MALABAR COAL

MAXWELL PROJECT

Agricultural Impact Assessment

In Support of an Application for a Gateway Certificate

ATTACHMENT A

Biophysical Strategic Agricultural Land Verification Assessment

August 2018

MAXWELL PROJECT

Malabar Coal Limited
Biophysical Strategic Agricultural Land Verification Assessment

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Maxwell Project

Malabar Coal Limited

Biophysical Strategic Agricultural Land Verification Assessment

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EXECUTIVE SUMMARY

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project).

An application for a Gateway Certificate is being lodged for those parts of the development that require a new mining lease. The land that will be subject to this application is referred to as the Gateway Certificate Application Area.

The presence of Biophysical Strategic Agricultural Land (BSAL) within the Gateway Certificate Application Area has been assessed based on surveys completed for this report in conjunction with surveys within the study area undertaken by SLR in 2015. The assessment has been conducted in accordance with the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (Office of Environment & Heritage and Department of Primary Industries – Office of Agricultural Sustainability and Food Security, 2013).

Fourteen soil units have been identified across the Gateway Certificate Application Area. Of these soil units, only one soil unit was verified as BSAL (SLR (2015)). This area of BSAL is approximately 72 hectares, however some of this soil unit has been disturbed by Edderton Road, which bisects this soil unit. This area of verified BSAL is located outside of proposed surface development areas for the Project.

1 INTRODUCTION

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project).

The Project is located in the Upper Hunter Valley of NSW, east-southeast of Denman and south-southwest of Muswellbrook. The Project underground mining area is located entirely within Exploration Licence (EL) 5460.

Malabar owns and operates the existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395 (known as the Maxwell Infrastructure). The Maxwell Infrastructure includes an existing coal handling and preparation plant (CHPP), rail facilities and other infrastructure and services (including water management infrastructure, administration buildings, workshops and services). The Project would utilise the existing Maxwell Infrastructure and include the development of new infrastructure from the mine entry to the Maxwell Infrastructure.

Malabar engaged SLR Consulting Australia Pty Ltd (SLR) to undertake a Biophysical Strategic Agricultural Land (BSAL) Verification Assessment to support an Application for a Gateway Certificate for the Project. The land that will be subject to this application is referred to as the Gateway Certificate Application Area. A portion of the Gateway Certificate Application Area, covering 1,458 hectares, was previously subject to survey and assessment in April 2015 in support of a Gateway Certificate Application for the Drayton South Coal Project (SLR, 2015), with the results represented in this report. This survey area has not been re-surveyed as part of the current assessment and is referred to as SLR (2015).

This document provides an assessment of the Gateway Certificate Application area land in accordance with 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), 2013) (Interim Protocol).

1.1 Study Area

To provide BSAL Verification Assessment for the Gateway Certificate Application Area plus a 100 metre buffer, an additional area of 1,757 hectares was assessed (**Figure 1**).

1.2 Legislation and Standards

1.2.1 Interim Protocol for Site Verification and Mapping of BSAL

In April 2013, the Interim Protocol (DPI-OASFS, 2013) was released by the NSW Government. The Interim Protocol outlines the process for seeking verification of whether or not land mapped as BSAL meets the established BSAL criteria. The *State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013* (the 2013 Mining SEPP amendment) requires certain types of developments to verify whether the proposed site is on BSAL.

The purpose of the Interim Protocol is to assist proponents and landholders to understand what is required to identify the existence of BSAL. It outlines the technical requirements for the on-site identification and mapping of BSAL.

1.2.2 Assessment Standards

The key standards for this assessment include:

- Interim Protocol;
- Australian Soil Classification (ASC) system (Isbell, 2002);
- Guidelines for Surveying Soil and Land Resources (National Committee on Soil and Terrain (NCST), 2008); and
- Australian Soil and Land Survey Field Handbook (NCST, 2009).

All figures shown in the main report are at 1:40,000 scale. In order to meet the requirements of the Interim Protocol, figures at 1:25,000 scale are shown in **Appendix A**.

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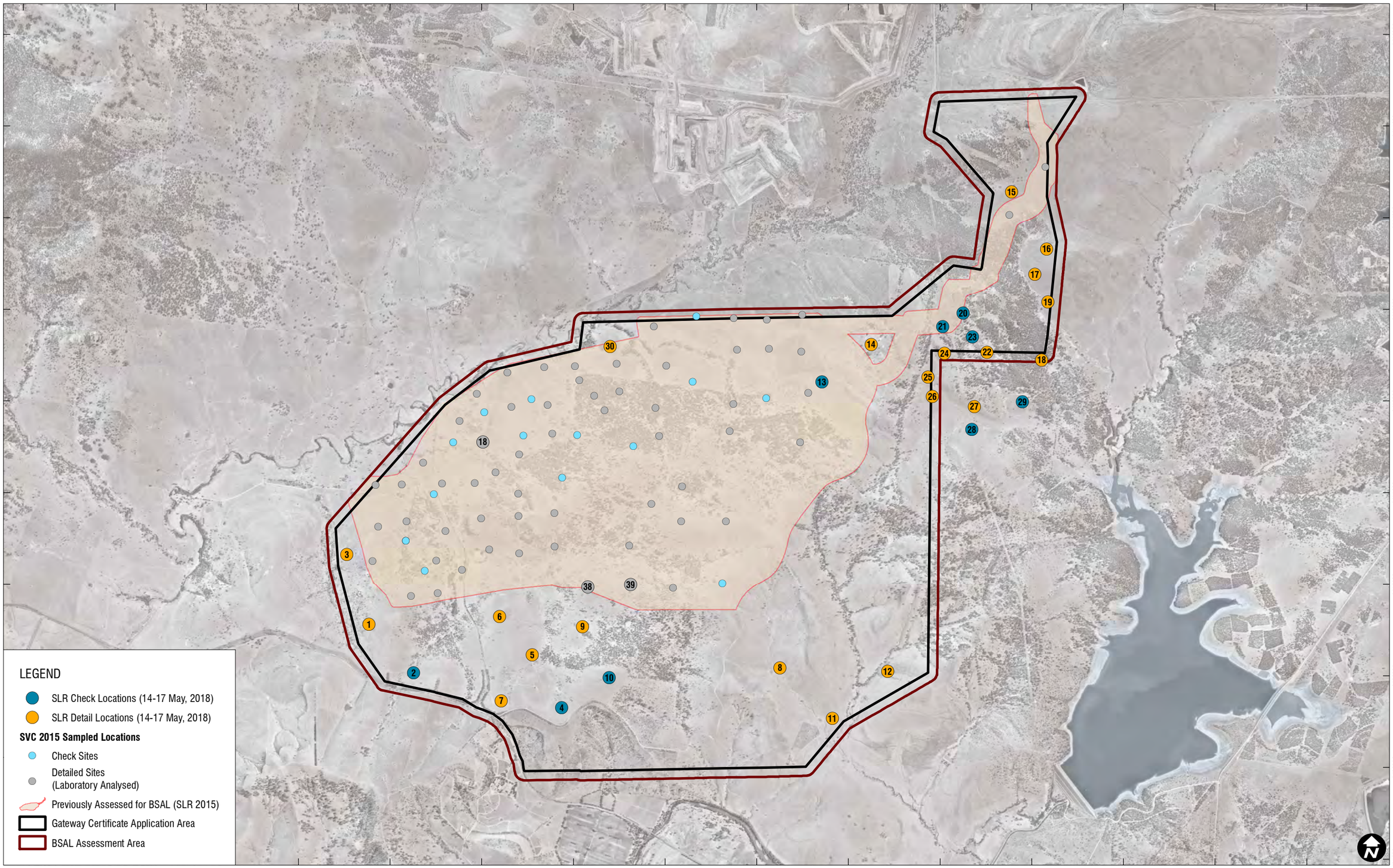

LEGEND

- SLR Check Locations (14-17 May, 2018)
- SLR Detail Locations (14-17 May, 2018)

SVC 2015 Sampled Locations

- Check Sites
- Detailed Sites (Laboratory Analysed)
- Previously Assessed for BSAL (SLR 2015)
- Gateway Certificate Application Area
- BSAL Assessment Area

0 500 1,000 1,500 2,000 m

Scale:1:40,000
GDA 1994 MGA Zone 56

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BSAL Assessment Area

FIGURE 1

2 METHODOLOGY

The site verification methodology for the Study Area has been undertaken consistent with the process described within the Interim Protocol; including the following steps:

1. Identify the project area (termed Study Area in this report) which will be assessed for BSAL;
2. Confirm access to a reliable water supply;
3. Choose the appropriate approach to map the soils information;
4. Undertake a risk assessment; and
5. Undertake field Soil Surveys and BSAL Assessment.

Each of these steps is described in further detail in the following subsections.

2.1 Step 1: Identify the Project Area which will be Assessed for BSAL

The Interim Protocol requires that *"the assessment area should include the entire project area and include at least a 100 metre buffer to take into account minor changes in design, surrounding disturbance and minor expansion. If BSAL is part of a larger contiguous mass of BSAL then the boundary of this area must also be identified."*

The Study Area for the BSAL Verification Assessment is shown in **Figure 1**. The Study Area includes a 100 metre buffer surrounding the Gateway Certificate Application Area.

The 2018 survey area totalled 1,757 hectares (excludes the area previously surveyed by SLR (2015)).

2.2 Step 2: Confirm access to a reliable water supply

The Interim Protocol requires that *"BSAL lands must have access to a 'reliable water supply'",* which includes rainfall of 350 mm or more per annum in 9 out of 10 years.

The Project is located in the Upper Hunter. The Interim Protocol confirms that all of the area in the Upper Hunter has access to a "reliable water supply".

2.3 Step 3: Choose the appropriate approach to map the soils information

The Interim Protocol states *"access to the project area will define the level of investigation that the proponent can undertake. If the proponent has access to the land then the BSAL verification requirements for on-site soils assessment as described in sections 6 and 9 of the Interim Protocol should be met. If the proponent does not have access then the proponent should develop a model of soils distribution guided by sections 6 and 9 based on landscape characteristics using the information listed in Section 5 of the Interim Protocol."*

Access was limited in some portions of the Study Area due to proximity to drainage lines and possible archaeological disturbance. These assessment sites were moved to the closest non-risk area, which in some cases were areas of greater than 10% slope, but still representative of the surrounding soil unit for mapping and assessment purposes.

Access restrictions due to land ownership resulted in 114 hectares in the north and north-west of the Study Area being correlated with contour data and adjoining soil type (a Sodosol and a Chromosol).

2.4 Step 4: Risk assessment

The Interim Protocol states *"the proponent should undertake a risk assessment as this will influence the density of soil sampling required as explained in Section 9.6.1. The proposed activity on parts or all of the project area may be of low risk to agriculture and so may only require a sampling density of 1:100 000. Alternatively other areas may be at higher risk of impact and so should have a sampling density of 1:25 000."*

The Study Area comprises areas of proposed underground mining and areas of proposed surface disturbance for a mine entry and transport corridor. SLR has assessed the following potential impacts of the Project within the Study Area on agriculture:

- Underground Mining: Level 5 – Very minor damage and minor impact to agricultural resources or industries. Probability: B – Likely, known to occur or it has happened. The risk matrix result was B5 which is considered a low risk. The area of underground mining requires an inspection density of 1:100,000.

- Surface Disturbance: Level 4 – Minor damage and/or short-term impact to agricultural resources or industries. Can be managed as part of routine operations. Probability A – Almost certain, common or repeating occurrence. The risk matrix result was A4 which is considered a medium risk. The areas of surface disturbance require an inspection density of 1:25,000.

2.5 Step 5: Field Soil Survey and BSAL Assessment

The field survey for the 2018 BSAL Verification Assessment was undertaken between May 14th and May 17th, 2018 by SLR's Principal Soil Scientist (Certified Professional Soil Scientist (CPSS) 2) Clayton Richards and SLR's Associate Agronomist, Murray Fraser.

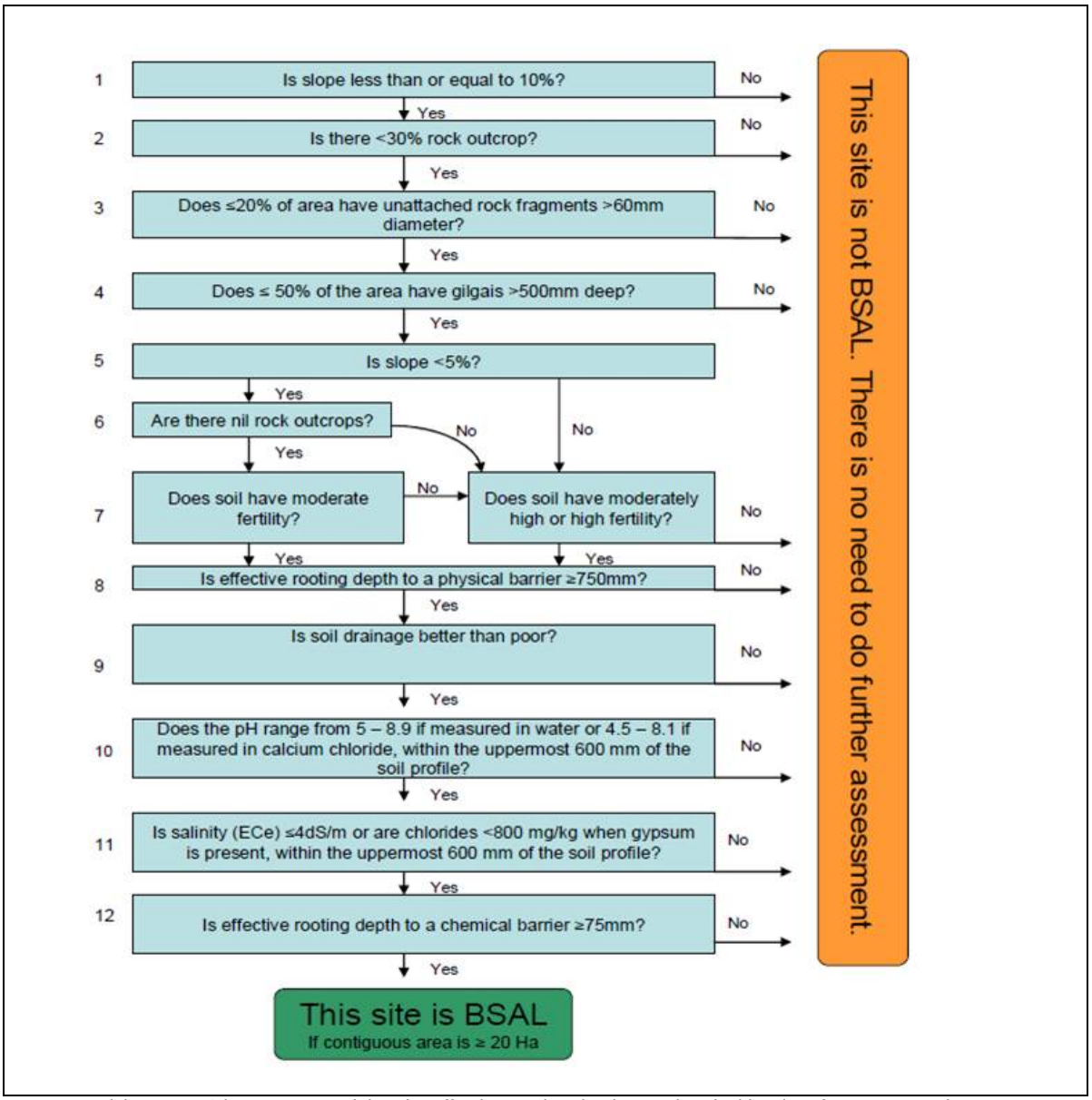
2.6 Field Soil Survey Methodology

For soil to be classified as BSAL it must meet the criteria outlined in the flow chart shown in **Diagram 1**. If any criteria is not met (except for those outlined in step 5 or step 6), the site is not BSAL and there is no need to continue the assessment.

Section 6 of the Interim Protocol states *"slope is the upward or downward incline of the land surface, measured in per cent. BSAL soils must have a slope of less than or equal to 10 per cent. If any criteria are not met, the site is not BSAL and there is no need to continue the assessment"*.

The design of the soil survey program was developed by following a process of applying the BSAL methodology as a desktop exercise in the first instance to identify any areas that would obviously not meet the criteria (termed exclusion zones). The field survey program was then developed to ensure that areas of relatively higher likelihood of meeting BSAL criteria were targeted for field analysis.

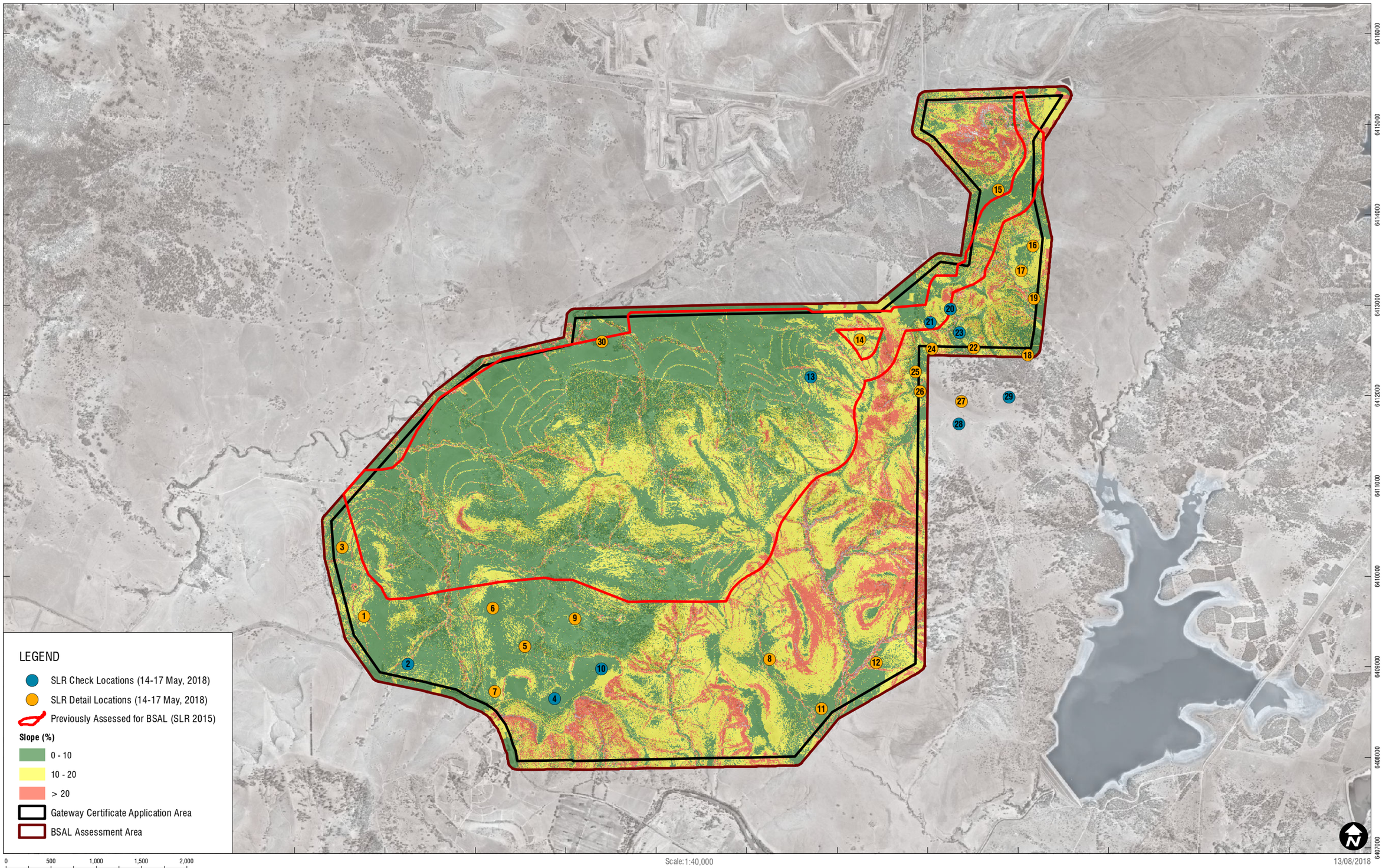
Diagram 1 BSAL Criteria Flow Diagram



Note: In applying step 12 it was assumed that the effective rooting depth to a chemical barrier of ≥75 mm was incorrect as stated in Diagram 1, and instead a value of ≥750 mm was adopted as stated in Section 6.10 of the Interim Protocol.

2.6.1 Exclusion Zones

Land greater than 10% slope (**Figure 2**) within the Study Area was identified using topographical data derived from updated LIDAR data provided by Malabar that was captured in June 2018. This updated LIDAR was applied across the entire BSAL Assessment Area, including the SLR (2015) Study Area. Areas with greater than 10% slope were excluded from the soil survey program, along with any areas which were less than or equal to 10% slope and also less than 20 hectares in contiguous area. In total, 1,178 hectares of the 2018 Study Area was determined not to meet the BSAL methodology Criteria 1, as shown in **Diagram 1** and on **Figure 3**. The Slope Analysis methodology is provided in **Appendix B**.



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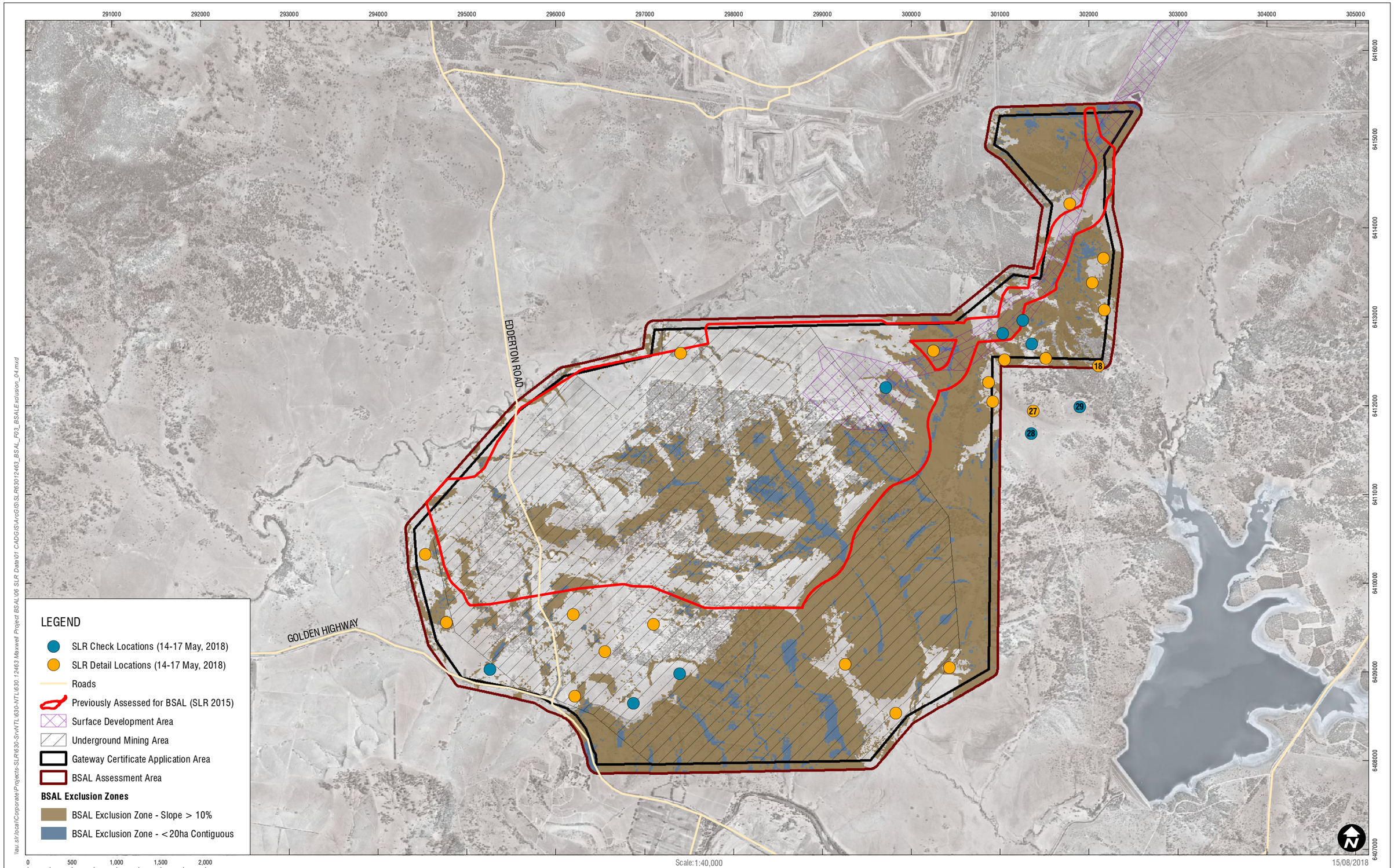
Slope Analysis

FIGURE 2



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BSAL Exclusion Areas

FIGURE 3

2.6.2 Soil Survey Density

To satisfy soil mapping requirements, the field soil survey program was undertaken of those areas outside the 2018 BSAL Exclusion Zone and comprised of thirty described sites, as shown on **Figure 3**. A breakdown of the soil survey density, as per Interim Protocol requirements, is provided in **Table 1**.

Table 1 2018 Survey – Assessment of Soil Survey Density

Category	**BSAL Study Area**
Total Study Area Hectares	3,215
Previously Surveyed (SLR, 2015) Hectares	1,458
BSAL Exclusion Zone (Greater Than 10% Slope) Hectares	1,068
BSAL Exclusion Zone (Less Than 20 Hectares Contiguous)	110
BSAL Survey Area Hectares	**579**
Survey Density	**BSAL Survey Area**
1:25,000 Survey Area (Potential Surface Disturbance) Hectares	34
1:25,000 (Potential Surface Disturbance) 2 Required Sites	Actual Sites Surveyed 5
1:100,000 Survey Area (Underground Mining & Nil Disturbance) Hectares	545
1:100,000 (Underground Mining) 6 Required Sites	Actual Sites Surveyed 25
Total Number Sites	**30**
Laboratory Analysed Sites	**21**

A breakdown of the soil survey density in the SLR (2015) Study Area is provided in **Table 2**. Soil collected from Site 18 in SLR (2015) was sent to the laboratory for analysis as part of this assessment.

Table 2 Soil Survey Density in SLR (2015) Study Area

Category	**SLR (2015) BSAL Study Area**
Previously Surveyed Study Area Hectares	1,458
BSAL Exclusion Zone (Greater Than 10% Slope) Hectares	456
BSAL Exclusion Zone (Less Than 20 Hectares Contiguous)	74
BSAL Survey Area Hectares	**928**
Survey Density	**BSAL Survey Area**
1:25,000 (Proposed Open-Cut Surface Disturbance) 38 Required Sites	Actual Sites Surveyed 74
Total Number Sites	**74**
Laboratory Analysed Sites	**60**

2.6.3 Soil Survey Observation Types

Soil profiles were assessed at 30 sites in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST, 2009). Each soil-profile exposure was excavated by a backhoe to either a depth of 1.2 metres, to equipment refusal, or to bedrock.

Detailed soil profile morphological descriptions were prepared at all sites to record the information specified in the Interim Protocol. Information was recorded for the major parameters specified in **Table 3**.

Global Positioning System (GPS) readings was taken for all sites where soil descriptions are recorded. Vegetation type, landform and aspect were also noted. Soil exposures from pits were photographed during field operations.

Table 3 Field Assessment Parameters

Descriptor	Application
Horizon depth	Weathering characteristics, soil development
Field colour	Permeability, susceptibility to dispersion/erosion
Field texture grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary distinctness and shape	Erosional/dispositional status, textural grade
Consistence force	Structural stability, dispersion, ped formation
Structure pedality grade	Soil structure, root penetration, permeability, aeration
Structure ped and size	Soil structure, root penetration, permeability, aeration
Stones – amount and size	Water holding capacity, weathering status, erosional/depositional character
Roots – amount and size	Effective rooting depth, vegetative sustainability
Ants, termites, worms etc.	Biological mixing depth

Of the 30 sites, 21 sites were detailed sites and nine sites were check sites.

Check sites are mapping observations examined in sufficient detail to allocate the site to a specific soil type and map unit.

For detailed sites, soil was collected from each major soil horizon (soil layer). After assessment, soil pits were backfilled with the remaining soil.

Soil samples from the 21 detailed sites were utilised in the BSAL verification laboratory testing program. Samples were analysed in order to classify Australian Soil Classification (ASC) (Isbell, 2002) soil taxonomic class and enable BSAL verification.

Soil collected from each major soil horizon (soil layer) was sent to a NATA accredited laboratory (EAL Laboratories) for analysis. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in **Table 4**.

Table 4 Laboratory Analysis Parameters

Property	Application
Coarse Fragments (>2mm)	Soil workability; root development
Particle-Size Distribution (<2mm)	Determine fraction of clay, silt, fine sand and coarse sand; nutrient retention; exchange properties; erodibility; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Soil Reaction (pH)	Nutrient availability; nutrient fixation; toxicities (especially aluminium and manganese); liming; sodicity; correlation with other soil properties
Electrical Conductivity (EC)	Appraisal of salinity hazard in soil substrates or groundwater; total soluble salts
Cation Exchange Capacity (CEC) & Exchangeable Cations	Nutrient status; calculation of exchangeable cations including sodium, calcium, magnesium, potassium and exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
Munsell Colour Chart (Munsell)	Drainage, oxidation, fertility, correlation with other physical, chemical and biological properties

Soil salinity in the samples from the detailed sites was determined through measurement of the electrical conductivity (EC) of soil:water (1:5) suspensions. These values were converted to the EC of a saturated extract (ECe) based on soil texture in accordance with the Interim Protocol. The methodology and results of the conversions for all detailed sites are shown in **Appendix E**.

3 SOILS ASSESSMENT

Four additional soil units in this Study Area were identified and mapped according to the dominant ASC soil type (**Figure 4**) during the soil survey and analysis of laboratory results. These four soil units and their associated map sites are show below in **Table 5**.

Section 9.6.2 of the Interim Protocol states "*All soil map units will have some soil variation. The dominant soil type upon which BSAL status is determined should comprise great than 70 per cent of a soil map unit*." Section 9.6.3 of the Interim Protocol further confirms "*BSAL status is determined on the dominant soil type within a soil map unit*."

A description of one detail representative site from each mapped soil unit follows in **Tables 7** to **18**, with the remaining soil profile descriptions shown in **Appendix C**. Laboratory certificates of analysis are shown in **Appendix D**. Once the Gateway Certificate Application Area was refined by Malabar Coal, Sites 27, 28 and 29 were no longer within the Study Area, however they have been included in this assessment to ensure consistency with the laboratory analysis data presented in **Appendix D**.

The small areas of Mesonatric Brown Sodosol (56 hectares), Eutrophic Brown Chromosol; Moderate – Unit B (10 hectares), Subnatric Brown Sodosol – Unit B (47 hectares) and Subnatric Brown Sodosol – Unit A (1 hectare) were correlated with SLR (2015) soil and topographic data to finalise the soil mapping.

Table 5 Soil Units within BSAL Survey Area

Soil Unit	ASC Soil Type	Mapping Class	Detail Site	Check Site	Hectares
11	**Epipedal Brown Vertosol**	**Dominant**	**5, 9**	**4, 10**	103
12	**Eutrophic Red Chromosol**	**Dominant**	**3, 6**	**2**	235
	Eutrophic Red Dermosol	Sub-Dominant	1	Nil	
	Eutrophic Brown Chromosol		7	Nil	
13	**Epipedal Black Vertosol**	**Dominant**	**8, 12**	Nil	71
	Eutrophic Grey Dermosol	Sub-Dominant	11	Nil	
14	**Subnatric Brown Sodosol – Unit C**	**Dominant**	**16, 17, 22, 25, 27**	**20, 21, 28**	56
	Subnatric Grey Sodosol	Sub-Dominant	26	Nil	
	Red Sodosol		Nil	23, 29	
	Mottled-Mesonatric Brown Sodosol		18	Nil	
	Eutrophic Brown Dermosol		19	Nil	
	Eutrophic Brown Chromosol		24	Nil	
				Subtotal	**465**
5	Subnatric Brown Sodosol – Unit A	Mapping Correlated With SLR (2015)			1
8	Mesonatric Brown Sodosol				56
9	Eutrophic Brown Chromosol; Moderate – Unit B				10
10	Subnatric Brown Sodosol – Unit B				47
				Subtotal	**114**
				Total	**579**

Additional assessed and mapped sites were correlated with the SLR (2015) Study Area soil types to ensure mapping density and scale was per the Interim Protocol. These sites were:

- Check Site 13 Brown Sodosol in the Mesonatric Brown Sodosol.
- Detail Site 14 Mottled-Subnatric Red Sodosol (subdominant soil type in Mesonatric Brown Sodosol).
- Detail Site 15 Eutrophic Brown Chromosol (subdominant soil type in Mesonatric Brown Sodosol).
- Detail Site 30 Epipedal Brown Vertosol (subdominant soil type in Subnatric Brown Sodosol – Unit B).

These soil profile descriptions are also shown in **Appendix C**.

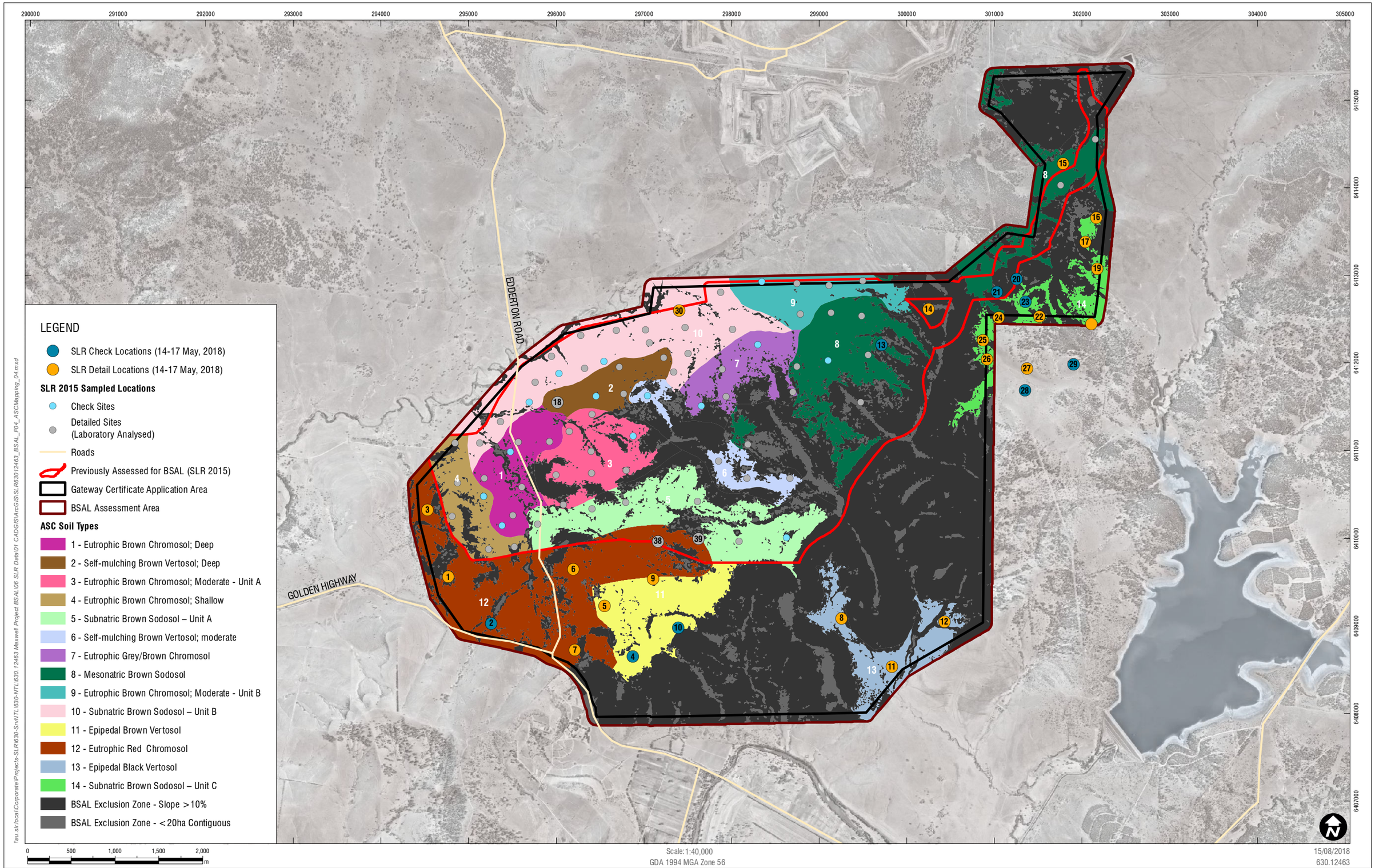
To maintain accuracy with the combined soil mapping of SLR (2015), Sites 38 and 39 (both classed by SLR [2015] as Eutrophic Red Chromosol) have been remapped to Soil Unit 12 (Eutrophic Red Chromosol) (**Figure 4**). The extents of the soil units have also been updated to reflect the most recent slope analysis.

A summary of the total area of each soil unit with the combined soil mapping of SLR (2015) is presented in **Table 6**.

Table 6 Soil Units within the Gateway Certificate Application Area and 100 metre Buffer

Soil Unit	Soil Unit	Hectares
1[#]	Eutrophic Brown Chromosol; Deep	72
2	Self-Mulching Brown Vertosol; Deep	53
3	Eutrophic Brown Chromosol; Moderate – Unit A	76
4	Eutrophic Brown Chromosol; Shallow	57
5[#]	Subnatric Brown Sodosol – Unit A	144
6	Self-Mulching Brown Vertosol; Moderate	33
7	Eutrophic Grey/Brown Chromosol	63
8	Mesonatric Brown Sodosol	228
9	Eutrophic Brown Chromosol; Moderate – Unit B	71
10[#]	Subnatric Brown Sodosol – Unit B	226
11	Epipedal Brown Vertosol	103
12[#]	Eutrophic Red Chromosol	254
13	Epipedal Black Vertosol	71
14	Subnatric Brown Sodosol – Unit C	56
	Soil Unit Subtotal	**1,507**
Exclusion	Greater than 10% slope or less than 20 hectares contiguous area	1,708
	Total	**3,215**

These soil units are bisected by Edderton Road. It is expected that the soil resource would have been significantly impacted in the area of development, however the area of Edderton Road has been conservatively retained in the total soil unit area.



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ASC Soil Types

FIGURE 4

Soil Unit 11: Brown Vertosol

Epipedal Brown Vertosol

Table 7 Summary: Epipedal Brown Vertosol (Site 9)

Overview	
	
Landscape Site 9	
ASC Name	Epipedal Brown Vertosol
Representative Site	Site 9
Other Mapped Sites	4, 5, 10
Survey Type	Detailed
Dominant Topography	Mid Slope
Dominant Land Use	Cattle Grazing
Vegetation	White Box, Grey Box, Acacia, Red Grass
Inherent Soil Fertility	Moderately High
Slope	9%
Aspect	North
Site Verified	Non-BSAL – Sodicity & ECe

Table 8 Profile: Epipedal Brown Vertosol (Site 9)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Very dark brown (7.5YR 2.5/2) silty clay, moderately structured 10-20 mm blocky peds with strong consistence and a rough fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.40	Dark brown (7.5YR 3/3) silty clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a smooth fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with gradual and wavy boundary. Sampled 0.20 – 0.30
	B22 0.40 – 0.75	Dark yellowish brown (10YR 3/4) medium clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a smooth fabric. 10% soft calcium nodules <10 mm. Nil mottling, nil stone content, coarse roots common. Well drained with gradual and wavy boundary. Sampled 0.40 – 0.50 and 0.65 – 0.75
	B23 +0.75	Brown (7.5YR 4/4) heavy clay, massive with strong consistence and a smooth fabric. 10% soft calcium nodules <10 mm. Nil mottles, nil stone content, few coarse roots. Well drained, layer continues beyond sampling depth. Not sampled.

Table 9 Chemical Parameters: Epipedal Brown Vertosol (Site 9)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	rating	%	rating	dS/m	rating	ratio	rating
A1	6.4	Slightly Acidic	3.1	Non-Sodic	0.6	Non-Saline	1.5	Low
B21	8.0	Moderately Alkaline	11.6	Sodic	1.7	Non-Saline	0.8	Very Low
B22	8.6	Strongly Alkaline	19.7	Strongly Sodic	6.2	Moderately Saline	0.6	Very Low
B22	8.7	Strongly Alkaline	17.4	Strongly Sodic	5.6	Moderately Saline	1.1	Low

Soil Unit 12: Red Chromosol

Eutrophic Red Chromosol

Table 10 Summary: Eutrophic Red Chromosol (Site 3)

Overview	
	
Landscape Site 3	
ASC Name	Eutrophic Red Chromosol
Representative Site	Site 3
Other Mapped Sites	1, 2, 6, 7
Survey Type	Detailed
Dominant Topography	Mid Slope
Dominant Land Use	Cattle Grazing
Vegetation	Acacia, Casuarina, Wire Grass, Red Grass
Inherent Soil Fertility	Moderately High
Slope	8%
Aspect	South-West
Site Verified	Non-BSAL – Soil Depth & Drainage

Table 11 Profile: Eutrophic Red Chromosol (Site 3)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.15	Dark yellowish brown (10YR 4/4) loamy sand, weak crumb structure 2-10 mm peds with weak consistence and a rough fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	A2 0.15 – 0.40	Strong brown (7.5YR 4/6) loamy sand, weakly structured 5-10 mm blocky peds with weak consistence and a rough fabric. Bleached when dry. Nil mottling, nil stone content, fine roots common. Well drained with an abrupt and even boundary. Sampled 0.20 – 0.30
	B2 0.40 – 0.65	Yellowish red (5YR 4/6) clay loam, strongly structured 20-50 mm subangular blocky peds with strong consistence and a rough fabric. 25% distinct yellow mottles; nil stone content; coarse roots common. Poorly drained with a clear and even boundary. Sampled 0.40 – 0.50
	BC +0.65	Weathered sandstone. Not sampled.

Table 12 Chemical Parameters: Eutrophic Red Chromosol (Site 3)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	rating	%	rating	dS/m	rating	ratio	rating
A1	6.3	Slightly Acidic	3.5	Non-Sodic	0.5	Non-Saline	2.7	Moderate
A2	6.2	Slightly Acidic	3.7	Non-Sodic	0.2	Non-Saline	4.3	Balanced
B2	6.8	Neutral	4.3	Non-Sodic	0.3	Non-Saline	2.8	Moderate

Soil Unit 13: Black Vertosol

Epipedal Black Vertosol

Table 13 Summary: Epipedal Black Vertosol (Site 12)

Overview	
	
Landscape Site 12	
ASC Name	Epipedal Black Vertosol
Representative Site	Site 12
Other Mapped Sites	8, 11
Survey Type	Detailed
Dominant Topography	Lower Slope
Dominant Land Use	Cattle Grazing
Vegetation	White Box, Kurrajong, Red Grass, Wire Grass
Inherent Soil Fertility	High
Slope	8%
Aspect	West
Site Verified	Non-BSAL – pH 8.2 (1:5 $CaCl_2$) & Rock Outcrop^

^Rock outcrop photos shown at the end of **Appendix C**

Table 14 Profile: Epipedal Black Vertosol (Site 12)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Dark brown (7.5YR 3/2) silty clay, strongly structured 10-20 mm blocky peds with strong consistence and a rough fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.50	Dark brown (7.5YR 3/2) heavy clay, strongly structured 20-50 mm subangular blocky peds with strong consistence and a smooth fabric. 20% soft calcium nodules 10-20 mm. Nil mottling, nil stone content, abundant coarse roots. Well drained with a gradual and wavy boundary. Sampled 0.20 – 0.30 and 0.40 – 0.50
	B22 0.50 – 0.90	Very dark brown (7.5YR 2.5/3) medium clay, strongly structured 40-50 mm subangular blocky peds with strong consistence and a smooth fabric. 40% soft calcium nodules 10-20 mm. Nil mottling, nil stone content, coarse roots common. Well drained with a gradual and wavy boundary. Sampled 0.65 – 0.75
	B23 +0.90	Very dark brown (7.5YR 2.5/3) heavy clay, massive structure. Layer continues beyond sample depth. Not sampled.

Table 15 Chemical Parameters: Epipedal Black Vertosol (Site 12)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	rating	%	rating	dS/m	rating	ratio	rating
A1	7.8	Mildly Alkaline	0.9	No-Sodic	1.6	Non-Saline	6.6	High
B21	8.2	Moderately Alkaline	2.1	Non-Sodic	0.9	Non-Saline	3.7	Moderate
B21	8.8	Strongly Alkaline	8.4	Marginally Sodic	2.0	Non-Saline	1.8	Low
B22	8.9	Strongly Alkaline	14.6	Strongly Sodic	3.7	Slightly Saline	1.2	Low

Soil Unit 14: Brown Sodosol

Subnatric Brown Sodosol – Unit C

Table 16 Summary: Subnatric Brown Sodosol (Site 16)

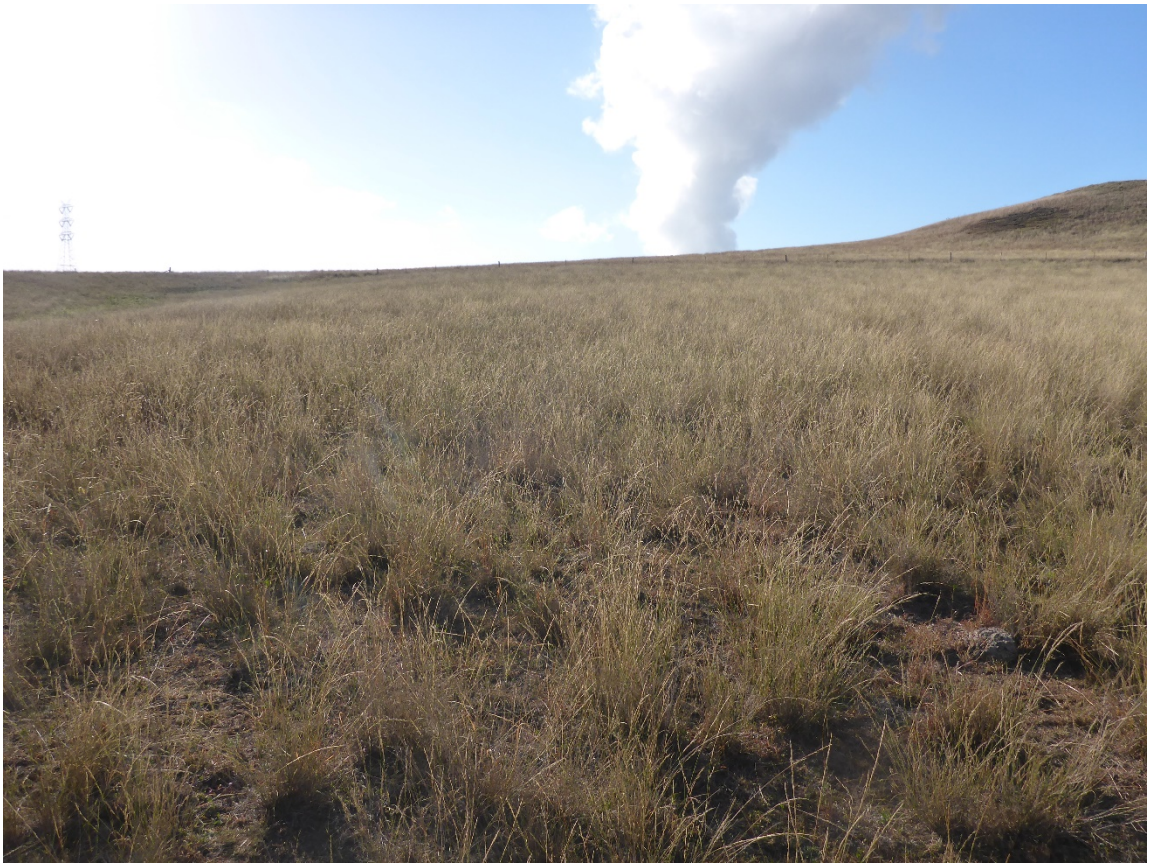
Overview	
	
Landscape Site 16	
ASC Name	Subnatric Brown Sodosol
Representative Site	Site 16
Other Mapped Sites	17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29
Survey Type	Detail
Dominant Topography	Mid Slope
Dominant Land Use	Cattle Grazing
Vegetation	Wire Grass, Corkscrew Grass
Inherent Soil Fertility	Moderately Low
Slope	9%
Aspect	North-West
Verified	Non-BSAL – Fertility

Table 17 Profile: Subnatric Brown Sodosol (Site 16)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.15	Dark brown (7.5YR 3/3) silty clay loam, strongly structured 10-20 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.15– 0.40	Dark brown (7.5YR 3/4) heavy clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. Nil mottles; nil stone content; coarse roots common. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 +0.40	Dark reddish brown (5YR 3/3) heavy clay, strongly structured 30-50 mm subangular blocky peds with strong consistence and a rough fabric. <5% soft calcium nodules 10-20 mm. Nil mottles, nil stone content, coarse roots common. Well drained with layer continuing beyond sampling depth. Sampled 0.40 – 0.50 and 0.65 – 0.75

Table 18 Chemical Parameters: Subnatric Brown Sodosol (Site 16)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	rating	%	rating	dS/m	rating	ratio	rating
A1	5.7	Moderately Acidic	2.3	Non-Sodic	0.9	Non-Saline	1.4	Low
B21	7.1	Neutral	6.4	Marginally Sodic	0.5	Non-Saline	1.0	Low
B22	8.3	Moderately Alkaline	12.0	Sodic	1.6	Non-Saline	0.7	Very Low
B22	8.6	Strongly Alkaline	14.4	Strongly Sodic	1.6	Non-Saline	1.3	Low

4 BIOPHYSICAL STRATEGIC AGRICULTURAL LAND ASSESSMENT

This BSAL Verification Assessment has been conducted in accordance with Interim Protocol.

Review of SLR (2015)

SLR (2015) in its final BSAL Verification Assessment (Revision 2) determined that Soil Unit 1: Eutrophic Brown Chromosol; deep was verified BSAL. Based on the latest slope analysis, the area of this soil unit is 72 hectares. It is noted that some of this soil unit has already been disturbed by Edderton Road, which bisects this soil unit. Therefore, the area of actual BSAL remaining would be less than 72 hectares

The summary BSAL assessment tables for SLR (2015) are shown in **Appendix C**.

Consideration of comments in the *Report by the Mining & Petroleum Gateway Panel to Accompany a Conditional Gateway Certificate for the Drayton South Coal Project* (April 2015) is provided in **Appendix F**.

This BSAL Verification Assessment

The BSAL status was determined on the dominant soil type within each soil unit. According to the Interim Protocol, the findings of this BSAL Verification Assessment, as shown in **Table 19** and **Figure 5**, are:

- Exclusion areas of 1,068 hectares for land greater than 10% slope were identified and excluded as potential BSAL in the Study Area for this assessment.
- Exclusion areas of 110 hectares for land of slope less than 10%, but with less than 20 hectares contiguous area were identified and excluded as potential BSAL in the Study Area for this assessment.
- There were 579 hectares, comprising eight Soil Units, verified as non-BSAL within the Survey Area for this assessment.

The BSAL assessment and limitations for each soil unit and sample site is shown in **Table 20**.

Table 19 2018 BSAL Assessment Summary

Soil Survey BSAL Assessment	**Hectares**
Verified BSAL	Nil
Verified Non-BSAL	579
Exclusion Area	1,178
BSAL Assessment Total	**1,757**
Verified Non-BSAL	**Hectares**
Soil Type Verified Non-BSAL	579
Exclusion Greater Than 10% Slope	1,068
Exclusion Less Than 20 Hectares Contiguous Area	110
Verified Non-BSAL Total	**1,757**

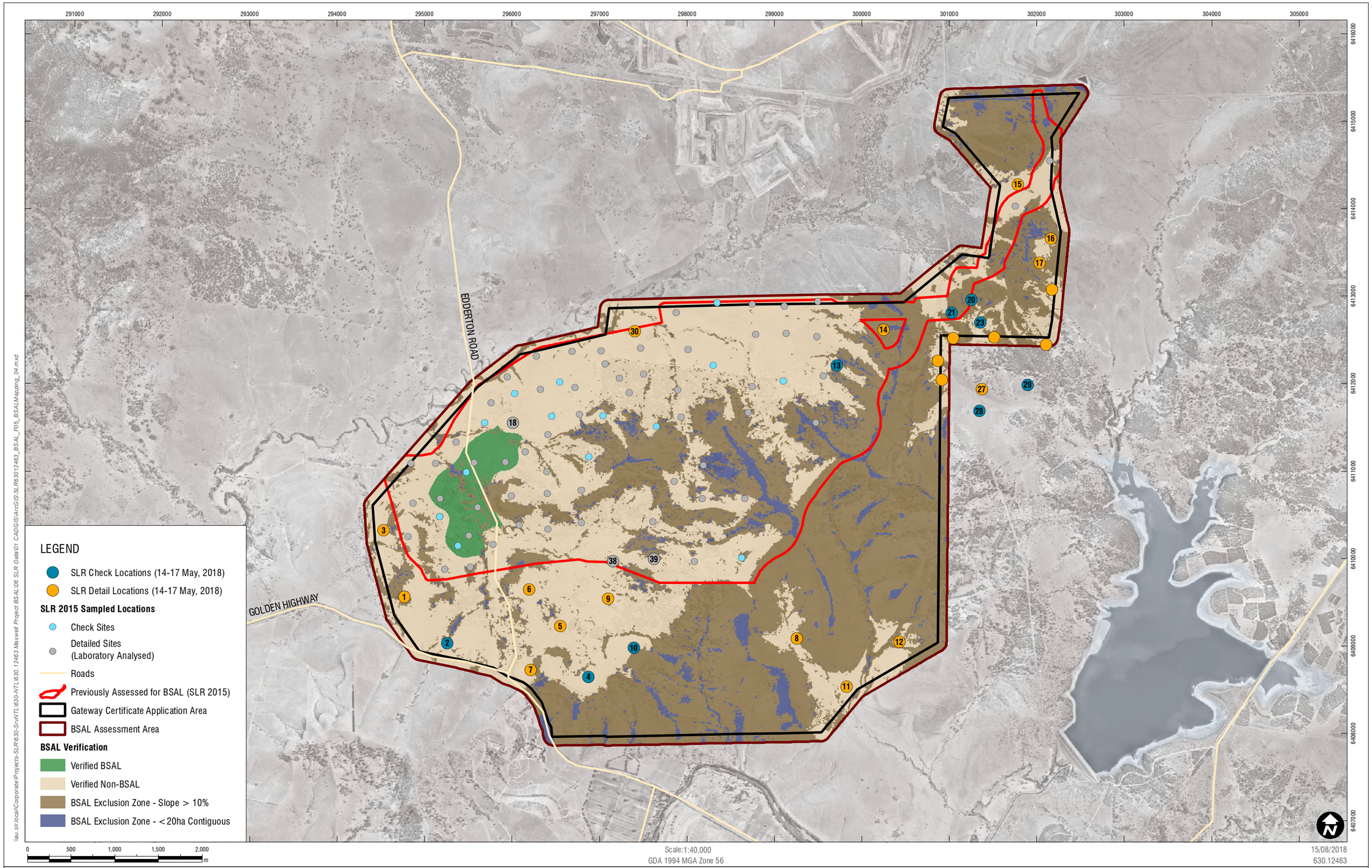
Table 20 BSAL Assessment

Site Number	Inspection Type	ASC Soil Type (to ASC Great Group for detailed sites)	1. Is slope < 10%?	2. Is there < 30% Rock Outcrop?	3. < 20% unattached Rock Fragments > 60mm?	4. Does < 50% have Gilgais >500mm deep?	5. Is Slope <5%?	6. Are there nil rock outcrops?	7a. Does soil have moderate fertility?	7b. Does soil have moderately high or high fertility?	8. Is ERD to a physical barrier >750mm?	9. Is drainage better than poor?	10. Is pH between 5.0 and 8.9 (water) and 4.5 and 8.1 (CaCl2)?	11. Is salinity (ECe) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Is the Soil Unit BSAL?
Soil Unit 11 – Epipedal Brown Vertosol																NLT – not lab tested
4	Check	Epipedal Brown Vertosol	✓	✓	✓	✓	✖	✓	✓	✓	✖	✓	NLT	NLT	NLT	**No**
5	Detailed	Epipedal Brown Vertosol	✓	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✓	✓	
9	Detailed	Epipedal Brown Vertosol	✓	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✖	✖	
10	Check	Epipedal Brown Vertosol	✓	✓	✓	✓	✓	✓	✓	✓	✖	✓	NLT	NLT	NLT	
Soil Unit 12 – Eutrophic Red Chromosol																NLT – not lab tested
1	Detailed	Eutrophic Red Dermosol	✓	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✖	✖	**No**
2	Check	Red Chromosol	✖	✓	✓	✓	✖	✓	✓	✓	✖	✖	NLT	NLT	NLT	
3	Detailed	Eutrophic Red Chromosol	✓	✓	✓	✓	✖	✓	✓	✓	✖	✖	✓	✓	✓	
6	Detailed	Eutrophic Red Chromosol	✓	✓	✓	✓	✓	✓	✓	✓	✖	✖	✓	✓	✓	
7	Detailed	Eutrophic Brown Chromosol	✖	✓	✓	✓	✖	✓	✓	✓	✖	✖	✓	✓	✓	
Soil Unit 13 – Epipedal Black Vertosol																^ – rock outcrop shown in **Appendix C**
8	Detailed	Epipedal Black Vertosol	✖	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✖	✖	**No**
11	Detailed	Eutrophic Grey Dermosol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
12	Detailed	Epipedal Black Vertosol	✓	✓	✓	✓	✖	✖^	✓	✓	✓	✓	✖	✓	✓	
Soil Unit 14 – Subnatric Brown Sodosol																
16	Detailed	Subnatric Brown Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✓	✓	✓	✓	✓	**No**
17	Detailed	Subnatric Brown Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✓	✓	✓	✓	✓	
18	Detailed	Mottled-Mesonatric Brown Sodosol	✓	✓	✓	✓	✓	✓	✖	✖	✖	✖	✓	✖	✖	

Table 20 BSAL Assessment (Continued)

Site Number	Inspection Type	ASC Soil Type (to ASC Great Group for detailed sites)	1. Is slope < 10%?	2. Is there < 30% Rock Outcrop?	3. < 20% unattached Rock Fragments > 60mm?	4. Does < 50% have Gilgais >500mm deep?	5. Is Slope <5%?	6. Are there nil rock outcrops?	7a. Does soil have moderate fertility?	7b. Does soil have moderately high or high fertility?	8. Is ERD to a physical barrier >750mm?	9. Is drainage better than poor?	10. Is pH between 5.0 and 8.9 (water) and 4.5 and 8.1 (CaCl2)?	11. Is salinity (ECe) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Is the Soil Unit BSAL?
Soil Unit 14 – Subnatric Brown Sodosol (Continued)																NLT – not lab tested
19	Detailed	Eutrophic Brown Dermosol	✓	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✓	✓	
20	Check	Brown Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✓	✖	NLT	NLT	NLT	
21	Check	Brown Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✖	✓	NLT	NLT	NLT	
22	Detailed	Mottled-Subnatric Brown Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✓	✖	✓	✖	✖	
23	Check	Red Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✓	✖	NLT	NLT	NLT	
24	Detailed	Eutrophic Brown Chromosol	✖	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✖	✖	**No**
25	Detailed	Subnatric Brown Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✓	✓	✓	✖	✖	
26	Detailed	Subnatric Grey Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✓	✓	✓	✖	✖	
27	Detailed	Subnatric Brown Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✖	✓	✓	✖	✖	
28	Check	Brown Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✖	✓	NLT	NLT	NLT	
29	Check	Red Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✖	✖	NLT	NLT	NLT	
Additional Site within SLR (2015) Survey Area – Subnatric Brown Sodosol																
30	Detailed	Epipedal Brown Vertosol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✖	✖	**No**
Additional Sites within SLR (2015) Survey Area – Mesonatric Brown Sodosol																NLT – not lab tested
13	Check	Brown Sodosol	✓	✓	✓	✓	✖	✓	✖	✖	✖	✓	NLT	NLT	NLT	
14	Detailed	Mottled-Subnatric Red Sodosol	✖	✓	✓	✓	✖	✓	✖	✖	✖	✖	✓	✖	✖	**No**
15	Detailed	Eutrophic Brown Chromosol	✓	✓	✓	✓	✖	✓	✓	✓	✓	✓	✓	✓	✓	
Additional Analysis of SLR (2015) Site – Self-Mulching Brown Vertosol																
18 (SLR 2015)	Detailed	Epipedal Brown Vertosol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✖	✖	**No**

✓ = passes the BSAL criteria ✖ = fails the criteria but not excluded as BSAL ✖ = fails the BSAL criteria



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BSAL Verification Map

FIGURE 5

5 CONCLUSION

SLR Consulting has completed a BSAL assessment encompassing the Maxwell Project Gateway Certificate Application area plus a 100 metre buffer.

The surveys were conducted in 2 parts;

1. SLR (2015) BSAL Site Verification Assessment Drayton South Coal Project.

2. A 2018 study to survey areas not covered by the 2015 study.

The assessment has identified 72 hectares of verified BSAL, however some of this soil unit has already been disturbed by Edderton Road, which bisects this soil unit. The area of verified BSAL is located outside of proposed surface development areas for the Project.

6 REFERENCES

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