	0.2	1.9	10.1	2.5	0.4	2.88
21	Feb Core 7 10-20	0.07	6.3	5.6	13.4	0.2	1.2	8.2	2.4	0.4	1.92
22	Feb Core 7 20-30	0.03	6.7	5.8	8.3	0.2	0.8	5.0	1.8	0.5	0.75
23	Feb Core 7 50-60	0.03	7.4	6.4	16.6	0.1	1.6	10.1	4.1	nt	0.36
24	Feb Core 7 80-90	0.03	7.9	6.9	14.4	0.2	1.4	8.8	4.1	nt	nt



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 4 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al	OC (%)
25	Bylong 82.1 0-10	0.07	5.6	5.0	5.1	0.1	0.5	3.6	1.1	0.3	1.74
26	Bylong 82.2 25-35	<0.01	6.6	5.5	1.6	0.2	0.2	0.9	0.5	0.4	0.18
27	Bylong 82.3 55-65	0.12	6.8	5.7	7.2	1.3	0.4	2.1	3.8	0.8	0.17
28	Bylong 82.4 90-100	0.20	6.5	5.6	5.7	1.5	0.3	1.4	2.7	<0.1	nt
29	Bylong 77.1 0-10	0.12	6.1	5.4	6.9	0.1	1.1	4.7	1.5	0.2	2.05
30	Bylong 77.2 25-35	0.03	6.3	5.3	5.1	0.1	0.8	2.8	1.0	0.2	0.67
31	Bylong 77.3 55-65	0.03	7.6	6.7	15.3	0.2	1.3	10.2	3.1	0.4	0.34
32	Bylong 77.4 90-100	0.08	8.3	7.5	17.3	0.2	1.2	12.0	3.6	nt	nt
33	Bylong 81.1 0-10	0.03	6.5	5.6	14.6	0.1	1.2	10.1	2.5	0.1	2.41
34	Bylong 81.2 25-35	<0.01	7.3	6.1	6.2	<0.1	0.4	4.5	1.2	nt	0.78
35	Bylong 81.3 55-65	0.01	7.7	6.5	11.3	0.1	0.8	8.2	2.3	nt	1.57
36	Bylong 81.4 90-100	0.01	8.0	6.9	19.5	0.2	0.7	13.3	4.7	nt	nt

SR Young

SOIL CONSERVATION SERVICE
Scone Research Centre

Page 5 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al	OC (%)
37	Bylong 83.1 0-10	0.06	6.4	5.6	13.4	0.1	1.4	8.2	3.2	0.4	3.20
38	Bylong 83.2 20-30	0.03	7.5	6.4	17.8	0.1	2.4	8.0	6.2	nt	0.63
39	Bylong 83.3 50-60	0.04	8.4	7.3	18.1	0.2	2.0	7.1	7.3	nt	0.37
40	Bylong 83.4 70-80	0.12	9.0	8.0	17.9	0.5	1.8	6.1	8.5	nt	nt
41	Bylong 61.1 0-10	0.07	7.4	6.6	9.3	0.2	0.8	5.8	2.4	nt	1.51
42	Bylong 61.2 25-35	0.01	7.4	6.1	4.4	0.2	0.6	2.3	1.3	nt	0.53
43	Bylong 61.3 55-65	<0.01	8.1	6.8	2.4	0.1	0.3	1.1	0.8	nt	0.19
44	Bylong 61.4 90-100	0.01	8.4	7.1	3.2	0.2	0.4	1.6	1.0	nt	nt
45	Bylong 52.1 0-10	0.25	8.4	7.8	28.4	0.5	0.4	19.0	6.3	nt	4.41
46	Bylong 52.2 25-35	0.10	8.7	8.0	14.4	0.3	0.1	13.1	2.8	nt	1.12
47	Bylong 52.3 50-60	0.06	8.7	8.0	10.4	0.3	0.1	8.3	2.1	nt	0.62
48	Bylong 52.4 90-100	0.03	8.7	8.0	9.0	0.3	0.2	7.1	2.3	nt	nt



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 6 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH (CaCl ₂)	CEC	Na	K	Ca	Mg	Al	OC (%)
49	Bylong 51.1 0-10	0.07	6.3	5.5	15.0	0.2	1.7	8.9	3.7	<0.1	2.18
50	Bylong 51.2 25-35	0.04	6.3	5.4	22.7	0.3	1.9	11.4	7.9	<0.1	0.58
51	Bylong 51.3 55-65	0.14	8.9	8.1	25.6	0.6	2.0	15.7	8.8	nt	0.34
52	Bylong 51.4 90-100	0.18	9.1	8.3	27.6	1.2	2.5	15.5	10.3	nt	nt
53	Bylong 80.1 0-10	0.04	6.8	6.0	13.2	0.1	1.1	10.0	1.8	<0.1	1.98
54	Bylong 80.2 25-35	0.10	8.4	7.8	16.6	0.1	0.6	17.3	1.3	nt	0.53
55	Bylong 80.3 90-100	0.09	8.8	8.0	18.0	0.1	0.9	17.4	1.2	nt	nt

nt = not tested



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 7 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
1	Feb Core 1 0-10	21	19	22	37	1	5	7.5YR 6/3	7.5YR 3/3
2	Feb Core 1 20-30	40	17	17	26	<1	3(2)	5YR 6/6	5YR 4/6
3	Feb Core 1 50-60	47	15	15	23	<1	5	5YR 6/6	5YR 4/6
4	Feb Core 2 0-10	11	12	33	42	2	5	10YR 5/3	10YR 3/3
5	Feb Core 2 10-20	14	14	30	37	5	3(1)	7.5YR 6/3	7.5YR 4/4
6	Feb Core 2 30-40	24	12	27	35	2	3(2)	7.5YR 7/3	7.5YR 4/6
7	Feb Core 3 0-10	21	34	36	9	0	5	10YR 4/1	10YR 2/1
8	Feb Core 3 20-30	30	34	31	5	0	3(1)	10YR 4/1	10YR 2/1
9	Feb Core 3 50-60	33	23	26	17	1	3(1)	10YR 5/1	10YR 2/1
10	Feb Core 3 80-90	26	14	21	31	8	3(1)	10YR 5/2	10YR 2/2



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 8 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
11	Feb Core 5 0-10	14	19	46	12	9	5	7.5YR 5/3	7.5YR 3/3
12	Feb Core 5 20-30	40	16	37	6	1	2(1)	5YR 6/6	5YR 4/6
13	Feb Core 5 40-50	35	16	40	8	1	2(2)	5YR 6/6	5YR 4/6
14	Feb Core 5 70-80	38	17	38	7	<1	2(3)	7.5YR 6/4	7.5YR 5/4
15	Feb Core 6 0-10	13	12	45	26	4	3(1)	10YR 3/2	10YR 2/1
16	Feb Core 6 20-30	16	9	32	41	2	3(1)	10YR 3/2	10YR 2/1
17	Feb Core 6 30-40	6	4	18	71	1	3(1)	10YR 4/2	10YR 2/2
18	Feb Core 6 60-70	10	9	31	49	1	3(1)	10YR 4/3	10YR 2/2
19	Feb Core 6 90	is	is	is	is	is	3(1)	10YR 4/2	10YR 2/2
20	Feb Core 7 0-10	17	21	33	29	<1	3(1)	10YR 5/3	10YR 2/2
21	Feb Core 7 10-20	18	22	30	29	1	3(1)	10YR 4/2	10YR 2/2
22	Feb Core 7 20-30	14	20	31	26	9	3(1)	10YR 5/3	10YR 3/3
23	Feb Core 7 50-60	38	17	23	19	3	3(2)	7.5YR 6/4	7.5YR 4/4
24	Feb Core 7 80-90	26	8	16	35	15	3(1)	7.5YR 5/4	7.5YR 4/6

is = insufficient sample



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 9 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
25	Bylong 82.1 0-10	11	16	22	51	<1	8	10YR 5/3	10YR 3/3
26	Bylong 82.2 25-35	6	11	27	55	1	3(1)	10YR 7/3	10YR 6/3
27	Bylong 82.3 55-65	28	9	22	41	<1	2(1)	10YR 7/4	10YR 6/6
28	Bylong 82.4 90-100	21	7	22	49	1	2(3)	7.5YR 6/4	7.5YR 5/6
29	Bylong 77.1 0-10	7	14	25	25	29	3(1)	10YR 5/4	10YR 4/4
30	Bylong 77.2 25-35	10	13	26	26	25	3(1)	7.5YR 5/4	7.5YR 4/4
31	Bylong 77.3 55-65	42	12	16	23	7	3(1)	5YR 6/6	5YR 4/6
32	Bylong 77.4 90-100	41	13	22	22	2	4	5YR 6/6	5YR 5/8
33	Bylong 81.1 0-10	12	15	18	51	4	3(1)	10YR 4/2	10YR 3/1
34	Bylong 81.2 25-35	5	5	14	71	5	3(1)	10YR 4/2	10YR 3/1
35	Bylong 81.3 55-65	8	9	28	54	1	3(1)	10YR 4/2	10YR 3/1
36	Bylong 81.4 90-100	17	21	31	29	2	3(1)	10YR 5/2	10YR 3/1



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 10 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
37	Bylong 83.1 0-10	18	13	30	32	7	8	7.5YR 5/3	7.5YR 3/3
38	Bylong 83.2 20-30	49	15	18	14	4	3(2)	5YR 6/6	5YR 4/6
39	Bylong 83.3 50-60	42	13	24	14	7	2(1)	5YR 6/4	5YR 4/6
40	Bylong 83.4 70-80	35	15	24	17	9	3(1)	5YR 6/4	5YR 4/6
41	Bylong 61.1 0-10	4	7	14	69	6	8	10YR 5/2	10YR 2/2
42	Bylong 61.2 25-35	5	1	12	73	9	3(1)	10YR 5/2	10YR 3/2
43	Bylong 61.3 55-65	3	0	10	82	5	3(1)	10YR 6/3	10YR 4/3
44	Bylong 61.4 90-100	4	0	27	68	1	3(1)	10YR 6/3	10YR 4/3
45	Bylong 52.1 0-10	20	14	20	44	2	4	10YR 4/1	10YR 2/1
46	Bylong 52.2 25-35	12	7	20	58	3	5	10YR 4/1	10YR 2/1
47	Bylong 52.3 50-60	9	3	18	64	6	4	10YR 5/2	10YR 2/2
48	Bylong 52.4 90-100	10	2	19	59	10	3(1)	7.5YR 5/3	7.5YR 3/3



SOIL CONSERVATION SERVICE
Scone Research Centre

Page 11 of 11

Report No: SCO12/232R2
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
49	Bylong 51.1 0-10	26	25	39	10	<1	8	7.5YR 5/3	7.5YR 4/3
50	Bylong 51.2 25-35	54	19	25	2	0	7	5YR 6/4	5YR 4/6
51	Bylong 51.3 55-65	34	24	31	4	7	4	10YR 7/4	10YR 5/4
52	Bylong 51.4 90-100	29	26	33	4	8	4	10YR 7/3	10YR 5/4
53	Bylong 80.1 0-10	20	16	37	23	4	8	7.5YR 5/3	7.5YR 3/3
54	Bylong 80.2 25-35	39	11	28	18	4	4	5YR 5/4	5YR 4/4
55	Bylong 80.3 90-100	42	12	21	17	8	4	5YR 6/4	5YR 4/6



END OF TEST REPORT

2013 Fieldwork: Sites Laboratory Analysed

Site No.	Site No.	Site No.
1	77	216
5	79	225
22	82	234
31	83	236
33	90	253
37	104	259
42	106	266
43	110	274
49	117	264
50	126	278
51	132	284
54	145	290
58	147	293
64	156	297
72	195	295
78	202	305
		303
		311

CERTIFICATE OF ANALYSIS

Work Order	: EB1311511	Page	: 1 of 43
Client	: SLR Consulting Australia Pty Ltd	Laboratory	: Environmental Division Brisbane
Contact	: MS ADELE CALANDRA	Contact	: Vanessa Turnbull
Address	: LEVEL 1, 241 DENNISON STREET BROADMEADOW NSW 2292	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: calandra@gssenvironmental.com	E-mail	: vanessa.turnbull@alsenviro.com
Telephone	: +61 02 4920 3000	Telephone	: 61-7-3552 8660
Facsimile	: +61 02 4961 3360	Facsimile	: 61-7-3352 3662
Project	: Han01-005	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 14-MAY-2013
Sampler	: ----	Issue Date	: 31-MAY-2013
Site	: ----		
Quote number	: EN/032/12	No. of samples received	: 203
		No. of samples analysed	: 203

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



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

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
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics



Page : 2 of 43
Work Order : EB1311511
Client : SLR Consulting Australia Pty Ltd
Project : Han01-005

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

- **ED008 (Exchangeable Cations with pre-treatment) : Sample EB1311511-089 (215-55-65) shows poor duplicate results due to sample heterogeneity. Confirmed by re-extraction and re-analysis.**



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				132 0-10	132 20-30	132 45-55	132 85-95	147 0-10
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-001	EB1311511-002	EB1311511-003	EB1311511-004	EB1311511-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.6	7.6	7.5	8.0	6.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	102	47	29	161	46
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	11.5	6.8	2.6	12.9	12.1
Exchangeable Magnesium	----	0.1	meq/100g	5.4	4.3	1.7	10.8	2.6
Exchangeable Potassium	----	0.1	meq/100g	0.4	0.2	0.1	0.2	1.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.3	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	17.4	11.4	4.5	24.2	15.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID				
				Client sampling date / time				
				147 20-30	147 35-45	147 60-70	145 0-10	145 20-30
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-006	EB1311511-007	EB1311511-008	EB1311511-009	EB1311511-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.3	8.3	6.0	8.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	152	120	128	23	35
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	11.0	29.7	28.1	5.2	4.6
Exchangeable Magnesium	----	0.1	meq/100g	2.2	2.3	3.7	2.3	6.2
Exchangeable Potassium	----	0.1	meq/100g	0.8	0.3	0.3	0.8	0.5
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.5
Cation Exchange Capacity	----	0.1	meq/100g	14.1	32.4	32.1	8.3	11.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				145 50-60	145 85-95	110 0-10	110 25-35	110 45-55
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-011	EB1311511-012	EB1311511-013	EB1311511-014	EB1311511-015
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.9	9.2	6.0	6.4	5.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	288	673	77	12	29
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	13.4	22.8	6.7	3.6	5.5
Exchangeable Magnesium	----	0.1	meq/100g	11.7	12.2	1.5	1.0	2.8
Exchangeable Potassium	----	0.1	meq/100g	0.4	0.4	0.6	0.5	0.5
Exchangeable Sodium	----	0.1	meq/100g	1.2	1.8	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	26.7	37.1	8.9	5.1	8.7



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				110 70-80	110 90-100	106 0-10	106 20-30	106 45-55
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-016	EB1311511-017	EB1311511-018	EB1311511-019	EB1311511-020
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.4	7.6	6.7	7.0	7.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	24	43	47	165	54
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	7.2	7.9	10.1	5.6	5.2
Exchangeable Magnesium	----	0.1	meq/100g	3.8	3.2	2.6	1.8	3.4
Exchangeable Potassium	----	0.1	meq/100g	0.4	0.3	0.8	0.6	0.6
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	11.3	11.4	13.5	8.0	9.3



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				106 80-90	126 0-10	126 10-20	126 40-50	126 65-75
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-021	EB1311511-022	EB1311511-023	EB1311511-024	EB1311511-025
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.0	6.6	7.0	6.5	6.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	502	33	22	31	28
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.5	6.7	4.5	4.9	3.5
Exchangeable Magnesium	----	0.1	meq/100g	7.2	1.5	1.2	5.7	5.4
Exchangeable Potassium	----	0.1	meq/100g	0.7	1.8	1.2	0.5	0.5
Exchangeable Sodium	----	0.1	meq/100g	0.1	<0.1	<0.1	0.1	0.4
Cation Exchange Capacity	----	0.1	meq/100g	12.5	9.9	6.9	11.2	9.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				126 85-95	117 0-10	117 10-20	117 30-40	117 50-60
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-026	EB1311511-027	EB1311511-028	EB1311511-029	EB1311511-030
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.4	6.2	6.7	9.4	9.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	24	55	49	464	974
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.0	4.9	3.1	3.6	22.8
Exchangeable Magnesium	----	0.1	meq/100g	4.5	1.7	1.6	5.0	7.5
Exchangeable Potassium	----	0.1	meq/100g	0.5	1.4	0.9	0.7	0.7
Exchangeable Sodium	----	0.1	meq/100g	0.4	0.1	0.3	2.9	3.3
Cation Exchange Capacity	----	0.1	meq/100g	8.4	8.1	5.9	12.2	34.4



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				202 0-10	202 25-35	202 45-55	202 60-70	202 85-95
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-031	EB1311511-032	EB1311511-033	EB1311511-034	EB1311511-035
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.1	6.7	7.2	7.5	7.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	36	8	11	13	11
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	7.6	6.6	7.2	5.1	4.5
Exchangeable Magnesium	----	0.1	meq/100g	1.5	1.7	2.0	2.0	1.9
Exchangeable Potassium	----	0.1	meq/100g	1.0	0.3	0.3	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	10.1	8.7	9.4	7.4	6.6



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	54 0-10	54 25-35	54 45-55	54 85-95	77 0-10
				Client sampling date / time	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-036	EB1311511-037	EB1311511-038	EB1311511-039	EB1311511-040
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.6	9.3	9.8	9.9	6.3
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		15	287	533	508	63
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.6	8.1	29.7	22.3	11.4
Exchangeable Magnesium	----	0.1	meq/100g		2.5	9.3	11.7	11.7	2.1
Exchangeable Potassium	----	0.1	meq/100g		0.2	0.6	0.6	0.6	0.7
Exchangeable Sodium	----	0.1	meq/100g		0.3	2.0	2.1	3.0	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		6.7	19.9	44.2	37.5	14.3





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				77 25-35	77 45-55	77 80-90	76 0-10	76 25-35
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-041	EB1311511-042	EB1311511-043	EB1311511-044	EB1311511-045
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.2	7.5	7.7	6.4	6.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	16	18	151	164
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	10.4	6.5	7.2	8.4	5.6
Exchangeable Magnesium	----	0.1	meq/100g	1.9	1.4	1.4	2.4	1.7
Exchangeable Potassium	----	0.1	meq/100g	0.5	0.4	0.3	1.0	0.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g	12.8	8.3	9.0	11.9	7.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	76 45-55	76 80-90	79 0-10	79 25-35	79 40-50
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-046	EB1311511-047	EB1311511-048	EB1311511-049	EB1311511-050
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.6	8.9	5.7	7.3	9.0
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		216	409	873	731	732
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.1	3.8	18.0	14.2	4.4
Exchangeable Magnesium	----	0.1	meq/100g		1.7	4.8	9.2	14.1	6.6
Exchangeable Potassium	----	0.1	meq/100g		0.2	0.3	0.7	0.2	0.1
Exchangeable Sodium	----	0.1	meq/100g		0.6	1.3	<0.1	0.8	0.9
Cation Exchange Capacity	----	0.1	meq/100g		4.7	10.1	28.0	29.4	12.1





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				79 80-90	82 0-10	82 25-35	82 45-55	82 80-90
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-051	EB1311511-052	EB1311511-053	EB1311511-054	EB1311511-055
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	9.3	5.5	6.1	8.1	8.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	451	27	9	86	76
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	2.9	9.4	7.0	15.6	24.0
Exchangeable Magnesium	----	0.1	meq/100g	8.1	2.4	2.2	2.9	2.8
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.6	0.3	0.3	0.3
Exchangeable Sodium	----	0.1	meq/100g	1.5	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	12.8	12.4	9.6	18.8	27.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	83 0-10	83 25-35	83 45-55	83 80-90	236 0-10
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-056	EB1311511-057	EB1311511-058	EB1311511-059	EB1311511-060
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.3	6.4	7.1	7.5	6.2
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		66	9	13	17	35
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		9.0	6.4	6.0	5.2	13.2
Exchangeable Magnesium	----	0.1	meq/100g		3.2	3.3	3.5	2.3	3.0
Exchangeable Potassium	----	0.1	meq/100g		0.7	0.5	0.5	0.4	2.4
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		12.8	10.3	10.0	8.0	18.7





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				236 15-25	236 35-45	236 55-65	236 80-90	234 0-10
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-061	EB1311511-062	EB1311511-063	EB1311511-064	EB1311511-065
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.6	7.2	7.2	7.8	6.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	60	50	52	292	62
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	16.4	4.5	6.2	17.0	5.1
Exchangeable Magnesium	----	0.1	meq/100g	4.4	1.3	2.0	8.2	1.1
Exchangeable Potassium	----	0.1	meq/100g	1.8	0.5	0.9	1.2	0.8
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.2	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	22.7	6.4	9.1	26.6	7.1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	234 20-30	234 45-55	234 60-70	225 0-10	225 10-20
				Client sampling date / time	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-066	EB1311511-067	EB1311511-068	EB1311511-069	EB1311511-070
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.5	7.2	7.6	6.1	6.8
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		28	68	61	57	23
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.6	6.4	6.7	5.4	6.8
Exchangeable Magnesium	----	0.1	meq/100g		1.1	2.8	3.1	1.2	1.2
Exchangeable Potassium	----	0.1	meq/100g		0.4	0.9	0.7	0.7	0.8
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		5.1	10.1	10.7	7.2	8.7





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				225 30-40	225 60-70	225 80-90	305 0-10	305 40-50
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-071	EB1311511-072	EB1311511-073	EB1311511-074	EB1311511-075
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.0	8.5	8.7	6.6	7.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	26	87	99	32	22
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.8	5.7	11.3	6.4	0.8
Exchangeable Magnesium	----	0.1	meq/100g	1.0	0.8	2.2	1.6	0.3
Exchangeable Potassium	----	0.1	meq/100g	0.7	0.3	0.5	0.6	0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	8.5	6.8	14.0	8.8	1.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				305 60-70	305 80-90	303 0-10	303 25-35	303 45-55
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-076	EB1311511-077	EB1311511-078	EB1311511-079	EB1311511-080
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.5	7.9	6.5	6.7	7.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	29	53	94	58	93
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.8	6.9	7.6	13.0	14.9
Exchangeable Magnesium	----	0.1	meq/100g	4.0	6.3	2.6	4.3	5.9
Exchangeable Potassium	----	0.1	meq/100g	0.5	0.6	1.1	0.9	0.4
Exchangeable Sodium	----	0.1	meq/100g	0.3	0.7	<0.1	<0.1	0.4
Cation Exchange Capacity	----	0.1	meq/100g	10.6	14.5	11.3	18.3	21.6



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				303 85-95	311 0-15	311 25-35	311 45-55	311 70-80
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-081	EB1311511-082	EB1311511-083	EB1311511-084	EB1311511-085
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.1	5.2	5.4	5.4	6.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	100	17	6	20	9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	11.6	1.0	0.2	0.4	0.9
Exchangeable Magnesium	----	0.1	meq/100g	6.3	0.4	0.3	0.3	0.5
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.1	0.2	0.4
Exchangeable Sodium	----	0.1	meq/100g	0.2	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	18.4	1.6	0.6	0.8	1.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	215 0-10	215 20-30	215 35-45	215 55-65	297 0-10
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-086	EB1311511-087	EB1311511-088	EB1311511-089	EB1311511-090
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.7	8.4	8.7	8.7	8.7
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		33	52	67	65	76
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		10.7	4.6	1.7	8.0	12.6
Exchangeable Magnesium	----	0.1	meq/100g		2.0	0.4	0.2	0.9	7.2
Exchangeable Potassium	----	0.1	meq/100g		1.1	0.2	0.2	0.1	0.3
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		13.8	5.2	2.0	9.0	20.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				297 25-35	297 60-70	297 85-95	293 0-10	293 25-35
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-091	EB1311511-092	EB1311511-093	EB1311511-094	EB1311511-095
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.4	8.4	8.4	6.6	7.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	100	168	805	17	44
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	15.8	12.9	21.5	6.9	8.5
Exchangeable Magnesium	----	0.1	meq/100g	11.0	8.4	20.3	3.1	6.4
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.4	0.3	0.4
Exchangeable Sodium	----	0.1	meq/100g	1.1	0.9	2.4	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g	28.2	22.4	44.6	10.3	15.4



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	293 45-55	293 70-80	295 0-10	295 25-35	295 45-55
				Client sampling date / time	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-096	EB1311511-097	EB1311511-098	EB1311511-099	EB1311511-100
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.1	8.5	7.6	8.6	8.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		37	141	48	139	568
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.2	10.4	15.3	16.0	14.5
Exchangeable Magnesium	----	0.1	meq/100g		1.6	6.2	9.4	15.9	19.8
Exchangeable Potassium	----	0.1	meq/100g		0.1	0.3	0.4	0.4	0.4
Exchangeable Sodium	----	0.1	meq/100g		<0.1	0.6	0.2	1.5	1.7
Cation Exchange Capacity	----	0.1	meq/100g		4.0	17.5	25.3	33.8	36.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				295 85-95	156 0-10	156 25-35	156 45-55	156 80-90
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-101	EB1311511-102	EB1311511-103	EB1311511-104	EB1311511-105
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.4	6.4	7.0	7.2	8.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	947	48	23	21	96
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	29.7	9.7	10.3	7.9	16.7
Exchangeable Magnesium	----	0.1	meq/100g	19.0	1.4	1.3	1.0	1.9
Exchangeable Potassium	----	0.1	meq/100g	0.3	1.0	0.5	0.3	0.4
Exchangeable Sodium	----	0.1	meq/100g	1.0	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	50.0	12.0	12.1	9.3	19.1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID				
				Client sampling date / time				
				31 0-10	31 25-35	31 45-55	31 65-75	5 0-10
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-106	EB1311511-107	EB1311511-108	EB1311511-109	EB1311511-110
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.2	4.9	5.2	5.7	5.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	98	257	118	17	637
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.3	0.5	<0.1	<0.1	11.2
Exchangeable Magnesium	----	0.1	meq/100g	0.9	0.7	0.5	0.3	1.4
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.1	<0.1	1.7
Exchangeable Sodium	----	0.1	meq/100g	0.3	0.2	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.7	1.6	0.8	0.5	14.3





Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				5 20-30	5 45-55	5 85-95	43 0-10	43 25-35
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-111	EB1311511-112	EB1311511-113	EB1311511-114	EB1311511-115
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.6	7.8	8.1	5.5	6.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	923	551	540	61	24
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	8.4	26.3	32.6	3.4	5.7
Exchangeable Magnesium	----	0.1	meq/100g	0.4	11.0	12.9	1.2	8.8
Exchangeable Potassium	----	0.1	meq/100g	0.7	0.9	0.9	0.6	1.0
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.4
Cation Exchange Capacity	----	0.1	meq/100g	9.5	38.4	46.5	5.1	16.0



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				43 45-55	43 80-90	42 0-10	42 25-35	42 45-55
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-116	EB1311511-117	EB1311511-118	EB1311511-119	EB1311511-120
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.4	7.8	6.4	7.7	8.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	52	73	63	34	115
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.8	4.6	9.4	16.8	27.6
Exchangeable Magnesium	----	0.1	meq/100g	10.1	9.5	3.7	5.0	6.1
Exchangeable Potassium	----	0.1	meq/100g	1.1	0.7	0.8	0.7	0.6
Exchangeable Sodium	----	0.1	meq/100g	0.7	0.6	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	17.7	15.4	14.0	22.6	34.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				42 85-95	51 0-10	51 25-35	51 45-55	33 0-10
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-121	EB1311511-122	EB1311511-123	EB1311511-124	EB1311511-125
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.7	6.5	6.9	7.6	7.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	109	78	187	272	91
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	26.7	3.2	3.3	3.5	12.5
Exchangeable Magnesium	----	0.1	meq/100g	3.8	3.7	8.0	8.3	8.2
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.4	0.7	0.7	1.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.3	1.1	1.8	0.4
Cation Exchange Capacity	----	0.1	meq/100g	30.9	7.6	13.2	14.2	22.6



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	33 25-35	33 50-55	49 0-10	49 20-30	49 40-50
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
				EB1311511-126	EB1311511-127	EB1311511-128	EB1311511-129	EB1311511-130
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.6	9.0	8.3	8.5	8.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	150	357	124	107	97
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.3	4.4	30.9	37.7	41.9
Exchangeable Magnesium	----	0.1	meq/100g	3.9	3.3	5.7	5.4	6.6
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	1.2	0.8	0.8
Exchangeable Sodium	----	0.1	meq/100g	0.6	0.8	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	10.1	8.8	37.8	43.9	49.3



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				22 0-10	22 25-35	22 45-55	22 60-70	37 0-10
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-131	EB1311511-132	EB1311511-133	EB1311511-134	EB1311511-135
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.8	6.8	8.4	5.1	8.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	23	27	126	568	142
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.8	3.4	7.9	1.0	21.2
Exchangeable Magnesium	----	0.1	meq/100g	0.9	2.1	2.0	2.7	9.4
Exchangeable Potassium	----	0.1	meq/100g	0.4	0.8	0.8	0.6	2.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	3.2	6.4	10.7	4.4	33.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				37 25-35	37 45-55	50 0-10	50 10-20	50 45-55
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-136	EB1311511-137	EB1311511-138	EB1311511-139	EB1311511-140
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.3	8.7	6.6	7.4	8.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	176	464	47	48	300
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	37.3	3.4	8.8	9.6	6.0
Exchangeable Magnesium	----	0.1	meq/100g	12.3	3.3	5.9	8.7	10.6
Exchangeable Potassium	----	0.1	meq/100g	1.2	0.1	1.4	1.1	0.5
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.4	<0.1	0.3	0.9
Cation Exchange Capacity	----	0.1	meq/100g	51.1	7.3	16.2	19.7	18.1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				50 80-90	1 0-5	1 25-35	1 55-65	1 80-90
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-141	EB1311511-142	EB1311511-143	EB1311511-144	EB1311511-145
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.8	6.2	6.9	7.1	7.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	477	78	28	20	21
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	23.0	9.9	8.2	7.3	7.5
Exchangeable Magnesium	----	0.1	meq/100g	19.9	3.0	4.5	5.1	5.8
Exchangeable Potassium	----	0.1	meq/100g	0.8	1.6	0.6	0.3	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.6	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	44.2	14.4	13.3	12.8	13.7



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				284 0-10	284 25-35	284 55-65	284 75-85	278 0-10
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-146	EB1311511-147	EB1311511-148	EB1311511-149	EB1311511-150
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.4	7.6	7.3	7.7	7.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	89	78	84	90	100
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	11.6	10.5	8.8	9.6	36.0
Exchangeable Magnesium	----	0.1	meq/100g	6.4	5.4	5.0	8.4	13.8
Exchangeable Potassium	----	0.1	meq/100g	0.9	0.9	0.4	0.6	1.7
Exchangeable Sodium	----	0.1	meq/100g	0.3	0.4	0.3	0.8	0.1
Cation Exchange Capacity	----	0.1	meq/100g	19.2	17.2	14.6	19.4	51.6



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				278 35-45	278 50-60	278 85-95	290 0-10	290 25-35
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-151	EB1311511-152	EB1311511-153	EB1311511-154	EB1311511-155
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.8	9.0	9.2	7.2	8.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	191	445	461	55	74
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	33.2	27.2	26.1	10.6	11.1
Exchangeable Magnesium	----	0.1	meq/100g	15.1	11.2	10.9	5.6	7.0
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.2	0.2	0.5	0.5
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.2	0.4	<0.1	0.3
Cation Exchange Capacity	----	0.1	meq/100g	49.1	38.8	37.6	16.7	18.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	290 45-55	290 70-80	253 0-10	253 25-35	253 50-60
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-156	EB1311511-157	EB1311511-161	EB1311511-162	EB1311511-163
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		9.0	8.5	7.3	7.7	8.2
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		111	437	43	32	32
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		7.8	13.4	12.6	7.0	12.7
Exchangeable Magnesium	----	0.1	meq/100g		6.1	13.9	5.7	4.0	7.4
Exchangeable Potassium	----	0.1	meq/100g		0.3	0.3	1.1	0.5	0.4
Exchangeable Sodium	----	0.1	meq/100g		0.7	1.2	<0.1	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g		14.9	28.8	19.5	11.6	20.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				253 70-80	274 0-10	274 20-30	274 45-55	274 60-70A
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-164	EB1311511-165	EB1311511-166	EB1311511-167	EB1311511-168
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.1	6.7	7.3	7.5	7.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	69	75	32	18	26
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.3	2.6	1.5	7.4	1.2
Exchangeable Magnesium	----	0.1	meq/100g	3.2	0.9	0.3	2.7	0.6
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.2	<0.1	0.4	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	8.7	3.6	1.8	10.6	2.0



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	274 60-70B	266 0-10	266 10-20	266 35-45	266 55-65
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-169	EB1311511-170	EB1311511-171	EB1311511-172	EB1311511-173
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.7	5.9	6.4	6.5	7.0
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		33	41	17	11	22
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		9.3	2.0	1.2	1.4	4.4
Exchangeable Magnesium	----	0.1	meq/100g		4.3	0.4	0.2	0.3	1.0
Exchangeable Potassium	----	0.1	meq/100g		0.4	0.4	0.2	0.2	0.3
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		14.1	2.8	1.7	2.0	5.7



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				264 0-10	264 20-30	264 45-55	264 80-90	259 0-10
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-174	EB1311511-175	EB1311511-176	EB1311511-177	EB1311511-178
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.0	6.9	7.0	6.9	5.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	217	32	34	50	91
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.9	4.6	7.5	5.1	6.3
Exchangeable Magnesium	----	0.1	meq/100g	0.8	1.5	2.6	2.1	1.6
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.7	1.0	0.2	1.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	6.4	6.7	11.2	7.5	8.9



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	259 15-25	259 35-45	259 60-70	64 0-10	64 25-35
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-179	EB1311511-180	EB1311511-181	EB1311511-182	EB1311511-183
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.2	6.6	7.0	5.9	5.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		62	21	37	44	20
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		4.0	2.8	2.2	4.2	2.6
Exchangeable Magnesium	----	0.1	meq/100g		1.7	1.2	1.0	1.3	4.9
Exchangeable Potassium	----	0.1	meq/100g		0.5	0.2	0.2	0.5	0.6
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g		6.2	4.2	3.4	6.0	8.3



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				64 45-55	64 80-90	58 0-10	58 25-35	58 45-55
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-184	EB1311511-185	EB1311511-186	EB1311511-187	EB1311511-188
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.1	6.8	5.7	6.2	7.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	28	68	117	40	252
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.0	2.0	5.0	2.4	1.2
Exchangeable Magnesium	----	0.1	meq/100g	2.5	5.1	1.6	6.0	4.2
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.5	0.5	0.6	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.5	<0.1	0.2	0.3
Cation Exchange Capacity	----	0.1	meq/100g	4.0	8.2	7.1	9.3	6.1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	58 80-90	73 0-10	73 25-35	73 45-55	73 80-90
Client sampling date / time					13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit		EB1311511-189	EB1311511-190	EB1311511-191	EB1311511-192	EB1311511-193
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.7	7.1	8.2	8.5	8.3
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		601	89	51	104	192
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		3.4	14.9	10.4	8.2	10.2
Exchangeable Magnesium	----	0.1	meq/100g		13.7	8.6	7.5	5.8	6.2
Exchangeable Potassium	----	0.1	meq/100g		0.4	2.3	0.3	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g		1.5	<0.1	0.4	0.6	0.7
Cation Exchange Capacity	----	0.1	meq/100g		19.0	25.9	18.6	14.8	17.4



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				104 0-3	104 3-10	104 25-35	104 45-50	104 60-70
Client sampling date / time				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-194	EB1311511-195	EB1311511-196	EB1311511-197	EB1311511-198
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.3	6.4	5.6	6.1	6.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	60	136	42	57	58
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	2.9	2.9	0.6	1.0	1.2
Exchangeable Magnesium	----	0.1	meq/100g	0.8	0.7	0.4	4.0	8.1
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.7	0.3	0.4	0.3
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.3	0.9
Cation Exchange Capacity	----	0.1	meq/100g	4.0	4.4	1.3	5.7	10.6



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				90 0-10	90 25-35	90 45-55	90 60-70	195 0-10
				13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00
Compound	CAS Number	LOR	Unit	EB1311511-199	EB1311511-200	EB1311511-201	EB1311511-202	EB1311511-203
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.8	6.0	5.7	7.6	5.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	82	12	17	54	53
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.5	1.5	2.5	2.5	8.1
Exchangeable Magnesium	----	0.1	meq/100g	0.3	0.4	1.8	3.5	1.9
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.1	0.2	0.2	0.8
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.2	2.1	4.5	6.2	10.9



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	195 25-35	195 45-55	195 70-80	----	----
				Client sampling date / time	13-MAY-2013 15:00	13-MAY-2013 15:00	13-MAY-2013 15:00	----	----
Compound	CAS Number	LOR	Unit		EB1311511-204	EB1311511-205	EB1311511-206	----	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.0	7.6	8.2	----	----
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		29	38	78	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		9.6	7.8	8.9	----	----
Exchangeable Magnesium	----	0.1	meq/100g		3.3	3.2	5.3	----	----
Exchangeable Potassium	----	0.1	meq/100g		0.7	0.6	0.7	----	----
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g		13.6	11.7	15.0	----	----



Soil Conservation Service

SOIL TEST REPORT

Page 1 of 18

Scone Research Centre

REPORT NO: SCO13/124R1

REPORT TO: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

REPORT ON: Two hundred and two soil samples
Ref: Han01-005

PRELIMINARY RESULTS
ISSUED: Not issued

REPORT STATUS: Final

DATE REPORTED: 3 June 2013

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

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

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

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 2 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
1	132 0-10 cm	21	9	22	46	2	3 (1)	10YR 4/1	10YR 2/1
2	132 20-30 cm	21	4	20	53	2	3 (1)	10YR 4/1	10YR 2/1
3	132 45-55 cm	11	0	34	54	1	3 (1)	10YR 5/1	10YR 4/2
4	132 85-95 cm	44	33	15	8	0	5	10YR 5/2	10YR 3/2
5	147 0-10 cm	38	31	26	5	<1	8	7.5YR 5/6	7.5YR 4/4
6	147 20-30 cm	50	27	17	3	3	3 (1)	7.5YR 5/6	7.5YR 4/4
7	147 35-45 cm	50	31	11	4	4	4	7.5YR 6/4	7.5YR 4/6
8	147 60-70 cm	31	37	21	10	1	4	10YR 6/4	10YR 4/4
9	145 0-10 cm	14	11	29	23	23	8	10YR 6/4	10YR 3/3
10	145 20-30 cm	36	9	22	25	8	2 (2)	7.5YR 4/3	7.5YR 3/4
11	145 50-60 cm	39	11	24	21	5	2 (2)	7.5YR 5/6	7.5YR 4/6
12	145 85-95 cm	36	10	20	21	13	2 (3)	5YR 5/6	5YR 4/6



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 3 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
13	110 0-10 cm	16	18	43	23	<1	8	7.5YR 5/3	7.5YR 3/3
14	110 25-35 cm	24	24	38	13	1	2 (1)	7.5YR 6/4	7.5YR 4/4
15	110 45-55 cm	48	14	31	7	0	5	5YR 6/6	5YR 4/6
16	110 70-80 cm	46	17	31	6	0	3 (1)	7.5YR 6/6	5YR 5/6
17	110 90-100 cm	32	23	31	6	8	4	7.5YR 6/3	7.5YR 4/6
18	106 0-10 cm	14	16	51	18	1	8	7.5YR 5/3	7.5YR 3/3
19	106 20-30 cm	22	18	42	9	9	3 (1)	5YR 6/3	5YR 4/4
20	106 45-55 cm	15	21	55	8	1	3 (2)	5YR 5/4	5YR 3/4
21	106 80-90 cm	34	22	39	5	0	5	7.5YR 6/3	7.5YR 4/4
22	126 0-10 cm	23	22	38	15	2	3 (1)	7.5YR 4/6	5YR 3/4
23	126 10-20 cm	28	19	37	15	1	3 (2)	5YR 5/6	5YR 3/4
24	126 40-50 cm	60	11	19	10	0	5	5YR 4/6	2.5YR 3/6
25	126 65-75 cm	60	13	18	8	1	5	5YR 4/6	2.5YR 3/6
26	126 85-95 cm	50	15	22	11	2	2 (1)	5YR 5/8	2.5YR 3/6

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SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 4 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
27	117 0-10 cm	10	14	51	21	4	8	7.5YR 5/3	7.5YR 2.5/3
28	117 10-20 cm	11	13	54	16	6	2 (2)	5YR 5/3	5YR 3/3
29	117 30-40 cm	31	12	39	12	6	2 (3)	5YR 5/4	5YR 4/4
30	117 50-60 cm	35	13	28	16	8	2 (3)	7.5YR 5/4	7.5YR 4/4
31	202 0-10 cm	11	19	28	33	9	8	7.5YR 5/2	7.5YR 2.5/2
32	202 25-35 cm	5	7	19	41	28	3 (1)	7.5YR 5/3	7.5YR 3/4
33	202 45-55 cm	13	12	26	40	9	3 (1)	7.5YR 5/3	7.5YR 3/3
34	202 60-70 cm	16	12	23	39	10	3 (1)	7.5YR 5/3	7.5YR 3/3
35	202 85-95 cm	15	13	24	32	16	3 (1)	7.5YR 5/4	7.5YR 3/4
36	54 0-10 cm	6	8	19	22	45	3 (2)	7.5YR 6/2	7.5YR 3/3
37	54 25-35 cm	30	12	21	23	14	2 (1)	10YR 5/3	10YR 4/4
38	54 45-55 cm	37	13	14	22	14	2 (1)	10YR 6/2	10YR 5/4
39	54 85-95 cm	16	13	32	25	14	2 (1)	10YR 6/3	10YR 4/4



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 5 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
40	77 0-10 cm	11	13	25	43	8	8	10YR 4/2	10YR 2/2
41	77 25-35 cm	15	9	18	44	14	3 (1)	10YR 4/2	10YR 2/2
42	77 45-55 cm	10	6	12	47	25	3 (1)	7.5YR 4/2	7.5YR 2.5/2
43	77 80-90 cm	13	7	16	49	15	3 (2)	7.5YR 4/2	7.5YR 2.5/2
44	76 0-10 cm	27	26	13	33	1	3 (1)	7.5YR 5/3	7.5YR 2.5/3
45	76 25-35 cm	14	13	13	58	2	3 (1)	10YR 5/2	10YR 3/2
46	76 45-55 cm	9	8	15	62	6	2 (2)	7.5YR 6/3	7.5YR 4/4
47	76 80-90 cm	26	11	19	41	3	2 (3)	10YR 7/3	10YR 5/4
48	79 0-10 cm	21	38	31	9	1	8	10YR 4/2	10YR 2/1
49	79 25-35cm	23	37	26	14	<1	5	10YR 4/2	10YR 2/1
50	79 40-50 cm	13	19	28	35	5	4	10YR 6/2	10YR 4/3
51	79 80-90 cm	36	9	24	28	3	2 (3)	10YR 6/4	10YR 4/4

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SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 6 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
52	82 0-10 cm	19	12	32	34	3	8	10YR 5/2	10YR 2/2
53	82 25-35 cm	20	12	20	32	16	3 (2)	7.5YR 5/2	7.5YR 3/2
54	82 45-55 cm	21	14	23	33	9	5	7.5YR 5/3	7.5YR 3/2
55	82 80-90 cm	24	15	19	35	7	5	7.5YR 5/2	7.5YR 3/2
56	83 0-10 cm	16	16	29	25	14	8	7.5YR 5/2	7.5YR 3/2
57	83 25-35 cm	25	15	32	26	2	8	7.5YR 5/2	7.5YR 3/3
58	83 45-55 cm	22	17	27	30	4	3 (2)	7.5YR 5/3	7.5YR 3/3
59	83 80-90 cm	22	15	24	27	12	3 (2)	7.5YR 4/3	7.5YR 3/3
60	236 0-10 cm	26	24	30	19	1	8	10YR 4/2	10YR 2/2
61	236 15-25 cm	26	15	34	24	1	8	10YR 4/2	10YR 2/1
62	236 35-45 cm	12	0	24	60	4	3 (2)	10YR 4/2	10YR 2/2
63	236 55-65 cm	15	8	38	38	1	3 (2)	10YR 4/3	10YR 3/2
64	236 80-90 cm	28	17	40	15	<1	3 (1)	10YR 4/3	10YR 2/2



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 7 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
65	234 0-10 cm	18	15	38	26	3	8	7.5YR 5/3	7.5YR 3/3
66	234 20-30 cm	26	16	34	20	4	3 (1)	7.5YR 6/3	7.5YR 4/4
67	234 45-55 cm	43	12	28	14	3	3 (2)	5YR 5/6	5YR 4/6
68	234 60-70 cm	44	9	28	18	1	3 (1)	5YR 5/6	5YR 4/6
69	225 0-10 cm	14	12	44	27	3	8	7.5YR 5/3	7.5YR 3/3
70	225 10-20 cm	20	11	43	23	3	8	7.5YR 5/3	7.5YR 3/3
71	225 30-40 cm	21	12	43	22	2	3 (2)	7.5YR 5/3	7.5YR 3/3
72	225 60-70 cm	19	13	46	19	3	2 (1)	5YR 6/4	5 YR 4/4
73	225 80-90 cm	33	12	37	15	3	4	5YR 6/4	5 YR 4/6
74	305 0-10 cm	19	14	35	27	5	3 (1)	10YR 4/3	10YR 2/2
75	305 40-50 cm	10	2	13	40	35	3 (3)	7.5YR 5/3	7.5YR 3/4
76	305 60-70 cm	27	13	41	17	2	2 (1)	10YR 5/4	10YR 3/3
77	305 80-90 cm	33	15	39	13	0	2 (1)	10YR 5/3	10YR 3/3

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SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 8 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
78	303 0-10 cm	14	11	29	36	10	8	10YR 4/2	10YR 2/2
79	303 25-35 cm	23	17	28	26	6	3 (1)	10YR 5/2	10YR 3/2
80	303 45-55 cm	37	31	24	7	1	3 (3)	10YR 4/2	10YR 2/1
81	303 85-95 cm	33	19	27	19	2	5	10YR 5/2	10YR 3/2
82	311 0-15 cm	4	6	18	66	6	8	7.5YR 5/4	7.5YR 3/4
83	311 25-35 cm	5	8	16	62	9	3 (1)	7.5YR 6/3	7.5YR 4/4
84	311 45-55 cm	4	7	19	53	17	3 (1)	5YR 6/4	5YR 4/4
85	311 70-80 cm	5	6	18	49	22	2 (1)	5YR 6/4	5 YR 4/6
86	215 0-10 cm	16	19	33	26	6	8	7.5YR 4/3	7.5YR 3/2
87	215 20-30 cm	9	8	14	44	25	3 (1)	7.5YR 6/2	7.5YR 4/3
88	215 35-45 cm	8	7	15	32	38	4	7.5YR 6/3	7.5YR 4/4
89	215 55-65 cm	15	9	22	37	17	3 (1)	7.5YR 6/4	7.5YR 4/4



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 9 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
90	297 0-10 cm	23	23	42	12	<1	8	10YR 4/3	10YR 2/2
91	297 25-35 cm	44	24	27	5	0	3 (2)	10YR 4/2	10YR 2/1
92	297 60-70 cm	29	14	25	32	0	3 (1)	10YR 5/3	10YR 3/2
93	297 85-95 cm	61	18	14	7	0	4	10YR 4/1	10YR 2/1
94	293 0-10 cm	10	13	30	33	14	8	10YR 4/3	10YR 2/2
95	293 25-35 cm	21	17	32	21	9	3 (2)	7.5YR 4/4	7.5YR 2.5/3
96	293 45-55 cm	5	3	5	29	58	3 (2)	7.5YR 5/3	7.5YR 3/4
97	293 70-80 cm	21	20	29	25	5	2 (1)	7.5YR 5/3	7.5YR 3/3
98	295 0-10 cm	27	35	28	10	0	3 (1)	10YR 4/2	10YR 2/2
99	295 25-35 cm	47	27	22	4	0	3 (2)	10YR 4/2	10YR 2/2
100	295 45-55 cm	52	20	20	6	2	4	10YR 4/2	10YR 2/2
101	295 85-95 cm	51	19	18	9	3	4	10YR 5/3	10YR 3/2

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SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 10 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
102	156 0-10 cm	21	18	26	31	4	8	7.5YR 5/3	7.5YR 3/3
103	156 25-35 cm	29	15	23	29	4	3 (2)	10YR 5/3	10YR 3/2
104	156 45-55 cm	17	8	15	32	28	5	7.5YR 5/3	7.5YR 3/3
105	156 80-90 cm	23	7	23	35	12	4	7.5YR 5/3	7.5YR 3/3
106	31 0-10 cm	8	7	17	63	5	8	10YR 5/2	10YR 4/1
107	31 25-35 cm	8	5	12	68	7	8	10YR 5/3	10YR 4/2
108	31 45-55 cm	8	6	17	60	9	8	10YR 6/2	10YR 4/3
109	31 65-75 cm	8	6	19	58	9	8	10YR 6/2	10YR 4/3
110	5 0-10 cm	15	18	42	13	12	5	7.5YR 4/6	7.5YR 3/4
111	5 20-30 cm	20	14	36	10	20	6	5YR 5/6	5YR 3/4
112	5 45-55 cm	69	8	16	5	2	4	5YR 4/6	5YR 3/6
113	5 85-95 cm	49	12	20	8	11	4	5YR 5/6	5YR 4/6



SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 11 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
114	43 0-10 cm	14	14	30	32	10	3 (1)	7.5YR 5/4	7.5YR 3/4
115	43 25-35 cm	70	6	11	9	4	3 (1)	5YR 5/6	5YR 3/4
116	43 45-55 cm	81	5	9	5	<1	2 (1)	5YR 5/6	5YR 3/4
117	43 80-90 cm	42	11	21	22	4	2 (1)	7.5YR 5/6	7.5YR 4/4
118	42 0-10 cm	35	28	29	6	2	8	7.5YR 5/4	7.5YR 3/4
119	42 25-35 cm	62	20	15	3	0	4	5YR 5/6	5YR 4/6
120	42 45-55 cm	50	21	10	9	10	4	7.5YR 6/4	7.5YR 4/4
121	42 85-95 cm	29	32	13	15	11	4	7.5YR 6/4	7.5YR 4/6
122	51 0-10 cm	19	12	31	23	15	2 (1)	7.5YR 6/2	7.5YR 4/3
123	51 25-35 cm	47	9	33	10	1	2 (1)	7.5YR 6/4	7.5YR 4/6
124	51 45-55 cm	42	10	37	9	2	2 (1)	7.5YR 6/4	7.5YR 4/6
125	33 0-10 cm	59	15	19	7	0	2 (1)	10YR 5/3	10YR 2/2
126	33 25-35 cm	61	20	12	5	2	2 (1)	10YR 5/3	10YR 2/2
127	33 50-55 cm	66	19	10	5	0	2 (1)	10YR 5/3	10YR 3/3

SR Young

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Page 12 of 18

Report No: SCO13/124R1
Client Reference: Adele Calandra
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
128	49 0-10 cm	41	15	12	21	11	8	10YR 4/2	10YR 2/2
129	49 20-30 cm	46	17	10	19	8	4	10YR 4/1	10YR 2/1
130	49 40-50 cm	39	18	11	14	18	4	10YR 4/1	10YR 2/1
131	22 0-10 cm	11	12	31	40	6	3 (1)	10YR 6/4	7.5YR 4/6
132	22 25-35 cm	39	5	23	30	3	3 (2)	10YR 6/3	10YR 5/4
133	22 44-55 cm	35	5	20	30	10	3 (1)	10YR 6/4	10YR 4/4
134	22 60-70 cm	29	6	22	39	4	6	10YR 5/6	10YR 4/6
135	37 0-10 cm	58	13	20	9	<1	3 (1)	7.5YR 4/4	7.5YR 3/3
136	37 25-35 cm	62	16	14	7	1	4	7.5YR 5/3	7.5YR 3/4
137	37 45-55 cm	64	13	15	8	0	4	7.5YR 5/4	7.5YR 4/4
138	50 0-10 cm	21	43	31	5	0	8	10YR 5/3	10YR 3/2
139	50 10-20 cm	32	40	24	4	0	3 (3)	10YR 5/3	10YR 3/2
140	50 45-55 cm	55	27	15	3	0	4	10YR 5/3	10YR 3/3
141	50 80-90 cm	44	27	17	9	3	4	10YR 5/3	10YR 4/2



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Page 13 of 18

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Lab No	Method		P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id		clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
142	1	0-5 cm	13	20	24	6	37	3 (1)	7.5YR 4/4	5YR 3/3
143	1	35-35 cm	61	25	12	1	1	5	5YR 5/8	5YR 3/4
144	1	55-65 cm	48	29	17	4	2	5	5YR 5/8	2.5YR 3/6
145	1	80-90 cm	32	23	38	3	4	5	5YR 5/6	2.5YR 3/6
146	284	0-10 cm	20	36	41	3	<1	3 (1)	7.5YR 4/3	7.5YR 3/2
147	284	25-35 cm	24	35	37	4	<1	3 (1)	7.5YR 4/3	7.5YR 3/2
148	284	55-65 cm	23	22	46	9	<1	2 (1)	10YR 5/3	10YR 3/2
149	284	75-85 cm	33	30	31	5	1	2 (1)	10YR 5/3	10YR 3/2
150	278	0-10 cm	52	25	19	4	<1	4	10YR 4/1	10YR 2/1
151	278	35-45 cm	60	22	15	3	0	4	10YR 5/2	10YR 3/2
152	278	50-60 cm	26	15	34	17	8	4	10YR 7/1	10YR 5/3
153	278	85-95 cm	23	13	30	19	15	4	10YR 7/1	10YR 5/3

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Page 14 of 18

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Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
154	290 0-10 cm	14	14	30	42	<1	7	10YR 4/2	10YR 2/1
155	290 25-35 cm	20	18	42	20	<1	3 (1)	10YR 4/2	10YR 2/2
156	290 45-55 cm	21	19	30	30	0	3 (3)	10YR 4/3	10YR 2/2
157	290 70-80 cm	39	20	22	19	0	5	10YR 4/2	10YR 2/2
158	275 0-10 cm	nr	nr	nr	nr	nr	nr	nr	nr
159	275 25-35 cm	nr	nr	nr	nr	nr	nr	nr	nr
160	275 60-70 cm	nr	nr	nr	nr	nr	nr	nr	nr
161	253 0-10 cm	26	18	27	28	1	3 (1)	10YR 4/3	10YR 2/2
162	253 25-35 cm	22	11	23	41	3	3 (1)	7.5YR 4/3	7.5YR 2.5/2
163	253 50-60 cm	26	21	35	18	<1	3 (1)	10YR 5/3	10YR 3/2
164	253 70-80 cm	12	2	20	62	4	3 (1)	7.5YR 5/3	7.5YR 3/3

nr = sample not received



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Page 15 of 18

Report No: SCO13/124R1
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Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
165	274 0-10 cm	6	3	12	44	35	8	7.5YR 4/2	7.5YR 3/2
166	274 20-30 cm	6	2	14	51	27	3 (1)	7.5YR 4/3	7.5YR 2.5/2
167	274 45-55 cm	16	4	22	49	9	3 (1)	10YR 4/2	10YR 2/2
168	274 60-70A cm	5	2	9	38	46	3 (1)	7.5YR 4/3	7.5YR 3/2
169	274 60-70B cm	9	6	18	33	34	3 (1)	10YR 4/2	10YR 2/2
170	266 0-10 cm	8	5	16	67	4	8	10YR 6/3	10YR 4/4
171	266 10-20 cm	8	7	12	61	12	3 (2)	7.5YR 6/4	7.5YR 4/6
172	266 35-45 cm	11	10	11	59	9	3 (2)	10YR 7/4	10YR 5/8
173	266 55-65 cm	33	8	12	44	3	3 (1)	10YR 6/6	10YR 5/8
174	264 0-10 cm	11	15	45	27	2	5	7.5YR 5/4	7.5YR 3/3
175	264 20-30 cm	20	16	48	16	<1	3 (3)	10YR 6/4	10YR 4/4
176	264 45-55 cm	22	12	28	37	1	3 (2)	10YR 5/6	10YR 3/4
177	264 80-90 cm	13	10	38	38	1	3 (1)	10YR 5/4	10YR 4/3

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Page 16 of 18

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Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
178	259 0-10 cm	19	17	24	38	2	3 (1)	10YR 5/3	10YR 3/2
179	259 15-25 cm	20	13	18	46	3	3 (2)	10YR 5/3	10YR 3/2
180	259 35-45 cm	14	7	28	45	6	3 (2)	7.5YR 5/3	7.5YR 4/4
181	259 60-70 cm	12	7	29	38	14	3 (2)	7.5YR 6/4	7.5YR 4/6
182	64 0-10 cm	15	13	31	31	10	8	7.5YR 5/3	7.5YR 3/3
183	64 25-35 cm	51	9	15	20	5	2 (1)	5YR 5/6	5YR 4/6
184	64 45-55 cm	45	12	15	22	6	2 (1)	5YR 5/6	5YR 4/6
185	64 80-90 cm	38	7	23	26	6	2 (2)	5YR 5/6	5YR 4/6
186	58 0-10 cm	19	9	25	36	11	3 (1)	7.5YR 5/3	7.5YR 3/3
187	58 25-35 cm	56	7	16	17	4	2 (1)	5YR 5/6	5YR 4/6
188	58 45-55 cm	55	7	17	19	2	2 (2)	7.5YR 5/4	7.5YR 4/4
189	58 80-90 cm	58	10	15	15	2	2 (1)	7.5YR 6/4	7.5YR 4/6



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Page 17 of 18

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Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
190	73 0-10 cm	21	28	43	8	<1	8	10YR 4/2	10YR 2/1
191	73 25-35 cm	29	19	41	11	0	3 (2)	10YR 4/3	10YR 2/2
192	73 45-55 cm	28	10	48	14	0	3 (2)	10YR 4/3	10YR 3/2
193	73 80-90 cm	20	8	58	14	0	3 (2)	10YR 4/3	10YR 3/2
194	104 0-3 cm	6	5	22	63	4	8	7.5YR 5/3	7.5YR 3/4
195	104 3-10 cm	6	3	24	62	5	8	7.5YR 5/3	7.5YR 3/3
196	104 25-35 cm	9	7	22	50	12	na	7.5YR 7/3	7.5YR 4/6
197	104 45-55 cm	51	4	10	31	4	2 (1)	10YR 6/6	10YR 5/8
198	104 60-70 cm	41	3	10	32	14	3 (1)	10YR 6/6	10YR 5/8

na = not applicable



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Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	Dry	Moist
199	90 0-10 cm	11	6	59	22	2	8	10YR 5/3	10YR 3/3
200	90 25-35 cm	15	9	55	18	3	3 (1)	7.5YR 7/3	7.5YR 5/4
201	90 45-55 cm	33	13	43	11	0	3 (2)	7.5YR 7/4	7.5YR 5/6
202	90 60-70 cm	25	10	42	18	5	4	10YR 7/3	10YR 6/4
203	195 0-10 cm	11	11	41	28	9	8	7.5YR 4/3	7.5YR 3/2
204	195 25-35 cm	16	9	36	28	11	3 (2)	7.5YR 4/3	7.5YR 3/3
205	195 45-55 cm	16	10	33	29	12	3 (1)	7.5YR 4/3	7.5YR 3/2
206	195 70-80 cm	17	11	32	28	12	3 (1)	7.5YR 4/2	7.5YR 2/2



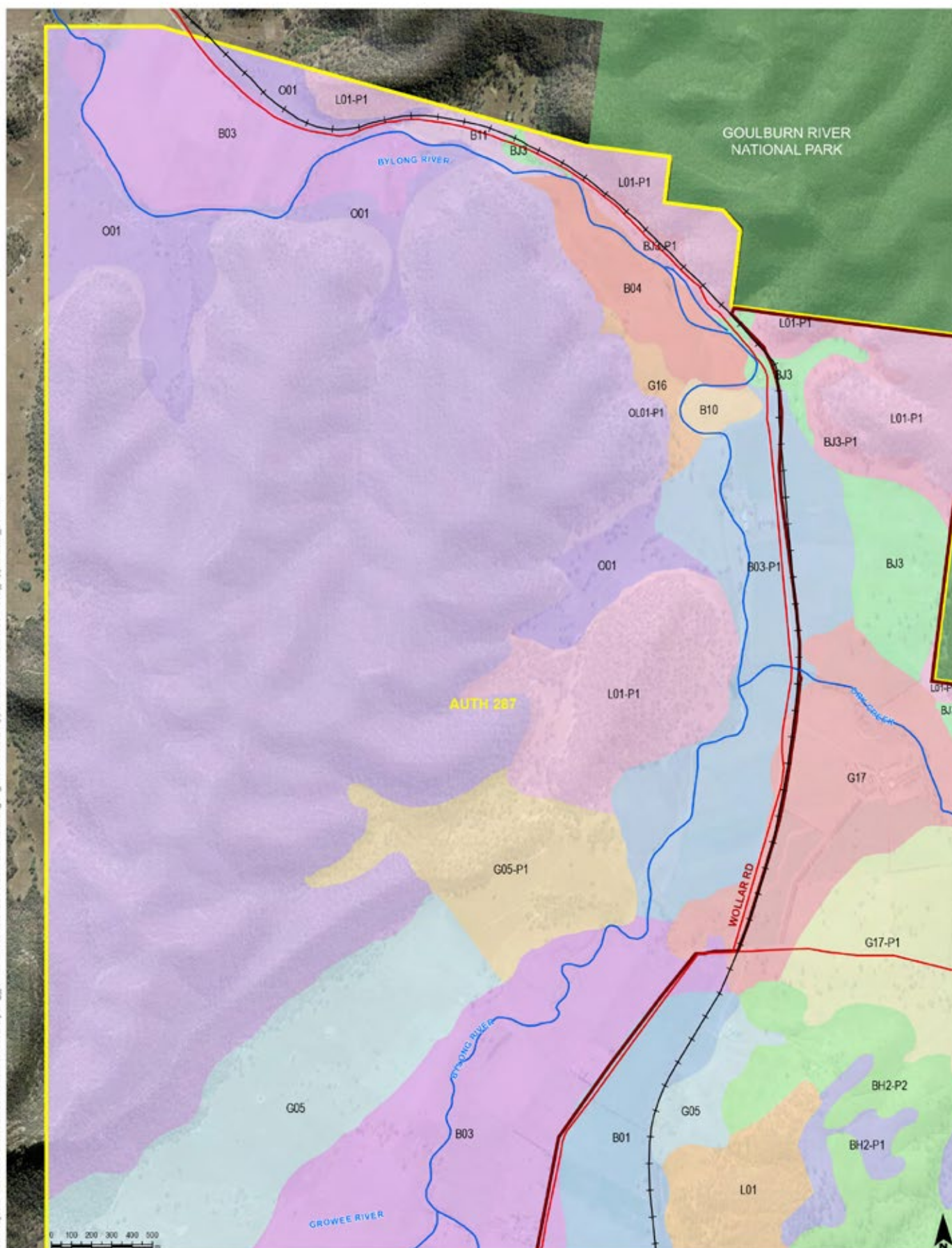
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Appendix D

Report Number 630.11072.00000

Soil Unit Maps 1:25,000 Scale

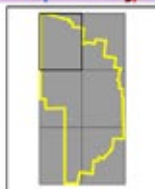
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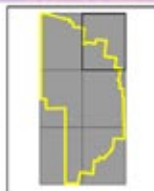
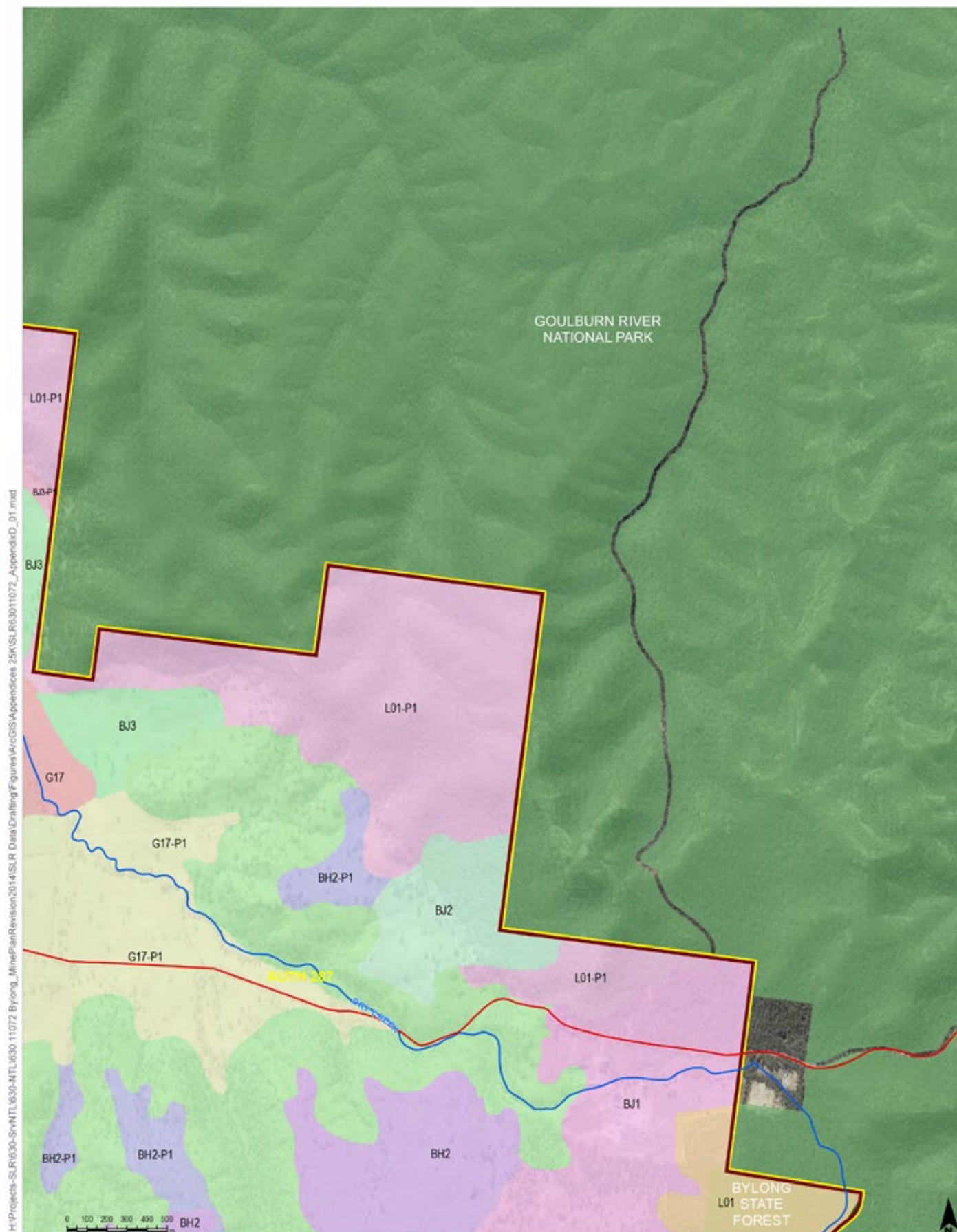


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Coal Authorizations

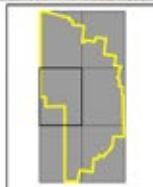
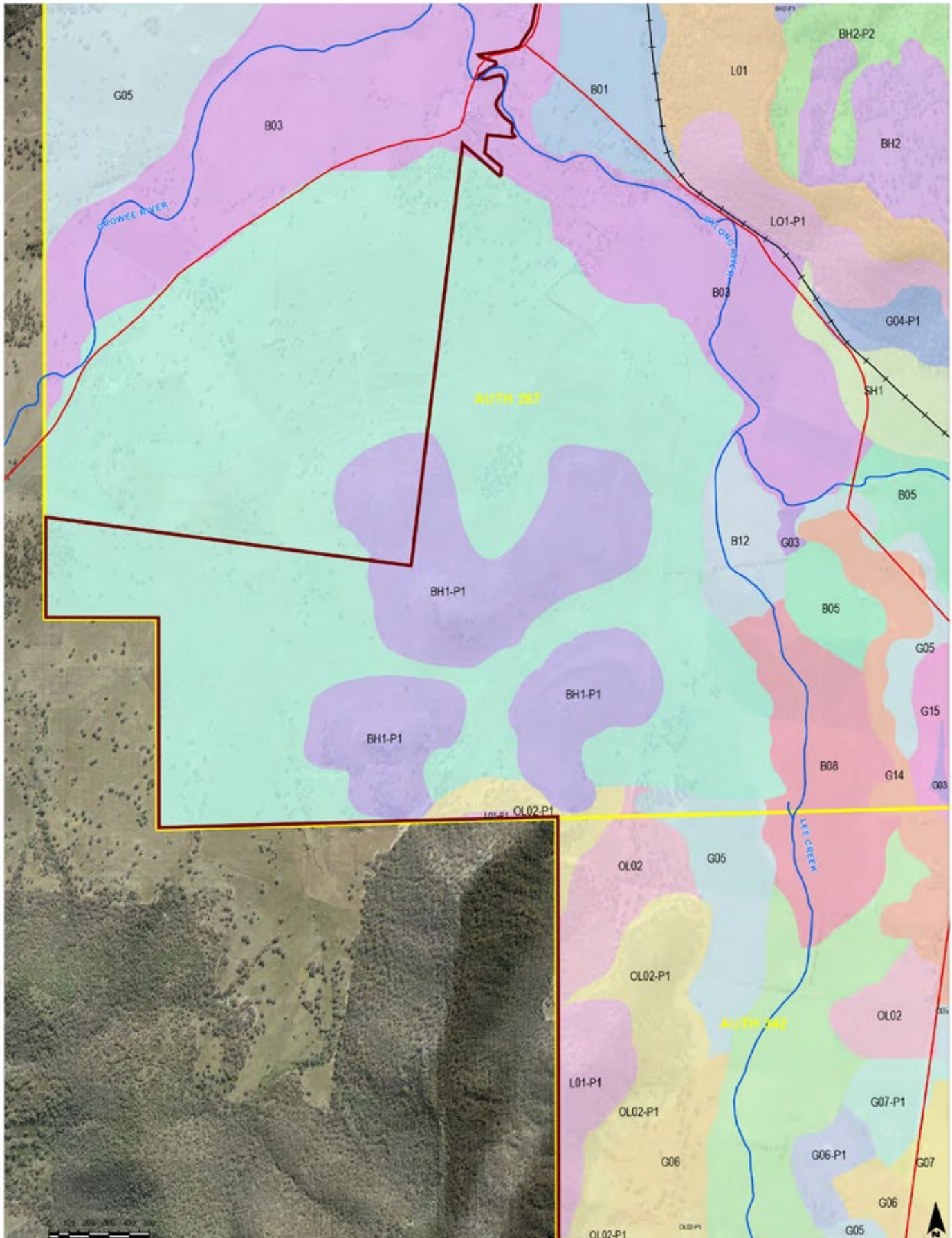
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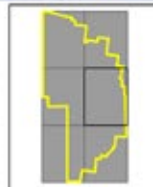
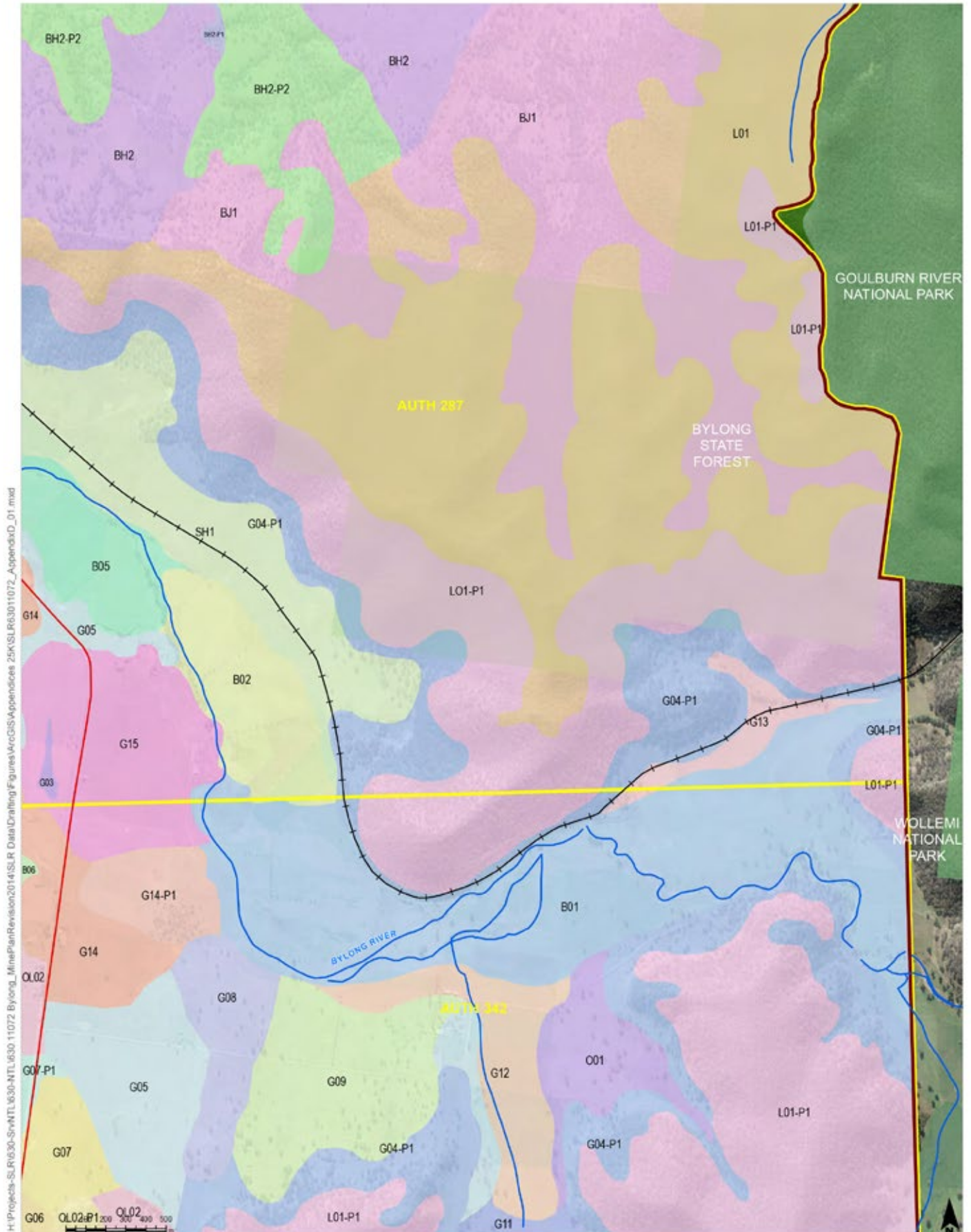
Soil Unit Map

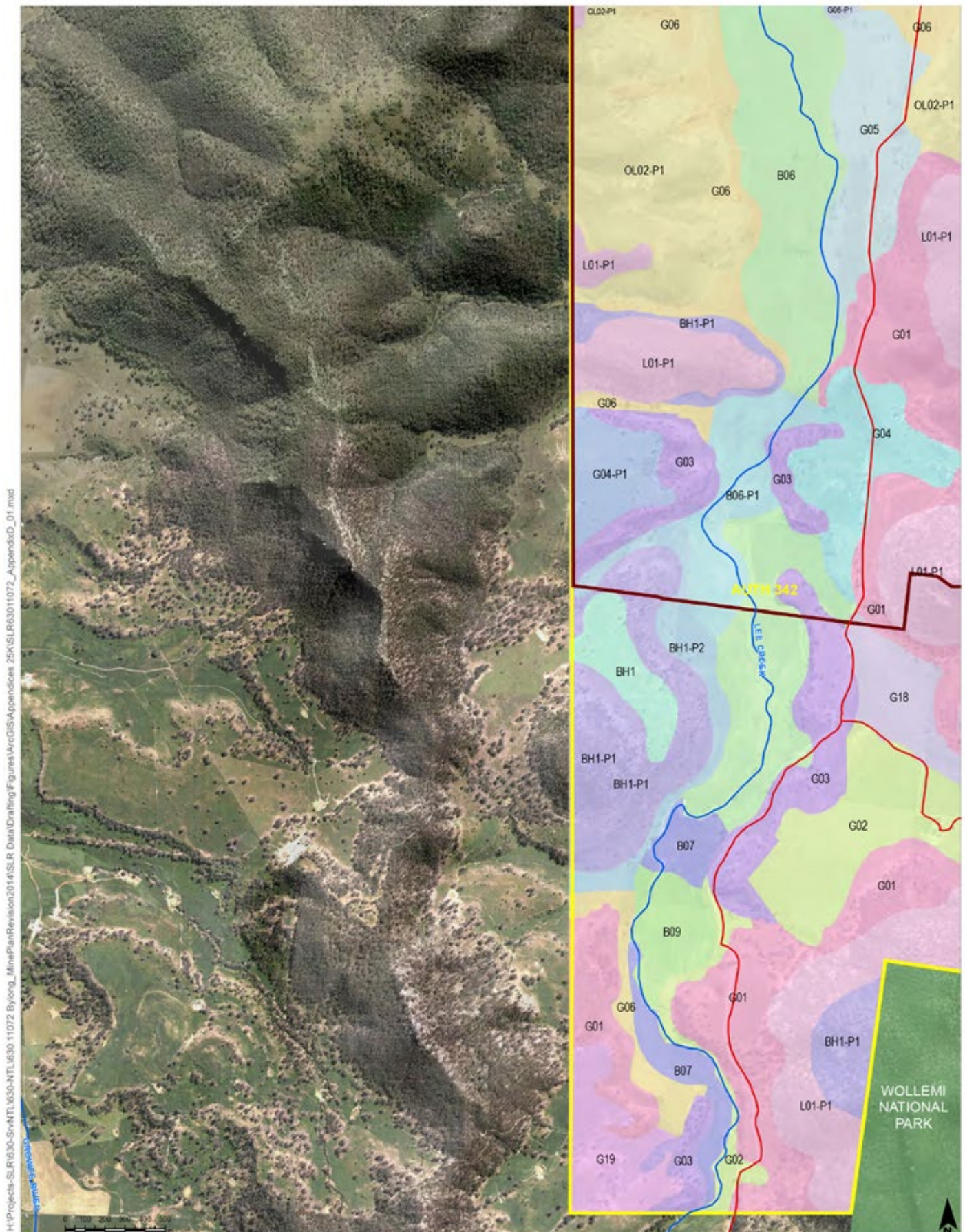
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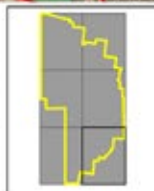
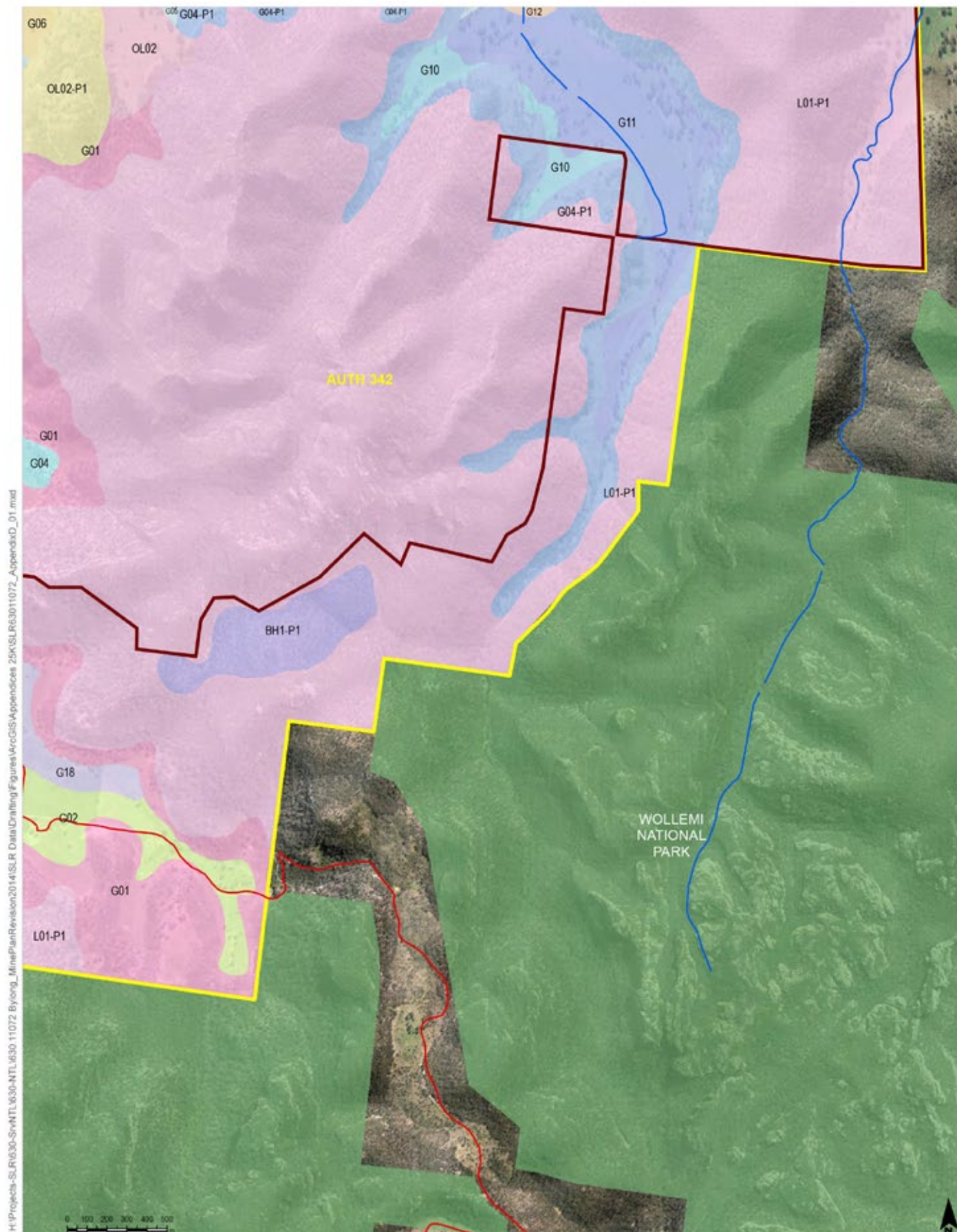


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Appendix E

Report Number 630.11072.00000

Soil Units – Detailed Profile Descriptions

TABLE OF CONTENTS

BALD HILL SOIL LANDSCAPE	5
BALD HILL SOIL LANDSCAPE	5
SOIL UNIT BH1 – EUTROPHIC RED DERMOSOL (DEEP SOIL DEPTH)	6
SOIL UNIT BH1-P1 – RED CHROMOSOL (SHALLOW SOIL DEPTH)	8
SOIL UNIT BH1-P2 – EUTROPHIC RED CHROMOSOL / RED DERMOSOL INTERGRADE (MODERATE SOIL DEPTH)	9
SOIL UNIT BH2 – EUTROPHIC RED DERMOSOL (DEEP SOIL DEPTH)	11
SOIL UNIT BH2-P1 – RED DERMOSOL (MODERATE SOIL DEPTH)	12
SOIL UNIT BH2-P2 – RED CHROMOSOL (SHALLOW SOIL DEPTH)	13
BENJANG SOIL LANDSCAPE	14
SOIL UNIT BJ1 – EUTROPHIC BROWN CHROMOSOL (DEEP SOIL DEPTH)	15
SOIL UNIT BJ2 – SELF-MULCHING BROWN VERTOSOL (SHALLOW SOIL DEPTH)	17
SOIL UNIT BJ3 – SUBNATRIC YELLOW SODOSOL (DEEP SOIL DEPTH)	19
SOIL UNIT BJ3-P1 – SUBNATRIC YELLOW SODOSOL (SHALLOW SOIL DEPTH)	20
BYLONG SOIL LANDSCAPE	22
SOIL UNIT B01 – EUTROPHIC BLACK DERMOSOL OVERLYING STRATIC RUDOSOL	23
SOIL UNIT B02 – EUTROPHIC BLACK DERMOSOL (DEEP SOIL DEPTH)	25
SOIL UNIT B03 – EUTROPHIC BLACK DERMOSOL (DEEP SOIL DEPTH)	27
SOIL UNIT B3-P1 – EUTROPHIC BLACK DERMOSOL (SALINE)	28
SOIL UNIT B04 – BLACK DERMOSOL (MODERATE SOIL DEPTH)	30
SOIL UNIT B05 – BROWN-ORTHIC TENOSOL	32
SOIL UNIT B06 – EUTROPHIC BLACK DERMOSOL OVERLYING STRATIC RUDOSOL	34
SOIL UNIT B6-P1 – EUTROPHIC BLACK DERMOSOL OVERLYING STRATIC RUDOSOL (SALINE)	35
SOIL UNIT B07 – CHERNIC-LEPTIC TENOSOL	36
SOIL UNIT B08 – EUTROPHIC GREY DERMOSOL OVERLYING STRATIC RUDOSOL	38
SOIL UNIT B09 – BLACK DERMOSOL	40
SOIL UNIT B10 – LEPTIC TENOSOL	41
SOIL UNIT B11 – MESOTROPHIC BROWN KANDOSOL	43
SOIL UNIT B12 – STRATIC RUDOSOL OVERLYING BLACK DERMOSOL	45
GROWEE	47
GROWEE SOIL LANDSCAPE UNIT	47
SOIL UNIT G01 – EUTROPHIC RED CHROMOSOL (MODERATE SOIL DEPTH)	48
SOIL UNIT G02 – EUTROPHIC RED CHROMOSOL (DEEP SOIL DEPTH)	50
SOIL UNIT G03 – LITHIC RUDOSOL	52
SOIL UNIT G04 – MESOTROPHIC BROWN CHROMOSOL (MODERATE SOIL DEPTH)	53
SOIL UNIT G04-P1 – BROWN CHROMOSOL (SHALLOW SOIL DEPTH)	54
SOIL UNIT G05 – EUTROPHIC RED CHROMOSOL (MODERATE SOIL DEPTH)	56

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Soil, Land Capability and Strategic Agricultural Land Assessment
Appendix E - Soil Units

SOIL UNIT G05-P1 – RED CHROMOSOL (SHALLOW SOIL DEPTH)	57
SOIL UNIT G06 – EUTROPHIC RED CHROMOSOL (MODERATE SOIL DEPTH)	59
SOIL UNIT G06-P1 – RED CHROMOSOL (SHALLOW SOIL DEPTH)	61
SOIL UNIT G07 – EUTROPHIC RED CHROMOSOL (DEEP SOIL DEPTH)	63
SOIL UNIT G7-P1 – EUTROPHIC RED CHROMOSOL (GRAVELLY)	64
SOIL UNIT G08 – EUTROPHIC RED DERMOSOL (SHALLOW SOIL DEPTH)	66
SOIL UNIT G09 – EUTROPHIC BROWN CHROMOSOL (MODERATE SOIL DEPTH)	68
SOIL UNIT G10 – EUTROPHIC BLACK KANDOSOL	70
SOIL UNIT G11 – STRATIC RUDOSOL	72
SOIL UNIT G12 – BLACK DERMOSOL (DEEP SOIL DEPTH)	73
SOIL UNIT G13 – BLACK-ORTHIC TENOSOL; LIGHT SANDY TEXTURED	75
SOIL UNIT G14 – EUTROPHIC BROWN CHROMOSOL (DEEP SOIL DEPTH)	77
SOIL UNIT G14-P1 – BROWN CHROMOSOL (SHALLOW SOIL DEPTH)	78
SOIL UNIT G15 – SUBNATRIC BROWN SODOSOL	80
SOIL UNIT G16 – STRATIC RUDOSOL	82
SOIL UNIT G17 – EUTROPHIC RED CHROMOSOL (DEEP SOIL DEPTH)	83
SOIL UNIT G17-P1 – EUTROPHIC RED CHROMOSOL (MODERATE SOIL DEPTH)	84
SOIL UNIT G18 – MESONATRIC YELLOW SODOSOL (DEEP SOIL DEPTH)	86
SOIL UNIT G19 – BROWN CHROMOSOL (MODERATE SOIL DEPTH)	88
LEES PINCH	89
LEES PINCH SOIL LANDSCAPE UNIT	89
SOIL TYPE L1 – CLASTIC RUDOSOL	90
SOIL TYPE L1-P1 – CLASTIC RUDOSOL; VERY SHALLOW	91
OGILVIE SOIL LANDSCAPE	92
OGILVIE SOIL LANDSCAPE UNIT	92
SOIL UNIT O1 – MESONATRIC BROWN SODOSOL (MODERATE SOIL DEPTH)	93
SOIL UNIT O1-P1: SUBNATRIC BROWN SODOSOL (SHALLOW SOIL DEPTH)	94
SOIL UNIT O2 – CLASTIC RUDOSOL (DEEP SOL DEPTH)	96
SOIL UNIT O2-P1 – CLASTIC RUDOSOL (MODERATE SOIL DEPTH)	97
SANDY HOLLOW SOIL LANDSCAPE	99
SANDY HOLLOW SOIL LANDSCAPE UNIT	99
SOIL UNIT SH1 – SUBNATRIC RED SODOSOL (DEEP SOIL DEPTH)	100

Within the Study Area there are forty soil types and 14 soil phases covering eight soil landscapes. An overview of the soil types identified within the Study Area is provided in **Table A5.1** and full profile descriptions are provided in this appendix.

Table A5.1 – Soil Types

Soil Type		
No.	ASC Name	Representative Site
BH1	Eutrophic Red Dermosol (deep)	126
BH1-P1: Shallow Phase	Red Chromosol (shallow)	139
BH1-P2: Moderate Phase	Eutrophic Red Chromosol (moderate)	31 (GSSE, 2012)
BH2	Eutrophic Red Dermosol (deep)	1
BH2-P1: Moderate Phase	Red Dermosol (moderate)	7
BH2-P2: Shallow Phase	Red Chromosol (shallow)	28
BJ1	Eutrophic Brown Chromosol (deep)	22
BJ2	Self-mulching Brown Vertosol (shallow)	33
BJ3	Subnatic Yellow Sodosol (deep)	14 (GSSE, 2012)
BJ3-P1: Shallow Phase	Subnatic Yellow Sodosol (shallow)	51
B01	Eutrophic Black Dermosol overlying Stratic Rudosol	52 (GSSE, 2012)
B02	Eutrophic Black Dermosol (deep)	3 (GSSE, 2012)
B03	Eutrophic Black Dermosol (alakine)	278
B03-P1: Saline Phase	Eutrophic Black Dermosol (saline)	295
B04	Black Dermosol (moderate)	251
B05	Brown-Orthic Tenosol	131
B06	Eutrophic Black Dermosol overlying Stratic Rudosol	2 (GSSE, 2012)
B07	Chernic-leptic Tenosol	81 (GSSE, 2012)
B08	Eutrophic Grey Dermosol overlying Stratic Rudosol	72 (GSSE, 2012)
B09	Black Dermosol	60
B10	Leptic Tenosol	11 (GSSE, 2012)
B11	Eutrophic Brown Kandosol	305
B12	Stratic Rudosol overlying Black Dermosol	132
G01	Eutrophic Red Chromosol (moderate)	58
G02	Eutrophic Red Chromosol (deep)	26 (GSSE, 2012)
G03	Lithic Rudosol	93
G04	Mesotrophic Brown Chromosol (moderate)	90
G04-P1	Mesotrophic Brown Chromosol (shallow)	82
G05	Eutrophic Red Chromosol (moderate)	47 (GSSE, 2012)
G05-P1: Shallow Phase	Red Chromosol (shallow)	283
G06	Eutrophic Red Chromosol (moderate)	110
G06-P1: Shallow Phase	Red Chromosol; shallow	238
G07	Eutrophic Red Chromosol (deep)	106
G07-P1: Gravelly Phase	Eutrophic Red Chromosol (gravelly)	156
G08	Eutrophic Red Dermosol (shallow)	147
G09	Eutrophic Brown Chromosol (moderate)	145
G10	Eutrophic Black Kandosol	195

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Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Soil Type		
G11	Stratic Rudosol	208
G12	Black Dermosol (deep)	67 (GSSE, 2012)
G13	Black-Orthic Tenosol (light sandy textured)	77
G14	Eutrophic Brown Chromosol (deep)	50 (GSSE, 2012)
G14-P1	Brown Chromosol (shallow)	100
G15	Subnatric Brown Sodosol	104
G16	Stratic Rudosol	252
G17	Eutrophic Red Chromosol (deep)	43
G17-P1: Moderate Phase	Eutrophic Red Chromosol (moderate)	42
G18	Mesonatric Yellow Sodosol (deep)	25 (GSSE, 2012)
G19	Brown Chromosol* (moderate)	61
L1	Clastic Rudosol	31
L1-P1: Shallow Phase	Clastic Rudosol (very shallow)	N/A
O1	Mesonatric Brown Sodosol (moderate)	8 (GSSE, 2012)
O1-P1: Shallow Phase	Subnatric Brown Sodosol (shallow)	54
O2	Clastic Rudosol (deep)	173
O2-P1: Moderate Phase	Clastic Rudosol (moderate)	231
SH1	Subnatric Red Sodosol (deep)	5 (GSSE, 2012)

BALD HILL SOIL LANDSCAPE

The Bald Hill soil landscape unit covers low hillocks and basalt or dolerite caps. It occurs on the Tertiary basalt geological unit and the parent rock is olivine basalt and dolerite. Elevations range from 240-1000 m and slope gradients are between 5-50%. The dominant soils are Euchrozem-Chocolate Soil intergrades (Dermosols and Chromosols), shallow stony loams (Lithosols) on crests and Chocolate Soils (Chromosols) on lower slopes.

The Bald Hill soil landscape unit covers 1,781.8 ha (17.2%) of the Project Site and is represented entirely by two soil types; Red Dermosol and Red Chromosol. Each soil type is also represented by two soil phases, moderate and shallow soil depth.



Bald Hill Soil Landscape

Soil Unit BH1 – Eutrophic Red Dermosol (deep soil depth)

Soil Unit BH1 is a Dermosol. Dermosols have structured B2 horizons and lack strong texture contrast between A and B horizons. This soil unit is comprised of five distinct soil horizons and is characterised by loam grading into heavy clay. Soil pH trends from neutral to slightly acidic. The profile is non-saline and non-sodic and exhibits slight dispersion characteristics in topsoil and moderate to high characteristics at depth. CEC is low throughout, exchangeable calcium is low relative to magnesium and this soil type has moderately high inherent fertility.

Table A5.2 provides a summary of this soil type.

Table A5.2 – Overview: Soil Type BH1

Site Description		
 		
Plate 1 – Profile (Site 126) Plate 2 – Landscape (Site 126)		
ASC Name		Eutrophic Red Dermosol (deep soil depth)
Great Soil Group		Euchrozem
Representative Site		Site 126
Associated Soil Landscape Unit		Bald Hill
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Cultivation for fodder crops and beef cattle grazing
Land and Soil Capability Class		Class 3; water erosion & soil structure
Interim Protocol - BSAL		Yes
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.0 – 0.10	Dark reddish-brown (5YR3/4) loam with strong structure of 10-20 mm subangular blocky peds with a strong consistence. Nil mottling; 5-10% 2-5 mm stone content, abundant fine roots; neutral pH (pH 6.6) and well drained. Clear and even boundary.
B1	0.10 – 0.25	Dark reddish-brown (5YR3/4) clay loam, strong structure grade of 20-30 mm subangular blocky peds with a strong consistence. Nil mottling; 5-10% 2-5 mm stone content; many fine roots; neutral pH (pH 7.0) and well drained. Gradual and even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.25 – 0.60	Dark red (2.5YR3/6) heavy clay, strong structure grade of 50 mm subangular blocky peds with a strong consistence. Nil mottling; 5-10% 2 mm stone content; common fine roots; slightly acidic pH (pH 6.5) and moderately well drained. Gradual and even boundary.						
B22	0.60 – 0.85	Dark red (2.5YR3/6) heavy clay, strong structure grade of 50-100 mm subangular blocky peds with a strong consistence. Yellow mottling of 5-10%; 10% 5-10 mm stone content; common fine roots; slightly acidic (pH 6.3) and moderately well drained. Gradual and even boundary.						
B3	0.85-1.00	Dark red (2.5YR3/6) heavy clay, strong structure grade of 20-30 mm subangular blocky peds with a strong consistence. Yellow mottling of 5%; 20-30% 5-10 mm stone content; few fine roots; slightly acidic (pH 6.4).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	9.9	Low	1.0	Non-sodic	0.3	Non-saline	3(1)	Slight
B1	6.9	Low	1.4	Non-sodic	0.2	Non-saline	3(2)	Slight
B21	11.2	Low	0.9	Non-sodic	0.2	Non-saline	5	Slight
B22	9.8	Low	4.1	Non-sodic	0.2	Non-saline	5	Slight
B3	8.4	Low	4.8	Non-sodic	0.1	Non-saline	2(1)	High to moderate

Soil Unit BH1-P1 – Red Chromosol (shallow soil depth)

Soil Unit BH1-P1 is a phase of unit BH1. It is located on steeper slopes and crests and has a shallow soil depth. Soil Unit BH2-P1 is comprised of three major soil horizons and is characterised by loamy sand overlying clay that abuts bedrock. Soil pH is slightly acidic in the topsoil and neutral in the subsoil. This soil type has moderate high inherent fertility in accordance with the Interim Protocol.

Table A5.3 provides a summary of this soil unit.

Table A5.3 – Overview: Soil Type BH1-P1

Site Description		
 Plate 3 – Profile (Site 139)		 Plate 4 – Landscape (Site 139)
ASC Name	Red Chromosol (shallow soil depth)	
Great Soil Group	Non-calci Brown Soil	
Representative Site	Site 139	
Associated Soil Landscape Unit	Bald Hill	
Dominant Slope Association	Moderately inclined slopes (10-18%) and some crests.	
Land Use	Grazing	
Land and Soil Capability Class	Class 6; shallow soil depth	
Interim Protocol - BSAL	No; slope >10%	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (7.5YR3/4) loamy sand, moderate structure grade of 10 mm subangular blocky peds with moderate consistence. Nil mottles; 15% 1-2 mm stone content; abundant fine and medium roots; slightly acidic (pH 6.0) and well drained. Clear and even boundary.
B1	0.15 – 0.40	Yellowish-red (5YR4/6) sandy clay, strong structure grade of 50 mm angular blocky peds with strong consistence. Nil mottles; 25% 2 mm stone content; many fine and medium roots; neutral (pH 7.0) and moderately drained. Clear and wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

BC	0.40– 0.55	Yellowish-red (5YR4/6) heavy clay, moderate structure grade of 20-30 mm angular blocky peds with moderate consistence. Nil mottles; 70% 2 mm stone content; many fine roots; neutral (pH 7.0). Abrupt and wavy boundary.
C	0.55+	Weathered bedrock

Soil Unit BH1-P2 – Eutrophic Red Chromosol / Red Dermosol Intergrade (moderate soil depth)

Soil Unit BH1-P2 is a phase of unit BH1 and is moderately deep. Soil Unit BH1-P2 is comprised of four major soil horizons and is characterised by loam overlying heavy clay trending to light clay with depth. The profile is non-saline, non-sodic and generally has slight to negligible dispersion characteristics. CEC is moderate throughout, exchangeable calcium is low relative to magnesium and this soil type has moderately high inherent fertility.

Table A5.4 provides a summary of this soil unit.

Table A5.4 – Overview: Soil Type BH1-P2

Site Description	
 Plate 5 – Profile (Site 31; Core 83) (GSSE, 2012)	 Plate 6 – Landscape (Site 31; Core 83) (GSSE, 2012)
ASC Name	Eutrophic Red Chromosol / Red Dermosol Intergrade (moderate soil depth)
Great Soil Group	Red-Brown Earth / Euchrozem
Representative Site	Site 31; Core 83 (GSSE, 2012)
Associated Soil Landscape Unit	Bald Hill
Dominant Slope Association	Gently inclined (3-10%)
Land Use	Grazing
Land and Soil Capability Class	Class 3; water erosion, soil structure, acidification & soil depth hazards
Interim Protocol - BSAL	No; soil pH, pH >8.9 at 0.5 m

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Interim Protocol –Soil Fertility			Moderately High					
Horizon	Depth (m)	Description						
A1	0.00 – 0.10	Dark brown (7.5YR3/3) loam, moderate structure grade of <5 mm blocky peds with moderate consistence. Nil mottles; 10% <5 mm stone content; many fine roots; slightly acidic (pH 6.4) and well drained. Gradual and even boundary.						
B21	0.10 – 0.30	Yellowish-red (5YR4/6) heavy clay, strong structure grade of 10-20 mm blocky peds with strong consistence. Nil mottles; nil stone content; some fine roots; mildly alkaline (pH 7.5) and well drained. Gradual and even boundary.						
B22	0.30 – 0.50	Yellowish-red (5YR4/6) medium clay, strong structure grade of 10-20 mm blocky peds with strong consistence. Nil mottles; nil stone content; some fine roots; moderately alkaline (pH 8.4) and well drained. Gradual and even boundary.						
B3	0.50 – 0.80	Yellowish-red (5YR4/6) light clay, strong structure grade of 20-50 mm blocky peds with strong consistence. Nil mottles; bedrock fragment presence; strongly alkaline (pH 9.0).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	13.4	Moderate	0.7	Non-sodic	0.6	Non-saline	8	Negligible
B21	17.8	Moderate	0.6	Non-sodic	0.2	Non-saline	3(2)	Slight
B22	18.1	Moderate	1.1	Non-sodic	0.3	Non-saline	2(1)	High to moderate
B3	17.9	Moderate	2.8	Non-sodic	1.0	Non-saline	3(1)	Slight

Soil Unit BH2 – Eutrophic Red Dermosol (deep soil depth)

Soil Unit BH2 is a Dermosol. Soil Unit BH2 is comprised of five major soil horizons and is characterised by silty loam grading into silty clay. Soil pH is slightly acidic in the topsoil and neutral in subsoil. The profile is non-saline, non-sodic and has slight dispersion characteristics. CEC is moderate throughout, exchangeable calcium is low relative to magnesium and this soil type has moderately high inherent fertility.

Table A5.5 provides a summary of this soil type.

Table A5.5 – Overview: Soil Type BH2

Site Description		
 Plate 7 – Profile (Site 1)  Plate 8 – Landscape (Site 1)		
ASC Name		Eutrophic Red Dermosol (deep soil depth)
Great Soil Group		Euchrozem
Representative Site		Site 1
Associated Soil Landscape Unit		Bald Hill (teschenite)
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; water erosion hazard
Interim Protocol –BSAL		Yes
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.05	Dark reddish-brown (5YR3/3) silty loam with strong structure of 20 mm subangular blocky peds with a moderate consistence. Nil mottling; nil stone content, abundant fine roots; slightly acidic pH (pH 6.2) and well drained. Abrupt and even boundary.
A2	0.05 – 0.15	70% sub rounded basalt; floating bedrock; not always present.
B21	0.15 – 0.40	Dark reddish-brown (5YR3/4) silty clay, strong structure grade of 20-30 mm angular blocky peds with a strong consistence. Nil mottling; nil stone content; few fine roots; neutral pH (pH 6.9) and well drained. Gradual and even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B22	0.40 – 0.80	Dark red (2.5YR3/6) silty clay, strong structure grade of 20-30 mm angular blocky peds with a strong consistence. Nil mottling; nil stone content; roots absent; neutral pH (pH 7.1) and well drained. Gradual and even boundary.						
B3	0.80 – 1.0	Dark red (2.5YR3/6) clay loam, strong structure grade of 20-30 mm subangular blocky peds with a strong consistence. Nil mottling; 10% weather basalt fragments; neutral (pH 7.1) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	14.4	Moderate	0.7	Non-sodic	0.7	Non-saline	3(1)	Slight
B21	13.3	Moderate	0.8	Non-sodic	0.2	Non-saline	5	Slight
B22	12.8	Moderate	0.8	Non-sodic	0.2	Non-saline	5	Slight
B3	13.7	Moderate	0.7	Non-sodic	0.2	Non-saline	5	Slight

Soil Unit BH2-P1 – Red Dermosol (moderate soil depth)

Soil Unit BH2-P1 is a phase of BH2 and is moderately deep. It is located on the upper reaches of the gently inclined slopes. Soil Unit BH2-P1 is comprised of three major soil horizons and is characterised by sandy clay loam grading into light-medium clay. Soil pH is slightly acidic throughout. This soil type has moderately high inherent fertility.

Table A5.6 provides a summary of this soil type.

Table A5.6 – Overview: Soil Type BH2-P1

Site Description	
	
Plate 9 – Profile (Site 7)	
ASC Name	Eutrophic Red Dermosol (moderate)
Great Soil Group	Euchrozem
Representative Site	Site 7
Associated Soil Landscape Unit	Bald Hill (teschenite)
Dominant Slope Association	Gently inclined (3-10%)
Land Use	Grazing
Land and Soil Capability Class	Class 4; shallow soil depth

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Interim Protocol –BSAL		No; physical barrier, bedrock at 0.65 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Reddish-brown (2.5YR4/4) sandy clay loam with strong structure of 10-30 mm subangular blocky peds with a moderate consistence. Nil mottling; 5% 1-5 mm stone content, many fine roots; slightly acidic pH (pH 6.5) and well drained. Gradual wavy boundary.
B1	0.10 – 0.40	Dark reddish-brown (2.5YR3/4) light clay, strong structure grade of 20-50 mm angular blocky peds with a strong consistence. Nil mottling; nil stone content; many medium roots; slightly acidic pH (pH 6.5) and well drained. Gradual and even boundary.
B2	0.40 – 0.65	Dark reddish-brown (2.5YR3/4) light-medium clay, strong structure grade of 50-100 mm angular blocky peds with a strong consistence. Nil mottling; 20% 1-5 mm stone content; few coarse roots; slightly acidic pH (pH 6.5) and well drained. Clear and irregular boundary.
BC	0.65+	Weathered bedrock

Soil Unit BH2-P2 – Red Chromosol (shallow soil depth)

Soil Unit BH2-P2 is a phase of unit BH2 and located on the steeper slopes. It has a shallow soil depth and would be a Chromosol, rather than a Dermosol, due to the convex nature of the slopes. Soil Unit BH2-P2 is characterised by significant stone and gravel content (50%), with teschenite cobbles up to 300 mm.

Table A5.7 provides a summary of this soil unit.

Table A5.7 – Overview: Soil Type BH1-P2

Site Description	
	
Plate 10 – Profile (Site 28)	Plate 11 – Landscape (Site 28)
ASC Name	Red Chromosol (shallow soil depth)
Great Soil Group	Non-calci Brown Soil
Representative Site	Site 28
Associated Soil Landscape Unit	Bald Hill
Dominant Slope Association	Moderately inclined slopes (10-32%)
Land Use	Grazing
Land and Soil Capability Class	Class 6; water erosion hazard and shallow soil depth
Interim Protocol –BSAL	No; slope > 10%
Interim Protocol –Soil Fertility	Moderately high

BENJANG SOIL LANDSCAPE

The Benjang soil landscape unit occurs on rounded rolling hills with large open valleys and some sandstone cliffs and occurs beside the more rugged Lees Pinch soil landscape in the east of the Project area. It occurs on the Illawarra Coal Measures geological unit and the parent rock is shale, sandstone, conglomerate, mudstone, coal, tuff and some basalt. The rolling hills range in elevation from 240-440 m and are generally rounded with frequent outcrops of sandstone or conglomerate on the summits. The landform slopes are 10-25%. The main soils are Red, Yellow and Brown Solodics (Sodosols) on steeper benched country and, Non-calcic Brown Soils (Chromosols) on upper slopes and Brown Podzolic Soils (Chromosol) on flat slopes. Solodic soil has the potential to cause minor to severe sheet erosion on cleared hillslopes and minor rill and gully erosion on the mid to lower slopes. Soils on the steeper benched country with hard rocks and near horizontal bedding, has resulted in poor soil drainage.

The Benjang soil landscape unit covers 517.5 ha (5.0%) of the Project Site and is represented by three soil types; Brown Chromosols, Brown Vertosols and Yellow Sodosols. The Yellow Sodosol is also represented by a shallow phase soil.



Benjang Soil Landscape Unit

Soil Unit BJ1 – Eutrophic Brown Chromosol (deep soil depth)

Soil Unit BJ1 is a Chromosol. Chromosols are soils with strong texture contrast between A and B horizons that do not have strongly acidic or sodic B horizons. Soil Unit BJ1 is comprised of four major soil horizons and is characterised by loam overlying light medium clay. Soil pH is neutral becoming strongly acidic at depth and the profile is non-saline. It is non-sodic and has slight to negligible dispersion characteristics. CEC is low throughout, exchangeable calcium is low relative to magnesium and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.8 provides a summary of this soil type.

Table A5.8 – Overview: Soil Type BJ1

Site Description		
 		
Plate 12 – Profile (Site 22) Plate 13 – Landscape (Site 22)		
ASC Name		Eutrophic Brown Chromosol (deep soil depth)
Great Soil Group		Non-calclac Brown Soil
Representative Site		Site 22
Associated Soil Landscape Unit		Benjang
Dominant Slope Association		Gently inclined slopes (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; water erosion, soil structure, acidification, salinity, waterlogging hazard
Interim Protocol –BSAL		No; chemical barrier, ECe >4 at 0.6 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.20	Strong brown (7.5YR4/6) loam with very weak structure. Nil mottling; coarse fragments of 10%; many fine and coarse roots; neutral pH (pH 6.8) and well drained. Clear and wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.20 – 0.40	Yellowish-brown (10YR5/4) light-medium clay, moderate structure grade of 10-20 mm subangular blocky peds with a moderate consistence. Grey mottling of 10%, <10% coarse fragments; many fine and coarse roots; neutral pH (pH 6.8) and moderately well drained. Gradual and wavy boundary.						
B22	0.40 – 0.60	Dark yellowish-brown (10YR4/4) light clay, moderate structure grade of 20-40 mm columnar peds with a moderate consistence. Grey mottling of 30%, coarse fragment content of 30%; few fine roots; moderately alkaline pH (pH 8.4) and imperfectly drained. Gradual and wavy boundary.						
B23	0.60 – 0.90	Dark yellowish-brown (10YR4/6) clay loam, moderate structure grade of 20-30 mm columnar peds with a moderate consistence. Grey mottling of 30%, nil coarse fragments; very few fine roots; strongly acidic (pH 5.1) and imperfectly drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	3.2	Very low	3.1	Non-sodic	0.2	Non-saline	3(1)	Slight
B21	6.4	Low	1.6	Non-sodic	0.2	Non-saline	3(2)	Slight
B22	10.7	Low	0.9	Non-sodic	1.1	Non-saline	3(1)	Slight
B23	4.4	Very low	2.3	Non-sodic	4.9	Moderately saline	6	Negligible

Soil Unit BJ2 – Self-mulching Brown Vertosol (shallow soil depth)

Soil Unit BJ2 is a Vertosol. Vertosols are clay soils with shrink-swell properties that exhibit strong cracking when dry. Unit BJ2 is comprised of three major soil horizons and is characterised by uniform heavy clay overlying bedrock. Soil pH is mildly alkaline becoming strongly alkaline at depth; the topsoil is non-saline and the subsoil slightly saline. It has non-sodic topsoil, marginally sodic subsoil and moderate to high dispersion characteristics throughout. CEC is moderate to low throughout, exchangeable calcium is low relative to magnesium throughout and this soil type has high inherent fertility in accordance with the Interim Protocol.

Table A5.9 provides a summary of this soil type.

Table A5.9 – Overview: Soil Type BJ2

Site Description		
 		
Plate 14 – Profile (Site 33) Plate 15 – Landscape (Site 33)		
ASC Name		Self-mulching Brown Vertosol (shallow soil depth)
Great Soil Group		Brown Clay
Representative Site		Site 33
Associated Soil Landscape Unit		Benjang
Dominant Slope Association		Gently inclined slopes (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 6; shallow soil depth
Interim Protocol –BSAL		No; physical barrier, bedrock at 0.5 m
Interim Protocol –Soil Fertility		High
Horizon	Depth (m)	Description
A1	0.00–0.20	Very dark brown (10YR 2/2) heavy clay with strong structure grade of 20-50 mm angular blocky peds with strong consistence. Nil mottling; 10% angular 5 mm shale coarse fragments; abundant fine and coarse roots; mildly alkaline (pH 7.4) and well drained. Clear boundary.
B1	0.20–0.40	Very dark brown (10YR 2/2) heavy clay with strong structure grade, 30-50 mm angular blocky peds with strong consistence. Nil mottling; nil coarse fragments; many fine roots; strongly alkaline (pH 8.6) and well drained. Clear boundary.
B2	0.40–0.50	Dark brown (10Y 3/3) heavy clay with strong structure grade, 50+ mm blocky peds with strong consistence. Nil mottling; 5-10% angular 5 mm shale coarse fragments; few fine roots; strongly alkaline (pH 9.0) and well drained. Clear boundary.
C	0.50+	Shale bedrock

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	22.6	Moderate	1.8	Non-sodic	0.5	Non-saline	2(1)	High to moderate
B1	10.1	Low	5.9	Non-sodic	0.9	Non-saline	2(1)	High to moderate
B2	8.8	Low	9.1	Marginally sodic	2.1	Slightly saline	2(1)	High to moderate

Soil Unit BJ3 – Subnatic Yellow Sodosol (deep soil depth)

Soil Unit BJ3 is a Sodosol. Sodosols are soils with strong texture contrast between A and B horizons that have sodic B horizons. Soil Unit BJ3 is comprised of four major soil horizons and is characterised by sandy clay loam overlying sandy clay. Soil pH is neutral in the topsoil and moderately alkaline in the subsoil. It is non-saline and contains sodic subsoil. CEC is low throughout, exchangeable calcium is low relative to magnesium throughout and this soil type has moderately low inherent fertility.

Table A5.10 provides a summary of this soil unit.

Table A5.10 – Overview: Soil Type BJ3

Site Description		
 Plate 16 – Profile (Site 14; Core 71) (GSSE, 2012)  Plate 17 – Landscape (Site 14; Core 71) (GSSE, 2012)		
ASC Name	Subnatic Yellow Sodosol (deep soil depth)	
Great Soil Group	Solodic Soil	
Representative Site	Site 14; Core 71 (GSSE, 2012)	
Associated Soil Landscape Unit	Benjang	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 4; acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Very dark greyish-brown (10YR3/2) sandy clay loam, moderate structure grade of <5 mm subangular blocky peds with moderately weak consistence. Nil mottling; 5% 5 mm stone content; many fine roots; neutral pH (pH 6.6) and well drained. Clear and wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

A2	0.15 – 0.35	Brown (7.5YR3/3) sandy clay loam, massive structure grade. Nil mottling; nil stone content; many fine roots; neutral pH (pH 7.3) and moderately well drained. Clear and wavy boundary.				
B21	0.35 – 0.60	Brown (7.5YR5/3) sandy clay, moderate structure grade of 10 mm subangular blocky peds with moderately weak consistence. Nil mottling; 20-30% 20 mm stone content; very few roots; moderately alkaline (pH 8.1) and imperfectly drained. Clear and wavy boundary.				
B22	0.60 – 1.00	Very dark brown (10YR2/2) sandy clay, moderate structure grade of 10 mm subangular blocky peds with moderately weak consistence. Nil mottling; 40% 20-30 mm stone content; very few roots; moderately alkaline (pH 8.2) and imperfectly drained.				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	8	Low	0.6	Non-sodic	0.6	Non-saline
A2	5.6	Very low	0.9	Non-sodic	0.2	Non-saline
B21	5.2	Very low	9.6	Marginally Sodic	0.2	Non-saline
B22	6.5	Low	10.8	Sodic	0.3	Non-saline

Soil Unit BJ3-P1 – Subnatric Yellow Sodosol (shallow soil depth)

Soil Unit BJ3-P1 is a phase of unit BJ3. It is located on steeper slopes and has a shallower soil depth. Soil Unit BJ3-P1 is comprised of three major soil horizons and is characterised by loam overlying medium clay. Soil pH is neutral trending into mildly alkaline at depth. It contains non-saline topsoil and is slightly saline in the lower subsoil. The topsoil is non-sodic, the subsoil sodic the profile has high dispersion characteristics. CEC is low in the topsoil and moderate in the subsoil, exchangeable calcium is deficient relative to magnesium throughout and this soil type has moderately low inherent fertility.

Table A5.11 provides a summary of this soil unit.

Table A5.11 – Overview: Soil Type BJ3-P1

Site Description	
	
Plate 18 – Profile (Site 51)	Plate 19 – Landscape (Site 51)
ASC Name	Subnatric Yellow Sodosol (shallow soil depth)
Great Soil Group	Solodic Soil
Representative Site	Site 51
Associated Soil Landscape Unit	Benjang
Dominant Slope Association	Steeply inclined (10-32%)

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Land Use		Grazing						
Land and Soil Capability Class		Class 6; shallow soil depth						
Interim Protocol –BSAL		No; slope >10%						
Interim Protocol –Soil Fertility		Moderately low						
Horizon	Depth (m)	Description						
A2	0.00 – 0.20	Brown (7.5YR4/3) loam, weak structure grade of 5 mm subangular peds. Many fine roots; slightly acidic (pH 6.5) and moderately well drained. Clear wavy boundary.						
B21	0.20 – 0.40	Strong brown (7.5YR4/6) medium clay, moderate structure grade of 20 mm angular blocky peds with strong consistence. Few fine roots; neutral pH (pH 6.9) and imperfectly drained. Gradual wavy boundary.						
B22	0.40 – 0.55	Strong brown (7.5YR4/6) light-medium clay, moderate structure grade of 10 mm subangular blocky peds with strong consistence. Very few fine roots; mildly alkaline (pH 7.6) and imperfectly drained.						
CB	0.55+	Weathering bedrock						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A2	7.6	Low	3.9	Non-sodic	0.7	Non-saline	2(1)	High to moderate
B21	13.2	Moderate	8.3	Marginally sodic	1.4	Non-saline	2(1)	High to moderate
B22	14.2	Moderate	12.7	Sodic	2.3	Slightly saline	2(1)	High to moderate

BYLONG SOIL LANDSCAPE

The Bylong soil landscape unit covers alluvial flats and low terraces of the Growee Creek and at Bylong. It occurs on the Quaternary alluvium geological unit and the parent material is alluvium. Elevations range from 260-320 m and the landform consists of low (<10m) alluvial terraces with swampy hollows and abandoned channels. The main soils are Non-calci Brown (Chromosols) Soil-Prairie Soil (Dermosols) intergrades on the alluvial flats, Chernozems on channel benches and the Brown Clays (Vertosols) occurring in drainage areas, with basaltic colluviums. This soil landform provides a stable landscape with little erosion except for stream bank erosion along main drainage channels.

The Bylong soil landscape unit covers 1,664.2 ha (16.2%) of the Project Site and is represented by 12 soil types and 1 phase. A total of 6 soil types within this unit are Black Dermosols, with other soil types including Brown-Orthic Tenosol, Chernic-Leptic Tenosol, Grey Dermosol, Leptic Tenosol, Brown Kandosol and Stratic Rudosol. The Black Dermosol is also represented by a saline phase soil.



Bylong Soil Landscape Unit

Soil Unit B01 – Eutrophic Black Dermosol overlying Stratic Rudosol

Soil Unit B01 is a Dermosol overlying light textured Stratic Rudosol. This soil unit is of alluvial origin and is comprised of four distinct soil characterised by a loam overlying a sandy loam that overlies a coarser textured buried Rudosol. Soil pH trends from moderately alkaline to strongly alkaline; the topsoil is slightly saline and non-saline in the remainder of the profile. It is non-sodic and has negligible to slight dispersion characteristics. CEC is high to moderate in the topsoil and low in the remainder of the profile, exchangeable calcium is low relative to magnesium and this soil type has high inherent fertility.

Table A5.12 provides a summary of this soil unit.

Table A5.12 – Overview: Soil Unit B01

Site Description		
 Plate 20 – Profile (Site 52; Core 33) (GSSE, 2012)  Plate 21 – Landscape (Site 52; Core 33) (GSSE, 2012)		
ASC Name		Eutrophic Black Dermosol overlying light textured Stratic Rudosol
Great Soil Group		Chernozem overlying Alluvial Soil (light textured)
Representative Site		Site 52; Core 33 (GSSE, 2012)
Associated Soil Landscape Unit		Bylong
Dominant Slope Association		Very gently inclined (<1%)
Land Use		Pasture
Land and Soil Capability Class		Class 3; soil structure hazard
Interim Protocol –BSAL		Yes
Interim Protocol –Soil Fertility		High
Horizon	Depth (m)	Description
A1	0.00 – 0.20	Black (10YR2/1) loam, moderate structure grade of 5-10 mm blocky peds with moderate consistence. Nil mottling and nil stone content. Moderately alkaline (pH 8.4). Well drained with clear and even boundary.
B11	0.20 – 0.40	Black (10YR2/1) sandy loam, moderately weak structure grade of 5-10 mm blocky peds with moderate consistence. Nil mottling and nil stone content. Strongly alkaline (pH 8.7). Well drained with gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B12	0.40 – 0.60	Strong brown (7.5YR4/6) sandy loam, very weak structure grade of 5-10 mm blocky peds with weak consistence. Nil mottling and nil stone content. Strongly alkaline (pH 8.7). Abrupt and wavy boundary (can occur at 0.4 m)						
A1b	0.60 – 1.00	Strong brown (7.5YR4/6) loamy sand, apedal. Nil mottling and nil stone content. Strongly alkaline (pH 8.7).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	28.4	High	1.8	Non-sodic	2.4	Slightly saline	4	Negligible
B11	14.4	Moderate	2.1	Non-sodic	1.4	Non-saline	5	Slight
B12	10.4	Low	2.9	Non-sodic	0.8	Non-saline	4	Negligible
A1b	9.0	Low	3.3	Non-sodic	0.7	Non-saline	3(1)	Slight

Soil Unit B02 – Eutrophic Black Dermosol (deep soil depth)

Soil Unit B02 is a Black Dermosol. This soil unit is comprised of four distinct soil horizons characterised by a silty loam grading into a clay loam. Soil pH trends from neutral to strongly alkaline; salinity is moderate in the topsoil and low in the subsoil; the topsoil is non-sodic and the subsoil is marginally sodic, and the profile has slight dispersion characteristics. CEC is high throughout the profile and this soil type has high inherent fertility.

Table A5.13 provides a summary of this soil unit.

Table A5.13 – Overview: Soil Unit B02

Site Description		
 Plate 22 – Profile (Site 3; Core 20) (GSSE, 2012)  Plate 23 – Landscape (Site 3; Core 20) (GSSE, 2012)		
ASC Name	Eutrophic Black Dermosol (deep soil depth)	
Great Soil Group	Chernozem	
Representative Site	Site 3; Core 20 (GSSE, 2012)	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Improved pasture and fodder crops	
Land and Soil Capability Class	Class 4; soil salinity hazard	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	High	
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Black (10YR2/1) silty loam, moderate structure grade of 10 mm subangular peds with moderate consistence. Nil mottling and nil stone content. Neutral pH (pH 6.6). Well drained with clear and even boundary.
B1	0.10 – 0.30	Black (10YR2/1) silty clay loam, moderate structure grade of 10-20 mm subangular peds with moderate consistence. Nil mottling and nil stone content. Well drained with gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.30 – 0.60	Black (10YR2/1) clay loam, moderate structure grade of 10 mm subangular peds with moderate consistence. Grey mottles of 20% and nil stone content. Strongly alkaline (pH 8.8). Well drained with gradual boundary.						
B22	0.60 – 0.90	Very dark brown (10YR2/2) clay loam, moderate structure grade of 10-20 mm angular blocky peds with moderate consistence. Nil mottling and nil stone content. Strongly alkaline (pH 8.8).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	40.4	Very high	2.2	Non-sodic	4.0	Slightly saline	5	Slight
B1	38.5	High	3.9	Non-sodic	0.9	Non-saline	3(1)	Slight
B21	29.0	High	9.0	Marginally sodic	2.0	Non-saline	3(1)	Slight
B22	22.1	Moderate	6.3	Marginally sodic	1.0	Non-saline	3(1)	Slight

Soil Unit B03 – Eutrophic Black Dermosol (deep soil depth)

Soil Unit B03 is a Black Dermosol. This soil unit is comprised of four distinct soil horizons characterised by a silty clay and heavy clay grading into a clay loam. Soil pH trends from mildly alkaline to strongly alkaline; topsoil is non-saline and slightly saline in the subsoil. The profile is non-sodic and has negligible dispersion characteristics. CEC is high to very high throughout the profile. Exchangeable calcium is low relative to magnesium and this soil type has high inherent fertility.

Table A5.14 provides a summary of this soil unit.

Table A5.14– Overview: Soil Unit B03

Site Description		
 Plate 24 – Profile (Site 278)  Plate 25 – Landscape (Site 278)		
ASC Name		Eutrophic Black Dermosol (deep soil depth)
Great Soil Group		Chernozem
Representative Site		Site 278
Associated Soil Landscape Unit		Bylong
Dominant Slope Association		Gently inclined to very gently inclined (0-3%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; soil structure and salinity hazard
Interim Protocol –BSAL		No; soil pH, pH>8.9 at depth of 0.45 m
Interim Protocol –Soil Fertility		High
Horizon	Depth (m)	Description
A1	0.00 – 0.30	Black (7.5YR 2.5/1) silty clay, moderate structure grade of 5-105 mm subangular blocky peds with moderate consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; mildly alkaline (pH 7.8) and well drained. Gradual even boundary.
B21	0.30 – 0.45	Very dark greyish brown (10YR 3/2) heavy clay, moderate structure grade of 10-20 mm subangular blocky peds with moderate consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; strongly alkaline (pH 8.8) and well drained. Gradual even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B22	0.45 – 0.80	Brown (10YR 5/3) clay loam, moderately weak structure grade of 10-20 mm subangular blocky peds with weak consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; strongly alkaline (pH 9.0) and well drained. Gradual even boundary.						
B23	0.80 – 1.00	Brown (10YR 5/3) clay loam, moderately weak structure grade of 10-20 mm blocky peds with weak consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; very strongly alkaline (pH 9.2) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	51.6	Very high	0.2	Non-sodic	0.9	Non-saline	4	Negligible
B21	49.1	Very high	0.4	Non-sodic	1.1	Non-saline	4	Negligible
B22	38.8	High	0.5	Non-sodic	3.8	Slightly saline	4	Negligible
B23	37.6	High	1.1	Non-sodic	4.0	Slightly saline	4	Negligible

Soil Unit B3-P1 – Eutrophic Black Dermosol (saline)

Soil Unit B3-P1 is a phase of unit B03. It is located on similar slopes; however has saline subsoil. Soil Unit B3- P1 is comprised of four major soil horizons and is characterised by silty clay loam grading into heavy clay. Soil pH is mildly alkaline and increases in alkalinity to strongly alkaline in the subsoil. It is non-saline in the topsoil becoming moderately saline in the subsoil. It is non-sodic and has slight to negligible dispersion characteristics. CEC is high to very high throughout, exchangeable calcium is low to deficient relative to magnesium and this soil type has high inherent fertility.

Table A5.15 provides a summary of this soil unit.

Table A5.15 – Overview: Soil Type B2-P1

Site Description	
 Plate 26 – Profile (Site 295)	 Plate 27 – Landscape (Site 295)
ASC Name	Eutrophic Black Dermosol (saline)
Great Soil Group	Chernozem
Representative Site	Site 295

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Associated Soil Landscape Unit		Bylong						
Dominant Slope Association		Gently inclined to very gently inclined (0-3%)						
Land Use		Grazing						
Land and Soil Capability Class		Class 4; soil salinity hazard						
Interim Protocol –BSAL		No; chemical barrier, ECe >4 dS/m at 0.6 m						
Interim Protocol –Soil Fertility		High						
Horizon	Depth (m)	Description						
A1	0.00 – 0.15	Very dark brown (10YR2/2) silty clay loam, moderate structure grade of 5-10 mm blocky peds with moderately weak consistence. Nil mottles; nil stone content; many fine and coarse roots; mildly alkaline (pH 7.6) and well drained. Clear and even boundary.						
B1	0.15 – 0.30	Very dark brown (10YR2/2) silty clay, moderate structure grade of 10-20 mm subangular blocky peds with moderate consistence. Nil mottles; nil stone content; many fine and coarse roots; strongly alkaline (pH 8.6) and well drained. Clear and even boundary.						
B21	0.30 – 0.60	Very dark brown (10YR2/2) heavy clay, strong structure grade of 20-40 mm subangular blocky peds with strong consistence. Nil mottles; nil stone content; many fine roots; strongly alkaline (pH 8.6) and well drained. Clear and even boundary.						
B22	0.60 – 1.00	Very dark greyish-brown (10YR3/2) heavy clay, strong structure grade of 20-40 mm subangular blocky peds with strong consistence. Nil mottles; nil stone content; many fine roots; strongly alkaline (pH 8.5) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	25.3	High	0.8	Non-sodic	0.4	Non-saline	3(1)	Slight
B1	33.8	High	4.4	Non-sodic	1.2	Non-saline	3(2)	Slight
B21	36.5	High	4.7	Non-sodic	3.3	Moderately saline	4	Negligible
B22	50.0	Very high	2.0	Non-sodic	5.5	Moderately saline	4	Negligible

Soil Unit B04 – Black Dermosol (moderate soil depth)

Soil Unit B04 is a Dermosol. It is comprised of five major soil horizons and is characterised by a loam grading to medium clay. Soil pH is slightly acidic in the topsoil and increases in alkalinity to strongly alkaline in the subsoil. This soil type has high inherent fertility.

Table A5.16 provides a summary of this soil unit.

Table A5.16 – Overview: Soil Type B04

Site Description		
 Plate 28 – Profile (Site 251)	 Plate 29 – Landscape (Site 251)	
	Date & Time: Tue Apr 9 15:24:36 EST 2013 Position: -33.3730° 151.59 1870° Altitude: 231m Magnetic Declination: 1.1° 5005.2507m/s (True) Elevation Grade: -4.18% Horizon Grade: +0.00% Slope: 12°	
ASC Name	Black Dermosol (moderate soil depth)	
Great Soil Group	Chernozem	
Representative Site	Site 251	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Gently inclined (1-3%)	
Land Use	Native grass; evidence of past cultivation	
Land and Soil Capability Class	Class 4; shallow soil depth	
Interim Protocol –BSAL	No; physical barrier, bedrock at 0.75 m	
Interim Protocol –Soil Fertility	High	
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Black (7.5YR 2.5/1) silty clay loam, moderately strong structure grade of 10-155 mm subangular blocky peds with moderately weak consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; slightly acidic (pH 6.5) and well drained. Gradual even boundary.
B11	0.10 – 0.25	Black (7.5YR 2.5/1) silty clay, moderate structure grade of 5-10 mm subangular blocky peds with moderately weak consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; mildly alkaline (pH 7.5) and well drained. Gradual even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B12	0.25 – 0.40	Black (10YR 2.5/1) medium clay, moderate structure grade of 10-20 mm subangular blocky peds with strong consistence. Nil mottles; <5% 5 mm stone content; common fine roots; moderately alkaline (pH 8.0) and well drained. Gradual even boundary.
B21	0.40 – 0.65	Very dark grey (10YR 3/1) heavy clay, strong structure grade of 20-40 mm subangular blocky peds with strong consistence. Nil mottles; 5% 5 mm stone content; few fine roots; moderately alkaline (pH 8.0) and well drained. Gradual even boundary.
BC	0.65 – 0.75	Very dark grey (10YR 3/1) medium clay, strong structure grade of 20-40 mm subangular blocky peds with strong consistence. Nil mottles; 20% 5 mm stone content; very few fine roots; strongly alkaline (pH 8.5) and well drained. Clear even boundary.
C	0.75-1.00+	Bedrock; sandstone

Soil Unit B05 – Brown-Orthic Tenosol

Soil Unit B05 is a Tenosol. This soil unit is comprised of four distinct soil horizons characterised by a clay loam overlying a loamy sand/sand at depth. Soil pH trends from moderately acidic to moderately alkaline. This soil type has moderately low inherent fertility.

Table A5.17 provides a summary of this soil unit.

Table A5.17 – Overview: Soil Unit B05

Site Description		
 Plate 30 – Profile (Site 131)  Plate 31 – Landscape (Site 131)		
ASC Name	Brown-Orthic Tenosol	
Great Soil Group	Alluvial Soil – light sandy textured	
Representative Site	Site 131	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Lucerne crops	
Land and Soil Capability Class	Class 4; soil acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A11	0.00 – 0.20	Very dark greyish-brown (10YR3/2) clay loam moderate structure grade of 10 mm subangular blocky peds with strong consistence. Nil mottling; 20% quartz <2 mm stone content; abundant fine roots; moderately acidic (pH 6.0) and well drained. Abrupt even boundary.
A12	0.20 – 0.40	Dark yellowish-brown (10YR3/6) loamy sand, very weak structure grade of <5 mm subangular blocky peds with weak consistence. Nil mottling; <5% stone content; many fine roots; moderately alkaline (pH 8.0) and well drained. Gradual even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

A13	0.40 – 0.70	Strong brown (7.5YR4/6) sand with apedal structure grade. Nil mottling; nil stone content; few fine roots; moderately alkaline (pH 8.0) and well drained. Diffuse even boundary.
A14	0.70 – 1.00	Light brown (7.5YR6/3) sand with apedal structure grade. Nil mottling; nil stone content; few fine roots; moderately alkaline (pH 8.0) and well drained. Diffuse even boundary.

Soil Unit B06 – Eutrophic Black Dermosol overlying Stratic Rudosol

Soil Unit B06 is a Dermosol overlying a Stratic Rudosol. This soil unit is comprised of five distinct soil horizons characterised by loam overlying coarser textured buried sandy loam. Soil pH trends from moderately acidic to moderately alkaline. The profile is non-saline, non-sodic and slight dispersion characteristics. Cation exchange capacity is moderate throughout the profile. This soil type has high inherent fertility.

Table A5.18 provides a summary of this soil unit.

Table A5.18 – Overview: Soil Unit B06

Site Description		
 Plate 32 – Profile (Site 2; Core 2) (GSSE, 2012)  Plate 33 – Landscape (Site 2; Core 2) (GSSE, 2012)		
ASC Name	Eutrophic Black Dermosol overlying Stratic Rudosol (medium textured)	
Great Soil Group	Chernozem overlying alluvial soil (medium textured)	
Representative Site	Site 2; Core 2 (GSSE, 2012)	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Lucerne crops	
Land and Soil Capability Class	Class 3; soil structure hazard	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	High	
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (10YR2/2) loam, moderate structure grade of 5 mm subangular peds with weak consistence. Nil mottling and nil stone content. Well drained with gradual boundary.
B1	0.10 – 0.60	Black (10YR2/1) loam, moderate structure grade of 10-20 mm subangular peds with weak consistence. Nil mottling and nil stone content. Neutral pH (pH 6.7). Well drained with gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B2	0.60 – 0.80	Black (10YR2/1) loam, weak structure grade of 5 mm subangular peds with weak consistence. Nil mottling and nil stone content. Moderately alkaline (pH 8.0). Well drained with an abrupt wavy boundary.				
A11b	0.80 – 1.00	Dark greyish-brown (10YR4/2) sandy loam, apedal structure grade. Nil mottling and nil stone content. Moderately alkaline (pH 8.3). Gradual boundary.				
A12b	1.00 – 1.20	Black (10YR2/1) fine sandy loam, weak structure grade. Nil mottling and nil stone content. Moderately alkaline (pH 8.2).				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	23.4	Moderate	1.7	Non-sodic	1.5	Non-saline
B1	20.5	Moderate	1.5	Non-sodic	0.5	Non-saline
B2	21.2	Moderate	2.4	Non-sodic	0.4	Non-saline
A11b	11.2	Low	4.5	Non-sodic	0.4	Non-saline
A12b	17.7	Moderate	4.5	Non-sodic	1.5	Non-saline

Soil Unit B6-P1 – Eutrophic Black Dermosol overlying Stratic Rudosol (saline)

Soil Unit B6-P1 is a phase of unit B06. It is a localised area situated downstream of a landscape ‘pinch’ zone where soil salt is stored from upstream discharge. Field observations dense salt tolerant plants with a soil ECe of greater than 5 ds/m.

Soil Unit B07 – Chernic-leptic Tenosol

Soil Unit B07 is a Tenosol. This soil unit is of alluvial origin and is comprised of four distinct soil horizons characterised by a loam grading overlying loamy sand overlying a loam at depth. Soil pH trends from slightly acidic to moderately alkaline; the profile is non-saline and non-sodic, with slight dispersion characteristics. Cation exchange capacity is moderate in the topsoil, low in the middle of the solum becoming moderate again with depth. This soil type has moderately low inherent fertility.

Table A5.19 provides a summary of this soil unit.

Table A5.19– Overview: Soil Unit B07

Site Description		
 Plate 34– Profile (Site 81; Core 30) (GSSE, 2012)  Plate 35 – Landscape (Site 81; Core 30) (GSSE, 2012)		
ASC Name	Chernic-leptic Tenosol	
Great Soil Group	Alluvial Soil – light sandy textured	
Representative Site	Site 81; Core 30 (GSSE, 2012)	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Lucerne crops	
Land and Soil Capability Class	Class 4; soil acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Low	
Horizon	Depth (m)	Description
A11	0.00 – 0.25	Very dark grey (10YR3/1) loam, moderate structure grade of 5-10 mm subangular blocky peds with weak consistence. Nil mottling and 5-10% stone content of 10-20 mm fragments. Slightly acidic pH (pH 6.5). Well drained with clear boundary.
A12	0.25 – 0.55	Very dark grey (10YR3/1) loamy sand, very weak structure grade of <2 mm rounded peds with very weak consistence. Nil mottling and 5% stone content of 5-10 mm fragments. Neutral pH (pH 7.3). Well drained with clear boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

A13	0.55 – 0.75	Very dark grey (10YR3/1) loamy sand, apedal structure grade. Nil mottling and nil stone content. Mildly alkaline (pH 7.7). Well drained with clear boundary						
A14	0.75 – 1.00	Very dark grey (10YR3/1) loam, moderate structure grade of 20-50 mm subangular blocky peds with strong consistence. Nil mottling and 5-10% stone content of 10-20 mm fragments. Moderately alkaline (pH 8.0).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A11	14.6	Moderate	0.7	Non-sodic	0.3	Non-saline	3(1)	Slight
A12	6.2	Low	1.6	Non-sodic	0.2	Non-saline	3(1)	Slight
A13	11.3	Low	0.9	Non-sodic	0.2	Non-saline	3(1)	Slight
A14	19.5	Moderate	1.0	Non-sodic	0.1	Non-saline	3(1)	Slight

Soil Unit B08 – Eutrophic Grey Dermosol overlying Stratic Rudosol

Soil Unit B08 is a Grey Dermosol overlying light textured Stratic Rudosol. This soil unit is of alluvial origin and is comprised of four distinct soil characterised by a clay loam grading into a light overlying loamy sand. Soil pH is strongly acidic in the topsoil and increases in alkalinity to mildly alkaline in the subsoil. It is non-saline and non-sodic throughout. CEC is moderate, exchangeable calcium is low to deficient relative to magnesium and this soil type has moderately high inherent fertility.

Table A5.20 provides a summary of this soil unit.

Table A5.20 – Overview: Soil Type B08

Site Description		
 Plate 36 – Profile (Site 72; Core 36) (GSSE, 2012)  Plate 37 – Landscape (Site 72; Core 36) (GSSE, 2012)		
ASC Name	Eutrophic Grey Dermosol overlying Stratic Rudosol	
Great Soil Group	Prairie soil overlying Alluvial Soil (light textured)	
Representative Site	Site 72; Core 36 (GSSE, 2012)	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Lucerne crops	
Land and Soil Capability Class	Class 3; soil structure hazard	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.00– 0.25	Very dark greyish-brown (10YR3/2) clay loam, moderate structure grade of 5-10 mm blocky peds with moderate consistence. Nil mottles; 1nil stone content; abundant fine and coarse roots; moderately acidic (pH 5.6) and moderately well drained. Gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.25 – 0.50	Very dark brown (7.5YR3/1) light clay, strong structure grade of 10-20 mm blocky peds with strong consistence. Yellow mottles of 20%; nil stone content; abundant fine and coarse roots; moderately acidic (pH 5.9) and imperfect drainage. Gradual boundary.				
B22	0.50 – 0.90	Very dark grey (10YR3/1) light clay, strong structure grade of 10-20 mm blocky peds with strong consistence. Nil mottles; nil stone content; many fine and coarse roots; mildly alkaline (pH 7.7) and moderately well drained. Abrupt even boundary.				
A1b	0.90+	Very dark grey (7.5YR3/1) loamy sand light clay, very weak structure grade of <5 mm angular peds with strong consistence. Nil mottles; nil stone content; many fine roots; mildly alkaline (field pH 9.0) and rapid drainage.				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	19.4	Moderate	0.3	Non-sodic	0.5	Non-saline
B21	13.6	Moderate	0.4	Non-sodic	0.3	Non-saline
B22	22.1	Moderate	0.9	Non-sodic	0.6	Non-saline

Soil Unit B09 – Black Dermosol

Soil Unit B09 is comprised of two major soil horizons and is characterised by silty loam throughout the profile. Soil pH is moderately acidic throughout. This soil type has high inherent fertility. This soil has been correlated with a Chernozem from the Singleton Soil Landscape Units (Kovac & Lawrie, 1991).

Table A5.21 provides a summary of this soil unit.

Table A5.21 – Overview: Soil Type

Site Description		
 		
Plate 38 – Profile (Site 60) Plate 39 – Landscape (Site 60)		
ASC Name		Black Dermosol
Great Soil Group		Chernozem
Representative Site		Site 60
Associated Soil Landscape Unit		Bylong
Dominant Slope Association		Very gently inclined (0-1%)
Land Use		Remnant pasture; irrigation
Land and Soil Capability Class		Class 3; soil structure hazard
Interim Protocol –BSAL		Yes
Interim Protocol –Soil Fertility		High
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark reddish-brown (7.5YR2.5/2) silty loam, moderate structure grade of 5-10 mm subangular peds with moderate consistence. Nil mottles; nil stone content; abundant fine and coarse roots; moderately acidic (pH 6.0) and well drained. Gradual boundary.
B1	0.10 – 0.35+	Dark reddish-brown (7.5YR5/1) silty loam, moderate structure grade of 5-10 mm subangular peds with moderate consistence. Nil mottles; nil stone content; abundant fine and coarse roots; moderately acidic (pH 6.0) and well drained. Gradual boundary.

Soil Unit B10 – Leptic Tenosol

Soil Unit B10 is a Leptic Tenosol. This soil unit is comprised of three distinct soil horizons and is characterised by sandy clay overlying clayey sand that grades into coarse sand. Soil pH trends from moderately alkaline to strongly alkaline; salinity is moderate throughout, the profile is non-sodic and CEC is high in the topsoil and low in the subsoil.

Table A5.22 provides a summary of this soil unit.

Table A5.22 – Overview: Soil Unit B10

Site Description		
 Plate 40 – Profile (Site 11; Core 68) (GSSE, 2012)  Plate 41 – Landscape (Site 11; Core 68) (GSSE, 2012)		
ASC Name	Leptic Tenosol	
Great Soil Group	Alluvial Soil – light sandy textured	
Representative Site	Site 11; Core 68 (GSSE, 2012)	
Associated Soil Landscape Unit	Bylong	
Dominant Slope Association	Very gently inclined (0-1%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 4; soil salinity hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Low	
Horizon	Depth (m)	Description
A11	0.00 – 0.25	Very dark brown (10YR2/2) sandy clay, moderately weak structure grade of 5 mm blocky peds with a weak to moderate consistence. Nil mottling and nil stone content. Moderately alkaline (pH 8.0). Well drained with a clear and even boundary.
A12	0.25 – 0.50	Very dark yellowish brown (10YR4/4) clayey sand, apedal structure grade of < 2mm singular grains. Nil mottling and nil stone content. Strongly alkaline (pH 8.7). Well drained with a gradual boundary.
A13	0.50+	Loose coarse sand; water present in core hole to depth of 25 cm.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A11	27.0	High	0.7	Non-sodic	4.2	Moderately saline
A12	7.3	Low	0.7	Non-sodic	4.1	Moderately saline

Soil Unit B11 – Mesotrophic Brown Kandosol

Soil Unit B11 is a Kandosol. This soil unit is comprised of four distinct soil horizons and is characterised by loam/sandy loam overlying clay loam. Soil pH trends from neutral to moderately alkaline alkaline. The profile is non-saline and generally non-sodic, with A12 horizon marginally sodic. The dispersion characteristics are slight in topsoil and moderate to high in subsoil. CEC is very low to moderate with depth. Exchangeable calcium is low relative to magnesium and this soil type has moderately low inherent fertility.

Table A5.23 provides a summary of this soil unit.

Table A5.23 – Overview: Soil Unit B11

Site Description		
 Plate 42 – Profile (Site 305)  Plate 42 – Landscape (Site 305)		
ASC Name		Mesotrophic Brown Kandosol
Great Soil Group		Brown Earth
Representative Site		Site 305
Associated Soil Landscape Unit		Bylong
Dominant Slope Association		Gently inclined (1-3%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; soil structure and acidity hazard
Interim Protocol –BSAL		No; moderately low inherent fertility
Interim Protocol –Soil Fertility		Moderately low
Horizon	Depth (m)	Description
A11	0.00 – 0.30	Very dark brown (10YR2/2) loam, weak structure grade of 5-10 mm subangular blocky peds with moderately weak consistence. Nil mottling; <5% stone content; abundant roots; neutral pH (pH 6.6) and well drained. Clear wavy boundary.
A12	0.30 – 0.55	Dark brown (7.5YR 3/4) sandy loam, apedal structure grade. Nil mottling; 80% 20 mm stone content; abundant roots; neutral pH (pH 7.0) and well drained. Clear wavy boundary.
B21	0.55 – 0.80	Dark brown (10YR 3/3) clay loam, weak structure grade of 5-10 mm blocky peds with

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

		weak consistence. Nil mottling; <5% 5 mm stone content; common roots; mildly alkaline (pH 7.5) and well drained. Clear wavy boundary.						
B22	0.80– 1.00	Dark brown (10YR 3/3) clay loam, moderate structure grade of 10-20 mm subangular blocky peds with moderately strong consistence. Mottling of 20% orange; <5% 5 mm stone content; few roots; moderately alkaline (pH 7.9) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A11	8.8	Low	1.1	Non-sodic	0.3	Non-saline	3(1)	Slight
A12	1.2	Very Low	8.3	Marginally sodic	0.3	Non-saline	3(3)	Moderate
B21	10.6	Low	2.8	Non sodic	0.2	Non-saline	2(1)	High to moderate
B22	14.5	Moderate	4.8	Non sodic	0.5	Non-saline	2(1)	High to moderate

Soil Unit B12 – Stratic Rudosol overlying Black Dermosol

Soil Unit B12 is a Stratic Rudosol overlying a Black Dermosol. This soil unit is of alluvial origin and is comprised of four distinct soil characterised by a clay loam/sandy loam overlying silty clay. Soil pH trends from neutral in the topsoil to moderately alkaline in the buried soil. The profile is non-saline and non-sodic and has slight dispersion characteristics. CEC is variable between very low and moderate, exchangeable calcium is low relative to magnesium and this soil type has moderately low inherent fertility. Inherent fertility is taken from the non-buried soil as this soil is at least 0.75 m deep.

Table A5.24 provides a summary of this soil unit.

Table A5.24 – Overview: Soil Unit B12

Site Description		
 		
Plate 44 – Profile (Site 132) Plate 45 – Landscape (Site 132)		
ASC Name		Stratic Rudosol overlying Black Dermosol
Great Soil Group		Alluvial soil; light sandy textured overlying Prairie Soil
Representative Site		Site 132
Associated Soil Landscape Unit		Bylong
Dominant Slope Association		Very gently inclined (0-1%)
Land Use		Improved pasture
Land and Soil Capability Class		Class 4; soil acidification hazard
Interim Protocol –BSAL		No; moderately low inherent fertility
Interim Protocol –Soil Fertility		Moderately low
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Black (10YR2/1) clay loam, strong structure grade of 5-10 mm subangular blocky peds with moderately strong consistence. Nil mottling; nil stone content; abundant roots; neutral pH (pH 6.6) and well drained. Gradual wavy boundary.
B21	0.10 – 0.35	Black (10YR2/1) sandy clay loam, very weak structure grade of <5 mm angular blocky peds with very weak consistence. Nil mottling; nil stone content; abundant roots; mildly alkaline (pH 7.6) and well drained. Clear even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B22	0.35 – 0.75	Dark greyish-brown (10YR4/2) sandy loam, apedal structure grade. Nil mottling; 20% 5 mm quartz stone content; few roots; moderately alkaline (pH 8.0) and well drained. Clear even boundary.						
A1b	0.75 – 1.10	Very dark greyish-brown (10YR3/2) silty clay, strong structure grade of >100 mm polyhedral peds with strong consistence. Mottling; 20% 5 mm quartz stone content; few roots; moderately alkaline (pH 8.0) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	17.4	Moderate	0.6	Non-sodic	0.9	Non-saline	3(1)	Slight
B21	11.4	Low	0.9	Non-sodic	0.4	Non-saline	3(1)	Slight
B22	4.5	Very low	2.2	Non-sodic	0.4	Non-saline	3(1)	Slight
A1b	24.2	Moderate	1.2	Non-sodic	1.4	Non-saline	5	Slight

GROWEE

The Growee soil landscape unit covers undulating rises and low hills, with broad, widely spaced shallow valleys. The small, closely spaced valleys occur in the areas of undulating low rises. The main valleys often have terraced alluvium near the drainage lines. This unit occurs throughout the Project area primarily in association with the Bylong soil landscape unit. It occurs on the Illawarra Coal Measures geological unit and parent rock is shale, sandstone, conglomerate, coal, tuff and clay. The slopes are generally less than 10% throughout the area. The main soils are Red, Yellow and Brown Solodic soils (Sodosols) which occur on the top of a slope, midslope, and on the lower slope respectively. Non-calci Brown Soils (Chromosols) also occur on the moderately well drained lower slopes and Yellow Solodic Soils (Sodosols) occur on lower slopes with poor drainage. The Solodic Soils can cause minor sheet erosion on slopes.

The Growee soil landscape unit covers 2,298.0 ha (22.4%) of the Project Site and is represented by 19 soil types and 4 phases. A total of 6 soil types within this unit are Red Chromosols, 4 soil types are Brown Chromosol with other soil types including Lithic Rudosols, Red Dermosols, Black Kandosols Stratic Rudosols, Black Dermosols, Black-Orthic Tenosols and Yellow Sodosols. The Red Chromosols are also represented by 2 shallow and 1 moderate soil depth phase; Brown Chromosols are also represented by a shallow soil phase.



Growee Soil Landscape Unit

Soil Unit G01 – Eutrophic Red Chromosol (moderate soil depth)

Soil Unit G01 is a Chromosol. Soil Unit G1 is comprised of four major soil horizons and is characterised by clay loam overlying heavy clay. Soil pH is moderately acidic becoming strongly alkaline at depth; the topsoil is non-saline and the subsoil is slightly saline. It has non-sodic topsoil, a marginally sodic subsoil and moderate to high dispersion characteristics throughout. CEC is low throughout, exchangeable calcium is deficient relative to magnesium throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.25 provides a summary of this soil type.

Table A5.25 – Overview: Soil Type G01

Site Description		
 Plate 46 – Profile (Site 58)  Plate 47 – Landscape (Site 58)		
ASC Name	Eutrophic Red Chromosol (moderate soil depth)	
Great Soil Group	Red-Brown Earth	
Representative Site	Site 58	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Moderately inclined slopes (10-32%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; water erosion hazard	
Interim Protocol –BSAL	No; slope >10%	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.00–0.15	Dark brown (7.5YR 3/3) clay loam with weak structure grade, 1-5 mm subangular blocky peds with weak consistence. Nil mottling; <10% angular 5mm coarse fragments; many fine and coarse roots; moderately acidic (pH 5.7) and well drained. Clear boundary.
B21	0.15 – 0.40	Yellowish-red (5YR 4/6) heavy clay with strong structure grade, 10-30 mm angular blocky peds with strong consistence. Nil mottling; nil coarse fragments; many fine and coarse roots; slightly acidic (pH 6.2) and moderately well drained. Gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B22	0.40 – 0.60	Brown (7.5YR 4/4) heavy clay with strong structure grade, 30-50 mm angular blocky peds with strong consistence. Orange mottling of 20%; nil coarse fragments; few fine roots; moderately alkaline (pH 7.4) and moderately well drained. Gradual boundary.						
B3	0.60 - 1.00+	Strong Brown (7.5YR 4/6) heavy clay with strong structure grade, 50-100 mm angular blocky peds with strong consistence. Brown mottling of 20%; 20% sandstone coarse fragments; very few roots; strongly alkaline (pH 8.7) and moderately well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	7.1	Low	1.4	Non-sodic	1.0	Non-saline	3(1)	Slight
B21	9.3	Low	2.2	Non-sodic	0.2	Non-saline	2(1)	High to moderate
B22	6.1	Low	4.9	Non-sodic	1.5	Non-saline	2(2)	High
B3	19.0	Moderate	7.9	Marginally sodic	3.5	Slightly saline	2(1)	High to moderate

Soil Unit G02 – Eutrophic Red Chromosol (deep soil depth)

Soil Unit G02 is a Chromosol. Soil Unit G2 is comprised of four major soil horizons and is characterised by loamy sand/loam overlying light-medium clay. Soil pH is slightly acidic becoming moderately alkaline at depth and the profile is slightly saline in the topsoil and non-saline in the subsoil. It is non-sodic and has slight to negligible dispersion characteristics throughout. CEC is low in the topsoil and moderate in the subsoil, exchangeable calcium is low relative to magnesium throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.26 provides a summary of this soil type.

Table A5.26 – Overview: Soil Type G02

Site Description		
 Plate 48 – Profile (Site 26; Core 77) (GSSE, 2012)  Plate 49 – Landscape (Site 26; Core 77) (GSSE, 2012)		
ASC Name	Eutrophic Red Chromosol (deep soil depth)	
Great Soil Group	Red-Brown Earth	
Representative Site	Site 26; Core 77 (GSSE, 2012)	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined slopes (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 4; soil acidification hazard	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark yellowish-brown (10YR 4/4) fine sandy loam with weak structure grade, 1-5 mm subangular blocky peds with weak consistence. Nil mottling; <10% rounded conglomerate coarse fragments; abundant fine roots; slightly acidic (pH 6.1) and well drained. Clear boundary.
A2	0.10 – 0.20	Brown (7.5YR 4/4) loam with weak structure grade, 12-10mm subangular blocky peds

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

		with weak consistence. Nil mottling; 5% subangular shale coarse fragments; common fine roots; slightly acidic (pH 6.3) and moderately well drained. Abrupt boundary.						
B21	0.4 0– 0.60	Yellowish-red (5YR 4/6) light-medium clay with strong structure grade, 10-50 mm angular blocky peds with strong consistence. Nil mottling; 10-20% subangular shale coarse fragments; few fine roots; mildly alkaline (pH 7.6) and moderately well drained. Gradual boundary.						
B22	0.60 - 0.90	Yellowish-red (5YR 5/8) light-medium clay with strong structure grade, 50-100 mm angular blocky peds with strong consistence. Yellow mottles of 10%; 20% subangular shale coarse fragments; very few fine roots; moderately alkaline (pH 8.3) and imperfectly drained well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	6.9	Low	1.4	Non-sodic	2.7	Slightly saline	3(1)	Slight
A2	5.1	Very low	2.0	Non-sodic	0.3	Non-saline	3(1)	Slight
B21	15.3	Moderate	1.3	Non-sodic	0.3	Non-saline	3(1)	Slight
B22	17.3	Moderate	1.2	Non-sodic	0.7	Non-saline	4	Negligible

Soil Unit G03 – Lithic Rudosol

Soil Unit G03 is a Rudosol. Soil Unit G03 is comprised of loamy sand topsoil overlying sandstone bedrock. Topsoil pH is moderately acidic and this soil type has low inherent fertility.

Table A5.27 provides a summary of this soil type.

Table A5.27 – Overview: Soil Type G03

Site Description		
 Plate 50 – Profile (Site 93)  Plate 51 – Landscape (Site 93)		
ASC Name	Lithic Rudosol	
Great Soil Group	Skeletal Soil	
Representative Site	Site 93	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Moderately inclined slopes (10-18%) with some flat crests.	
Land Use	Grazing	
Land and Soil Capability Class	Class 7; shallow soil depth	
Interim Protocol –BSAL	No; slope >10%	
Interim Protocol –Soil Fertility	Low	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Brown (7.5YR 4/3) loamy sand with apedal structure grade. Nil mottling; 30% 2 mm; coarse fragments; fine roots; moderately acidic (pH 6.0) and well drained. Irregular clear boundary.
CB	0.15 – 0.55	Weathered rock

Soil Unit G04 – Mesotrophic Brown Chromosol (moderate soil depth)

Soil Unit G04 is a Chromosol. It is comprised of three major soil horizons and is characterised by a sandy loam overlying clay loam. Soil pH is strongly to moderately acidic throughout and the profile is non-saline. It is non-sodic and has slight to negligible dispersion characteristics throughout. CEC is very low throughout, exchangeable calcium relative to magnesium is balanced in the topsoil and grades to deficient in the subsoil and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.28 provides a summary of this soil type.

Table A5.28 – Overview: Soil Type G04

Site Description		
  Plate 52 – Profile (Site 90) Plate 53 – Landscape (Site 90)		
ASC Name	Mesotrophic Brown Chromosol (moderate soil depth)	
Great Soil Group	Red-Brown earth	
Representative Site	Site 90	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; soil acidification hazard	
Interim Protocol –BSAL	No; physical barrier, bedrock at 0.6 m	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (10YR 3/3) sandy loam, weak structure grade of 5-10 mm subangular blocky peds with weak consistence. Nil mottling; <5% rounded coarse fragments; abundant fine roots; very strongly acidic (pH 4.8) and well drained. Clear wavy boundary.
A2	0.15 – 0.35	Brown (7.5YR 4/4) sandy loam with apedal structure grade.. Nil mottling; 20% 30 mm sandstone coarse fragments; common fine roots; moderately acidic (pH 6.0) and moderately well drained. Clear boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B2	0.35 – 0.60	Strong brown (7.5YR 5/6) clay loam, moderate structure grade of 10-30 mm angular blocky peds with moderate consistence. Grey mottling of 10%; nil coarse fragments; common fine roots; moderately acidic (pH 5.7) and moderately well drained. Clear boundary.						
BC	0.60+	Weathering bedrock; 80% sandstone fragments; mildly alkaline (pH 7.6).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	2.2	Very Low	4.5	Non-sodic	1.1	Non-saline	8	Negligible
A2	2.1	Very Low	4.8	Non-sodic	0.2	Non-saline	3(1)	Slight
B2	4.5	Very Low	2.2	Non-sodic	0.1	Non-saline	3(2)	Slight

Soil Unit G04-P1 – Brown Chromosol (shallow soil depth)

Soil Unit G04-P1 is a phase of unit G4. It is located on the steeper slopes and has a shallower soil depth. Soil Unit G04-P1 is comprised of four major soil horizons and is characterised by sandy loam overlying sandy clay. Soil pH is very strongly acidic in the topsoil and increases to strongly alkaline at depth.

Table A5.29 provides a summary of this soil type.

Table A5.29 – Overview: Soil Type G04-P1

Site Description	
 Plate 54 – Profile (Site 82)	 Plate 55 – Landscape (Site 82)
ASC Name	Brown Chromosol (shallow soil depth)
Great Soil Group	Red-Brown Earth
Representative Site	Site 82
Associated Soil Landscape Unit	Growee
Dominant Slope Association	Moderately inclined slopes (10-32%)
Land Use	Grazing

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Land and Soil Capability Class		Class 6; water erosion hazard
Interim Protocol –BSAL		No; slope >10%
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (7.5YR3/2) sandy loam, moderate structure grade of 5-10 mm subangular blocky peds with moderate consistence. Nil mottles; <5% 5 mm stone content; abundant fine roots; very strongly acidic (pH 5.0) and well drained. Gradual and even boundary.
B1	0.15 – 0.35	Brown (7.5YR4/3) sandy clay, strong structure grade of 30-50 mm subangular blocky peds with moderate consistence. Nil mottles; 5% 10-15 mm stone content; slightly acidic pH (pH 6.5) and well drained. Gradual and even boundary.
B21	0.35 – 0.50	Brown (7.5YR4/4) sandy clay, strong structure grade of 30-50 mm angular blocky peds with a moderate consistence. Nil mottles; 10% 10 mm stone content; neutral pH (pH 7.0) and well drained. Clear and even boundary.
B22	0.50 – 0.65	Brown (7.5YR4/3) sandy clay, moderate structure grade of 20-30 mm subangular blocky peds with a weak consistence. Nil mottles 10% 10 mm stone content; strongly alkaline pH (pH 9.0) and well drained.
BC	0.65+	Weathering bedrock

Soil Unit G05 – Eutrophic Red Chromosol (moderate soil depth)

Soil Unit G05 is a Chromosol. Soil Unit G05 is comprised of three major soil horizons and is characterised by a sandy loam overlying light to medium clay. Soil pH is slightly acidic in the topsoil and increases down the profile to strongly alkaline at depth. It is non-sodic throughout. CEC is low in the topsoil and moderate in the upper part of the subsoil, exchangeable calcium is low to deficient relative to magnesium throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.30 provides a summary of this soil unit.

Table A5.30 – Overview: Soil Type G05

Site Description		
 Plate 56 – Profile (Site 47; Core 41) (GSSE, 2012)  Plate 57 – Landscape (Site 47; Core 41) (GSSE, 2012)		
ASC Name	Eutrophic Red Chromosol (moderate soil depth)	
Great Soil Group	Red-Brown Earth	
Representative Site	Site 47; Core 41 (GSSE, 2012)	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; soil acidification hazard	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.0 – 0.20	Dark yellowish-brown (10YR3/4) sandy loam, weak structure grade of 2 mm peds with weak consistence. Nil mottles, 50% 10-20 mm coarse stone content; abundant fine roots; slightly acidic (pH 6.2) and rapid drainage. Sharp and even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B1	0.20– 0.60	Reddish-brown (5YR4/4) light clay, strong structure grade of 10-20 mm angular blocky peds with strong consistence. Yellow mottles of 10-20%; 20% 20-40 mm coarse stone content; many fine roots; moderately alkaline (pH 7.9) and moderately drained. Gradual even boundary.				
B2	0.60– 0.90	Reddish-brown (5YR4/4) medium clay, moderately strong structure grade of 10-20 mm angular blocky peds with strong consistence. Yellow mottles of 10-20%; 20% 20-40 mm coarse stone content; common fine roots; strongly alkaline (pH 8.8) and moderately drained. Sharp even boundary.				
BC	0.90+	Weathered sandstone with shale				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	5.0	Very low	1.0	Non-sodic	0.6	Non-saline
B1	15.4	Moderate	2.6	Non-sodic	0.2	Non-saline
B2	10.0	Low	3.0	Non-sodic	0.5	Non-saline

Soil Unit G05-P1 – Red Chromosol (shallow soil depth)

Soil Unit G05-P1 is a shallow phase of unit G5 and is comprised of a loam topsoil overlying medium clay. The soil profile pH is strongly acidic in the topsoil trending to slightly acidic with depth and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.31 provides a summary of this soil type.

Table A5.31 – Overview: Soil Type G05-Shallow Phase

Site Description	
 Plate 58 – Profile (Site 283)	 Plate 59 – Landscape (Site 283)
ASC Name	Red Chromosol (shallow soil depth)
Great Soil Group	Non-calci Brown Soil
Representative Site	Site 283
Associated Soil Landscape Unit	Growee
Dominant Slope Association	Gently inclined (3-10%)

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Land Use		Grazing
Land and Soil Capability Class		Class 6; shallow soil depth
Interim Protocol –BSAL		No; physical barrier, weathering parent material at 0.4 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A11	0.00 – 0.05	Dark reddish-brown (5YR3/2) clay loam, weak structure grade of 5 mm platy peds with weak consistence. Nil mottles, <5% 5mm coarse stone content; abundant fine roots; strongly acidic (pH 5.1) and well drained. Clear and even boundary.
A12	0.05 – 0.20	Reddish-brown (5YR4/3) light clay, moderate structure grade of 10-20 mm subangular peds with moderate consistence. Nil mottles, <5% 5mm coarse stone content; abundant fine roots; slightly acidic (pH 6.2) and rapid drainage. Gradual and even boundary.
B2	0.20 – 0.40	Reddish-brown (5YR4/3) medium clay, strong structure grade of 20-40 mm subangular peds with moderate consistence. Nil mottles, 10% 10 mm coarse stone content; common fine roots; moderately acidic (pH 6.0) and moderate drainage. Sharp boundary.
BC	0.40+	Weathering parent material (sandstone and siltstone interbeds).

Soil Unit G06 – Eutrophic Red Chromosol (moderate soil depth)

Soil Unit G06 is a Chromosol that is derived from weathered siltstone (as compared to sandstone). It is comprised of four major soil horizons and is characterised by loam overlying medium clay. Soil pH is slightly to moderately acidic throughout and is non-saline. It is non-sodic and generally has slight to negligible dispersion characteristics. CEC is low throughout, exchangeable calcium is balanced relative to magnesium in the topsoil, although low in the remainder of the profile, and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.32 provides a summary of this soil unit.

Table A5.32 – Overview: Soil Type G06

Site Description		
 Plate 60 – Profile (Core 110)  Plate 61 – Landscape (Core 110)		
ASC Name		Eutrophic Red Chromosol (moderate soil depth)
Great Soil Group		Non-Calcic Brown Soil
Representative Site		Core 110
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 4; shallow soil depth
Interim Protocol –BSAL		No; physical barrier, bedrock at 0.75 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A11	0.00 – 0.15	Dark Brown (7.5YR3/3) loam, moderate structure grade of 5 mm subangular blocky peds with weak consistence. Nil mottles; 5-10% coarse stone content; abundant fine roots; moderately acidic (pH 6.0) and well drained. Gradual and even boundary.
A12	0.15 – 0.35	Brown (7.5YR4/4) loam, moderate structure grade of 10 mm angular blocky peds with moderate consistence. Nil mottles; 5-10% coarse stone content; abundant fine roots; slightly acidic (pH 6.4) and well drained. Abrupt and even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

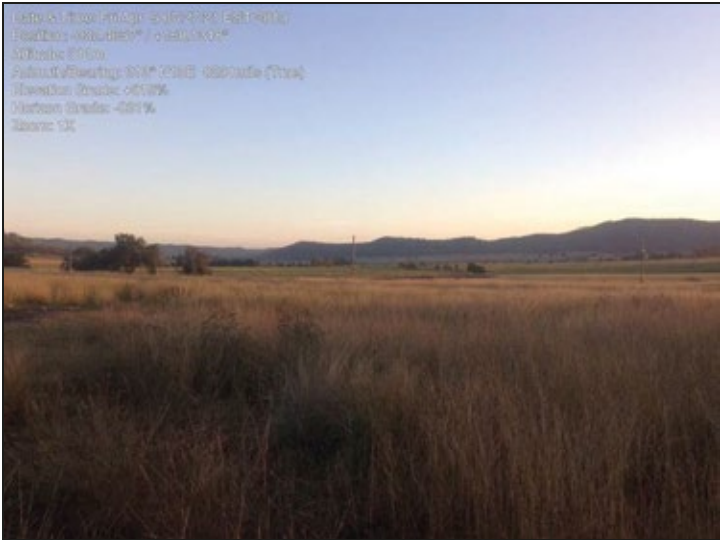
B21	0.35 – 0.60	Yellowish-red (5YR4/6) medium clay, strong structure grade of 50 – 100 mm subangular blocky peds with moderate consistence. Nil mottles; nil coarse stone content; many fine roots; moderately acidic (pH 5.7) and moderately drained. Gradual boundary.						
B22	0.60 – 0.75	Yellowish-red (5YR5/6) medium clay, strong structure grade of 50 – 100 mm subangular blocky peds with moderate consistence. Nil mottles; nil coarse stone content; many fine roots; slightly acidic (pH 6.4) and moderately drained. Clear boundary.						
CB	0.75 – 1.00	Weathering siltstone; 80% coarse fragments and mildly alkaline (pH 7.6).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A11	8.9	Low	1.1	Non-sodic	0.7	Non-saline	8	Negligible
A12	5.1	Very low	2.0	Non-sodic	0.1	Non-saline	2(1)	High to moderate
B21	8.7	Low	1.1	Non-sodic	0.2	Non-saline	5	Slight
B22	11.3	Low	0.9	Non-sodic	0.2	Non-saline	3(1)	Slight
CB	11.4	Low	0.9	Non-sodic	0.4	Non-saline	4	Negligible

Soil Unit G06-P1 – Red Chromosol (shallow soil depth)

Soil Unit G06-P1 is a Shallow phase of unit G06. It is located on the flatter slopes and has a shallower soil depth. This phase is comprised of sandy loam topsoil overlying medium clay, which is underlain by bedrock at 0.5 m. Topsoil pH is slightly acidic and at depth becomes moderately alkaline.

Table A5.33 provides a summary of this soil type.

Table A5.33 – Overview: Soil Type G06-Shallow Phase

Site Description		
 Plate 62 – Profile (Site 238)  Plate 63 – Landscape (Site 238)		
ASC Name	Red Chromosol (shallow soil depth)	
Great Soil Group	Non-Calcic Brown Soil	
Representative Site	Site 238	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 6; shallow soil depth	
Interim Protocol –BSAL	No; physical barrier, bedrock at 0.5 m	
Interim Protocol –Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A11	0.00 – 0.05	Dark reddish-grey (5YR 4/2) sandy loam, weak structure grade of 5 mm platy peds with weak consistence. Nil mottling; 5% 5 mm coarse fragments; abundant fine roots; strongly acidic (pH 5.5) and well drained. Clear wavy boundary.
A12	0.05 – 0.15	Reddish-brown (5YR 4/3) fine sandy loam with apedal structure. Nil mottling; 5% 5 mm coarse fragments; abundant fine roots; moderately acidic (pH 6.0) and well drained. Clear wavy boundary.
B2	0.15 – 0.30	Reddish-brown (5YR 4/4) silty clay, strong structure grade of 10-20 mm subangular blocky peds with strong consistence. Nil mottling; 5% 5mm coarse fragments; many fine roots; moderately acidic (pH 6.0) and moderately well drained. Gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B3	0.30 – 0.50	Very Pale Brown (10YR 7/4) medium clay, moderate structure grade of 10-20 mm subangular blocky peds with strong consistence. Orange mottling of 50%; 10% 5 mm coarse fragments; common fine roots; moderately alkaline (pH 8.0) and imperfectly drained. Clear boundary.
C	0.50+	Weathered bedrock

Soil Unit G07 – Eutrophic Red Chromosol (deep soil depth)

Soil Unit G07 is a Chromosol. It is comprised of four major soil horizons and is characterised by a bleached loam overlying medium clay. Soil pH is neutral in the topsoil and increases down to the profile to moderately alkaline at depth. It is non-saline becoming moderately saline at depth. It is non-sodic and has slight to negligible dispersion characteristics. CEC is low to moderate throughout; exchangeable calcium is balanced relative to magnesium in the topsoil, trending to deficient in the subsoil. This soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.34 provides a summary of this soil unit.

Table A5.34 – Overview: Soil Type G7

Site Description		
 Plate 64 – Profile (Site 106)		 Plate 65 – Landscape (Site 106)
ASC Name		Eutrophic Red Chromosol (deep soil depth)
Great Soil Group		Non-calcic Brown Soil
Representative Site		Site 106
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; water erosion, soil structure, acidification and salinity hazard
Interim Protocol –BSAL		No; chemical barrier, ECe >4 at 0.6 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (7.5YR3/3) loam, very weak structure grade of 2-5 mm subangular blocky peds with very weak consistence. Nil mottles; 5% 10 mm stone content; many fine roots; neutral (pH 6.7) and well drained. Clear and even boundary.
A2	0.10 – 0.30	Bleached (7.5 YR 8/3 dry) loam, weak structure grade of 2-5 mm subangular blocky peds with very weak consistence. Nil mottles; 5% 10 mm stone content; many fine roots; neutral (pH 7.0) and well drained. Abrupt boundary.
B1	0.30 – 0.60	Dark reddish-brown (5YR4/6) loam strong structure grade of 30-50 mm sub angular blocky peds with a very strong consistence. Nil mottles; 5% 10 mm stone content; few fine roots; mildly alkaline (pH 7.8) and well drained. Gradual boundary.
B2	0.60 – 1.00	Brown (5YR5/6) clay loam strong structure grade of 50-100 mm sub angular blocky peds with moderate consistence. Nil mottles; nil stone content; few fine roots; moderately alkaline (pH 8.0) and well drained.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating		rating	class	rating
A1	13.5	Moderate	0.7	Non-sodic	0.4	Non-saline	8	Negligible
A2	8.0	Low	1.3	Non-sodic	1.6	Non-saline	3(1)	Slight
B1	9.3	Low	1.1	Non-sodic	0.5	Non-saline	3(2)	Slight
B2	12.5	Moderate	0.8	Non-sodic	4.3	Moderately saline	5	Slight

Soil Unit G7-P1 – Eutrophic Red Chromosol (gravelly)

Soil Unit G07-P1 is a shallow phase of unit G07. It is located on the flatter slopes and has significant gravel content. It is comprised of four major soil horizons and is characterised by loam topsoil overlying clay loam subsoil. Topsoil pH is slightly acidic and at depth becomes moderately alkaline. It is non-sodic with slight dispersion characteristics, with topsoil slightly to moderately saline tending to non-saline in subsoil. CEC is very low throughout; exchangeable magnesium is low relative to calcium throughout. This soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.35 provides a summary of this soil type.

Table A5.35 – Overview: Soil Type G07-P1

Site Description	
 Plate 66 – Profile (Site 156)	 Plate 67 – Landscape (Site 156)
ASC Name	Eutrophic Red Chromosol (gravelly)
Great Soil Group	Non-calci Brown Soil
Representative Site	Site 238
Associated Soil Landscape Unit	Growee
Dominant Slope Association	Gently inclined (3-10%)
Land Use	Grazing
Land and Soil Capability Class	Class 4; salinity hazard
Interim Protocol –BSAL	No; soil salinity, ECe >4 at 0.15 m

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Interim Protocol –Soil Fertility			Moderately high					
Horizon	Depth (m)	Description						
A1	0.00 – 0.15	Dark brown (7.5YR3/3) loam, weak structure grade of 5 mm platy peds with weak consistence. Nil mottles; <5% 1-5 mm stone content; abundant fine roots; slightly acidic (pH 6.4) and well drained. Clear and even boundary.						
B1	0.15 – 0.40	Very dark grayish-brown (10YR3/2) clay loam, moderate structure grade of 5-10 mm subangular blocky peds with a moderate consistence. Yellow mottles of 10%; 10% 5-10 mm stone content; neutral pH (pH 7.0) and moderately drained. Gradual boundary.						
B21	0.00 – 0.60	Dark brown (7.5YR3/3) clay loam, moderate structure grade of 10-20 mm sub angular blocky peds with a moderately strong consistence. Yellow mottles of 10%; 40% 20 mm stone content; neutral pH (pH 7.2) and moderately drained. Gradual boundary.						
B22	0.60 – 1.00	Dark brown (7.5YR3/3) clay loam, moderate structure grade of 10-20 mm sub angular blocky peds with a moderately strong consistence. Yellow mottles of 5%; 50% 50 mm stone content; moderately alkaline (pH 8.4) and moderately drained. Gradual boundary.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	2.7	Very low	0.8	Non-sodic	2.3	Slightly saline	8	Negligible
B1	1.6	Very low	0.8	Non-sodic	5.9	Moderately saline	8	Negligible
B21	0.8	Very low	1.1	Non-sodic	2.7	Slightly saline	8	Negligible
B22	0.5	Very low	0.5	Non-sodic	0.4	Non-saline	8	Negligible

Soil Unit G08 – Eutrophic Red Dermosol (shallow soil depth)

Soil Unit G08 is a Dermosol. Dermosols are soils with structured B2 horizons and lack strong texture contrast between A and B Horizons. Soil Unit G08 is comprised of three major soil horizons and is characterised by silty clay loam grading into silty clay. Soil pH is neutral becoming moderately alkaline at depth and the profile is non-saline throughout. It is non-sodic and has slight to negligible dispersion characteristics. CEC is moderate to high throughout; exchangeable calcium relative to magnesium is balanced in the top soil, trending to magnesium deficient in the subsoil. This soil type has moderately high inherent fertility.

Table A5.36 provides a summary of this soil unit.

Table A5.36 – Overview: Soil Type G08

Site Description		
 		
Plate 68 – Profile (Site 147) Plate 69 – Landscape (Site 147)		
ASC Name		Eutrophic Red Dermosol (shallow soil depth)
Great Soil Group		Euchrozem
Representative Site		Site 147
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 6; shallow soil depth
Interim Protocol –BSAL		No; physical barrier, bedrock at 0.5 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Brown (7.5YR4/4) silty clay loam, strong structure grade of 20 mm subangular blocky peds with moderate consistence. Nil mottles; <5% 1 mm stone content; abundant fine roots; neutral (pH 6.7) and well drained. Gradual and even boundary

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.10 – 0.30	Brown (7.5YR4/4) silty clay, strong structure grade of 20-50 mm sub angular blocky peds with strong consistence. Red mottles of 5%; 5-10% 5-0 mm stone content; many fine roots; moderately alkaline (pH 8.0) and moderately well drained. Gradual and wavy boundary.						
B22	0.30 – 0.50	Strong brown (7.5YR4/6) silty clay, strong structure grade of 50-100 mm sub angular blocky peds with strong consistence. Red mottles of 10%; 20-30% 10-30 mm sandstone fragments; moderately alkaline (pH 8.3) and moderately well drained. Diffuse boundary.						
C	0.50+	Bedrock						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	15.8	Moderate	0.6	Non-sodic	0.4	Non-saline	8	Negligible
B21	14.1	Moderate	0.7	Non-sodic	1.3	Non-saline	3(1)	Slight
B22	32.4	High	0.3	Non-sodic	1.0	Non-saline	4	Negligible
C	32.1	High	0.3	Non-sodic	1.1	Non-saline	4	Negligible

Soil Unit G09 – Eutrophic Brown Chromosol (moderate soil depth)

Soil Unit G09 is a Chromosol. It is comprised of three major soil horizons and is characterised by a loam overlying light to medium clay. Soil pH is moderately acidic in the topsoil and very strongly alkaline in the subsoil. The topsoil is non-saline and the subsoil is moderately saline. It is non-sodic; however has high subsoil dispersion characteristics. CEC is low in the topsoil, high in the subsoil, exchangeable calcium is low relative to magnesium throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.37 provides a summary of this soil unit.

Table A5.37 – Overview: Soil Type G09

Site Description		
 		
Plate 70 – Profile (Site 145) Plate 71 – Landscape (Site 145)		
ASC Name		Eutrophic Brown Chromosol (moderate soil depth)
Great Soil Group		Red-Brown Earth
Representative Site		Site 145
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 5; salinity hazard
Interim Protocol –BSAL		No; chemical barrier, ECe >4 at 0.7 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (10YR3/3) loam, moderate structure grade of 10 mm subangular blocky peds with moderate consistence. Nil mottles; 30% 10 mm stone content; abundant fine and coarse roots; moderately acidic (pH 6.0) and well drained. Abrupt boundary.
B1	0.10 – 0.35	Dark brown (7.5YR3/4) light clay, strong structure grade of 50-70 mm polyhedral peds with strong consistence. Grey mottles of 20%; 20% 5 mm stone content; many fine roots; strongly alkaline (pH 8.8) and moderately well drained. Clear boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B2	0.35 – 0.70	Strong brown (7.5YR4/6) light-medium clay, strong structure grade of 100-150 mm polyhedral peds with strong consistence. Grey mottles of 10%; 20% 5 mm stone content; strongly alkaline (pH 8.9) and well drained. Clear boundary.						
BC	0.70 – 1.00	Yellowish-red (5YR4/6) light-medium clay. Grey mottles of 10-20%; 80% 10 mm sandstone fragments; very strongly alkaline (pH 9.2) and imperfectly drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	8.3	Low	1.2	Non-sodic	0.2	Non-saline	8	Negligible
B1	11.8	Low	4.2	Non-sodic	0.3	Non-saline	2(2)	High
B2	26.7	High	4.5	Non-sodic	2.5	Slightly saline	2(2)	High
BC	37.1	High	4.9	Non-sodic	5.8	Moderately saline	2(3)	Very high

Soil Unit G10 – Eutrophic Black Kandosol

Soil Unit G10 is a Kandosol. It is comprised of four major soil horizons and is characterised by a uniform loam profile. Soil pH is moderately acidic in the topsoil and increases down to the profile to moderately alkaline at depth. It is non-saline and non-sodic throughout and has slight to negligible dispersion characteristics. CEC is low to moderate throughout, exchangeable calcium is balanced relative to magnesium in the topsoil and low in subsoil, and this soil type has moderate inherent soil fertility.

Table A5.38 provides a summary of this soil unit.

Table A5.38 – Overview: Soil Type G10

Site Description		
 		
Plate 72 – Profile (Site 195)		Plate 73 – Landscape (Site 195)
ASC Name	Eutrophic Black Kandosol	
Great Soil Group	Brown Earth	
Representative Site	Site 195	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 3; water erosion, soil structure and acidification hazard	
Interim Protocol –BSAL	No; less than 20 ha	
Interim Protocol –Soil Fertility	Moderate	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (7.5YR3/2) loam, weak structure grade of 5-10 mm platy peds with weak consistence. Nil mottles; 20% 10 mm stone content; abundant roots; moderately acidic (pH 5.9) and well drained. Gradual wavy boundary.
B1	0.15 – 0.40	Dark brown (7.5YR3/3) loam, weak structure grade of 10 mm sub angular blocky peds with moderate consistence. Nil mottles; 10% 5-10 mm stone content; many roots; neutral pH (pH 7.0) and well drained. Gradual wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.40 – 0.60	Dark brown (7.5YR3/2) loam, weak structure grade of 5-10 mm sub angular blocky peds with moderate consistence. Nil mottles; 10% 20 mm stone content; common roots; mildly alkaline (pH 7.6) and well drained. Gradual wavy boundary.						
B22	0.60 – 1.00	Very dark brown (7.5YR2.5/2) loam, moderately weak structure grade of 20-30 mm sub angular blocky peds with moderate consistence. Nil mottles; 10% 20 mm stone content; few roots; moderately alkaline (pH 8.2) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	10.9	Low	0.9	Non-sodic	0.5	Non-saline	8	Negligible
B1	13.6	Moderate	0.7	Non-sodic	0.3	Non-saline	3(2)	Slight
B21	11.7	Low	0.9	Non-sodic	0.4	Non-saline	3(1)	Slight
B22	15.0	Moderate	0.7	Non-sodic	0.7	Non-saline	3(1)	Slight

Soil Unit G11 – Stratic Rudosol

Soil Unit G11 is a Rudosol. It is comprised of four major soil horizons and is characterised by an alternate sequence of sandy loams and loamy sands. Soil pH is strongly acidic in the topsoil and moderately acidic in the subsoil and this soil type has moderately low inherent fertility. **Table A5.39** provides a summary of this soil unit.

Table A5.39 – Overview: Soil Type G11

Site Description		
 Plate 74 – Profile (Site 208)  Plate 75 – Landscape (Site 208)		
ASC Name	Stratic Rudosol	
Great Soil Group	Alluvial Soils – Light textured	
Representative Site	Site 208	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; soil acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A11	0.00 – 0.15	Very dark brown (7.5YR2.5/2) sandy loam, weak structure grade of 5-10 mm subangular blocky peds with weak consistence. Nil mottles; 5% 5 mm stone content; strongly acidic (pH 5.0) and well drained. Gradual and even boundary.
A12	0.15 – 0.50	Very dark grey (7.5YR3/1) loamy sand with apedal structure grade. Nil mottles; 5% 5 mm stone content; moderately acidic (pH 6.0) and well drained. Clear wavy boundary.
B21	0.35 – 0.60	Brown (7.5YR2.5/1) sandy clay loam, weak structure grade of 10-20 mm sub angular blocky peds with weak consistence. Nil mottles; 5% 5 mm stone content; moderately acidic (pH 6.0) and well drained. Clear and wavy boundary.
B22	0.35 – 0.60	Dark reddish-brown (5YR 3/2) loamy sand with apedal structure grade. Nil mottles; 20% 10 mm stone content; moderately acidic (pH 6.0) and well drained.

Soil Unit G12 – Black Dermosol (deep soil depth)

Soil Unit G12 is a Dermosol. It is comprised of four major soil horizons and is characterised by a sandy clay loam grading into heavy clay at depth. The topsoil is moderately acidic and the alkalinity increases with depth to moderately alkaline. It is non-saline and non-sodic throughout. CEC is generally moderate to high and exchangeable calcium is low relative to magnesium and this soil type has high inherent soil fertility.

Table A5.40 provides a summary of this soil unit.

Table A5.40 – Overview: Soil Type G12

Site Description		
 Plate 76 – Profile (Site 67; Core 60) (GSSE, 2012)  Plate 77 – Landscape (Site 67; Core 60) (GSSE, 2012)		
ASC Name	Black Dermosol (deep soil depth)	
Great Soil Group	Cherozem	
Representative Site	Site 67; Core 60 (GSSE, 2012)	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Very gently inclined (0-3%)	
Land Use	Grazing; pasture improved	
Land and Soil Capability Class	Class 3; soil structure	
Interim Protocol –BSAL	Yes	
Interim Protocol –Soil Fertility	High	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Black (7.5YR2.5/1) sandy clay loam, moderate structure grade of 5 mm crumb peds with moderate consistence. Nil mottles; nil stone content; abundant fine and medium roots; moderately acidic (pH 5.9) and well drained. Gradual and even boundary.
B1	0.15 – 0.30	Black (7.5YR2.5/1) light clay with moderately strong structure grade of 10-20 mm subangular peds with moderate consistence. Nil mottles; nil stone content; abundant fine and medium roots; neutral pH (pH 6.9) and well drained. Gradual and even boundary

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.30 – 0.60	Black (7.5YR2.5/1) medium clay with moderate structure grade of 5-10 mm subangular peds with moderately weak consistence. Nil mottles; nil stone content; many fine and medium root; neutral pH (pH 7.2) and well drained. Gradual and even boundary				
B22	0.60 – 1.00	Very dark brown (7.5YR2.5/3) sandy clay loam with weak structure grade of 1-5 mm crumb peds with very weak consistence. Nil mottles; 10-20% 5-10 mm stone content; common fine roots; moderately alkaline (pH 8.3) and well drained.				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	27.2	High	0.18	Non sodic	1.6	Non-saline
B1	25.8	High	0.19	Non sodic	0.2	Non-saline
B21	18.2	Moderate	0.26	Non sodic	0.2	Non-saline
B22	8.8	Low	0.57	Non sodic	1.0	Non-saline

Soil Unit G13 – Black-Orthic Tenosol; light sandy textured

Soil Unit G13 is a Tenosol. Tenosols are soils with generally only weak pedological organisation apart from the A horizons. Soil Unit G13 is comprised of four major soil horizons and is characterised by loam grading into a sandy loam. Soil pH is slightly acidic in the topsoil and increases down to the profile to mildly alkaline at depth. It is non-saline and non-sodic throughout the profile and has slight to negligible dispersion characteristics. CEC is moderate in the topsoil, low in the subsoil, exchangeable calcium is low balanced to magnesium throughout and this soil type has low inherent fertility,

Table A5.41 provides a summary of this soil unit.

Table A5.41 – Overview: Soil Type G13

Site Description		
  Plate 78 – Profile (Site 77) Plate 79 – Landscape (Site 77)		
ASC Name		Black–Orthic Tenosol; light sandy textured
Great Soil Group		Earthy Sand
Representative Site		Site 77
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 5; soil acidification hazard
Interim Protocol –BSAL		No; moderately low inherent fertility
Interim Protocol –Soil Fertility		Moderately low
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Very dark brown (10YR2/2) loam, moderate structure grade of 5-10 mm subangular blocky peds with moderate consistence. Nil mottles; 5% singular stone content; abundant fine roots; slightly acidic (pH 6.3) and well drained. Clear and wavy boundary.
B1	0.15 – 0.25	Very dark brown (10YR2/2) loam, weak structure grade of 30 mm sub angular blocky peds with a moderate consistence. Nil mottles; 5% singular stone content; abundant fine roots; neutral pH (pH 7.2) and well drained. Clear and wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.25 – 0.55	Very dark brown (7.5YR2.5/2) sandy loam, weak structure grade of 5 mm rounded peds with weak consistence. Nil mottles; 20% 5-10 mm rounded stone content; many fine roots; mildly alkaline (pH 7.5) and well drained. Gradual boundary.						
B22	0.55 – 0.90	Very dark brown (7.5YR2.5/2) sandy loam, very weak structure grade of 2-5 mm peds with very weak consistence. Nil mottles; 10% 5-10 mm angular stone content; common to few fine roots; mildly alkaline (pH 7.75) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	14.3	Moderate	0.7	Non-sodic	0.6	Non-saline	8	Negligible
B1	12.8	Moderate	0.8	Non-sodic	0.2	Non-saline	3(1)	Slight
B21	8.3	Low	1.2	Non-sodic	0.2	Non-saline	3(1)	Slight
B22	9.0	Low	1.1	Non-sodic	0.3	Non-saline	3(2)	Slight

Soil Unit G14 – Eutrophic Brown Chromosol (deep soil depth)

Soil Unit G14 is a Chromosol. Soil Unit G14 is comprised of four major soil horizons and is characterised by sandy clay loam overlying medium clay. Soil pH is moderately acidic in the topsoil and increases to mildly alkaline at depth. It contains a non-saline and non-sodic throughout. CEC is low throughout, exchangeable calcium relative to magnesium is balanced in topsoil and low in the subsoil and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.42 provides a summary of this soil unit.

Table A5.42 – Overview: Soil Type G14

Site Description		
 Plate 80 – Profile (Site 50; Core 44) (GSSE, 2012)	 Plate 81 – Landscape (Site 50; Core 44) (GSSE, 2012)	
ASC Name	Eutrophic Brown Chromosol (deep soil depth)	
Great Soil Group	Non-calci Brown soil	
Representative Site	Site 50; Core 44 (GSSE, 2012)	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Very gently inclined (1-3%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; waterlogging hazard	
BSAL - Interim	No; fails drainage criteria	
BSAL – Soil Fertility	Moderately high	
Horizon	Depth (m)	Description
A1	0.0 – 0.10	Dark yellowish-brown (10YR4/2) sandy clay loam, weak structure grade of 5-10 mm platy peds with weak consistence. Nil mottles; nil stone content; many fine roots; moderately acidic (pH 5.6) and well drained. Gradual even boundary.
A2	0.10 – 0.50	Strong brown (7.5YR4/6) sandy clay loam, weak structure grade of 10-20 mm rounded peds with weak consistence. Nil mottles; 5% 5mm stone content; many fine roots; slightly acidic (pH 6.4) and well drained. Distinct even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.50 – 0.85	Strong brown (7.5YR4/6) medium clay, moderately strong structure grade of 20-40 mm angular blocky peds with moderate consistence. Mottles of 50% grey and red; nil stone content; fine roots common; neutral pH (pH 7.2) and imperfectly drained. Gradual even boundary.				
B22	0.85 – 1.00	Reddish brown (5YR4/4) medium clay, strong structure grade of 20-40 mm angular blocky peds with strong consistence. Mottles of 75% red, brown and yellow; nil stone content; few fine roots; mildly alkaline pH (pH 7.4) and poorly drained.				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	5.1	Very low	1.0	Non-sodic	0.3	Non-saline
B1	3.9	Very low	1.3	Non-sodic	0.2	Non-saline
B21	9.5	Low	0.5	Non-sodic	0.3	Non-saline
B22	10.4	Low	0.5	Non- sodic	0.3	Non-saline

Soil Unit G14-P1 – Brown Chromosol (shallow soil depth)

Soil Unit G14-P1 is a shallow phase of unit G14. It is located on slightly steeper slopes and has a shallower soil depth. Soil Unit G14-P1 is comprised of three major soil horizons and is characterised by sandy loam overlying medium clay. Soil pH is slightly acidic throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol. .

Table A5.43 provides a summary of this soil unit.

Table A5.43 – Overview: Soil Type G14-P1

Site Description	
 Plate 82 – Profile (Site 100)	 Plate 83 – Landscape (Site 100)
ASC Name	Brown Chromosol (shallow soil depth)
Great Soil Group	Non-calci Brown soil
Representative Site	Site 100
Associated Soil Landscape Unit	Growee
Dominant Slope Association	Gently inclined (3-10%)

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Land Use		Grazing
Land and Soil Capability Class		Class 6; shallow soil depth
Interim Protocol –BSAL		No; physical barrier, weathering sandstone at 0.5 m
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A11	0.00 – 0.10	Reddish-yellow (5YR6/6) sandy loam with apedal structure. Nil mottling; nil coarse fragments; many fine and coarse roots; slightly acidic (pH 6.5) and well drained. Clear and wavy boundary.
A12	0.10 – 0.20	Pink (5YR7/3) loamy sand with apedal structure. Nil mottling; nil coarse fragments; many fine roots; slightly acidic (pH 6.5) and well drained. Clear and wavy boundary.
B22	0.20 – 0.50	Yellowish-red (5YR5/8) medium clay, moderate structure grade of 10-20 mm angular blocky peds with a moderate consistence. Nil mottling; nil coarse fragments; fine roots common; slightly acidic (pH 6.5) and moderately well drained. Gradual and wavy boundary.
C	0.50+	Weathering sandstone

Soil Unit G15 – Subnatric Brown Sodosol

Soil Unit G15 is a Sodosol. Soil Unit G15 is comprised of three major soil horizons and is characterised by loamy sand/sandy loam overlying heavy clay. Soil pH is slightly acidic throughout and the profile is generally non-saline. It contains non-sodic topsoil, marginally sodic subsoil and has moderate to high subsoil dispersion characteristics. CEC is very low throughout, exchangeable calcium relative to magnesium is variable between balanced and calcium deficient throughout the profile and this soil type has moderately low inherent fertility.

Table A5.44 provides a summary of this soil unit.

Table A5.44 – Overview: Soil Type G15

Site Description		
		
Plate 84 – Profile (Site 104)		
ASC Name	Subnatric Brown Sodosol	
Great Soil Group	Solodic Soil	
Representative Site	Site104	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Very gently inclined (1-3%)	
Land Use	Grazing; native pasture	
Land and Soil Capability Class	Class 4; shallow soil depth	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A1	0.00 – 0.03	Dark brown (7.5YR3/4) loamy sand, apedal structure. Nil mottles; <5% 5 mm stone content; many fine roots; slightly acidic (pH 6.3) and well drained. Abrupt even boundary.
A2	0.03 – 0.30	Bleached (10.5YR8/3) sandy loam, apedal structure. Nil mottles; 10% 25 mm stone content; moderately acidic (pH 5.6) and well drained. Abrupt even boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B2	0.30 – 0.55	Yellowish-brown (10YR5/8) heavy clay, moderate structure grade of 50 mm angular blocky peds with strong consistence. Mottles of 30% orange; nil stone content; common fine roots; slightly acidic (pH 6.1) and imperfectly drained. Gradual even boundary.						
BC	0.55 – 0.70	Weathering rock; 10% 10 mm stone content; very few roots and slightly acidic (pH 6.2).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	4.0	Very low	2.5	Non-sodic	1.4	Non-saline	8	Negligible
A2	4.4	Very low	2.3	Non-sodic	3.1	Slightly saline	8	Negligible
B2	5.7	Very low	5.3	Non-sodic	0.3	Non-saline	2(1)	High to moderate
BC	10.6	Low	8.5	Marginally sodic	0.4	Non-saline	3(1)	Slight

Soil Unit G16 – Stratic Rudosol

Soil Unit G16 is a Rudosol. Soil Unit G16 is comprised of three major soil horizons and is characterised by sandy clay loam overlying loamy sand. Soil pH is moderately acidic in the topsoil and increases to moderately alkaline at depth and this soil type has moderately low inherent fertility.

Table A5.45 provides a summary of this soil unit.

Table A5.45 – Overview: Soil Type G16

Site Description		
 Plate 85 – Profile (Site 252)		 Plate 86 – Landscape (Site 252)
ASC Name	Stratic Rudosol	
Great Soil Group	Alluvial Soils – Light textured	
Representative Site	Site 252	
Associated Soil Landscape Unit	Growee	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; soil acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark reddish-brown (5YR 5/2) sandy clay loam, weak structure grade of 5-10 mm subangular peds with weak consistence. Nil mottles; 10% 10 mm stone content; abundant fine roots; moderately acidic (pH 6.0) and well drained. Clear even boundary.
B21	0.20 – 0.50	Very dark grey (5YR 3/1) clayey sand with apedal structure grade. Nil mottles; 20% <5 mm stone content; common fine roots; mildly alkaline (pH 7.5) and well drained. Clear even boundary.
B22	0.50 – 1.00	Dark reddish-brown (5YR 2.5/2) loamy sand with apedal structure grade. Nil mottles; 30% 20-50 mm stone content; common fine roots; moderately alkaline (pH 8.0) and well drained.

Soil Unit G17 – Eutrophic Red Chromosol (deep soil depth)

Soil Unit G17 is a Chromosol. Soil Unit G17 is comprised of four major soil horizons and is characterised by loam overlying heavy clay. Soil pH is strongly acidic in the topsoil and increases to mildly alkaline at depth. The profile is non-saline, non-sodic and has slight topsoil dispersion characteristics and high subsoil dispersion characteristics. CEC is low in the topsoil, moderate through the subsoil, exchangeable calcium is deficient relative to magnesium throughout and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.46 provides a summary of this soil unit.

Table A5.46 – Overview: Soil Type G17

Site Description		
 Plate 87 – Profile (Site 43)  Plate 88 – Landscape (Site 43)		
ASC Name		Eutrophic Red Chromosol (deep soil depth)
Great Soil Group		Non-calcic Brown Soil
Representative Site		Site 43
Associated Soil Landscape Unit		Growee but also mix of Bald hill & Benjang
Dominant Slope Association		Very gently inclined (1-3%)
Land Use		Grazing; pasture grass
Land and Soil Capability Class		Class 3; soil structure and acidification hazard
Interim Protocol –BSAL		Yes
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (7.5YR3/4) loam, weak structure grade of 10 mm platy peds with weak consistence. Nil mottles<10% 5-10 mm rounded quartz; abundant fine mottles; strongly acidic (pH 5.5) and well drained. Clear and wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.15 – 0.35	Dark reddish-brown (5YR3/4) heavy clay, strong structure grade of 10-20 mm angular blocky peds with strong consistence. Nil mottles; nil stone content; common fine roots; slightly acidic (pH 6.3) and moderately well drained. Gradual even boundary.						
B22	0.35 – 0.75	Dark reddish-brown (5YR3/4) heavy clay, strong structure grade of 20-50 mm angular blocky peds with strong consistence. Nil mottles; nil stone content; common fine roots; mildly alkaline (pH 7.4) and moderately well drained. Gradual even boundary.						
B23	0.75 – 1.00	Brown (7.5YR4/4) light-medium clay, moderate structure grade of 20-50 mm angular blocky peds with strong consistence. Mottles of 10% yellow and 5% grey; nil stone content; few fine roots; mildly alkaline (pH 7.8) and imperfectly drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	5.1	Very low	1.9	Non-sodic	0.5	Non-saline	3(1)	Slight
B21	16.0	Moderate	2.5	Non-sodic	0.1	Non-saline	3(1)	Slight
B22	17.7	Moderate	3.9	Non-sodic	0.3	Non-saline	2(1)	High to moderate
B23	15.4	Moderate	3.9	Non-sodic	0.5	Non-saline	2(1)	High to moderate

Soil Unit G17-P1 – Eutrophic Red Chromosol (moderate soil depth)

Soil Unit G17-P1 is a phase of G17. It is comprised of three major soil horizons and is characterised by silty clay loam overlying heavy clay. Soil pH is slightly acidic in the topsoil and increases to very strongly alkaline at depth. It is non-saline and non-sodic throughout and has negligible dispersion characteristics. CEC is moderate to high throughout, exchangeable calcium is low relative to magnesium in the topsoil, trending to low magnesium in the subsoil and this soil type has moderately high inherent fertility in accordance with the Interim Protocol.

Table A5.47 provides a summary of this soil unit.

Table A5.47 – Overview: Soil Type G17

Site Description	
 Plate 89 – Profile (Site 42)	 Plate 90 – Landscape (Site 42)
ASC Name	Eutrophic Red Chromosol (moderate soil depth)

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Great Soil Group		Non-Calcic Brown Soil						
Representative Site		Site 42						
Associated Soil Landscape Unit		Bald Hill						
Dominant Slope Association		Gently inclined (3-10%)						
Land Use		Grazing; lucerne						
Land and Soil Capability Class		Class 4; soil depth						
Interim Protocol –BSAL		No; physical barrier, weathering bedrock at 0.65 m						
Interim Protocol –Soil Fertility		Moderately high						
Horizon	Depth (m)	Description						
A1	0.00 – 0.15	Dark brown (7.5YR4/3) silty clay loam, moderate structure grade of 10 mm platy peds with moderate consistence. Nil mottles; nil stone content; abundant fine mottles; slightly acidic (pH 6.4) and well drained. Clear and even boundary.						
B21	0.15 – 0.30	Yellowish-red (5YR4/6) heavy clay, strong structure grade of 20-50 mm angular blocky peds with strong consistence. Nil mottles; nil stone content; common fine roots; mildly alkaline (pH 7.7) and moderately well drained. Gradual even boundary.						
B22	0.35 – 0.65	Brown (7.5YR4/4) heavy clay, strong structure grade of 20-50 mm angular blocky peds with strong consistence. Mottles of 20% yellow and 10% grey; 10% 2 mm angular stone content; common fine roots; very strongly alkaline (pH 8.5) and moderately well drained. Gradual even boundary.						
BC	0.65 – 1.00	Strong brown (7.5YR4/6) silty clay loam, massive structure; 40-50% 10-15 mm rounded shale gravel and very strongly alkaline (pH 8.7).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	14.0	Moderate	0.7	Non-sodic	0.5	Non-saline	8	Negligible
B21	22.6	Moderate	0.4	Non-sodic	0.2	Non-saline	4	Negligible
B22	34.2	High	0.3	Non-sodic	0.7	Non-saline	4	Negligible
BC	30.9	High	0.3	Non-sodic	0.9	Non-saline	4	Negligible

Soil Unit G18 – Mesonatric Yellow Sodosol (deep soil depth)

Soil Unit G18 is a Sodosol. Soil Unit G18 is comprised of four major soil horizons and is characterised by loam/loamy sand overlying clay loam. Soil pH is moderately acidic in the topsoil and neutral in the subsoil. It is non-saline and contains strongly sodic subsoil that has high subsoil dispersion characteristics. CEC is very low throughout; exchangeable calcium is low relative to magnesium in the topsoil and deficient in the subsoil. This soil type has moderately low inherent fertility.

Table A5.48 provides a summary of this soil unit.

Table A5.48 – Overview: Soil Type G18

Site Description		
 		
Plate 91 – Profile (Site 25; Core 82) (GSSE, 2012) Plate 92 – Landscape (Site 25; Core 82) (GSSE, 2012)		
ASC Name		Mesonatric Yellow Sodosol (deep soil depth)
Great Soil Group		Solodic Soil
Representative Site		Site 25; Core 82 (GSSE, 2012)
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Very Gently inclined (1-3%)
Land Use		Grazing
Land and Soil Capability Class		Class 4; soil acidification and waterlogging
Interim Protocol –BSAL		No; moderately low inherent fertility
Interim Protocol –Soil Fertility		Moderately low
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (10YR3/3) loam, weak structure grade of <5 mm peds with weak consistence. Nil mottling and no stone content; common medium and fine roots; moderately acidic (pH 5.6) and well drained. Clear even boundary.
A2	0.15 – 0.50	Bleached (7.5YR6/4 (dry)) loamy sand, weak structure grade of <5 mm peds with very weak consistence. Nil mottling; nil stone content; very few fine roots; neutral pH (pH 6.6 and moderately well drained. Abrupt wavy boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.50 – 0.90	Brownish-yellow (10YR6/6) clay loam, moderate structure grade of 40-80 mm rough faced angular blocky peds with moderate consistence. Mottling of 20% yellow; nil stone content; very few fine roots; neutral pH (pH 6.8) and imperfectly drained. Gradual wavy boundary.						
B22	0.90 – 1.00	Strong brown (7.5YR5/6) sandy clay loam, weak structure grade of 10-20 mm angular subangular blocky peds with weak consistence. Mottling of 20% grey mottles; nil stone content; very few fine roots; slightly acidic (pH 6.5) and imperfectly drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	5.1	Very low	1.92	Non-sodic	0.7	Non-saline	8	Negligible
B1	1.6	Very low	12.5	Sodic	0.2	Non-saline	3(1)	Slight
B21	7.2	Low	18.10	Strongly sodic	1.1	Non-saline	2(1)	High to moderate
B22	5.7	Very low	26.32	Strongly sodic	1.9	Non-saline	2(3)	Very high

Soil Unit G19 – Brown Chromsol (moderate soil depth)

Soil Unit G19 is a Chromsol. Soil Unit G19 is comprised of two major soil horizons and is characterised by clay loam grading to a fine sandy clay loam. Soil pH is slightly acidic in the topsoil and mildly alkaline in subsoil. This soil type had a moderately high inherent fertility.

Table A5.49 provides a summary of this soil unit.

Table A5.49 – Overview: Soil Type G19

Site Description		
 		
Plate 93 – Profile (Site 61) Plate 94 – Landscape (Site 61)		
ASC Name		Brown Chromsol* (moderate soil depth)
Great Soil Group		Non-calcic Brown Soil
Representative Site		Site 61
Associated Soil Landscape Unit		Growee
Dominant Slope Association		Gently inclined (3-10%)
Land Use		Grazing
Land and Soil Capability Class		Class 3; water erosion and soil structure hazard
Interim Protocol –BSAL		Yes
Interim Protocol –Soil Fertility		Moderately high
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Brown (7.5YR4/2) clay loam, moderate structure grade of 1-50 mm playy peds with moderate consistence. Nil mottles; nil stone content; occasional large conglomerate 'floaters'; slightly acidic (pH 6.5) and moderately well drained. Gradual and even boundary.
A2	0.15 – 0.35	Brown (7.5YR4/3) fine sandy clay loam, moderate structure grade of 10 – 20 mm sub angular blocky peds with a moderate consistence. Mottles of 15% red; nil stone content; occasional large conglomerate 'floaters'; strongly alkaline (pH 7.5) and moderately well drained.
Subsoil*	0.35+	

* Correlated with Non-calcic Brown Soil of the Growee soil landscape unit, *Soil Landscapes of the Singleton 1:250 000 Sheet* (Kovac & Lawrie, 1991)

LEES PINCH

The Lees Pinch soil landscape unit is characterised by rolling hills to steep mountains and generally covers the steep sections and rocky escarpments of the Great Dividing Range that surround the Bylong valley. Summits are rounded or edged by sandstone cliffs, large sandstone outcrops occur on many hills, with occasional small plateaus, and narrow inaccessible valleys and gorges are common. It occurs on the Narrabeen Group geological unit and parent rock is lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone. Elevation ranges from 180-800 m, with slopes up to 90%. The main soils are shallow siliceous sands with shallow loams (Rudosols/Tenosols), with Yellow and Brown Earths (Kandosols) on the footslopes and Yellow and Grey Soloths (Kurosols/Sodosols) on midslopes. Land is subject to moderate sheet and rill erosion when disturbed and is prone to mass movement on steep slopes.

The Lees Pinch soil landscape unit covers 2,541.2 ha (24.6%) of the Project Site and is represented by 1 soil type, Clastic Rudosol, and a very shallow soil depth phase.



Lees Pinch Soil Landscape Unit

Soil Type L1 – Clastic Rudosol

Soil Unit L1 is a Rudosol. Rudosols are soils that have negligible pedological organisation. Soil Unit L1 is characterised by loamy sand throughout the profile. Soil pH is strongly to very strongly acidic throughout the profile. It is saline, sodic and has negligible dispersion characteristics. CEC very low throughout; exchangeable calcium relative to magnesium and this soil type has very low inherent fertility.

Table A5.50 provides a summary of this soil unit.

Table A5.50 – Overview: Soil Type L1

Site Description								
								
Plate 95 – Profile (Site 31)			Plate 96 – Landscape (Site 31)					
Australian Soil Classification			Clastic Rudosol					
Great Soil Group			Earthy Sands					
Representative Site			Site 31					
Associated Soil Landscape Unit			Lees Pinch					
Dominant Slope Association			Steeply inclined (10-32%); dominant 18-32%					
Land Use			State Forest					
Land and Soil Capability Class			Class 6; mass movement					
Interim Protocol –BSAL			No; slope >10%					
Interim Protocol –Soil Fertility			Low					
Horizon	Depth (m)	Description						
A1	0.00 – 0.20	Dark gray (10YR4/1) loamy sand, weak structure grade of subangular blocky peds with weak consistence. Nil mottles; 5% 5-20 mm stone content; many fine roots; strongly acidic (pH 5.2) and well drained. Gradual and wavy boundary						
A2	0.20 – 0.40	Dark grayish-brown (10YR4/2) loamy sand, weak structure grade of subangular blocky peds with weak consistence. Nil mottles; 5% 5-15 mm stone content; many fine roots; very strongly acidic (pH 4.9) and well drained. Gradual and wavy boundary						
BC	0.40 – 0.75	Brown (10YR4/3) loamy sand, apedal structure grade. Nil mottles; 15% 5-15 mm stone content; many fine roots; strongly acidic (pH 5.2).						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	2.7	Very low	11.1	Sodic	2.2	Slightly saline	8	Negligible

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

A2	1.6	Very low	12.5	Sodic	5.8	Moderately saline	8	Negligible
BC	0.8	Very low	12.5	Sodic	2.7	Slightly saline	8	Negligible

Soil Type L1-P1 – Clastic Rudosol; very shallow

Soil Unit L1-P1 is a phase of L1. It is associated with the cliffs and very steeply precipitously inclined slope of the Lees Pinch Soil Landscape Unit. It is a shallow phase of L01 and also will contain shallow Bleached-Orthic Tenosols (shallow siliceous sands). Due to the inaccessible location, this soil phase was not sampled. It is assessed as Class 7 due to mass movement hazard and is not BSAL due to slope and shallow soil depth.

OGILVIE SOIL LANDSCAPE

The Ogilvie soil landscape unit covers steep hills and escarpments with sandstone and conglomerate outcrops forming cliffs. The landscape is also characterised by deep ravines with sandstone rubble and is present as isolated pockets in the Project area. It occurs on the Narrabeen Group geological unit and parent rock is sandstone, shale and conglomerate. The landform elevation ranges from 180-620 m, with slopes between 15-60%. The dominant soils are shallow loams and sands on the lower slopes (Rudosols/Tenosols). Siliceous sands and sandy earths occur in drainage lines on the lower slopes.

The Ogilvie soil landscape unit covers 1,382.2 ha (13.3%) of the Project Site and is represented by 2 soil types and 2 phases. Major soil types are Brown Sodosol, also represented by a shallow soil depth phase, and Clastic Rudosol, also represented by a moderate soil depth phase.



Ogilvie Soil Landscape Unit

Soil Unit O1 – Mesonatric Brown Sodosol (moderate soil depth)

Soil Unit O1 is a Sodosol. Soil Unit O1 is comprised of four major soil horizons and is characterised by a sandy clay loam overlying medium to heavy clay. Soil pH is slightly acidic in the topsoil and increases to very strongly alkaline at depth. It contains non-sodic topsoil and strongly sodic subsoil. CEC is moderate throughout, exchangeable calcium is low relative to magnesium throughout and this soil type has moderately low inherent fertility.

Table A5.51 provides a summary of this soil unit.

Table A5.51 – Overview: Soil Type O1

Site Description		
 Plate 97 – Profile (Site 8; Core 67) (GSSE, 2012)  Plate 98 – Landscape (Site 8; Core 67) (GSSE, 2012)		
ASC Name	Mesonatric Brown Sodosol (moderate soil depth)	
Great Soil Group	Solodic Soil	
Representative Site	Site 8; Core 67	
Associated Soil Landscape Unit	Ogilvie	
Dominant Slope Association	Gently inclined slopes (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 4; soil acidification and waterlogging hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A1	0.00 – 0.15	Brown (7.5YR4/2) sandy clay loam, moderately weak structure grade of 5 mm blocky peds with moderate consistence. Nil mottles and no stone content. Slightly acidic (pH 6.2). Well drained with a clear and even boundary.
B1	0.15 – 0.35	Brown (7.5YR4/3) medium clay, moderate structure grade of 10-20 mm subangular blocky peds with a moderate consistence. Nil mottles and no stone content. Strongly alkaline (pH 8.5). Moderately drained with a gradual boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B21	0.35 – 0.60	Strong brown (7.5YR4/6)* heavy clay, strong structure grade of 20-40 mm subangular blocky peds with a moderately strong consistence. Mottles of 40% grey and orange. Very strongly alkaline (pH 9.1). Imperfectly drained with a gradual boundary.				
B22	0.60 – 0.90	Strong brown (7.5YR4/6) heavy clay, strong structure grade of 20-40 mm blocky peds with a moderately strong consistence. Mottles of 40% grey and orange. Very strongly alkaline (pH 9.1). Imperfectly drained with a gradual boundary.				
C	0.90+	Weathered conglomerate				
Horizon	CEC		ESP		ECe	
	cmol/kg	rating	%	rating	dS/m	rating
A1	10.7	Low	0.9	Non-sodic	0.8	Non-saline
B1	18.8	Moderate	9.0	Marginally sodic	1.7	Non-saline
B21	21.3	Moderate	14.6	Strongly sodic	3.9	Slightly saline
B22	19.8	Moderate	16.7	Strongly sodic	4.3	Moderately saline

Soil Unit O1-P1: Subnatric Brown Sodosol (shallow soil depth)

Soil Unit O1-P1 is a phase of unit O1. It is located on the steeper slopes and has a shallower soil depth. Soil Unit O1-P1 is comprised of three major soil horizons and is characterised by loam overlying light-medium clay. Soil pH is slightly acidic in the topsoil and increases to very strongly alkaline at depth. It contains non-sodic topsoil, sodic subsoil and has high to moderate subsoil dispersion characteristics. CEC is low in the topsoil, high in the subsoil, exchangeable calcium is low relative to magnesium throughout and this soil type has moderately low inherent fertility.

Table A5.52 provides a summary of this soil unit.

Table A5.52 – Overview: Soil Type O1-P1

Site Description	
 Plate 99 – Profile (Site 54)	 Plate 100 – Landscape (Site 54)
ASC Name	Subnatric Brown Sodosol (shallow soil depth)
Great Soil Group	Solodic Soil

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Representative Site			Site 54					
Associated Soil Landscape Unit			Ogilvie					
Dominant Slope Association			Moderately inclined slopes (10-32%)					
Land Use			Woodland/light grazing					
Land and Soil Capability Class			Class 6; soil depth					
Interim Protocol –BSAL			No; slope >10%					
Interim Protocol –Soil Fertility			Moderately low					
Horizon	Depth (m)	Description						
A1	0.00 – 0.20	Dark Brown (7.5YR3/3) loam with apedal structure. Nil mottling; 50% angular coarse fragments of up to 50 mm; many fine and coarse roots; neutral pH (pH 6.6) and well drained. Clear and wavy boundary.						
B21	0.20 –0.45	Dark yellowish-brown (10YR4/4) light clay, moderate structure grade of 5-10 mm subangular blocky peds with a moderate consistence. Nil mottling, <10% coarse fragments; many fine roots and very strongly alkaline (pH 9.3). Moderately well drained. Gradual and wavy boundary.						
B22	0.45 – 0.60	Yellowish-brown (10YR5/4) light-medium clay, moderate structure grade of 10-50 mm subangular blocky peds with a moderate consistence. Nil mottling; <10% coarse fragments; very few roots; very strongly alkaline (pH 9.8) and imperfectly drained. Gradual and wavy boundary.						
BC	0.60+	Weathering sandstone						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	6.7	Low	4.5	Non-sodic	0.1	Non-saline	3(2)	Slight
B21	19.9	Moderate	10.1	Sodic	2.5	Slightly saline	2(1)	High to moderate
B22	44.2	Very high	4.8	Non-sodic	4.6	Moderately saline	2(1)	High to moderate
BC	37.5	High	8.0	Marginally sodic	4.8	Moderately saline	2(1)	High to moderate

Soil Unit O2 – Clastic Rudosol (deep sol depth)

Soil Unit O2 is a Rudosol. Soil Unit O2 is comprised of four major soil horizons and is characterised sandy loam/loamy sand grading into a sandy clay loam at depth. Soil pH is generally moderately alkaline and this soil type has low inherent fertility.

Table A5.53 provides a summary of this soil unit.

Table A5.53 – Overview: Soil Type O2

Site Description		
 Plate 101 – Profile (Site 173)  Plate 102 – Landscape (Site 173)		
ASC Name	Clastic Rudosol (deep soil depth)	
Great Soil Group	Lithosol	
Representative Site	Site 173	
Associated Soil Landscape Unit	Ogilvie	
Dominant Slope Association	Gently inclined slopes (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 4; soil acidification hazard	
Interim Protocol –BSAL	No; low inherent fertility	
Interim Protocol –Soil Fertility	Low	
Horizon	Depth (m)	Description
A11	0.00 – 0.15	Black (5YR2.5/1) sandy loam with apedal structure grade. Nil mottles; 15% 5 mm stone content; abundant fine and coarse roots; moderately alkaline (pH 8.0) and well drained. Clear and failed fertility criteria boundary.
A12	0.15 – 0.30	Reddish-brown (5YR4/4) loamy sand with apedal structure grade. Nil mottles; 30% 20 mm stone content; abundant fine and coarse roots; neutral (pH 6.0) and rapidly drained. Clear and wavy boundary.
A13	0.30 – 0.50	Reddish-brown (5YR4/4) loamy sand gravel layer with apedal structure grade. Nil mottles; 80% 30 mm stone content; abundant fine roots; moderately alkaline (pH 8.0) and well drained. Clear and wavy boundary.

B2	0.50 – 1.00	Dark reddish-brown (5YR3/3) sandy clay loam, very weak structure grade of subangular blocky 20 mm peds of moderate consistence. Nil mottles; 20% 30 mm stone content; abundant fine roots; moderately alkaline (pH 8.0) and well drained.

Soil Unit O2-P1 – Clastic Rudosol (moderate soil depth)

Soil Unit O2-P1 is a phase of unit O2. It is located on the steeper slopes has a shallower soil depth. This Phase is comprised of four major soil horizons and is characterised by a bleached sandy loam overlying medium clay. Soil pH is slightly acidic in the topsoil and increases to very strongly alkaline at depth and this soil type has low inherent fertility.

Table A5.54 provides a summary of this soil unit.

Table A5.54 – Overview: Soil Type O2-P1

Site Description	
 Plate 103 – Profile (Site 231)	 Plate 104 – Landscape (Site 231)
ASC Name	Clastic Rudosol (moderate soil depth)
Great Soil Group	Lithosol
Representative Site	Site 231
Associated Soil Landscape Unit	Ogilvie
Dominant Slope Association	Moderately inclined slopes (10-32%)
Land Use	Grazing
Land and Soil Capability Class	Class 5; water erosion and soil acidification hazard
Interim Protocol –BSAL	No; slope >10%
Interim Protocol –Soil Fertility	Low

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

Horizon	Depth (m)	Description
A11	0.00 – 0.10	Dark reddish-brown (5YR3/2) sandy loam, apedal structure grade. Nil mottles; 15% 5 mm stone content; abundant fine and coarse roots; very strongly acidic (pH 5.0) and well drained. Clear and even boundary.
A12	0.10 – 0.30	Reddish-brown (5YR4/4) sandy loam, apedal structure grade. Nil mottles; 20% 20 mm stone content; abundant fine and coarse roots; strongly acidic (pH 5.5) and rapidly drained. Clear and even boundary.
B2	0.30 – 0.60	Red (2.5YR5/6) sandy clay with very weak structure grade of 5-10 mm subangular peds with very weak consistence. Nil mottles; 40% 30 mm stone content; abundant fine roots; moderately acidic (pH 6.0) and well drained. Clear and even boundary.

SANDY HOLLOW SOIL LANDSCAPE

The Sandy Hollow soil landscape unit covers undulating terrain with smooth and gentle rises. It is associated with the Ogilvie and Lees Pinch soil landscape units as it grades into Lees Pinch on the steep slopes with cliffs and into Ogilvie on toeslopes. Within the Project area, it is a minor unit and occurs primarily in the central-east and eastern parts. It is located on Quaternary colluvium derived from the Narrabeen Group and the parent rock is sandstone, shale and conglomerate. Slopes are generally less than 10% with lengths ranging from 100-250 m. There are some outcrops of sandstone and also narrow flat benches on the sandstone with small broken scarps. Shallow valleys 20-40 m deep are cut into adjacent hills. Terraces sandy or gravelly alluvium occurs in the major valleys along streams. There is moderate gully erosion (<1.5m) in drainage lines and minor sheet and rill erosion on slopes. The main soils are Red and Yellow Solodic Soils (Sodosols) on the upper and midslopes and Yellow and Brown Solodic Soils (Sodosols) on the lower slopes. Red Earths (Kandosols) occur on the midslopes directly adjacent to sandstone benches with Siliceous Sands (Rudosols/Tenosols). Alluvial soils (Rudosols) occur along major drainage lines.

The Sandy Hollow soil landscape unit covers 132.1 ha (1.3%) of the Project Site and is represented by 1 soil type, Red Sodosol.



Sandy Hollow Soil Landscape Unit

Soil Unit SH1 – Subnatric Red Sodosol (deep soil depth)

Soil Unit SH1 is a Sodosol. It is comprised of four major soil horizons and is characterised by a loam overlying light-medium to light clay. Soil pH is strongly acidic in the topsoil and increases in alkalinity to strongly alkaline in the subsoil. It is slightly saline in the topsoil, trending from non-saline to moderately saline in the subsoil. It has non-sodic topsoil, sodic subsoil and high subsoil dispersion characteristics. CEC is low in topsoil and moderate in subsoil; exchangeable calcium is low to deficient relative to magnesium throughout and this soil type has moderately low inherent fertility.

Table A5.55 provides a summary of this soil unit.

Table A5.55 – Overview: Soil Type SH1

Site Description		
 Plate 105 – Profile (Site 5; Core 22) (GSSE, 2012)  Plate 106 – Landscape (Site 5; Core 22) (GSSE, 2012)		
ASC Name	Subnatric Red Sodosol (deep soil depth)	
Great Soil Group	Solodic Soil	
Representative Site	Site 5; Core 22 (GSSE, 2012)	
Associated Soil Landscape Unit	Sandy Hollow	
Dominant Slope Association	Gently inclined (3-10%)	
Land Use	Grazing	
Land and Soil Capability Class	Class 5; soil acidification hazard	
Interim Protocol –BSAL	No; moderately low inherent fertility	
Interim Protocol –Soil Fertility	Moderately low	
Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (7.5YR3/3) loam, of weak structure grade of 5 mm crumbly peds with weak consistence. Nil mottles; 10% 2-5 mm stone content; many fine roots; strongly acidic (pH 5.2) and well drained. Clear boundary.

Bylong Coal Project

Soil, Land Capability and Strategic Agricultural Land Assessment

Appendix E - Soil Units

B1	0.10 – 0.30	Yellowish-red (5YR4/6) light-medium clay of moderate structure grade of 50 mm subangular peds with weak consistence. Nil mottles; 5% 2-5 mm stone content; many fine roots; neutral (pH 7.3) and well drained. Gradual boundary						
B21	0.30 – 0.50	Yellowish-red (5YR4/6) light clay of strong structure grade of 50-100 mm subangular peds with strong consistence. Nil mottles; 5% 2-5 mm stone content; few fine roots; moderately alkaline (pH 8.2) and well drained. Gradational boundary						
B22	0.50 – 0.80	Yellowish-red (7.5YR5/4) light clay of strong structure grade of 100 mm subangular peds with strong consistence. Nil mottles; nil stone content; strongly alkaline (pH 8.5) and well drained.						
Horizon	CEC		ESP		ECe		EAT	
	cmol/kg	rating	%	rating	dS/m	rating	class	rating
A1	11.5	Low	2.6	Non-sodic	3.3	Slightly saline	5	Slight
B1	15.4	Moderate	7.1	Marginally sodic	0.6	Non-saline	2(1)	High to moderate
B21	16.6	Moderate	12.7	Sodic	1.2	Non-saline	2(2)	High
B22	21.9	Moderate	15.1	Strongly sodic	5.1	Moderately saline	2(3)	Very high