LIDDELL COAL OPERATIONS

APPENDIX **R**

Agricultural Impact Statement
(GSSE, 2013b)

APPENDICES

GLENCORE

Agricultural Impact Statement

Liddell Coal Operations

Proposed Modification to DA 305-11-01

September 2013

XCN07-014

SLR

GSS Environmental a Division of SLR Consulting Australia Pty Ltd (ABN 29 001 584 612) Effective 3 November 2012

GSS ENVIRONMENTAL

Environmental, Land and Project Management Consultants

Prepared on behalf of Liddell Coal Operations Pty Ltd

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Liddell Coal Operations
Proposed Modification to DA 305-11-01
Agricultural Impact Statement

Date: September 2013

Prepared for	Liddell Coal Operations Pty Ltd
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1.0 INTRODUCTION

GSS Environmental (GSSE) was engaged by Liddell Coal Operations (LCO) Pty Limited to prepare an Environmental Assessment (EA) for the LCO Proposed Modification (Mod 5) to DA 305-11-01 (the Project). This Agricultural Impact Statement (AIS) is intended to form part of the EA to be submitted to the New South Wales Department of Planning and Infrastructure (DP&I) under section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.1 Project Overview

LCO is an established open-cut coal mining operation approximately 25 kilometres north-west of Singleton in the Hunter Valley of New South Wales. The mine is operated and managed by LCO Pty Ltd, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore), on behalf of a joint venture between Glencore (67.5 per cent) and Mitsui Matsushima Australia (32.5 per cent).

LCO currently operates in accordance with development consent DA 305-11-01, and has approval to conduct mining operations until 31 December 2023, producing up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. This DA remains the current development consent for LCO, and has since been modified on four separate occasions. LCO is now seeking a further modification (Mod 5) to allow for the extension of open cut mining operations beyond the currently approved mining footprint so as maximise coal recovery at LCO (herein referred to as the Project). The key components of the Project, as illustrated in **Figure 1.1,** include the following:

- Expansion of the open cut mining footprint and associated ancillary disturbance areas - Extension of the South and Entrance Pits to the south east and, upon completion of mining in the pits, the mining of coal resources under the Mine Infrastructure Area (MIA) during which the MIA will be relocated to a temporary facility. The extension will enable the recovery of an additional 38 million tonnes (Mt) of coal.

- Extension to the Life of Mine – The extension of open cut mining activities will lead to an associated extension of the life of mine at LCO from 2023 to 2028.

- Additional Tailings Emplacement Area – A tailings emplacement area will be constructed within the final void of the South Pit to dispose of the additional tailings associated with the extension of open cut mining activities.

- Coal Processing – Coal will continue to be processed at the LCO CHPP at the approved rate of up to 8 Mtpa. Coal will no longer be received from, or sent to, the Cumnock CHPP for processing as currently approved under DA 305-11-01, as this CHPP has been demolished following the cessation of mining operations at Cumnock No. 1 Colliery. LCO seeks to maintain a contingency for coal processing by delivery of up to 1.5 Mtpa of ROM coal to Ravensworth Coal Handling and Preparation Plant (RCHPP) for washing via construction of a new stockpile, hopper, crusher and conveyor to provide a connection to the existing overland conveyor or by road transport route to RCHPP. In addition, up to 2 Mtpa may be received from Mt Owen Complex for processing via the same existing overland conveyor.

The proposed works lie wholly within both the existing development consent boundary and the mining lease ML 1597 boundary. No changes are proposed to the approved operating hours or mining method, which will remain as approved under DA 305-11-01.

1.2 Study Area

The current development consent, DA 305-11-01, allows for open cut mining and surface infrastructure at LCO which covers an approved mining footprint of 1374 hectares (ha), within a DA boundary of 1403 ha. LCO are seeking approval for an extension of open cut mining and associated ancillary disturbance totalling an area of 255 ha within the existing DA boundary, herein referred to as the Study Area, as shown in **Figure 1.1**.

For the purpose this AIS the 'regional area' is considered as encompassing the Singleton, Muswellbrook and Upper Hunter Local Government Areas (LGAs) (Upper Hunter Region).

1.3 Director General's Environmental Assessment Requirements

The DGR's were issued in February 2012. On the 30th May 2012, the Director General issued supplementary requirements for the Environmental Assessment which reads:

> *"An Agricultural Impact Statement that includes a specific focused assessment of the impacts of the proposal on strategic agricultural land, having regard to the draft gateway criteria in the draft Upper Hunter Strategic Regional Land Use Plan."*

1.4 Scope of this Report

This AIS, in accordance with the *Strategic Agricultural Land Use Policy: Guideline for Agricultural Impact Statements* (DP&I, 2012a), addresses the information listed in **Table 1.1**.

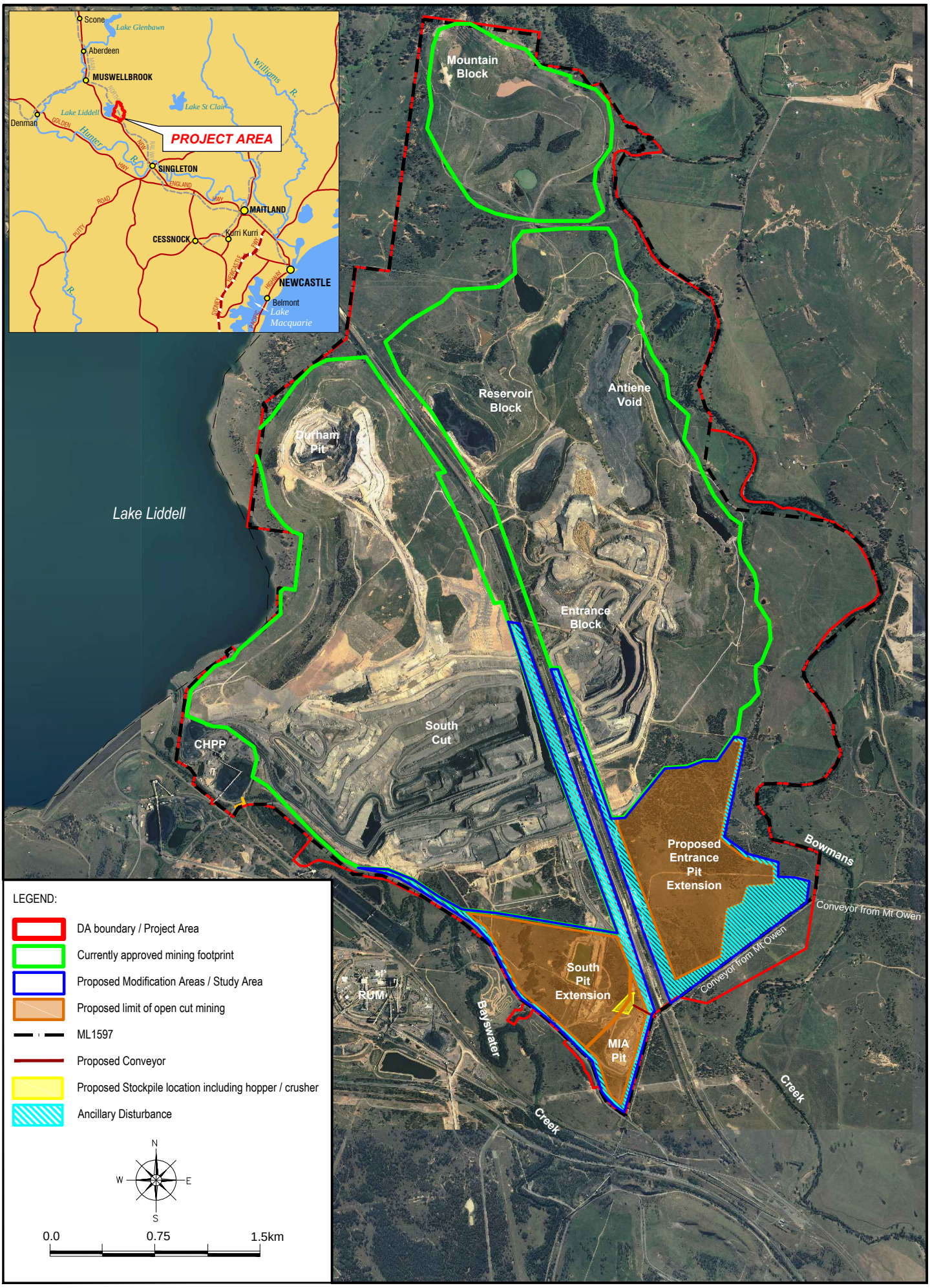
Table 1.1 AIS Requirements

This AIS must include the following information	Addressed in:
Information Relating to the Site and Region	
Detailed assessment of the agricultural resources and agricultural production of the project area	
This section should include detailed information (including maps) on:	
• the soils, slope, land characteristics, water characteristics (availability, quality);	Section 2
• relevant history of the agricultural enterprises from within the project area and also surrounding land acquired as part of the development's buffer and/or offset zone.	Section 3
For the project area this should include a description of:	
• any land identified as SAL in a Strategic Regional Land Use Plan on or within two kilometres of the project site (SAL will be further identified in an amendment to the Mining SEPP);	Section 2
• the location and area of land to be temporarily removed from agriculture during operation of the project, and the period of time	Section 4.1.1
• the location and area of land to be returned to agricultural use post-project, and its productive potential relative to pre-project;	Section 4.1.2
• the location and area of land that will not be returned to agriculture, including areas to be used for environmental plantings or biodiversity offsets;	Section 4.1.3
• the agricultural enterprises to be undertaken on any buffer and/or offset zone lands for the life of the project, and comparison with enterprises undertaken on the land prior to the project.	
Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the project area	
The AIS must contain maps/information for areas within the locality surrounding the project describing existing agricultural resources. This should include:	
• soil characteristics, including soil types and depth;	Section 2
• topography/slope;	Section 2
• key agricultural support infrastructure (e.g. roads, railways, processing facilities);	Section 3

This AIS must include the following information	Addressed in:
• water resources and other water users' extraction locations;	Section 2
• location and type of agricultural industries;	Section 3
• climate conditions.	Section 2
Describe the location and production levels of each commodity produced by all agricultural enterprises within the locality surrounding the project area.	Section 3

This AIS must include the following information	Addressed in:
Assessment of Impacts	
Identification and assessment of the impacts of the project on agricultural resources or industries	
The AIS should identify any adverse impacts on agricultural resources and production on the site and in the local area during the operation and post-operation phases of the project. The AIS should include a risk-based assessment (guided by the DGRs) of:	
• the effects of the project on agricultural resources;	Section 4
• consequential productivity effects of this on agricultural enterprises, including productivity impacts of any water moved away from agriculture and any water quality issues as they affect agriculture (this should extend to farm productivity, land values and flow on impacts to regional communities and environment);	
• uncertainty associated with the predicted impacts and mitigation measures and the consequences of and likelihood that these uncertainties will be realised;	
• further risks such as weed management, biosecurity, subsidence, dust, noise, vibration and traffic conditions.	
• The AIS should also consider other aspects, e.g. proposed biodiversity offsets that may result in the loss or dislocation of agricultural resources/industries)	
If the project site is located on or within 2 kilometres of any land identified as SAL in a Strategic Regional Land Use Plan, the AIS must specifically address the potential impacts of the project on the relevant SAL. This should include a consideration of the relevant Gateway criteria which include matters such as:	
• surface area disturbance, subsidence and soils;	Section 4
• salinity, soil pH and groundwater;	
• access to agricultural resources and infrastructure; and	
• agricultural scenic and landscape values.	
Account for any physical movement of water away from agriculture	
Any water that is transferred or will no longer be available for agricultural use as a result of the proposal should be identified and fully accounted for.	Section 4
The potential impacts of the development on water resources should be assessed against the minimal impact considerations, consistent with the requirements of the Aquifer Interference Policy (NOW, 2012).	
All predicted impacts should be based on robust modelling.	
Assessment of socio-economic impacts	
The AIS should include an assessment of the impacts on agricultural support services, processing and value adding industries and regional employment.	Section 4
The socio-economic impact assessment must detail agricultural support services and value adding industries relevant to affected agricultural enterprises including potential impacts on local and regional employment.	
The socio-economic impact assessment must also address any potential impact on visual amenity, landscape values and tourism infrastructure relied upon by local and regional agricultural enterprises.	
Mitigation Measures	
Identification of options for minimising adverse impacts on agricultural resources, including agricultural lands, enterprises and infrastructure at the local and regional level	
The AIS should document feasible options to avoid, minimise or mitigate potential impacts on agricultural resources including:	
• project design review/alternatives;	Section 4
• proposed monitoring programs to assess predicted versus actual impacts as the project progresses;	

This AIS must include the following information	Addressed in:
• trigger response plans and trigger points at which operations will cease or be modified or remedial actions will occur to address impacts including a process to respond to unforeseen impacts;	
• the proposed remedial action to be taken in response to a trigger event;	
• the basis for assumptions made about the extent to which remedial actions will address and respond to impacts;	
• demonstrated capacity for the rehabilitation of disturbed lands to achieve the final land use and restore natural resources;	
• Demonstrated planning for progressive rehabilitation that minimises the extent of disturbances.	
Consultation	
Document consultation with adjoining landusers and Government Departments	
An AIS should include details of an engagement strategy including:	
• consultation undertaken to date, including consultation undertaken at the Exploration Licence stage;	Section 5
• consultation with relevant government agencies;	
• consultation with impacted landholders and community groups;	
• the issues identified and measures to address these issues;	
• the outcomes of the consultation;	
• any commitments for further consultation.	



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Study Area and Regional Locality

FIGURE 1.1

2.0 AGRICULTURAL RESOURCES

2.1 Climate

The climate Upper Hunter Region is characterised by hot summer days, occasionally relieved by evening 'southerly busters', and cool dry winters. Summer temperatures often reach over 40°C for several days in January and February. Winter temperatures can result in frequent frosts in the coldest months.

The Bureau of Meteorology (BOM) classifies the Study Area within a Temperate Climate Zone, with no designated wet season; however, the area can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs in the region during warmer months.

The nearest BOM weather station to the Study Area is located at Jerrys Plains, (Weather Station 061086) approximately 15 km to the south west of the Study Area. Climate statistics (**Table 2.1**) supports a summer dominated rainfall pattern with relatively drier winter months, however heavy isolated falls may occur during winter (BOM, 2012).

The average annual rainfall is 645.4 mm and average maximum temperature ranges from 17.4°C in July to 31.7°C in January.

Table 2.1 Jerrys Plains Climate

Monthly Climate Statistics (1907 – 2012) **Jerrys Plains Post Office, BoM Station number 061086**													
Season	Summer			Autumn			Winter			Spring			**Year**
Month	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Mean max Temp (°C)	31.2	31.7	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.2	29.1	**25.2**
Mean min Temp (°C)	15.7	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	**10.6**
Mean rainfall (mm)	67.9	76.7	72.8	58.8	44.3	40.9	48.1	43.5	36.5	42.0	52.2	61.1	**645.4**
Mean rain days (no.)	6.4	6.5	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.9	6.2	**67.7**

2.2 Topography

The topography of the Study Area is characterised by undulating hills with local relief of up to 90 metres. Study Area also includes very gently inclined alluvial fans (1-3% slope), bordered by gently inclined rises (3-10% slope) at elevations ranging from 100 m Australian Height Datum (AHD) to 185 m AHD. The slope classes present within the proposed modification area are as follows:

- there is 82.54 hectares (32%) with slopes less than 5% within the Study Area;
- there is 98.49 hectares (39%) with slopes between 5% and 10% within the Study Area; and
- there is 73.22 hectares (29%) with slopes greater than 10% within the Study Area.

2.3 Hydrology

2.3.1 Surface Water

Regional surface water features are predominantly comprised of the Hunter River and its tributaries along with local dams and lakes associated with mining and power generation activities. The Hunter River forms the primary surface water drainage system in the region in terms of physical size and flow rate, comprising covering approximately 2,200,000 ha (Gilbert & Associates 2013).

There are three sub-catchments within the operating area of LCO:

- Lake Liddell along the north-western boundary;
- Bayswater Creek in the south-west; and
- Bowmans Creek (formerly Foybrook) in the east.

The Bayswater Creek catchment is approximately 96,000 ha, with flows dominated by releases from Lake Liddell via Macquarie Power Generation. Bayswater Creek system has been highly modified from its natural state to allow it to take this flow from Lake Liddell and the Hunter River Salinity Trading Scheme (HRSTS) in its upper reaches, with the lower reaches having been realigned to allow mining at Narama and Ravensworth South mines (Gilbert & Associates 2013).

Bowmans Creek runs along the eastern boundary of the LCO site and has a catchment of approximately 26,500 ha, which is of sufficient area to maintain flow under most climatic conditions. At present there are no diversions or realignments of Bayswater or Bowmans Creeks proposed for LCO (Gilbert & Associates, 2013).

2.3.2 Groundwater

The local and regional hydrogeological regime in and around LCO consists of two distinct aquifer systems: shallow unconfined aquifers of limited extent within the unconsolidated alluvium associated with the Hunter River and its tributaries including Bayswater and Bowman Creeks; and a regional hardrock aquifer system associated with the Permian coal measures. The alluvial aquifer is unconsolidated and characterised by deposits of silts, sands and gravels of varying permeability. The hardrock aquifer exhibits varying levels of groundwater storage and transmission, with the most permeable horizons being the coal seams themselves. Regionally, the coals seam aquifers are generally confined above and below by the interburden strata.

Previous underground mining in the Pikes Gully and Liddell seams under Bowmans Creek has been suspected of inducing cracking and leakage into underground workings. A number of investigations have been undertaken to determine the occurrence, extent and location of leakage from Bowmans Creek and the alluvial aquifer since losses were first identified in 1979. Several investigations and a review of monitoring data from 14 piezometers installed above longwall panels at LCO in June 1990 led the then Department of Land and Water Conservation in 1990 to conclude that creek flows had re-established and no long term loss of flow would result from mining. A review of monitoring data conducted by Mackie Environmental Research (MER) (2001) supported this, showing that significant changes in creek flow or storage within the alluvial lands do not have an observable influence on water levels within the old workings. SKM (2013) note however that this does not preclude the possibility that connective cracking is present and is acting as a relatively constant leakage source governed by crack impedance.

Groundwater quality in the alluvial and hard rock aquifers in the region varies, with water quality in the alluvium generally slightly less saline than in the coal measures. Alluvial groundwater generally has a salinity of 600-1800 mg/L, while the coal seam aquifers are generally 1800-3000 mg/L. Groundwater in the region is classed as brackish (SKM 2013).

2.3.3 User Extraction Points

A search of the NOW PINEENA groundwater database by SKM (2013) identified 12 registered groundwater bores within 2 km of the LCO DA boundary. Six of these bores are owned by LCO or the neighbouring XCN Mt Owen mine and three are registered as being for mining or exploration purposes. Of the remaining three bores no ownership information was listed in the database, however one is located to the northeast of LCO beyond the area of predicted impacts of the Project, and two are located on parcels of land owned by Ravensworth Operations P/L and Xstrata Mt Owen P/L.

The registered groundwater bores within 2 km of the Study Area are summarised in **Table 2.2**.

Table 2.2 Registered Groundwater Bores

Work No.	Licence No.	Owner	Purpose	Date Completed	Depth (m)
GW027690	20BL020923	Liddell Tenements	Irrigation	1/01/1966	6
GW028247	20BL020924	Liddell Tenements	Irrigation	1/01/1962	2
GW080212	20BL168065	Liddell Tenements	Monitoring	31/05/2002	--
GW080245	20BL168066	Liddell Tenements	Monitoring	7/08/2002	--
GW080213	20BL168064	Liddell Tenements	Monitoring	31/05/2002	--
GW080172	20BL168209	Xstrata Mt Owen Pty	Industrial	28/03/2002	--
GW078085	20BL166608	Not Listed	Stock	23/06/1997	13
GW080725	20BL168240	Not Listed	Mining	10/08/2000	130
GW080176	--	Not Listed	Unknown	4/02/2002	--
GW080173	--	Not Listed	Unknown	4/02/2002	--
GW035474	20BL028920	Private	Exploration	--	--
GW079793	--	Not Listed	Mining	--	3

Source: *SKM, 2013 (Table 2-5)*

LCO also have a number of surface water (**Table 2.3**) and groundwater (**Table 2.4**) extraction licences as summarised below.

Table 2.3 Surface Water Extraction Licences

Locality	Licence No.	Holder	Use	Annual Allocation (ML)
Hunter River	WAL7815	Liddell Tenements Pty Ltd	Industrial	20 ML
Hunter River	WAL13387	Novacoal Australia Pty Ltd	Diversion works - pumps	20 ML
Bowmans Creek	WAL18304	Enex Foydell Pty Ltd	Irrigation	32 ML
Bayswater Creek	WAL18306	Mitsushima Australia Pty Ltd Enex Liddell Pyt Ltd Gabume Pty Ltd	Industrial (coal mining purposes)	100 ML
Bowmans Creek	WAL18318	Enex Foydell Pty Ltd	Irrigation	55 ML
Foy Brook/Bowmans Creek	WAL18320	Enex Foydell Pty Ltd	Irrigation	50 ML

Table 2.4 Groundwater Licences

Locality	Licence No.	Holder	Purpose	Annual Extraction Allocation (ML)
Bowmans Creek Alluvial	WAL18302	Liddell Southern Tenements PL	Irrigation	5 ML
ALV1, ALV2, ALV3, ALV4, ALV7, ALV8	20BL168053	Liddell Coal Operations PL	Test Bore/Monitoring	N/A
Haz 2	20BL168060	Liddell Tenements PL	Industrial (2 bores)	5500 ML
Durham 2 & 4	20BL168061	Liddell Tenements PL	Industrial (2 bores)	1000 ML
8 South 3 & 4	20BL168062	Liddell Tenements PL	Industrial	6000 ML
Durham 1	20BL168063	Liddell Tenements PL	Industrial	6000 ML
LC1	20BL168064	Liddell Tenements PL	Monitoring	N/A
Dur 3	20BL168065	Liddell Tenements PL	Monitoring	N/A
Haz 6	20BL168066	Liddell Tenements PL	Monitoring	N/A
PGW5	20BL171092	Liddell Southern Tenements PL	Monitoring	N/A
M49	20BL172293	Liddell Southern Tenements PL	Dewatering	2500 ML (Combined with 20BL168209)
Mt Owen 1	20BL168209	Xstrata Mt Owen Pty Ltd	Stock, domestic, farming and test purposes	2500 ML (Combined with 20BL172293)
Mt Owen 2	20BL169544	Xstrata Mt Owen Pty Ltd	Dewatering	2500 ML
Middle Liddell	20BL172588	Liddell Coal Operations PL	Dewatering	6000 ML

Surface water is extracted from the Hunter River for basic landholder stock and domestic rights, while extraction licences for mining, industry, water utility provision, high security and general security entitlements have also been issued. Significant volumes of water are also taken and stored for power station use in Lake Liddell. The Hunter River is the major regional source of farm water supply for irrigation, stock watering and domestic use. Surface water usage also occurs on Bowmans Creek. Bowmans Creek has a total of 13 private water users for stock, domestic and irrigation purposes. Bayswater Creek has no private water users (Gilbert and Associates 2013).

2.4 Soil Landscape Units

The soil landscape within the Study Area has been mapped by the Soil landscapes of the Singleton 1:250,000 Sheet (Kovac & Lawrie, 1991). The Liddell soil landscape unit covers the vast majority of the Study Area, with the Hunter soil landscape unit covering a small area on the eastern limit of the Proposed Entrance Pit Extension, as illustrated on **Figure 2.1**.

Liddell

The Liddell soil landscape unit consists of undulating low hills and undulating hills on the Singleton Coal Measures, and the parent rock is lithic sandstone, shale mudstone, conglomerate, siltstone and coal seams. Slope gradients 4-7%, local relief 60-120m. The vegetation type is described as open woodland. The soils are dominated by Yellow Soloths (Dy2.41, Dy3.81) on slopes with some Yellow Solodic Soils (Dy3.32, Dy2.42, Dy3.42) on concave slopes. There are Earthy and Siliceous Sands (Uc5.22, Uc5.11) on mid to lower slopes, with some Red Soloths (Dr2.41), Red Solodic Soils (Dr2.42) and Red Podzolic Soils (Dr5.11).

Limitations to this unit include minor to severe sheet erosion with some minor rill erosion, and moderate gully erosion (up to 1.5m) in drainage lines.

Hunter

The Hunter soil landscape unit consists of alluvial floodplains of the Hunter River and its tributaries. Slope gradients 0-3%, local relief <10m. The majority of the Hunter soil landscape unit has previously been cleared of native vegetation for agricultural uses. The soils are dominated by Brown Clays and Black Earths (Ug5.34, Ug5.17) on prior stream channels and tributary flats. Alluvial soils (Loams, Um5 and Sands, Um5.52, Um6.1, Uc) occur on levees and flats adjacent to the current river channel. Red Podzolic Soils and Lateritic Podzolic Soils (Dr2.11, Db2.41) are located on old terraces, with Non-Calcic Brown Soils (Db1.13) and Yellow Solodic Soils in some drainage lines.

Limitations to this unit include minor stream bank erosion on current watercourses and minor sheet and gully erosion on adjacent terraces.

2.5 Dominant Soil Types and Inherent Fertility

Within the Study Area, dominant soil types were identified as part of the *Liddell Coal Operations - Soil and Land Resource Assessment* (GSSE, 2013), attached as **Appendix 2**. Their distribution within the Study Area is shown in **Figure 2.2**. **Table 2.5** provides an overview of each soil type, and the major points are summarised below.

- Three major soil orders are present in the Study Area: Dermosols, Sodosols and a Chromosol/Sodosol Complex.
- A significant area was previously disturbed by mining and therefore no soil type was determined.

Table 2.5 Dominant Soil Types

ASC Name	Study Area		Inherent Fertility*
	ha	%	
Brown Dermosol *(Upper Slopes and Crests)*	18.3	7	Moderately High
Brown Sodosol *(Mid Slope)*	151.1	59	Moderately Low
Brown Sodosol *(Lower Slope and Flats)*	17.8	7.0	Moderately Low
Brown Chromosol/Sodosol Complex *(Bowman Ck Alluvials)*	6.6	3	Moderately Low to Moderately High
Mining Disturbance	61.4	24	n/a
Total	**255.2**	**100**	

** Fertility based on Interim Protocol for Site Verification*

2.6 Acid Sulphate Soils

The likelihood of acid sulfate soils occurring in the Study Area is very low due to the Study Area's position approximately 95 km away from the coast and undulating topography indicating low risk; and moderate to well-drained soil profiles with minimal long term waterlogging.

2.7 Rural Land Capability

The Study Area has been assessed and classified into the Land Capability Classes described below (GSSE, 2013). The relevant Land Capability Classes for the Study Area are displayed in **Table 2.6** and shown on **Figure 2.3.**

Table 2.6 Pre-Disturbance Rural Land Capability Summary

Rural Land Capability Class	Study Area	
	ha	%
II	6.6	3
IV	17.8	7
V	169.4	66
Mining Disturbance	61.4	24
Total	**255.2**	**100**

Class II classification indicates the land is capable of most land uses and land management practices (i.e. suitable for intensive cropping with cultivation, grazing, forestry, or nature conservation). This land can be subject to sheet erosion as well as wind erosion and soil structure decline. To manage the limitations of this soil, cropping should be managed by reducing tillage and retaining stubble.

Class IV classification indicates that the land is capable of a range of land uses, such as grazing with occasional cultivation. However, for land uses such as cropping and intensive grazing, practices need

to be able to manage moderate to severe limitations. This land is generally used for grazing, and is suitable for pasture improvement.

Class V classification indicates that the land is capable of some land uses, and management practices are necessary to overcome the limitations. The land should not be cultivated for cropping or for establishing pasture grasses; however, the land can be used for grazing with occasional grazing for pasture improvement, but also requires conservation works.

2.8 Strategic Agricultural Land

As part of the *Strategic Regional Land Use Policy*, the Strategic Regional Land Use Plans (SRLUPs), include mapping of Biophysical Strategic Agricultural Land (BSAL), which are defined as areas with unique natural resource characteristics highly suited for agriculture.

The Study Area lies wholly within the Upper Hunter Strategic Regional Land Use Plan (DP&I, 2012), and approximately 2.8 ha of land within the Study Area has been mapped as BSAL, along Bowmans Creek, to the east of the Entrance Pit Extension (**Figure 2.4**).

GSSE undertook fieldwork in March 2013 in order to verify the existence of BSAL, particularly within the alluvial soil in the Study Area, and also confirm sodicity levels within some soil types previously mapped to verify the remaining area of the site was not considered BSAL.

The results of this fieldwork, and subsequent laboratory analysis of samples collected, confirmed that the alluvial soil is not considered to be BSAL according to the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – V7* (OEH 2013), as the relative fertility of Sodosols are considered moderately low, which fails the BSAL criteria. However it is worth noting that this marginally sodic material with an ESP of 9, whilst categorised as a Sodosol, is not considered to be limited by this ESP level for effective plant root function. An ESP >15 is listed as the threshold at which the soil is considered to be a physio-chemical limitation to effective rooting depth. Therefore the Chromosol/Sodosol complex of alluvial soil is not considered BSAL, but is potentially suited to moderate to high agricultural production.

Further information on the soils in the Study Area, and the verification process can be found in the *LCO Modification 5 Soil and Land Resource Assessment* (GSSE, 2013).

2.9 Vegetation and Land Use

Land use in the vicinity of the Study Area consists predominantly of mining and power generation activities, with few privately owned receptors or other sensitive receptors. Neighbouring mining operations include Ravensworth Operations to the south, Ravensworth Underground Mine and the RCHPP to the south west, and the Mt Owen Complex (incorporating Mt Owen, Ravensworth East and Glendell mining operations) to the east. Other mines in the wider surrounding area include Ashton Coal, Integra and Hunter Valley Operations. Two power stations, Bayswater and Liddell, are located adjacent to Lake Liddell to the west of LCO.

Private landholdings in proximity to the Study Area include small grazing properties and rural residences. The closest privately owned residence is approximately 1.9 km to the northeast of the Study Area.

The ecological assessment undertaken for the Project identified the following vegetation communities within the Study Area:

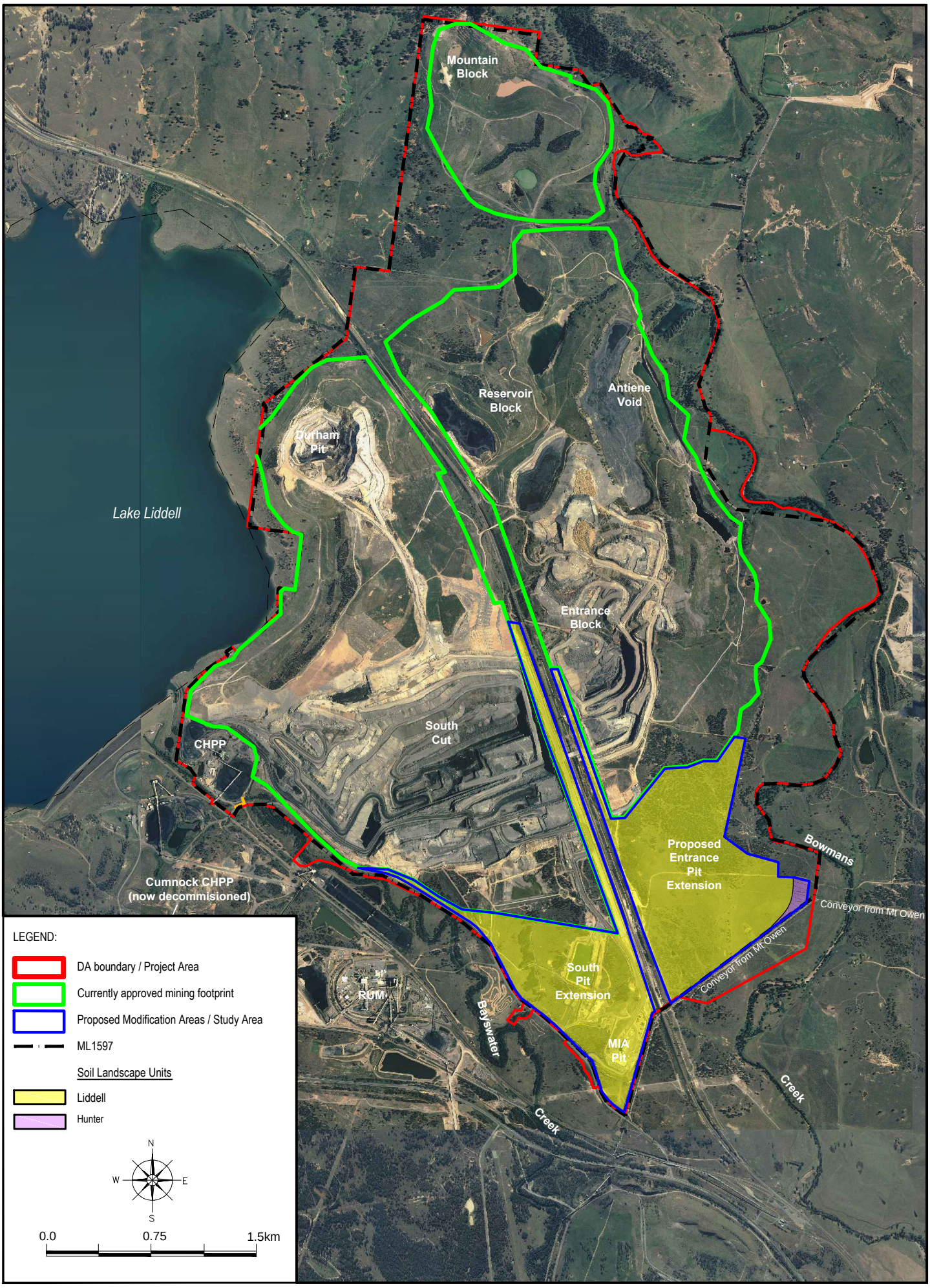
- Central Hunter Box – Ironbark Woodland, including a number of variants of this community as follows:
    - Central Hunter Box – Ironbark Woodland (Rough-barked Apple dominated)
    - Central Hunter Box – Ironbark Woodland (Regrowth)
    - Central Hunter Box – Ironbark Derived Native Grassland
- Central Hunter Swamp Oak Forest
- Central Hunter Bulloak Forest
- Disturbed Land

The Central Hunter Box – Ironbark Woodland, and variants Rough-barked Apple dominated and Regrowth communities, are all listed as threatened ecological communities (TEC) under the *Threatened Species Conservation Act 1995*.

A significant portion of the South Pit Extension has already been disturbed for the establishment of approved mine related infrastructure. The remainder of the area is covered by Central Hunter Box – Ironbark Woodland, derived native grassland, and Central Hunter Box – Ironbark Woodland (Regrowth), with a small area of Swamp Oak Forest along Chain of Ponds Creek.

Approximately half of the Entrance Pit Extension area consists of variants of the Central Hunter Box – Ironbark Woodland, including derived native grassland and regrowth communities with the rest of the area consisting of Bulloak forest.

The surrounding region has been extensively cleared of vegetation. Remaining land has also been highly disturbed in the past by land clearing for agriculture, and is now dominated by exotic pasture with isolated areas of native vegetation on some hill crests and drainage lines. Prior to clearing the area supported open woodland with species including red ironbark, yellow box, white box, and blakeys red gum (Kovac and Lawrie, 1991).



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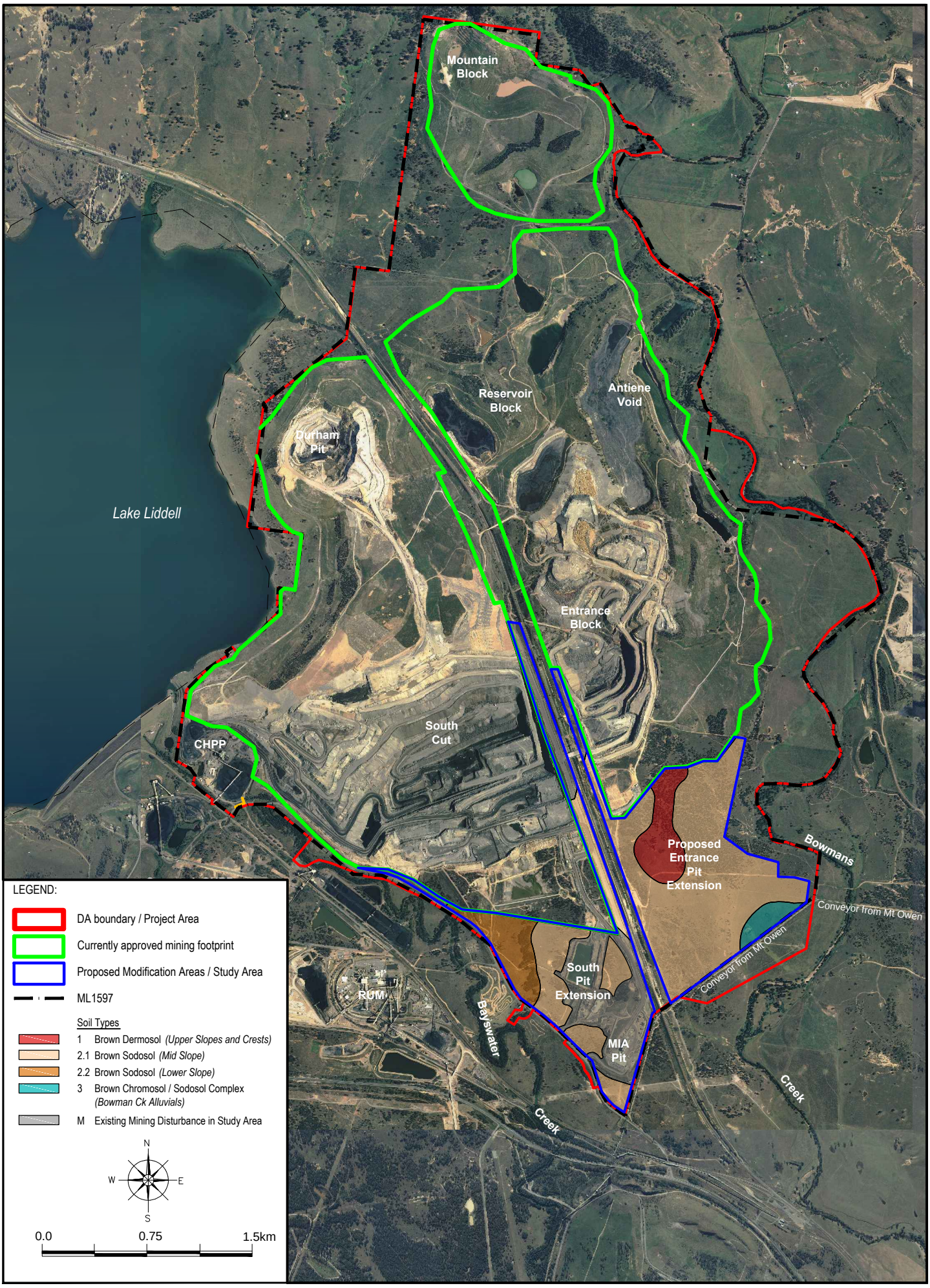
Soil Landscape Units

FIGURE 2.1



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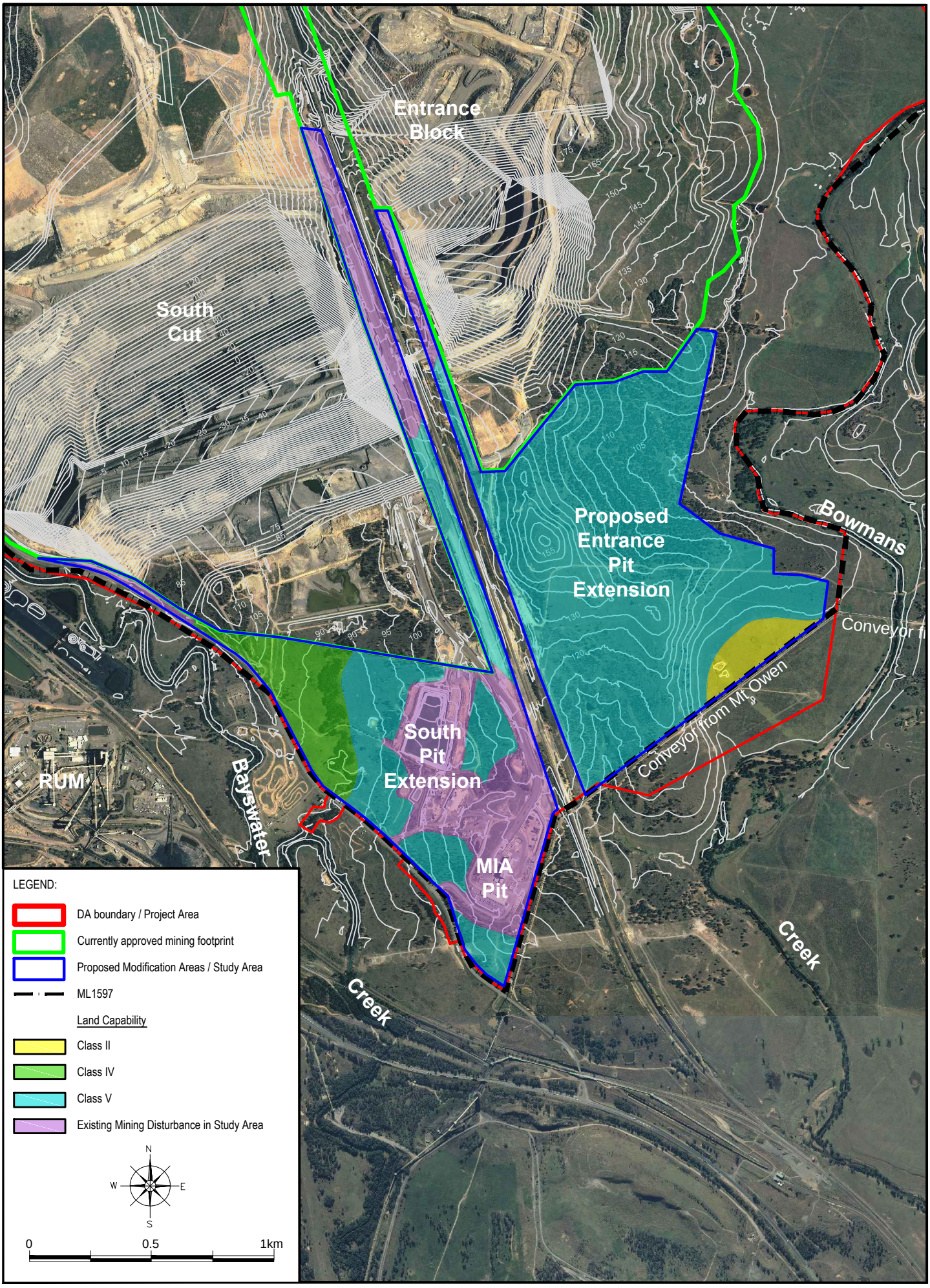
Soil Types

FIGURE 2.2



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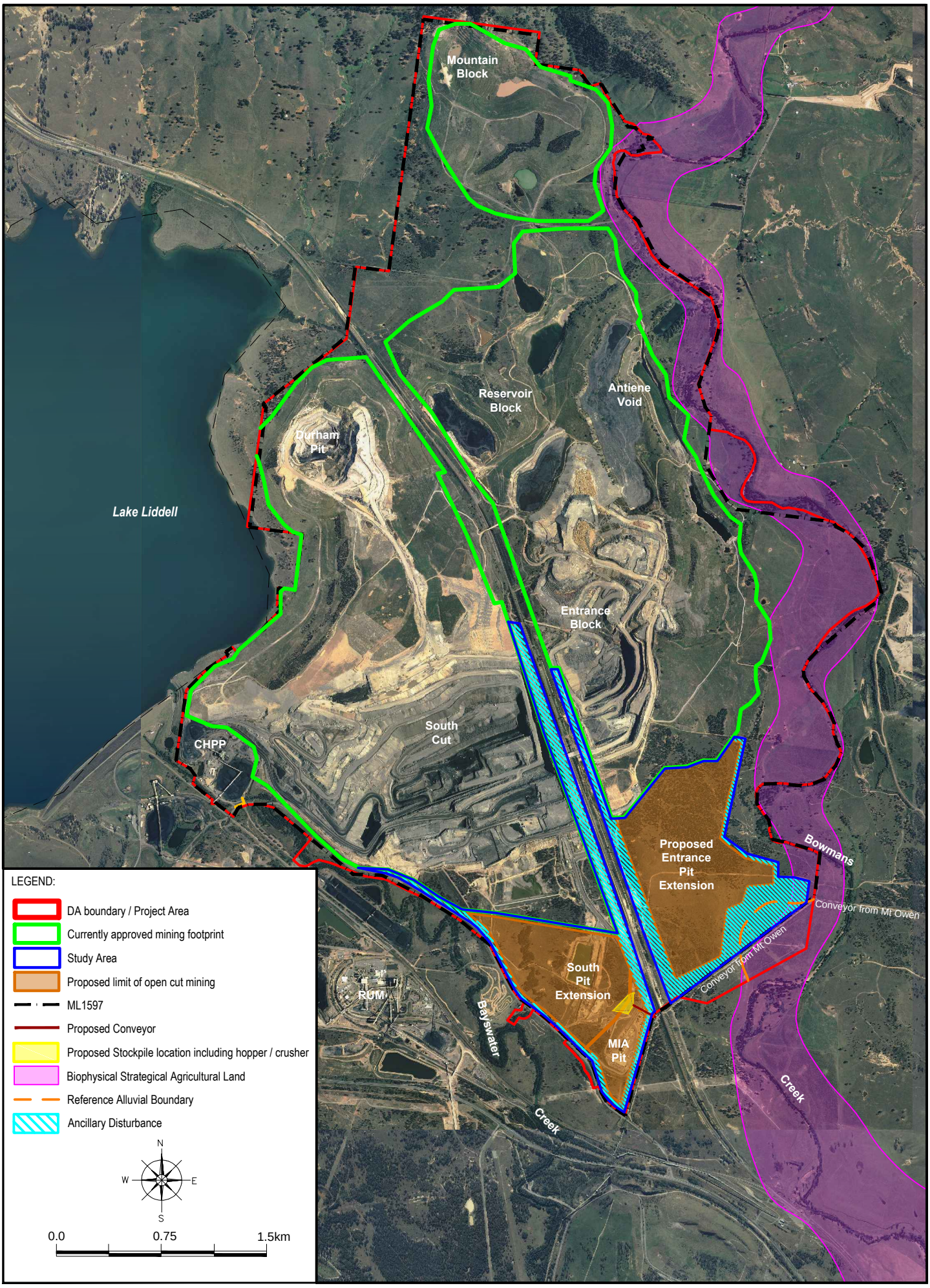
Pre-Mining Rural Land Capability

FIGURE 2.3



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Strategic Agricultural Land

FIGURE 2.4

3.0 LOCAL AND REGIONAL AGRICULTURAL ENTERPRISES

3.1 Agricultural History

Historically, the main economic activity in the Upper Hunter Region was primary production, with Singleton being the regional centre. Traditionally the main agricultural activities in the Upper Hunter Region are beef cattle and sheep grazing, dairying, viticulture and cereal cropping. Forestry was also an important industry in the nineteenth and early twentieth centuries (Hunter Valley Research Foundation (HVRF (a), 2011). Grazing expanded in the Upper Hunter rapidly after the 1820's when many large land grants were issued to pastoralists. The wine industry became established in the 1840's when the Hunter River Vignerons Association was formed (NSW Parliamentary Library Research Service, 2011). At its peak in the 1950 – 60's the dairy industry, based around Singleton, accounted for 30% of milk distributed in NSW (HVRF (a), 2011).

In recent decades there has been marked change in agricultural activities in the Upper Hunter; deregulation of the dairy industry in 2000 has seen many dairy operators leave the industry and a 57% decrease in employment in dairying between 1996 and 2006 (HVRF, 2011). Forestry has also declined, while beef and sheep grazing, cereal cropping, viticulture and thoroughbred horse breeding have all been growth industries in the past decade (HVRF (a), 2011).

A total of 187.7 ha of the Study Area has the potential to be utilised for cattle grazing and has been used for cattle grazing in the past, while the remaining 61.4 ha are already mine disturbance areas that have not been used for agricultural purposes for many years.

3.2 Key Agricultural Support Infrastructure

There is no known agricultural support infrastructure or processing facilities within the Study Area or surrounding area. There is a broad range of agricultural support infrastructure in the Upper Hunter Region, which include:

- livestock sale yards located at Singleton;
- regional abattoirs and meat processing plants located at Whittingham, Scone and Aberdeen;
- numerous grain receiver silos;
- associated agricultural businesses such as rural merchandise, irrigation suppliers and rural machinery dealerships; and
- major transport infrastructure including a rail network connected to Newcastle Port coal loading facility and the New England Highway.

3.3 Agricultural Land Use

The agricultural land use for the Upper Hunter Region is displayed in **Table 3.1**. It details the area of land used for agriculture in the region and the specific uses of the land. The major points are summarised below:

- agriculture is the major land use in the Upper Hunter Region accounting for 56% of land use;
- agricultural land is almost exclusively used for grazing, utilising 99% of all agricultural land, with sheep and meat cattle comprising 95% of total livestock numbers;

- cropping enterprises comprise a minor portion of agricultural activities comprising 1% of agricultural land use, with cereals for grain utilising 83% of this land area; and

- irrigation enterprises utilise 3% of the agricultural land area in the Upper Hunter Region.

Agricultural and employment statistical data contained the sections below, specifically Tables**3.1**¸ **3.2**, **3.4** and **3.5**, was sourced from Gillespie Economics (2013), *Liddell Coal Operations – Proposed Modification – Economic Review of Potential Agricultural Impacts* (attached as **Appendix 1**)

Table 3.1 Agricultural Land Use

	Units	Muswellbrook LGA	Singleton LGA	Upper Hunter LGA	Total
Agricultural Land Area					
Land area	ha	340,560	489,580	810,270	**1,640,410**
Area of agricultural land	ha	121,872	156,484	647,774	**926,130**
Proportion of agricultural land	%	36	32	80	**56**
Agricultural Enterprise					
Land under cropping activities	ha	1,130	551	10,409	**12,090**
Land under grazing activities	ha	120,742	155,933	637,365	**914,040**
Proportion of grazing land	%	99	99	98	**99**
Grazing Enterprises					
Sheep and lambs	no.	2,517	206	257,681	**260,404**
Meat cattle	no.	35,745	50,211	182,980	**268,936**
Milk cattle (excluding house cows)	no.	10,421	9,345	5,407	**25,173**
Pigs	no.	1,211	232	1,758	**3,201**
Total	no.	49,894	59,994	447,826	**557,714**
Sheep as proportion of total stock	%	5	<1	58	**47**
Meat cattle as proportion of total stock	%	72	84	41	**48**
Cropping Enterprises					
Cereals for grain	ha	346	175	9,533	**10,054**
Vegetables for human consumption	ha	14	73	26	**113**
Orchard trees (including nuts)	ha	369	134	173	**676**
Non-cereal broad acre crops	ha	32	35	677	**744**
Total land cropped	ha	1,130	551	10,409	**12,090**
Proportion of land under cereal cropping	%	31	32	92	**83**
Irrigation					
Area irrigated	ha	9,000	7,000	10,000	**26,000**
Irrigation volume applied	ML	30,894	27,394	31,225	**89,513**
Other agricultural uses	ML	1,728	2,015	4,792	**8,535**
Total water use	ML	32,621	29,409	36,017	**98,047**
Proportion of agricultural land irrigated	%	7	5	2	**3**

Source: *ABS, 2011*

3.4 Agricultural Production Value – Regional

The total combined value of agricultural production in the Upper Hunter Region is $142.7 million per annum. Livestock products and slaughtering contributed $116.4 million (81.6%) of the total agricultural production, as detailed in **Table 3.2**.

Table 3.2 Regional Agricultural Production

Agricultural Production	Muswellbrook LGA	Singleton LGA	Upper Hunter LGA	Total
Enterprise Group	**Gross Value ($M)[1]**	**Gross Value ($M)[2]**	**Gross Value ($M)[2]**	**$M**
Crops	9.6	8.2	8.5	26.3
Livestock slaughterings	11.3	17.4	49.6	78.3
Livestock products	13.1	11.5	13.5	38.1
Total gross agricultural production	**34.0**	**37.1**	**71.6**	**142.7**

Source: *ABS, 2011*

3.5 Agricultural Production Value – Study Area

Potential agricultural productivity was determined using NSW Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS) (2013) agricultural productivity data for agricultural enterprises representative for each of the land classes in the Study Area. The most profitable enterprises have been selected to provide a conservative 'best case' scenario under the current economic conditions. As such, these scenarios may not represent actual land use.

Rural Capability Land Class I and II could support cropping, specifically spray-irrigated Lucerne, to generate an annual gross margin of $1,333/ha. Class III land could support a rotational sequence of spray-irrigated or dryland Lucerne and cattle grazing to generate an average annual gross margin of $637/ha. Class IV land could support a rotational sequence of dryland Lucerne and cattle grazing to generate an average annual gross margin of $197/ha. Classes V, VI and VII land could support cattle grazing to generate a gross margin of between $126/ha and $55/ha per annum (**Table 3.3**).

Table 3.3 Agricultural Productivity: Study Area

Land Capability Class	Enterprise Type*	Enterprise Assumptions	Gross Margin ($/ha)	Study Area (ha)	Study Area Annual Gross Margin ($)
I & II	Lucerne: spray irrigated (large bales)	Yield of 10 tonnes / ha	**1,333**	**6.6**	**8,798**
III	Lucerne: spray irrigated (large bales)	Yield of 10 tonnes / ha	1,333	0	0
	Lucerne: dry land	Yield of 4 tonnes / ha	372	0	0
	Cattle grazing	10 dry sheep equivalent (DSE)	206	0	0
	Average		**637**	**0**	**0**
IV	Lucerne: dry land	Yield of 3 tonnes / ha	230	17.8	4,094
	Cattle grazing	8 DSE	164	17.8	2,919
	Average		**197**	**17.8**	**3,507**
V	Cattle grazing	6 DSE	**126**	**169.4**	**21,344**
VI	Cattle grazing	4 DSE	**109**	**0**	**0**
VII	Cattle grazing	2 DSE	**55**	**0**	**0**
	Total				**33,649**

3.6 Employment

The Upper Hunter Regional employment in the agriculture sector is shown in **Table 3.4**. The major points are summarised below:

- The region employs a total 2,692 persons in the agricultural industry, with agricultural production responsible for 78% of employment and agricultural related wholesaling and retailing comprising 22% of the agricultural workforce.

- The major agricultural production employers are beef, sheep and horse farming followed by horticulture and orchards. Pig and poultry farming are very minor employers in the region.

- The main agricultural related processing and manufacturing employment is provided by meat and poultry processing, whilst wine and other alcoholic beverage manufacturing, and meat and small goods manufacturing comprise the remainder.

Table 3.4 Regional Agricultural Employment by Sector

Agricultural Sector	**Regional Employment**	
Agricultural Production	**No. Person**	**%**
Beef Cattle Farming and Feedlots	751	28
Dairy Cattle Farming	176	7
Sheep Farming	41	2
Sheep-Beef Mixed Farming	116	4
Sheep-Beef-Grain Mixed Farming	54	2
Horse Farming	586	22
Grape Growing	67	2
Pig Farming	4	<1
Poultry Farming (Eggs and Meat)	18	1
Horticulture and Orchards	71	3
Other Grain and Crop Growing	60	2
Other Agriculture, Forestry, Fishing and Support Services	165	6
Subtotal	**2,109**	**78**
Agriculture Related Processing and Manufacturing	**No. Person**	**%**
Wine and Other Alcoholic Beverage Manufacturing	117	4
Meat and Poultry Processing	323	12
Cured Meat and Smallgoods Manufacturing	143	5
Subtotal	**583**	**22**
TOTAL	**2,692**	**100**

Source: *ABS, 2011*

The 2011 Australian Census (ABS, 2011) results showed there were 2,692 people in the Upper Hunter Region employed in agricultural production and related processing and manufacturing industries; this represents 13% of the taxable individuals across the Upper Hunter Region. A breakdown of agricultural employment types is shown in **Table 3.5**. There is no one directly employed in agriculture within the Study Area.

Table 3.5 Proportion of Agricultural Employment

Agricultural Sector	No. of Employees	Proportion of Total Employment (%)
Agricultural Production	**2,109**	10
Agriculture Related Processing and Manufacturing	**583**	3
Total Agricultural Employees	**2,692**	**13**
Total Taxable Individuals	**21,593**	**100**

Source: *ABS, 2011*

4.0 ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 Land Resources

4.1.1 Land Temporarily Removed from Agriculture

The Project proposes to encompass 255.2 ha, of which 61.4 ha is already mine disturbance and 187.2 ha is potential grazing land with 6.6 ha of potential cropping land. Upon completion of the Project, 98.8 ha will be available for potential agricultural production; this area is assumed to be temporarily removed from agriculture for the duration of the Project.

4.1.2 Land Permanently Removed from Agriculture

Upon cessation of mining the Project will achieve the targeted conceptual final landform, of which approximately 156.7 ha of land will be unavailable for agricultural production in the form of final void (Class VII & VIII). However it is noted however that of this area, approximately 61.4 ha is currently long term mine disturbance area.

When only considering land which currently has potential for agricultural production (193.8 ha), compared to land available for agricultural production upon completion of the Project (approximately 98.8 ha), there will be approximately 95 ha of land currently available for agricultural production which is permanently removed from agriculture. **Table 4.1** summarises the pre and post-mining land uses in the Study Area, with the conceptual post-mining land capability illustrated in **Figure 4.1**.

Table 4.1 Pre & Post Mining Land Use

	Pre-Disturbance (Ha)	% of Study Area	Post-Landform (Ha)	% of Study Area
Total Area	255.2	100	255.2	100
Potential Grazing	187.2	73	91.9	36
Potential Cropping	6.6	3	6.6	3
Mine Disturbance	61.4	24	Nil	Nil
Final Void (Class VII & VIII)	Nil	Nil	156.7	61

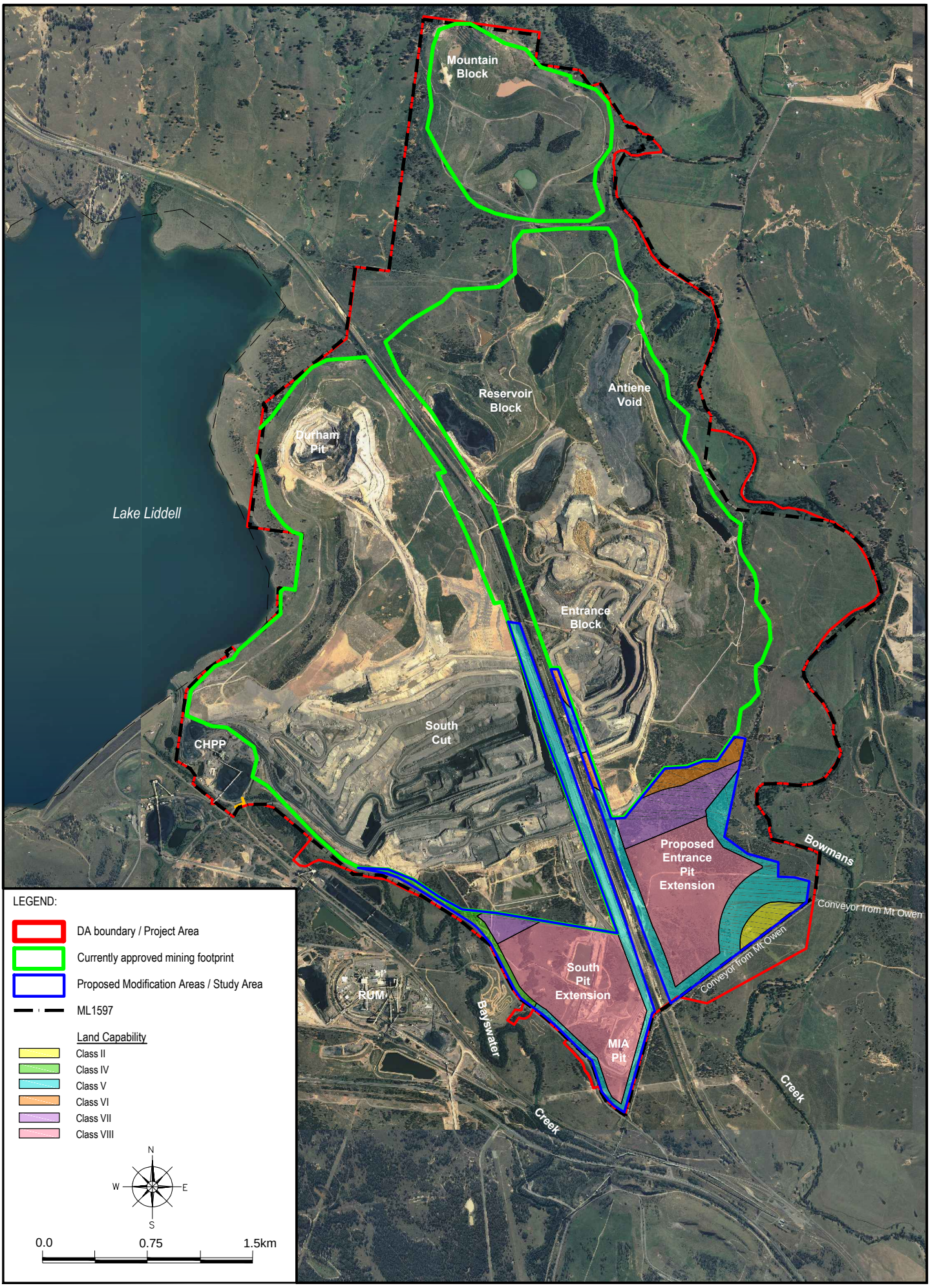
A detailed final closure plan will be developed closer to actual closure to confirm the areas of post-mining land uses.

4.1.3 Impact on Agricultural Resources from Biodiversity Offsets

The offset area proposed for the LCO Modification to DA 305-11-01 is located north of the project area within a property known as Mountain Block. Approximately 50 percent of this 166ha proposed biodiversity offset property has been historically cleared and used for agricultural purposes, mainly livestock grazing. The remainder of the property is well vegetated. A Biodiversity Offset Management Plan will be prepared for the Mountain Block property which will detail the planned improvements and the ongoing management for ecological value.

The Mountain Block property is located within the Singleton 1:100,000 Map Sheet and is covered by the Liddell and Rosevale soil landscapes. There is no Biophysical Strategic Agricultural Land (BSAL) mapped within the property or within a 100m buffer of the property according to the Upper Hunter Strategic Regional Land Use Plan. A desktop BSAL assessment was undertaken for both the Liddell and Rosevale soil landscapes. The Liddell soil landscape consists of 4% to 7% slopes, with

hardsetting surface yellow duplex soils and hardsetting to loose earthy and siliceous sands, all with low fertility. Soil salinity within the duplex soils tends to be high, with high to very high erosion hazard across all the represented soils. The land capability of this soil landscape is between V and VI. The Rosevale soil landscape consists of 15% to 20% slopes, with some extending to 60%, with hardsetting to loose surface soil upon a range of soil types including red and brown duplex soils, shallow clays and sands and brown earths. These soils typically exhibit low to moderate fertility, a high to very high erosion hazard and are limited to VI and VII land capability classes. Therefore the potential for BSAL to be present within this property is extremely low. .



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Post-Mining Rural Land Capability

FIGURE 4.1

4.1.4 Strategic Agricultural Land

The proposed Study Area has 2.8 ha of trigger mapped BSAL (**Figure 2.4**). Indicative Gateway criteria (Upper Hunter SRLUP) are summarised in **Table 4.2**, these criteria were used in the assessment of potential impacts on BSAL.

Table 4.2 Indicative Gateway Criteria for Biophysical Strategic Agricultural Land

Biophysical Strategic Agricultural Land Criteria
(a) Impacts on the land through surface area disturbance and subsidence
(b) Impacts on: (i) soil fertility (ii) rooting depth, or (iii) soil profile materials and thicknesses
(c) Increases in land surface microrelief or soil salinity, or significant changes to soil pH
d) Impacts on Highly Productive Groundwater, including the provisions of the Aquifer Interference Policy and the advice of the Minister for Primary Industries

The Project is not expected to impact the land through surface area disturbance as the proposed extent of open cut mining does not include the trigger mapped BSAL. Therefore there is not expected to be any impact on soil fertility, rooting depth, profile, microrelief, salinity or pH. As discussed below in greater detail (**Section 4.3.2**), the modelled impacts on groundwater are considered negligible both from a quantity and quality perspective. In particular, predicted post mining equilibrium water levels in both final voids are lower than predicted groundwater heads within the Bowmans Creek alluvial aquifer, indicating leakage from the voids to the alluvial aquifer is unlikely to occur and adversely impact groundwater quality in the alluvium (SKM 2013). As such, salinity risks to nearby BSAL is considered negligible as void water is shown to not enter the alluvial aquifer. In addition, given the limited agricultural users of groundwater in the immediate area, it was determined the proposed Project will have negligible impact on BSAL,

As noted in **Section 2.8**, the verification process undertaken in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land – V7* (OEH 2013), confirmed that the alluvial soil identified within the Study Area is not considered to be BSAL.

4.2 Other Impacts

4.2.1 Weed Management

Weed species could be inadvertently brought into the Study Area with imported materials, machinery, or allowed to invade naturally through removal of native vegetation. The presence of weed species has the potential to be a major hindrance to rehabilitation, regeneration activities and agricultural endeavours. The LCO Landscape Management Plan (incorporating a Weed Management Plan) (**Appendix 3**) will incorporate the proposed Modification to DA 305-11-01, where weed management in the Disturbance Area will continue implementing the following actions:

- regular site inspections to identify areas of weed infestation and type of weed species;
- development and implementation of an eradication plan applicable to the circumstances, which may include manual removal, spot spraying, boom spraying, aerial spraying or biological control;
- regular contact with neighbouring property owners to attempt to eradicate weed species from the surrounding area;

- early establishment and maintenance of vigorous grasses and native trees particularly during rehabilitation of overburden dumps; and

- regular maintenance of topsoil stockpiles to eradicate weed infestation.

4.2.2 Biosecurity

Biosecurity is defined in the *Draft NSW Biosecurity Strategy* (DPI, 2012) as 'the protection of the economy, environment and community from pests, diseases and weeds'. It includes measures to prevent new pests, diseases and weeds from entering our country and becoming established. On a regional level, as per **Section 4.2.1** above, appropriate weed management, as outlined in the LCO Landscape Management Plan (**Appendix 3**), will reduce biosecurity risks. Any import of equipment or machinery from overseas will follow the standard procurement safeguards and quarantine procedures as per Australian requirements. Given the processes above, it is considered that the proposed Project will not have any potential impact on the biosecurity of agricultural resources and enterprises within the region.

4.2.3 Subsidence

Not applicable to this Project as no underground mining is proposed and therefore no subsidence will occur.

4.2.4 Dust (Air Quality)

Pacific Environment Limited (2013) undertook an *Air Quality Assessment* associated with the Project. The potential impacts to agriculture are summarised below. An analysis of dust emissions for Year 2, Year 4 and Year 5 of the Project, which represent worst-case scenario for air quality, where coal and waste production are highest, where extraction or wind erosion areas are largest or where operations are located closest to receivers.

The modelling determined that the annual average PM_{10}, TSP or dust deposition criteria will not exceed current annual average criteria. Cumulative air quality impacts are anticipated to be negligible at the nearest residences located to the north of LCO's existing operations.

Given the air quality impacts from the Project are predicted to be negligible on the surrounding area, it is therefore expected that there will be negligible impact on agriculture in the area. No further mitigation measures are proposed in addition to the current LCO Dust Management Procedure (LCO 2009).

4.2.5 Noise and Vibration

Global Acoustics (2012) undertook an *Environmental Noise and Blasting Assessment* associated with the Project. The potential impacts to agriculture are summarised below.

The surrounding area is dominated by coal mining, with few sensitive receptors. Private landholdings in proximity to the Project include small grazing properties and rural residences. The closest privately owned residence is approximately 4.3 km to the northeast of the Project.

Model results for neutral meteorological conditions found no impacts were predicted. Under prevailing meteorological conditions, minor to moderate exceedances of the Project Significant Noise Criteria (PSNC) are predicted at the nearest receiver, the Liddell Recreation Area. However, this will have no impact on agriculture.

Operational noise levels were generally predicted to be less than PSNC at the majority of receptors under prevailing meteorological conditions for each of the modelled scenarios. However, minor exceedences of PSNC were determined for three of the 13 sensitive receptors.

Given the noise and vibration impacts from the Project are predicted to be minor on the surrounding area. It is expected that minor predicted exceedances of the PSNC will result in minimal impacts on residences and agriculture when taking into account the following mitigation measures.

Mitigation Measures

LCO intends to meet the current consent conditions outlined in Project Approval 305-11-01 through implementation of the following management strategies:

- A continued program of regular sound power screening testing to assist in managing sound power levels, and identify plant items requiring maintenance to noise attenuation packages;
- A continued program of attended monitoring as outlined in the Liddell Colliery Noise Monitoring Program to assist in demonstrating compliance with approved noise criteria;
- Continued management of blast vibration and overpressure through blast design utilising the established blast site law and monitoring of real time meteorological data;
- Continued monitoring of blast vibration and overpressure in accordance with the Liddell Coal Operations Meteorological Assessment, Blast Monitoring and Reporting Procedure;
- The use of a real time noise monitoring system in proximity to the nearest receptors to provide alerts if mining noise levels are close to the criterion. Alerts will prompt adaptive management techniques to allow mining operations to be altered as necessary for noise levels to remain within PSNC; and
- Where hire equipment is to be used at LCO it will be required to meet linear total sound power levels. An environmental noise assessment will be undertaken by a suitably qualified acoustic consultant prior to operating hire equipment on site. Where possible, hire equipment will be operated in low risk areas of the site.

4.2.6 Traffic

Parsons Brinkerhoff (2012) prepared a *Traffic Impact Assessment* for the Project with potential impacts to agriculture summarised below.

Product coal is transported to Newcastle via the Hunter Valley Rail Loop and Main Northern Railway. The Project does not represent an increase in rail transport tonnages and therefore will not create any additional competition for the use of rail infrastructure between the site and the port of Newcastle. The Hunter Valley Rail Loop operates 24 hours a day, seven days a week with a daily capacity of 65,000 tonnes.

Vehicle access to Liddell Colliery is from the New England Highway via two alternative access points. The Old New England Highway from the New England Highway is the primary access route for Liddell traffic the majority of which travels from Singleton. A smaller number of vehicles travelling from the west access the site from the New England Highway via Pikes Gully Road.

The traffic flows will remain substantially the same as a result of the Project. The Project will result in an extension to the life of the LCO operation, which will necessitate staff vehicle movements for a number of years beyond the mine life that was originally approved under DA 305-11-01. The Traffic Impact Assessment concluded that the road network and intersection currently operate within their

respective capacities and at satisfactory levels of service, and therefore no intersection upgrade is required and furthermore, no traffic impacts are anticipated as a result of the Project.

As the Project does not pose any additional traffic impacts, there is expected to be negligible impact on agricultural transport infrastructure and as such no mitigation measures are deemed necessary.

4.3 Water Resources

4.3.1 Surface water

Potential impacts of the Project on surface water were identified in the *Surface Water Assessment* (Gilbert and Associates, 2013). Following are the key conclusions from this assessment.

- There is potential for the Project to impact the flow regime in Bayswater and Bowmans Creeks as a result of catchment area and baseflow reduction. However, the combined effect of the reduced catchment area as a result of the Project and predicted maximum reduction in baseflow in Bowmans Creek is estimated to amount to a reduction in streamflow of approximately 2%. A similar minimal impact is anticipated in Bayswater Creek, with a reduction in catchment area reporting to Bayswater Creek as a result of the Project at maximum disturbance of 1.06%.

- Potential for export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages is considered to be low. The risk of spill from the mine water storages was evaluated as part of the site water balance and was determined as a very low risk to either Bowmans or Bayswater Creeks. In addition, neither final void is predicted to spill post-mining.

- Off-site discharges of salt to the Hunter River will be controlled by segregation and preferential re-use of the more saline water on site. If the proposed water management system is maintained and appropriate planning and management implemented, there is no foreseeable risk of significant additional contaminants being discharged from site (Gilbert and Associates, 2013).

The overall impact of the Project on surface water resources relied upon by agricultural enterprises is therefore considered to be low, with Gilbert & Associates (2013) recommending that the site water balance be reviewed annually to update predictions of water supply security and the need for water releases.

4.3.2 Groundwater

The results of the SKM (2013) predictive model simulations and groundwater impact assessment provided the following key conclusions. Further detail can be found in the *Groundwater Impact Assessment* (SKM 2013).

- The estimated leakage from the Bowmans Creek alluvium as a result of the Project is virtually identical to the predicted groundwater loss associated with the current approved mining operations until 2019.

- In 2019, currently approved mining operations cease and dewatering in the former underground workings from the 8 South 2, Middle Liddell and M49 bores is therefore no longer required. This results in groundwater levels starting to recover.

- The similarity in the leakage estimates between the Base Case and the Proposed Case prior to 2019 therefore confirms that dewatering of the old underground workings is the primary cause

of groundwater losses from the alluvium. In addition it appears that the proposed extension of the South Pit between 2014 and 2019 appears to have little effect on groundwater losses.

- After 2019, the estimated groundwater flux begins to slightly increase, indicating that the extension in the Entrance Pit begins to have minor additional groundwater impacts until 2021. Between 2021 and the end of mining in the Entrance Pit in approximately 2022 the predicted groundwater losses increase by 110 ML/yr. This peak leakage rate corresponds to the progression of the Entrance Pit to the south-eastern side of the dyke and the Davis Creek fault into the M49 workings.

Recent groundwater monitoring data indicates that groundwater levels in the alluvium have remained relatively stable, including over the period in which the model is predicting groundwater losses in the order of 120 ML/year (SKM, 2013). Given that the model is predicting similar leakage rates for the Project until 2019, the resulting incremental drawdown associated with the Project is negligible.

Predictive model results anticipate that peak estimated groundwater losses from the Bowmans Creek alluvium may result in approximately 1.4 m drawdown within the alluvial aquifer. This drawdown estimate falls below the minimal impact criteria for aquifer interference activities (maximum two metre decline in water table) as specified in the NSW Aquifer Interference Policy (NSW, 2012). The drawdown would account for approximately 4% to 8% of the estimated annual baseflow contribution to streamflow, or less than 2% of measured annual streamflow. These peak leakage rates are predicted to occur for only a limited time period (1-2 years) and fall well below the range of estimated baseflow contributions observed throughout the historical record. The model results suggest the Project is therefore likely to have a minimal impact on the surface water – groundwater system of Bowmans Creek and its alluvial aquifer. Predictive simulations further indicate that alluvial groundwater levels will return to current levels within 50 years following the end of mining.

Salinity levels have been assumed at 3,520 mg/L based on the average of recorded TDS values at the main water storage (Gilbert & Associates, 2013). This is above the maximum limit for healthy growth of beef cattle of 3,200 mg/L (NSW Industry & Investment 2009) and also for pasture plants such as lucerne and perennial grass pastures of 2,950 mg/L (NSW Department of Primary Industries 2006). Consequently potential production values for the above groundwater losses have not been determined as it is not suitable for agricultural production.

4.4 Socio-Economic Impacts

4.4.1 Farm Productivity

The Study Area is 255.2 ha and of this area 61.4 ha is already disturbed and not currently suitable for agricultural production. The Project will remove approximately 95 ha of potential agricultural land permanently and up to an additional 187.2 ha temporarily upon development for approximately 10 years.

Based on the nominated gross margins (**Section 3.5**), the Study Area has the capacity to generate a conservative estimated gross margin of $33,649 per annum (**Table 4.3**). Therefore, the proposed Project will have a negligible impact on regional agricultural farm productivity when compared to the annual agricultural gross value in the Upper Hunter Region ($142.7 million).

4.4.2 Support Services/ Processing and Value-Adding Industries

Agricultural Support Services

Given an annual carrying capacity of 1160 DSE (Dry Sheep Equivalents) over the 187.2 ha of Land Capability Class 4 and Class 5 land within the Study Area, the area of potential cattle grazing land could carry 69 cows with calves, with a cow and calf unit rated at 16.89 DSE per ha.

Again, using the beef cattle gross margin budget, given a herd of 69 cows with calves, input costs of $8,387 per annum would have been spent in various local agricultural support services in the area, such as agricultural suppliers, veterinarians, other cattle farms and livestock saleyards.

Using a similar analysis for the 6.6 ha of irrigated lucerne hay production, with a potential to produce 66 tonnes of lucerne hay per annum, input costs of $4,996 would have been spent in various agricultural support services in the area such as agricultural suppliers, contractors and other cattle farms per year.

This total of $13,383 potential lost income will have a negligible impact on agricultural support services relevant to the affected lucerne hay and cattle grazing enterprise.

Processing & Value Adding Industries

The main value adding and processing industries which could be impacted by the Project are the regional abattoirs and meat processing plants located at Scone, Whittingham and Aberdeen.

Current figures for the Upper Hunter Region values livestock slaughtering's at $78.3 million. Using the beef cattle gross margin budget, the potential slaughter value of cattle from the Study Area is $33,238 per annum or 0.04 % of the total value of livestock slaughtering's in the Upper Hunter Region.

The Project will have a negligible impact on processing and value adding industries relevant to the affected cattle grazing enterprise.

4.4.3 Employment

Given the relatively minor nature of the Project, the negligible impact of the Project on farm productivity, agricultural support services, processing and value adding industries, and that the Project will not result in an increase in existing employee numbers, annual production rates or operating hours, it is not anticipated to have any impacts upon agricultural employment in the Upper Hunter Region. The Project will allow for an extension of the mine life at LCO, resulting in the positive social and economic benefits associated with continued employment at the mine.

4.4.4 Visual Amenity

The area surrounding LCO is dominated by power generating activities, open cut coal mining operations and associated infrastructure, with few private residences or other sensitive receptors. The proposed extension to the open cut pits at LCO will be in a south-easterly direction, away from the nearest privately owned residences.

The proposed changes are not anticipated to result in any significant changes to the landscape beyond existing and that currently approved according to the main environmental assessment report (GSSE 2013).

The Project will have minimal impact on visual amenity when taking into account the mitigation measures summarised below. Upon completion of mining activities and subsequent land rehabilitation

the Project will have a positive impact on visual amenity with re-establishment of grazing land and tree planting.

Mitigation Measures

The potential visual impacts of the Project will be managed as follows:

- Rehabilitation of disturbed areas as soon as practical after mining;
- Prioritisation of rehabilitation, with areas that are most visually prominent to off-site private residences and public transport routes having highest priority; and
- Orientating lights on site away from sensitive receptors were practical.

4.4.5 Landscape Values

The area surrounding LCO is dominated by open cut coal mining operations and associated infrastructure, with few private residences or other sensitive receptors. The mine disturbance areas will be rehabilitated with a combination of pasture and tree plantings, an area of approximately 1,381 ha. There will be an area of approximately 156.7 ha which will consist of final void and surrounding steep slopes, which will not be suitable for agricultural production.

Within the Study Area there is 61.4 ha of mine related disturbance, which upon completion of the Project will be rehabilitated with pasture and tree species. Given the dominance of mining and power generation activities in the area, the Project will have negligible additional impacts on landscape values relied upon by agricultural enterprises. The planting of tree and pasture species will ensure impacts on the post mining landscape values are minimised.

4.4.6 Tourism

The area surrounding LCO is dominated by open cut coal mining operations and power generation activities, and associated infrastructure, with few private residences, sensitive receptors or tourism dependent agricultural enterprises. Therefore negligible impacts are anticipated given the lack of tourism infrastructure relied upon by local and regional agricultural enterprises.

4.5 Summary of Impacts and Mitigation Measures

The impacts discussed in **Section 4** have been listed in **Table 4.3** with their representative Agricultural Impact Risk Rating according to the *Strategic Agricultural Land Use Policy – Guideline for Agricultural Impact Statements at the Exploration Stage* (DTIRIS, 2012).

Table 4.3 Summary of Potential Impacts and Mitigation Measures

Agricultural Resource	Potential Impact	Summary of Mitigation Measures
Land Resources		
Land Temporarily Removed from Agriculture	Low	• Mine plan designed so that the open cut pit extension limits remain outside the alluvial boundary; and • Rehabilitation of disturbed areas will occur as soon as practical after mining.
Land Permanently Removed from Agriculture	Moderate	• Final landform rehabilitated to allow agricultural production where possible. Net increase of 130.3 ha of Land Capability Class VIII, which includes 61.4 ha of

Agricultural Resource	Potential Impact	Summary of Mitigation Measures
		current mine disturbance.
Impact on Agricultural Resources from Biodiversity Offsets	Low	• No portion of the offset property is trigger mapped as potential BSAL.
Strategic Agricultural Land	Low	• Mine plan designed so that the open cut pit extension limits remain outside the alluvial boundary; and
Other Impacts		
Weed Management	Low	• Treatment of entire weed infestations will be undertaken where possible; • Re-treatment of recurring infestations at regular intervals; • Annual monitoring of key weed infestations; • Annual monitoring for new infestations; • Mapping of key weed infestations following monitoring to track progress and focus control activities where necessary; and • Prompt rehabilitation of land post disturbance.
Biosecurity	Negligible	-
Subsidence	Not Applicable	-
Dust (Air Quality)	Negligible	-
Noise and Vibration	Low	• A continued program of regular sound power screening testing of equipment; • A continued program of attended monitoring as outlined in the LCO Noise Monitoring Program; • Continued management of blast vibration and overpressure through blast design; • Continued monitoring of blast vibration and overpressure in accordance with the LCO Meteorological Assessment, Blast Monitoring and Reporting Procedure; and • Where hire equipment is to be used at LCO it will be required to meet linear total sound power levels. Where possible, hire equipment will be operated in low risk areas of the site.
Water Resources		
Potential agricultural use of groundwater	Low	• Adaptive Management as per Groundwater Assessment (SKM 2013)
Potential agricultural use of surface water	Low	• Annual review of site water balance • Adoption of Water Management System proposed in Surface Water Assessment (Gilbert and Associates, 2013)
Socio-economic Impacts		
Farm Productivity	Negligible	• Rehabilitation of disturbed areas as soon as practical after mining; and

Agricultural Resource	Potential Impact	Summary of Mitigation Measures
		• No mapped BSAL impacted by the open cut pit extension.
Support Services / Processing and value-adding industries	Negligible	
Employment	Negligible	
Visual Amenity	Low	• Rehabilitation of disturbed areas as soon as practical after mining, with prioritisation of the most visually prominent areas; • Orientating lights on site away from sensitive receptors were practical.
Landscape Values	Negligible	-
Tourism	Negligible	-

4.6 Demonstrated Capacity for Rehabilitation

The principle objective for rehabilitation of mined land at Liddell is to return the site to a condition where its landforms, soils, hydrology, and flora and fauna are compatible with the surrounding land uses. The proposed end land use for the site includes a combination of grazing and bushland/wildlife habitat. The post-mining landform design of LCO has been generally undertaken in accordance with the *Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW* (Department of Mineral Resources, 1999).

Rehabilitation activities are undertaken as soon as possible following the completion of mining activities, in accordance with the LCO Rehabilitation Management Plan, a component of the LCO Landscape Management Plan.

Mine Closure Criteria (LCO, 2011) have been developed for LCO to monitor rehabilitation progress in line with internal XCN requirements and external relinquishment goals. Further revisions of the Closure Criteria will be required during the life of the operation as criteria and goals become more refined as LCO approached closure.

The Preliminary Closure Criteria describe five rehabilitation stages for all domains (infrastructure areas, open cut mining areas and tailings disposal areas):

1) Decommissioning;

2) Landform establishment;

3) Growth medium development;

4) Ecosystem Establishment; and

5) Ecosystem development.

Rehabilitation progress is documented in the *Liddell Coal Annual Environmental Management Report* (Clibborn, 2012) and shows that at conclusion of the 2012 reporting period; approximately 615 ha of mine disturbance had been rehabilitated to a mix of pasture and grasses or native forest/ecosystem. LCO plans to rehabilitate approximately 50 ha of mine disturbance during 2013, comprising of pasture and grasses.

The rehabilitation objectives and final landform will be further developed during the Mining Operations Plan period and through detailed mine closure planning.

Plate 1 – Liddell Coal Operations Site Rehabilitation

5.0 STAKEHOLDER CONSULTATION

Consultation has been undertaken with local, state and federal government authorities, Aboriginal groups, local landholders and other relevant stakeholders in preparation of this EA. At the commencement of the EA process, stakeholders for the Project were identified through a range of sources of information, in particular LCO's Social Involvement Plan (SIP). The SIP identifies stakeholders with an interest in the operations at LCO, and includes specific objectives and techniques for on-going communication between LCO and stakeholders, as well as detailing the company's annual community support program.

Identification of relevant stakeholders for the Project was also based on regulatory requirements for the Project, and in particular the DGRs relating to consultation. The DGRs require consultation with the following stakeholders:

- Office of Environment and Heritage
- NSW Office of Water
- DTIRIS – Mineral Resources and Energy;
- Department of Primary Industries;
- Hunter-Central Rivers Catchment Management Authority;
- Dams Safety Committee;
- Roads and Maritime Services;
- Muswellbrook Council;
- Singleton Council; and
- Relevant Aboriginal Groups.

The stakeholders identified, and the methods of engagement with these stakeholders, are detailed in Chapter 6 of the main Environmental Assessment (GSSE, 2013). A detailed stakeholder consultation log was kept during the preparation of the EA as a record of the consultation undertaken and is included in Appendix F of the EA (GSSE, 2013).

6.0 KEY FINDINGS

The purpose of this AIS is to assess the potential impacts of the Project on agricultural resources and businesses. The proposed LCO – Modification to DA 305-11-01, consists of an expansion of the current open cut mining footprint and associated extension of the life of mine. A summary of the key findings of the AIS is as follows:

- There is 2.8 ha of trigger mapped BSAL within the Study Area, however the proposed extension to the Entrance Pit does not extend into this area. Only limited ancillary disturbance such as vehicle tracks may occur within this area.

- There is 6.6 ha of land capability class II alluvial land within the Study Area. However, the limit of open cut mining does not encroach on this area. Furthermore, BSAL verification within the alluvial area showed this soil failed the criteria for BSAL.

- There is currently 193.8 ha of land potentially available for agricultural use within the Study Area. At completion of mining there will be approximately 98.5 ha potentially available for agricultural uses. This is represents the permanent removal of 95.3 ha from potential agricultural use.

- The impact of the Project on groundwater resources is considered negligible (SKM 2013). Furthermore there are 12 registered groundwater bores within 2 km of the LCA DA boundary. Six of these bores are owned by LCO or the neighbouring XCN Mt Owen mine and three are registered as being for mining or exploration purposes. Of the remaining three bores no ownership information was listed in the database, however one is located to the northeast of LCO beyond the area of predicted impacts of the Project, and two are located on parcels of land owned by Ravensworth Operations P/L and Xstrata Mt Owen P/L. No privately owned bores will therefore be impacted by the Project.

- The impact of the Project on surface water resources relied upon by agriculture is expected to be low, with a reduction in streamflow of less than 2% (SKM 2013). Potential for export of contaminants or increases in salinity are expected to be very low (Gilbert & Associates 2013).

- The Study Area has the capacity to generate a conservatively estimated gross margin of $33,649 per annum, which is considered a negligible impact on the regional agricultural farm productivity the Upper Hunter Region ($142.7 million).

- The assessment calculated a potential loss of $13,383 per annum to the agricultural support services within the region as a result of lost agricultural production. This is also considered a negligible impact on the regional economy.

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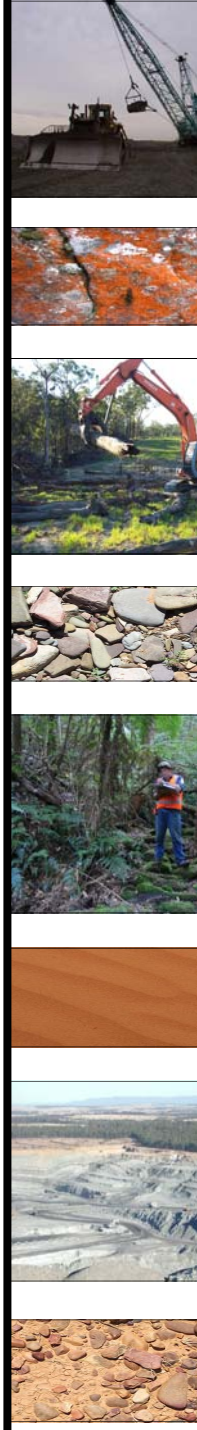

APPENDIX 1

Liddell Coal Operations

Proposed Modification

Economic Review of Potential Agricultural Impacts

Prepared for

Liddell Coal Operations Pty Ltd
C/- GSS Environmental Pty Limited

By

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May 2013

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1 INTRODUCTION

Liddell Coal Operations (LCO) is an established open-cut mining operation located at Ravensworth, approximately 25 kilometres north-west of Singleton in the Upper Hunter Valley of New South Wales in the Upper Hunter Valley of New South Wales. Liddell Coal Operations Pty Ltd manages LCO on behalf of the Liddell Joint Venture (LJV). The LJV ownership comprises Enex Liddell Pty Limited holding 35 per cent; Gabume Pty Limited holding 32.5 per cent; and Mitsui Matsushima Pty Limited holding 32.5 per cent. Gabume Pty Limited is wholly owned by Enex Liddell Pty Limited which is wholly owned by Xstrata Coal Pty Limited (XC). XC is ultimately controlled by GlencoreXstrata plc.

Mining at LCO has been in continuous operation since the 1950s, during which time mining operations have been subject to a number of development consents. In 2001, a development application (DA) was lodged with Planning NSW (now the Department of Planning and Infrastructure (DP&I)) to continue operations within the colliery holding. Development Consent DA 305-11-01 was granted by the Minister for Planning on 20 November 2002 for 21 years of continued mining operations at LCO. This DA remains the current development consent for LCO, and has since been modified on four separate occasions.

LCO is now seeking a further modification under section 75W of the *Environmental Planning and Assessment Act* (EPA Act), 1979 to allow for the extension of open cut mining operations beyond the currently approved mining footprint so as maximise coal recovery. The proposed expansion of mining is within both the existing development consent DA 305-11-01 boundary and mining lease ML 1597.

GSS Environmental (2013) prepared an Agricultural Impact Statement for the Modification. This report utilises the information provided by GSS Environmental (2013) to assess the potential economic implications of the impacts of the Modification on agricultural resources. In Section 2 some of the underlying issues that have been raised in relation to the perceived conflict between coal mining and the use of agricultural land and water are considered. Section 3 examines agricultural and mining industries in the Upper Hunter region. The economic efficiency and regional economic impact assessment frameworks for consideration of the economic impacts of projects that impact land and water resources, are identified in Section 4. Section 5 examines the economic efficiency and regional economic impacts of the Modifications use of land and water resources.

2 AGRICULTURAL AND MINING INDUSTRIES IN NEW SOUTH WALES

2.1 Land Use

Agricultural lands are important to NSW and cover approximately 81% of NSW (i.e. 65 million [M] hectares [ha]) (Australian Natural Resources Atlas [ANRA], 2009a). While the total agricultural land area in NSW has declined marginally since 1960 (Table 2.1), the area of land under major food crop production (i.e. wheat and barley[1]) has actually increased (Figure 2.1).

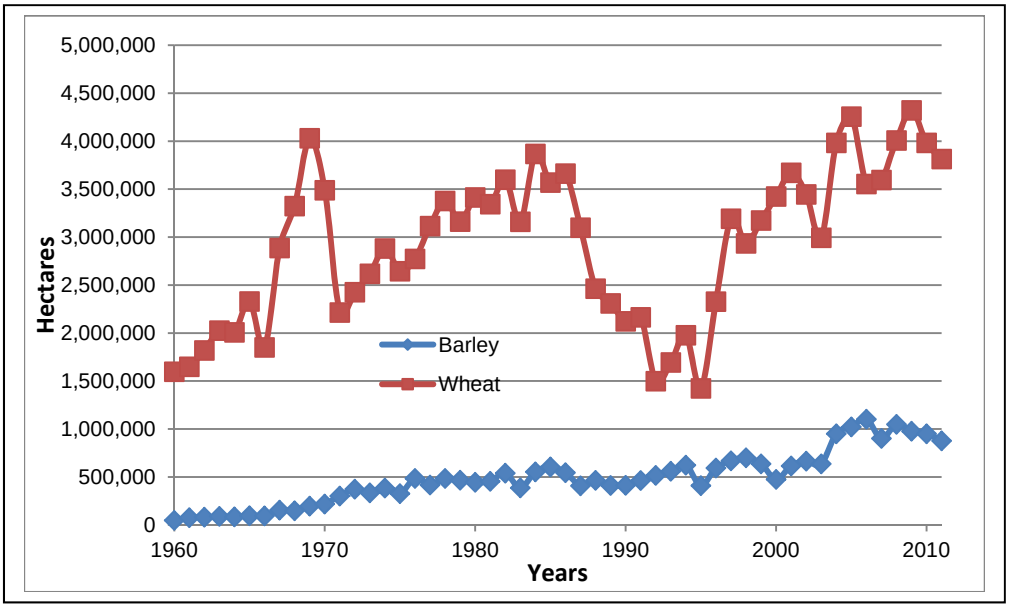
Table 2.1 - NSW Agricultural Land Area

Area of Agricultural Land (M ha)	1960	1980	1997
	69.95	65.01	60.90

Source: ANRA (2009b).

The NSW agricultural industry directly provides employment for 68,883 people or 2.3% of total employment in NSW (Australian Bureau of Statistics [ABS], 2011a)[2]. Payment to agriculture, forestry and fishing employees in 20010-11 was $1,539M and value-added was $7,062M. Gross operating surplus and gross mixed income from agriculture, forestry and fishing was $6,908M (ABS, 2011b).

Figure 2.1 - NSW Land Area Allocated to Wheat and Barley



Source: ABS (2013a).

Mining land use is a small fraction of the area of NSW (i.e. less than 0.1% of the total NSW land area) (Bureau of Regional Science 2009) and directly employs 29,798 or 1.0% of total employment in NSW (ABS, 2011a). Payment to mining employees in 2010-11 was $2,466M and value-added was $10,633M. Gross operating surplus and gross mixed income from mining was $10,035M (ABS, 2011b).

In this comparison, mining is a more significant sector than agriculture in terms of payments to employees, value-added and gross operating surplus and gross mixed income. However, agriculture does employ more people, albeit while using a much larger area of NSW to achieve this employment.

[1] Wheat and barley are the two largest food crops produced in Australia
[2] This is based on the ABS sector of Agriculture, forestry and fishing.

Nevertheless, no policy implication should be drawn from the relative magnitudes of existing sectors. What is relevant in a policy context is whether moving from one land use to another is more economically efficient or not. That is, do the benefits to the community from changing land uses exceed the costs to the community. This is discussed in more detail in Section 4.

2.2 Economic Growth in Regional Areas

Agricultural lands have historically supported the economies of regional areas. However, regional economies are facing a number of trends including:

- loss of significant industries such as abattoirs and timber mills from many rural areas;
- increased mechanisation of agriculture and aggregation of properties, resulting in loss of employment opportunities in this industry;
- preference of Australians for coastal living, particularly for retirement; and
- preference of many of today's fastest growing industries for locating in large cities (Collits, 2001).

The result is that there has been declining population growth in 47 out of 96 rural statistical local areas (SLAs) that are located in non-coastal statistical subdivisions in NSW (excluding Hunter Statistical Division) (ABS, 2011c). There has also been a decline in the population of smaller towns even in regions that have been growing.

Trends in agriculture are leading to improved productivity, but reduced economic stimulus in regional areas, as demand for inputs such as labour decline. In general, the prosperity of rural areas that are reliant on agriculture has also been in decline.

It is increased or new spending in regions that contributes to economic stimulus and growth. One potential source of new spending is mining projects that utilise the resource endowments of a region. Studies (Gillespie Economics, 2003, 2007) have shown that mining projects provide significant new economic activity to regional and rural economies through direct expenditures on inputs to production as well as the expenditure of employees. This latter stimulus is enhanced by the high wages paid in the mining sector.

Mining projects can also broaden the economic base of regions, thereby insulating the economy from external shocks such as droughts and downturns in agricultural commodity prices (Collits, 2001).

2.3 Prime Agricultural Land and Other Land Uses

In NSW, dryland and irrigated cropping land covers an area of 84,878 square km. Mining (and waste disposal) covers an area of 630 square km, 0.74% of the area of cropping lands (Table 2.2).

Table 2.2 - NSW Land Uses

Land use	Area (sqkm)	Area (%)
Nature conservation	61,058	7.6%
Other protected areas	2,478	0.3%
Minimal use	59,178	7.4%
Grazing native vegetation	309,428	38.6%
Production forestry	25,242	3.2%
Plantation forestry	4,200	0.5%
Grazing modified pastures	222,164	27.7%
Dryland cropping	74,692	9.3%
Dryland horticulture	390	0.0%
Irrigated pastures	3,160	0.4%
Irrigated cropping	10,186	1.3%
Irrigated horticulture	1,073	0.1%
Land in transition	951	0.1%
Intensive animal and plant production	243	0.0%
Intensive uses (mainly urban)	10,218	1.3%
Rural residential	4,387	0.5%
Mining and waste	630	0.1%
Water	11,352	1.4%
Total	**801,030**	**100.0%**

Source: Bureau of Rural Sciences (2009)

The threat to cropping land from mining would therefore appear to be minimal at a macro level. Nevertheless, the desirability of proposals that impact this land should be addressed at a micro level through a consideration of costs and benefits, including the costs to society of impacting high value, agricultural land.

2.4 Food Security

"Food security refers to the ability of individuals, households and communities to acquire appropriate and nutritious food on a regular and reliable basis, and using socially acceptable means. Food security is determined by the food supply in a community, and whether people have adequate resources and skills to acquire and use (access) that food" (NSW Centre for Public Health and Nutrition 2003).

With respect to food supply in NSW, the output of key food products such as wheat and barley from prime agricultural land has increased over time, as has the area of land allocated to these crops (ABS 2012).

Australia's agricultural industries have become more heavily export oriented over the last twenty years. Around two-thirds of agricultural production is now either directly or indirectly exported. The wool industry currently exports around 95 per cent of its production. The beef, sugar and wheat industries export around 65-75 per cent of their production, while the sheep meat, wine and dairy industries export around 50-60 per cent. With the exception of the wool industry — which has always been highly export oriented — these shares have all risen steadily in recent decades (Productivity Commissions 2005).

As identified by ABARES (2011, p. 2), "There is no foreseeable risk to Australia's food security. Australia produces twice as much food as it consumes, produces almost all its fresh food, and can easily afford the food it imports". Furthermore, "the global food security challenge is not about the capability of world agricultural producers to produce enough food to feed the world, but rather is about

ensuring that the poorest people in the world have the economic and physical access to the food they require to meet their nutritional needs" (ABARES 2011, p. 16).

2.5 Water Supplies and Mining

In NSW, the agriculture sector consumes the largest volume of water with 2,127 GL, or 49% of NSW water consumption in 2009-2010. Mining is a relatively small consumer of water, using 62 GL or 1% of NSW water consumption in 2009-2010 (Table 2.3).

Table 2.3 – NSW Water Consumption 2009-2010

Sector	GL	%
Agriculture	2,127	49%
Forestry and fishing	1	0%
Mining	62	1%
Manufacturing	142	3%
Electricity and gas	68	2%
Water supply(a)(b)	1,001	23%
Other industries(c)	357	8%
Household	565	13%
Total	**4,323**	**100%**

(a) Includes sewerage and drainage services
(b) Includes water losses
(c) Includes aquaculture and services to agriculture
Source: ABS (2011d)

Like land, water can also be considered a scarce resource that faces competing demands. Consequently, the government has established a framework to facilitate its allocation between competing uses.

The *NSW Water Management Act 2000* (WM Act) vests ownership of water in the Crown. Water access and use is now only permissible with possession of a water access licence (except in the case of harvestable rights, native title rights and some stock and domestic rights). Water Sharing Plans that are prepared under the WM Act set the rules by which water is shared between all users, including the environment, in each water management area in NSW. These plans also set rules for water trading, that is, the buying and selling of water licences and also annual water allocations (Montoya 2010).

The aim of water trading is to facilitate the re-allocation of water from sectors with low added value to sectors with a higher added value (Savenije and van der Zaag 2001). Like the situation with land, the price of water performs the function of rationing the scarce supply of water among competing uses. Users that value water the most will be willing to pay the most for water entitlements.

Water productivity is one measure of water efficiency and can be expressed as the amount of output produced from one unit of water. Table 2.4 provides data on water consumption and industry gross value added for 2009–10, from which water intensity by industry can be calculated. Mining in Australia recorded (on average) $196 million in gross valued added per gigalitre (GL) of water consumed in 2009–10 with the equivalent figure for coal mining being $298 million per GL. This compares to the agriculture sector which generated, on average, $3 million in gross value added for every GL of water consumed in 2009–10 (Table 2.3).

Table 2.4 - Industry Gross Value Added For Water Using Industries—2009–10 (Australia)

		Industry gross value added (a)	Water consumption	Industry gross value added per GL of water consumed
		$m	GL	$m/GL
Agriculture, forestry and fishing	Agriculture	24 265	6 987	3
	Aquaculture, forestry, fishing	4 499	200	22
	Total Agriculture, forestry and fishing	28 764	7,187	4
Mining	Coal mining	22 576	76	298
	Oil and gas extraction	26 340	34	785
	Other mining(b)	38 880	336	116
	Exploration and mining support services	8 309	44	187
	Total mining	96 105	489	196
Manufacturing	Food, beverages and tobacco	23 953	301	80
	Wood and paper products	7 736	81	96
	Printing, publishing and record media	4 088	4	941
	Petroleum, coal, chemical and associated products	17 807	77	230
	Non-metallic, mineral products	5 783	33	176
	Metal products	21 310	139	153
	Machinery and equipment	19 881	9	2 134
	Other manufacturing (includes furniture)	3 047	1	2 998
	Total manufacturing	107 707	658	164
Electricity and gas		18 837	297	64
Water supply, sewerage and drainage		7 191	1 893	4
All other industries		944 442	1 084	871
Total		**1 203 046**	**11 609**	**104**

(a) At 2009–10 current prices
(b) Includes services to mining
Source: ABS (2011d)

3 AGRICULTURAL AND MINING INDUSTRIES IN THE UPPER HUNTER REGION

3.1 Agriculture

The Upper Hunter region (i.e. the Singleton, Muswellbrook and Upper Hunter Shire local government areas [LGAs]) have a combined land area of 1.6M ha, of which 56% is agricultural land (Table 3.1). Of this agricultural land, 2.8% is irrigated with annual irrigation volumes of approximately 89,513 million litres (ML) (Table 3.1). The total value of agricultural production in this region in 2006 is estimated at $143M (Table 3.1).

Table 3.1 - Existing Agricultural Land Use and Value of Production in Upper Hunter Region 2006

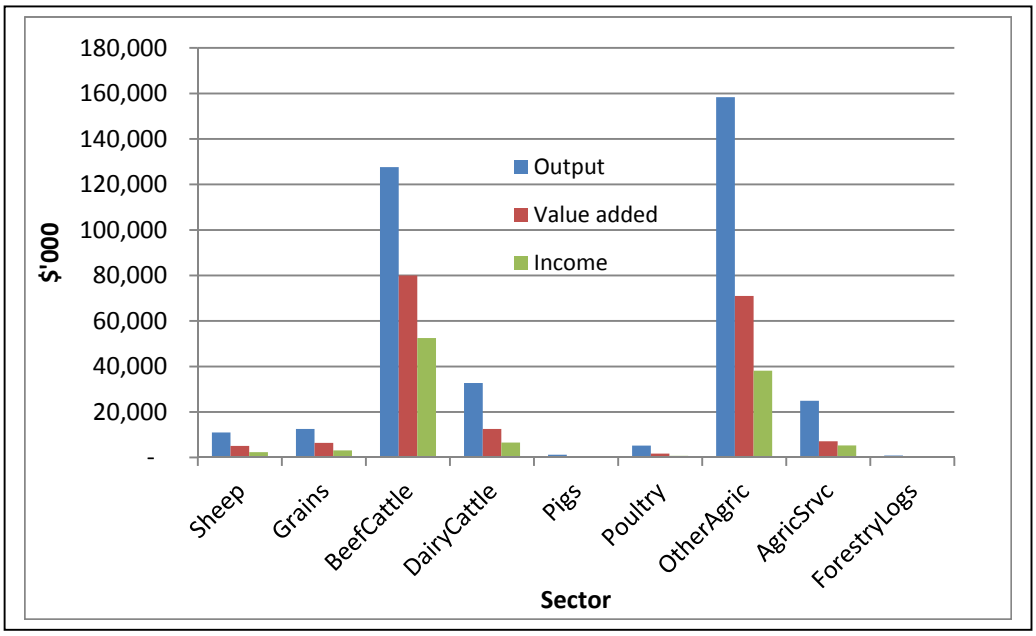
	Units	Singleton LGA	Muswellbrook LGA	Upper Hunter Shire LGA	Total
Area					
Land Area	ha '000	490	341	810	1,640
Area of Agricultural Land	ha '000	156	122	647	925
Irrigation					
Area Irrigated	ha '000	7	9	10	26
Irrigation Volume Applied	ML	27,394	30,894	31,225	89,513
Other Agricultural Uses	ML	2,015	1,728	4,792	8,535
Total Water Use	ML	29,409	32,621	36,017	98,047
Area Irrigated as Proportion of Agricultural Land	%	4.5	7.4	1.5	2.8
Value					
Gross Value of Crops	$M	8.2	9.6	8.5	26.3
Gross Value of Livestock Slaughterings	$M	17.4	11.3	49.6	78.3
Gross Value of Livestock Products	$M	11.5	13.1	13.5	38.1
Total Gross Value of Agricultural Production	**$M**	**37.1**	**34.0**	**71.6**	**142.7**

Source: ABS (2011e, 2011f, 2011g).

Note: Totals may have minor discrepancies due to rounding.

The input-output table developed for the Upper Hunter region (Gillespie Economics, 2013) provides an indication of the direct relative significance of the different agricultural sectors, affirming beef cattle and other agriculture (which includes grapes and horse breeding) as the main agricultural sectors (Figure 3.1).

Figure 3.1 - Agricultural Sectors in Upper Hunter Region



Source: Gillespie Economics (2013).

Total employment in the agricultural industry in the Upper Hunter region in 2011 was 2,109 (ABS, 2013). Table 3.2 provides a more detailed employment by industry breakdown which indicates that the main agricultural employment is in beef cattle farming, horse breeding, dairy cattle farming and grape growing.

Table 3.2 - Employment by Agricultural Sectors in the Upper Hunter Region 2011

Sector	No.
A000 Agriculture, Forestry and Fishing, nfd	12
0100 Agriculture, nfd	63
0112 Nursery Production (Outdoors)	4
0113 Turf Growing	5
0121 Mushroom Growing	35
0123 Vegetable Growing (Outdoors)	9
0131 Grape Growing	67
0137 Olive Growing	14
0139 Other Fruit and Tree Nut Growing	4
0140 Sheep, Beef Cattle and Grain Farming, nfd	16
0141 Sheep Farming (Specialised)	41
0142 Beef Cattle Farming (Specialised)	748
0143 Beef Cattle Feedlots (Specialised)	3
0144 Sheep-Beef Cattle Farming	116
0145 Grain-Sheep or Grain-Beef Cattle Farming	38
0149 Other Grain Growing	17
0159 Other Crop Growing nec	43
0160 Dairy Cattle Farming	176
0170 Poultry Farming, nfd	3
0171 Poultry Farming (Meat)	7
0172 Poultry Farming (Eggs)	8
0191 Horse Farming	586
0192 Pig Farming	4
0193 Beekeeping	3
0199 Other Livestock Farming nec	6
0301 Forestry	4
0400 Fishing, Hunting and Trapping, nfd	3
0520 Agriculture and Fishing Support Services, nfd	4
0522 Shearing Services	5
0529 Other Agriculture and Fishing Support Services	65
Total	**2,109**

Source: ABS (2013b)

3.2 Coal Mining

NSW DPI (2010) identifies 18 coal mines in the Hunter Coalfield producing 81.74 Mt of saleable coal in 2008/09. Conservatively assuming all of this production is steaming coal with a value of AUD$100 per tonne, this level of saleable coal production is estimated to have a value of around $8 billion (B) (Table 3.3) which is significantly greater than the value of all agricultural production in the Upper Hunter region (reported as $143M in Table 3.1). Direct employment in mining in the Hunter Coalfield as reported by NSW DPI (2010) was 9,086 which is also significantly greater than total employment in the agricultural industry in the Upper Hunter region in 2011, which was 2,109 (Table 3.2).

Table 3.3 - Coal Mining Production, Gross Value and Direct Employment in the Hunter Coalfield

Coal Mining	Units	Total
Coal Saleable Production (2008/2009)	Mt	81.74*
Gross Value of Coal Production (2008/9)	$M	8,176**
Direct Mining Employment (2009)	No.	9,086*

Source: * NSW Department of Primary Industries (DPI) (2010)
** Conservatively assuming only steaming coal production and a value of AUD$100/t which less than the median price for NSW Steaming coal exports in 2008-09 (DPI, 2010)

Note: Mt = million tonnes.

3.3 Agriculture, Mining, Manufacturing And Accommodation, Cafes And Restaurants

Table 3.4 provides ABS data on direct employment in the major agriculture activities in the region, the main mining activities in the region, the main manufacturing activities associated with agriculture and mining in the region and accommodation, cafes and restaurants in the region.

From this data it is evident that coal mining is by far the most significant provider of employment in the region and has strong backward linkages to, among other sectors, the mining and construction machinery manufacturing sector and explosives manufacturing sector. The mining sector provides 107 times the direct employment of the grape growing sector, 12 times the direct employment of the horse farming sector and over four times the direct employment of the entire accommodation, cafes and restaurants sectors. The most significant agriculture sector in terms of direct employment is beef grazing. Beef grazing also has strong linkages to the meat processing sector, which combined provide greater levels of direct employment than the grape growing and wine manufacturing sectors.

Table 3.4 - Employment in Agriculture, Mining, Manufacturing and Accommodation (Upper Hunter Region)

Agriculture		Mining		Manufacturing		Accommodation	
0131 Grape Growing	67	0600 Coal Mining	7,195	1111 Meat Processing	297	4400 Accommodation	366
0142 Beef Cattle Farming (Specialised)	748	1090 Other Mining Support Services	260	1113 Cured Meat and Smallgoods Manufacturing	143	4500 Food and Beverage Services, nfd	10
0191 Horse Farming	586	1012 Mineral Exploration	181	1214 Wine and Other Alcoholic Beverage Manufacturing	117	4511 Cafes and Restaurants	276
0144 Sheep-Beef Cattle Farming	116		-	1892 Explosive Manufacturing	122	4512 Takeaway Food Services	538
0145 Grain-Sheep or Grain-Beef Cattle Farming	38			2462 Mining and Construction Machinery Manufacturing	184	4513 Catering Services	50
0160 Dairy Cattle Farming	176					4520 Pubs, Taverns and Bars	165
0121 Mushroom Growing	35					4530 Clubs (Hospitality)	179
0141 Sheep Farming (Specialised)	41						
0159 Other Crop Growing nec	43						
0529 Other Agriculture and Fishing Support Services	65						
Total Agriculture	**2,109**	**Total Mining**	**7,970**	**Total Manufacturing**	**1,849**	**Total Accommodation, Cafes and Restaurants**	**1,584**

Source: ABS (2013b)
Note: Only the sectors containing the largest levels of employment are included in this table. However, the totals relate to all sectors, including those not reported here.

Figures 3.2 to 3.4 are generated from a 2012 input-output table of the regional economy (Muswellbrook LGA, Singleton LGA and Upper Hunter Shire LGA) and provide a sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the economy.

What is clear from these figures is that in terms of gross regional output, value-added, income, employment, imports and exports, coal mining is the most significant sector of the regional economy. For comparison, the horse breeding and grape growing sectors are located in the other agriculture

sector in Figures 3.2 to 3.4, while wine manufacturing is located in the food manufacturing sector. Accommodation, cafes and restaurants are located in the Accom/restaurants sector.

Figure 3.2 Sectoral Distribution of Gross Regional Output and Value-Added ($'000)

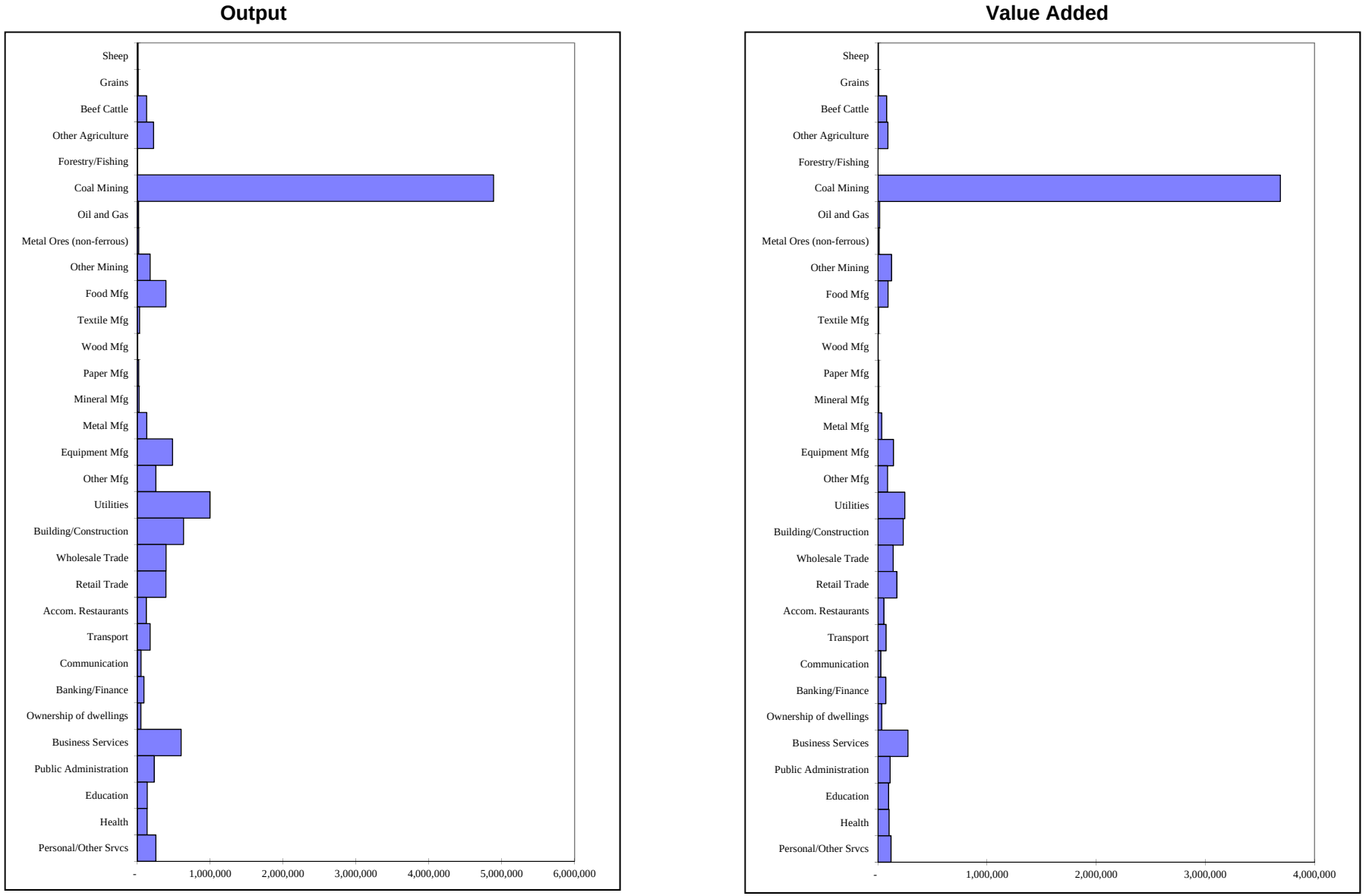
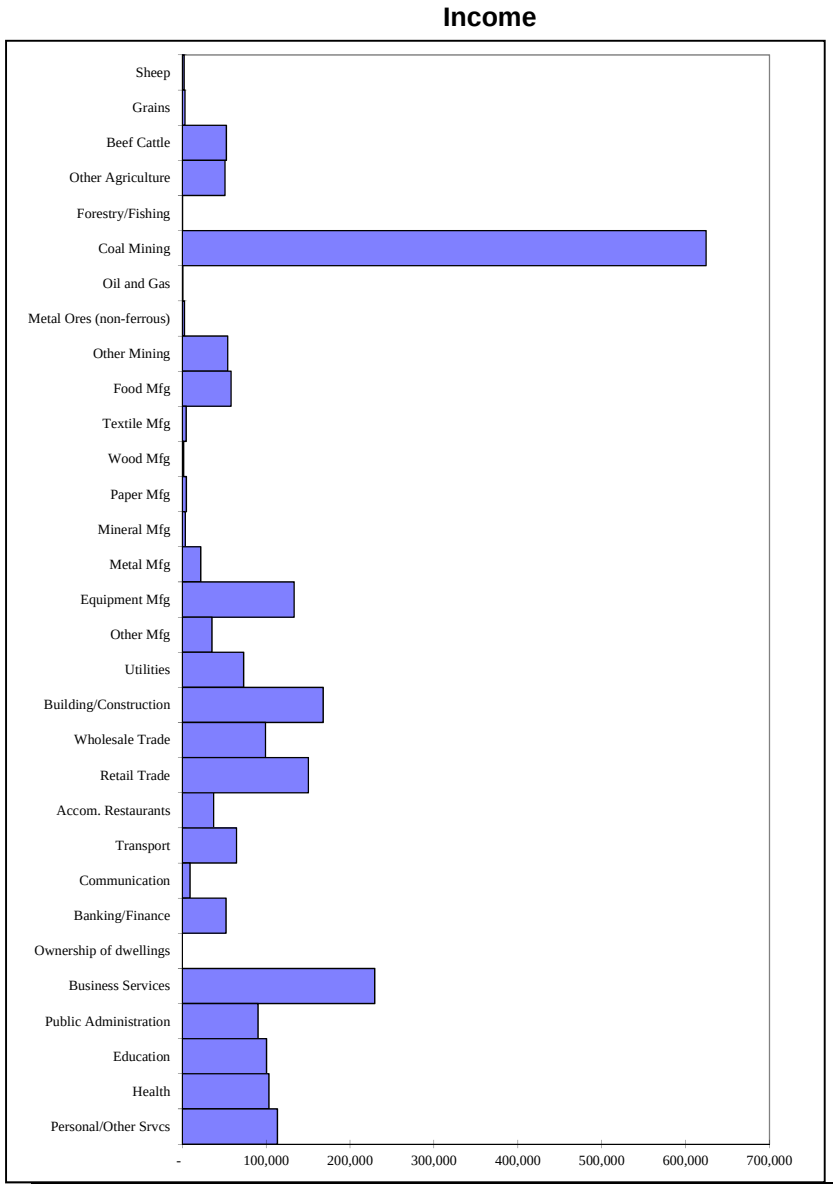


Figure 3.3 Sectoral Distribution of Income ($'000) and Employment (No.)



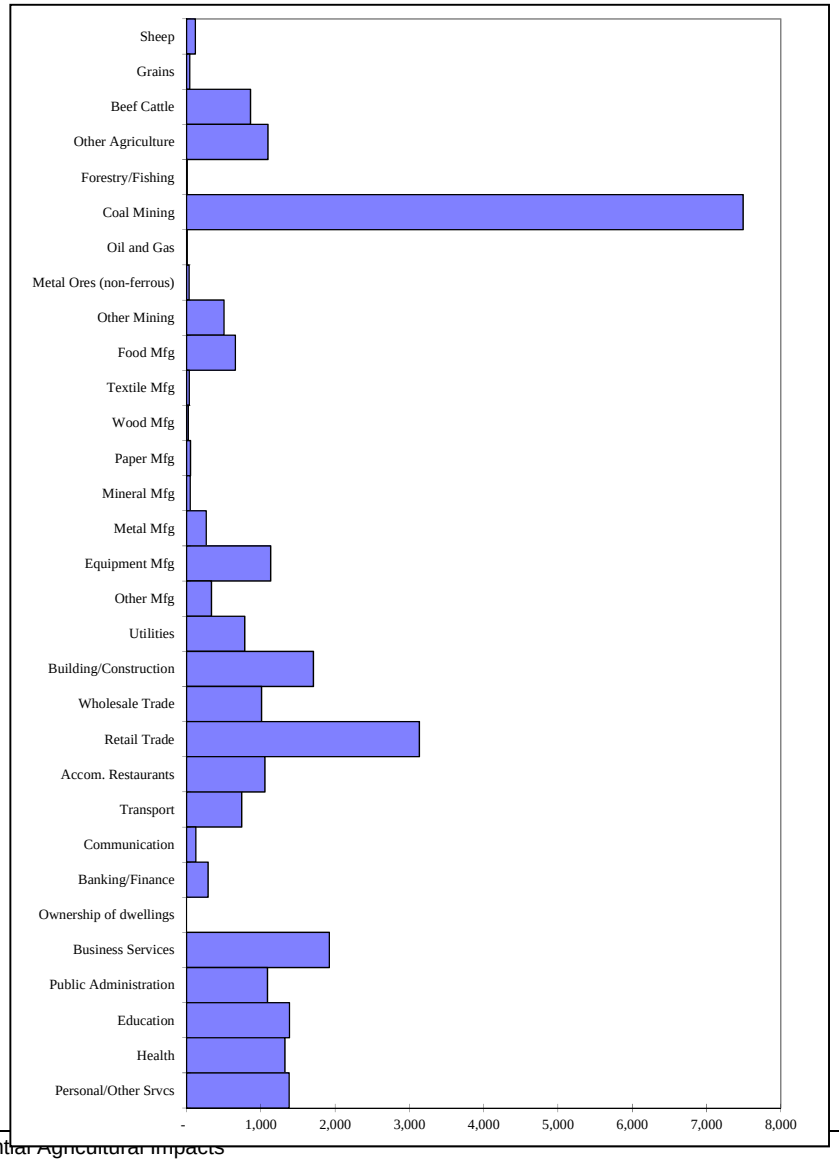
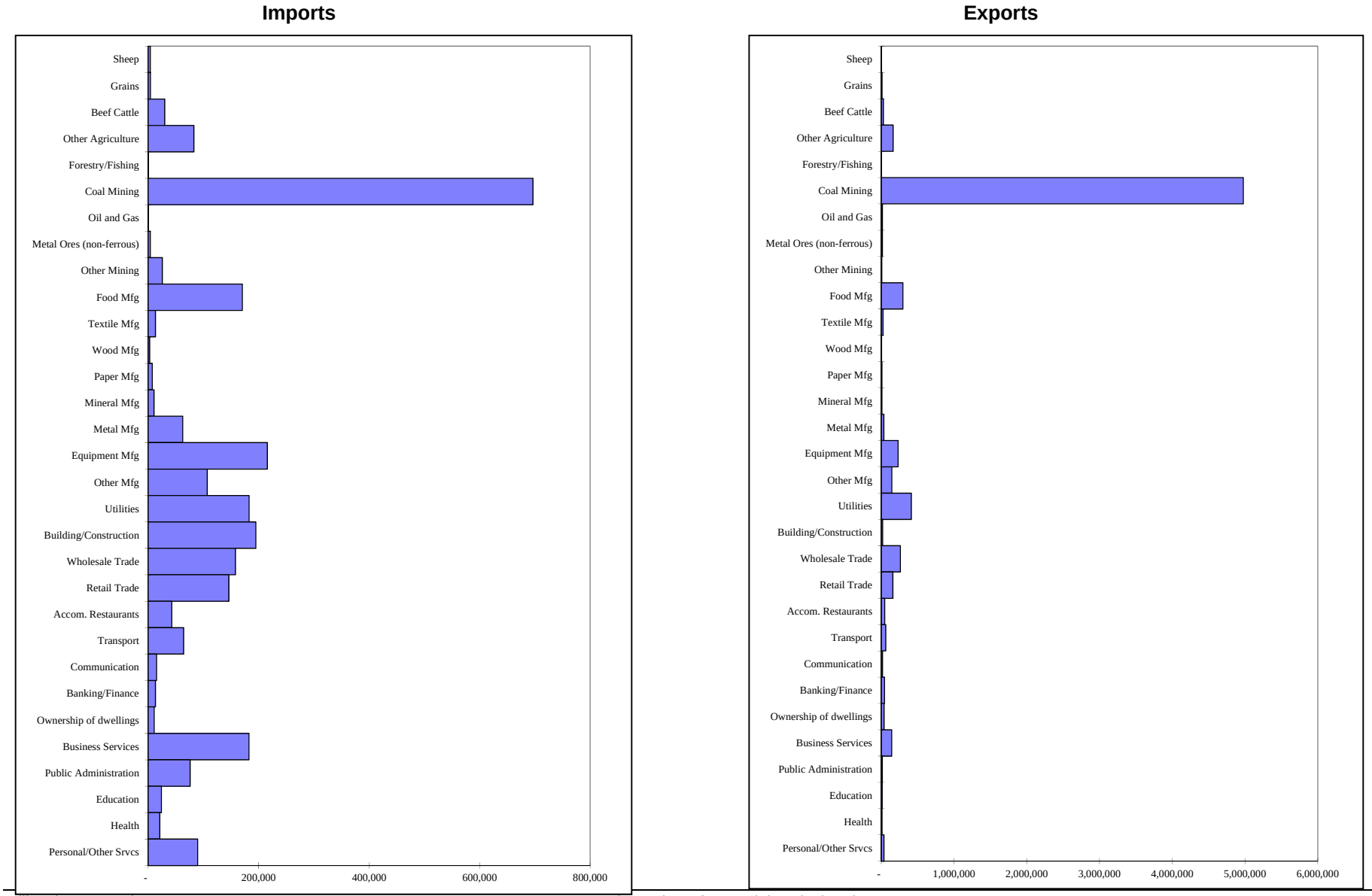


Figure 3.4 Sectoral Distribution of Imports and Exports ($'000)



4 ECONOMIC FRAMEWORKS FOR THE ASSESSMENT OF PROPOSALS THAT IMPACT AGRICULTURAL LAND AND WATER

4.1 Economic Efficiency

From an economic perspective, it is desirable to use scarce resources, such as capital, labour, land and water, to maximise economic welfare or community fulfilment. This is referred to as economic efficiency and refers to a situation where production costs are as low as possible (technical or productive efficiency), and consumers want the combination of goods and services that is being produced (allocative efficiency).

Economic efficiency can be achieved for market goods, where there are no externalities, through competitive markets. In this situation, the price mechanism (interaction of supply and demand) functions to allocate resources in a manner that maximises the net benefits to society as a whole.

Agricultural land and water (where property rights have been established) are market goods. The market will allocate these resources to their most productive use for society. The exception is where a change in land use or water use may result in market failure through the occurence of externalities. In these circumstances, markets will not allocate resources to maximise economic welfare. Government intervention may therefore be required to determine how resources should be allocated.

In these situations, any Government intervention should be guided by a consideration of the costs and benefits of the intervention. The method that economists use to do this is benefit cost analysis (BCA). The essence of BCA is:

- the estimation of the extent to which a community is made better off by a resource reallocation;
- the estimation of the extent to which the community is made worse off by a resource reallocation; and
- a comparison of these two figures.

If the benefits of the intervention are greater than the costs of the intervention then it provides net benefits to the community and results in an improvement in economically efficiency.

In a simple BCA framework, the potential costs and benefits of a mining project that impacts agricultural land and water may be as follows:

Table 4.1 – Potential Costs and Benefits of a Mining Proposal that Impacts Agricultural Land

	COSTS	**BENEFITS**
Net Production Benefits	**Production**	
	Opportunity costs of land, water and capital equipment	Value of mineral resource
	Capital and operating costs (including impact mitigation and rehabilitation)	Residual value of land and capital
Net Externalities	**Externalities**	
	Residual environmental impacts after impact mitigitation	Non use employment benefits of mining *

*these benefits have been estimated using choice modelling in Gillespie Economics (2008), Gillespie Economics (2009a) and Gillespie Economics (2009b).

Where the proposal uses agricultural land and water there is an opportunity cost to society of using these resources for mining instead of agriculture. The magnitude of this opportunity cost is reflected in the market value of land and water.

The market value of the land reflects, among other things, the discounted future net income that can be earned from the property and income reflects how much the community values the outputs from the land. Where agriculture production becomes increasingly scarce, this will be reflected in the value of

agricultural products and the value of agricultural land. However, the long term trend for agricultural commodity prices has been a decline in real value rather than an increase in value, reflecting that with growth in productivity, supply has strengthened more rapidly than demand (ABARES 2011). Between 1961 and 2008, world population grew by 117 per cent while food production grew by 179 per cent (ABARES 2011). While commodity price increases have risen over the last few years this is partly a response to government subsidies and mandates regarding the production of biofuels (ABARES 2011). In the future, growth in global food consumption is expected to slow. Strong productivity growth and the utilisation of hitherto unused cropping should ensure the continuing adequacy of food supplies (ABARES 2011). Consequently, substantial real increases in food prices are not anticipated.

Similiarly, the market value of agricultural water entitlements reflects, among other things, its value as an input to production (i.e. its marginal value product). Where water becomes increasingly scarce or the value of output that is produced from water becomes increasingly valuable, the value of water as an input to production increases.

The utlimate outcome of any BCA of a project is an empirical issue. But estimating the value of the opportunity cost of agricultural land and water is an integral component of the analysis.

4.2 Regional Economic Impact Assessment

Regional economic impact assessment (using input-output analysis) may provide additional information as an adjunct to economic efficiency analysis. Input-output analysis can be used to estimate the change in economic activity in a region from land and water resources being used for mining instead of agriculture. These changes in economic activity are defined in terms of a number of specific indicators of economic activity, such as:

- Gross regional output – the gross value of business turnover;
- Value-added – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output;
- Household income – the wages paid to employees including imputed wages for self employed and business owners; and
- Employment – the number of people employed (including full-time and part-time).

It is important not to confuse the results of regional economic impact assessment, which focuses on indicators of economic activity in a specific region, with the results of BCA which is concerned with the net benefits to Australia from a project.

5 MODIFICATION IMPACTS ON AGRICULTURAL RESOURCES

5.1 Introduction

The Modification will primarily impact agricultural resources through the mine disturbance footprint. The biodiversity offsets package is considered to have negligible impact on agricultural production and the incremental water requirements of the Modification are also estimated to be negligible.

5.2 Net Value of Potential Agriculture

194 ha of potential agricultural land within the Study Area will not be farmed for the duration of the Modification. Post-mining the Study Area will be rehabilitated to a range of Land Capability Classes with agriculture being capable of be carried out on 125ha (refer to Table 5.1).

Table 5.1 – Agricultural Impacts

Land Capability Class	Enterprise Type*	Enterprise Assumptions	Revenue ($/ha)	Variable Costs ($/ha)	Gross Margin ($/ha)	Pre Disturbance Ha	Post Disturbance Ha
I & II	Lucerne: spray irrigated (large bales)	Yield of 10 tonnes / ha	2,090	757	1,333	6.6	6.6
III	Lucerne: spray irrigated (large bales)	Yield of 10 tonnes / ha	2,090	757	1,333		
	Lucerne: dry land	Yield of 4 tonnes / ha	1,152	780	372		
	Cattle grazing	10 dry sheep equivalent (DSE)	331	125	206		
	Average				637		
IV	Lucerne: dry land	Yield of 3 tonnes / ha	864	634	230	17.8	6.6
	Cattle grazing	8 dry sheep equivalent (DSE)	264	100	164	17.8	6.6
	Average		564	367	197	17.8	6.6
V	Cattle grazing	6 dry sheep equivalent (DSE)	202	76	126	169.4	75.2
VI	Cattle grazing	4 dry sheep equivalent (DSE)	135	26	109		10.1
VII	Cattle grazing	2 dry sheep equivalent (DSE)	67	12	55		26.4
VIII			0	0	0	0	130.3
Mining Disturbance						61.4	
Total						**255.2**	**255.2**

Source: GSSE (2013)

Table 5.2 – Annual Value of Agricultural Production

	IMPACT OF PROJECT			POST MINING AGRICULTURE		
Land Capability Class	**Hectares**	**Output**	**Gross Margin**	**Hectares**	**Output**	**Gross Margin**
I & II	6.6	13,794	8,798	6.6	13,794	8,798
IV	8.9	7,690	2,047	3.3	2,851	759
	8.9	2,350	1,460	3.3	871	541
Total (IV)	17.8	10,039	3,507	6.6	3722.4	1300.2
V	169.4	34,219	21,344	75.2	15,190	9,475
VI		-	-	10.1	1,364	1,101
VII		-	-	26.4	1,769	1,452
VIII	0	-	-	68.9	-	-
Mining Disturbance	61.4			130.3		
Total	**255.2**	**$58,052**	**$33,649**	**324.1**	**$35,839**	**$22,126**

GSSE (2012) identify that land within the Study Area could otherwise potentially be used for cattle grazing, dryland lucerne production and spray irrigated lucerne production, with a gross value of production per annum of $58,052 and a net value[3] of production per annum of $33,649 (Table 5.2). The present value of foregone net value of production, in perpetuity, is estimated at $0.47M (at 7% discount rate).

However, agricultural production from the land is not foregone in perpetuity. Post mining the land could be used for cattle grazing, dryland lucerne production and spray irrigated lucerne production, with a gross value of production per annum of $35,839 and a net value[4] of production per annum of $22,126 (Table 5.2). The present value of this post mining agriculture, in perpetuity, is estimated at $0.12M (at 7% discount rate).

The net agricultural impact is therefore estimated at $0.34M (present value at 7% discount rate).

The BCA estimated the present value of net production benefits of the Modification to Australia at $315M and the net social benefit of the Modification to Australia at between $315M and $361M. The Modification is therefore considered to be a significantly more efficient use of the land resource than agricultural production.

5.2 Regional Impacts of Potential Agriculture

The regional impacts of the level of annual agricultural production temporarily forgone as a result of the Modification were estimated from the sectors in the regional input-output table (Gillespie Economics, 2013) within which production is located i.e. the *beef sector* and the *other agriculture sectors.* Table 5.3 summarises the estimated direct and indirect regional impacts of potential agricultural production using the land in the Study Area.

[3] Based on the gross margin which does not include an allocation for fixed costs or labour costs.
[4] Based on the gross margin which does not include an allocation for fixed costs or labour costs.

Table 5.3 – Annual Regional Economic Impacts of Potential Agricultural Production in the Study Area

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	58	13	9	22	80
Type 11A Ratio	1.00	0.22	0.16	0.38	1.38
VALUE ADDED ($'000)	33	5	4	9	42
Type 11A Ratio	1.00	0.15	0.13	0.28	1.28
INCOME ($'000)	19	3	3	6	25
Type 11A Ratio	1.00	0.14	0.16	0.30	1.30
EMPL. (No.)	0.4	0.0	0.1	0.1	0.5
Type 11A Ratio	1.00	0.13	0.14	0.27	1.27

Table 5.4 compares the average annual regional economic impacts associated with the Modification compared to the level of annual agricultural production that could potentially be undertaken in the Study Area.

Table 5.4 - Annual Regional Economic Impacts of Potential Agricultural Production Compared to the Modification

	Agricultural Impacts	Modification
Production Type	Lucerne and Beef Cattle	Coal
Direct Output Value ($000)	58	392,513
Direct Value Added ($000)	33	256,546
Direct Income ($000)	19	22,135
Direct Employment (No.)	0.4	238
Direct and Indirect Output Value ($000)	80	457,964
Direct and Indirect Value Added ($000)	42	283,354
Direct and Indirect Income ($000)	25	37,129
Direct and Indirect Employment (No.)	0.5	469

The Modification is estimated to provide considerable activity to the regional economy that is far in excess of the regional economic impacts associated with the level of annual agricultural production that could potentially be undertaken in the Study Area (Table 5.4).

The average annual direct annual output of the Modification is estimated at $392M. The potential annual agricultural production from the land resources that would be impacted by the Modification is $0.06M (Table 5.3).

The average annual direct regional employment provided by the Modification would be approximately 238 compared to less than one for agricultural production (Table 5.3).

This stimulus provided by the Modification would continue for approximately 7 years. Rehabilitated land would then be available for agricultural activities.

5 CONCLUSION

In the Upper Hunter region:

- The regional output value of existing coal production is considerably greater than agricultural production.
- The annual output value of the Modification would be greater than the output value of agriculture production in the Upper Hunter region in 2006.
- Direct employment provided by the Modification would be significantly higher than that provided by agricultural use of the land resources required for the Modification.
- The net production benefits of the Modification would be significantly higher than the potential agricultural production from the Study Area.

The Modification is considered to be a significantly more efficient use of the land resource than agricultural production.

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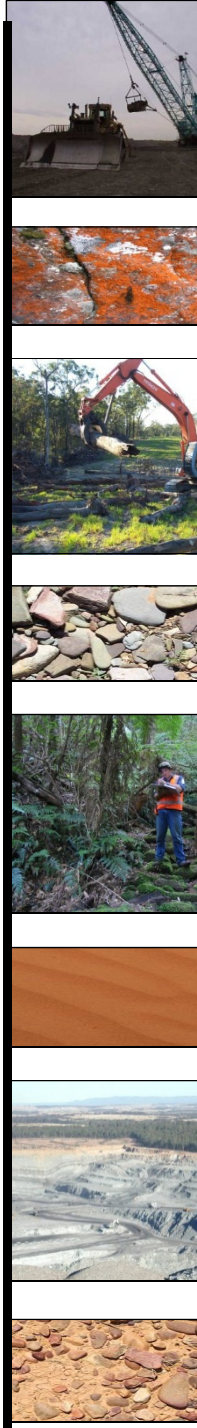

APPENDIX 2

GLENCORE

Liddell Coal Operations

Proposed Modification 5

Soil and Land Resource Assessment

April 2013

XCN07-023

SLR

GSS Environmental a Division of SLR Consulting Australia Pty Ltd (ABN 29 001 584 612) Effective 3 November 2012

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Environmental, Land and Project Management Consultants

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Date of Issue: 27th May 2013

GSSE Reference: XCN07-023

ISSUE AND AMENDMENT CONTROL HISTORY

Issue	Date	Description	Author	QA/QC
1	08/08/2012	Soil and Land Assessment Report Draft 1	MH	CR/RW
2	17/04/2013	Soil and Land Assessment Report Draft 2	MH/RW/CR	CR
3	27/05/2013	Soil and Land Assessment Report Final	MH/RW/CR	CR

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1.0 INTRODUCTION

1.1 Project Description

GSS Environmental (GSSE) was engaged by Liddell Coal Operations (LCO) Pty Limited (LCO) to undertake a Soil and Land Resource Assessment for a proposed extension to existing open cut mining operations at LCO (the Project). This will form part of an Environmental Assessment (EA) which will accompany an application to the Department of Planning and Infrastructure (DP&I) to modify the existing development consent under Section 75W, Part 3A of the *Environmental Planning and Assessment Act 1979.*

LCO is an established open cut coal mining operation operated by Liddell Coal Operations Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore), on behalf of a joint venture between Glencore (67.5 percent (%)) and Mitsui Matsushima Australia (32.5%). LCO currently operates in accordance with development consent DA 305-11-01, and has approval to conduct mining operations until 31 December 2023, producing up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. This DA remains the current development consent for LCO, and has been modified on four separate occasions.

LCO is now seeking a further modification (Mod 5) to allow for the extension of open cut mining operations beyond the currently approved mining footprint so as to maximise coal recovery. The proposed expansion of mining is within both the existing development consent DA 305-11-01 boundary and mining lease ML 1597.

This Soil and Land Resource Assessment report includes the methodology used in the assessment, a summary of the results, and a description of the management measures proposed to mitigate the potential soil and land resource impacts of the Project.

1.2 Study Area

LCO is located in the Upper Hunter Coalfields, approximately 25 kilometres (km) northwest of the township of Singleton and 17 km southeast of the township of Muswellbrook (refer **Figure 1**). Land use in the vicinity of the Study Area is predominantly mining and power generation; neighbouring mining operations include Drayton Coal to the west, Mt Owen Complex to the east, Ashton Coal to the south west, and Hunter Valley Operations (HVO) Complex and Ravensworth Operations to the south. Two power stations, Bayswater and Liddell, are located adjacent to Lake Liddell to the west of the Project.

The Project comprises the extension of mining in two main areas;

- The Entrance Pit Extension area; and
- The South Pit Extension area (including the Mine Infrastructure Area (MIA) Pit).

The Study Area subject to this Soil and Land Resource Assessment includes these components, which totals an area of 255.2 ha, as illustrated in **Figure 2**.

1.3 Assessment Objectives and Standards

The key objectives of the Soil and Land Resource Assessment undertaken by GSSE are as follows.

Objective 1 Classify and determine the soil profile types within the Study Area

To satisfy Objective 1 of the Soil and Land Resource Assessment, the soil taxonomic classification system used was the Australian Soil Classification (ASC) system (Isbell 1996). This system is routinely used as the soil classification system in Australia.

Objective 2 Provide a description of, and figures showing, the land capability within the Study Area

To satisfy Objective 2 of the Soil and Land Resource Assessment, the relevant guideline applied was *Systems Used to Classify Rural Lands in New South Wales* (Cunningham *et al*. 1988). This is the guideline approved by the Office of Environment and Heritage (OEH) (formerly the NSW Soil Conservation Service).

Objective 3 Provide a description of, and figures showing, the agricultural land suitability within the Study Area

To satisfy Objective 3 of the Soil and Land Resource Assessment, the relevant guideline applied was the *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries 1990). This is the guideline approved by The Department of Trade and Investment, Regional Infrastructure and Services NSW (DITRIS).

Objective 4 Provide selective topsoil and subsoil management recommendations

To satisfy Objective 4 of the Soil and Land Resource Assessment, the *Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas* (Elliot and Reynolds 2007, derived from Elliot & Veness, 1981) was utilised to determine which soil types in the Study Area are suitable for conserving and reuse in the site rehabilitation program. The approach described in this guideline remains the benchmark for land resource assessment in the Australian mining industry.

Objective 5 Provide recommendations to mitigate soil erosion and sedimentation associated with the works or soil stockpiles

To satisfy Objective 5 of the Soil and Land Resource Assessment, *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2E, Mines and Quarries* (DECC 2008) were used as a basis for recommendations of soil erosion and sedimentation mitigation measures associated with the proposed works.

LEGEND

DA Boundary / Project Area

FIGURE 1

Locality Plan

Project: LIDDELL SOILS & LAND RESOURCE

Client: LIDDELL COAL OPERATIONS

Version	Date:	Author:	Checked:	Approved:
1	21/05/12	ZJ	MH	MH

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File: Fg1_XCN07-023_LocalityPlan_V1

Projection: GDA94 MGA Zone 56

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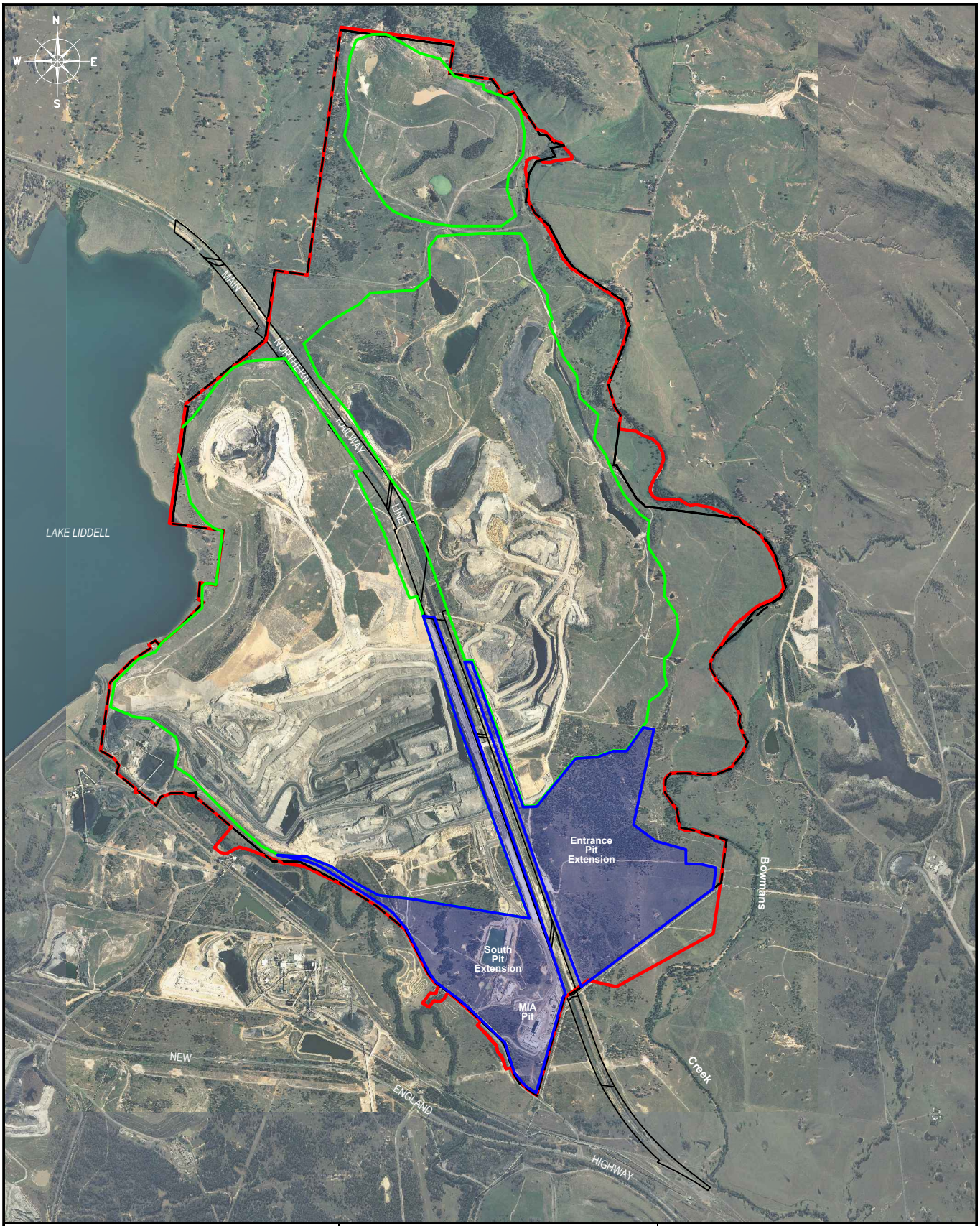

LEGEND

- Study Area
- DA Boundary
- ML 1597
- Approved Mining Footprint

0 1km 2km

Scale 1:40000

FIGURE 2

Study Area

Project: LIDDELL SOILS & LAND RESOURCE

Client: LIDDELL COAL OPERATIONS

Version	Date:	Author:	Checked:	Approved:
1	21/05/12	ZJ	MH	MH
2	13/08/12	LH	MH	MH
3	18/04/13	LH	MH	MH
4	6/06/13	LF	NA	NA

GSS ENVIRONMENTAL
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File: Fg2_XCN07-023_StudyArea_V1

Projection: GDA94 MGA Zone 56

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2.0 EXISTING ENVIRONMENT

2.1 Climate

Representative climate data for the site has been obtained from the nearest Bureau of Meteorology (BOM) weather station located in the township of Jerry's Plains, approximately 15 km to the south-east of the Study Area (Jerry's Plains Post Office, BOM Station 061086, Monthly Climate Statistics). The Study Area has a summer dominated rainfall with relatively drier winter months. Average annual rainfall is 645.7 millimetres (mm) and average maximum temperature ranges from 17.4^{o}C in July to 31.7^{o}C in January.

The BOM classifies the Study Area within a Temperate Climate Zone, with no designated wet season; however, the area can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs in the region during warmer months.

2.2 Soil Landscape Units

The soil landscapes within the Study Area have been described with reference to *Soil Landscapes of the Singleton 1:250 000 Sheet* (Kovac and Lawrie, 1991). Soil landscape units are defined as areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements (Kovac and Lawrie 1991). The Liddell Soil Landscape unit covers the vast majority of the Study Area, with the Hunter Soil Landscape unit covering a small region on the eastern limit of the proposed Entrance Pit Extension.

Liddell Soil Landscape

The Liddell Soil Landscape unit consists of undulating low hills and undulating hills. Slope gradients range from 4-7% with local relief of 60-120m. The vegetation type is open woodland. Soils are dominated by Yellow Soloths (Dy2.41, Dy3.81) on slopes with some Yellow Solodic Soils (Dy3.32, Dy2.42, Dy3.42) on concave slopes. There are Earthy and Siliceous Sands (Uc5.22, Uc5.11) on mid to lower slopes. Some Red Soloths (Dr2.41), Red Solodic Soils (Dr2.42) and Red Podzolic Soils (Dr5.11) are also present. These soils are associated with a Land Capability of V – VI.

Limitations to this unit include minor to severe sheet erosion with some minor rill erosion. Moderate gully erosion (up to 1.5m) can also occur in drainage lines.

Hunter Soil Landscape

The Hunter Soil Landscape unit consists of alluvial floodplains of the Hunter River and its tributaries. Slope gradients range from 0-3% with local relief of <10m. The landscape is cleared of native vegetation due to agricultural uses. Soils are dominated by Brown Clays and Black Earths (Ug5.34, Ug5.17) on prior stream channels and tributary flats. Alluvial soils (Loams, Um5 and Sands, Um5.52, Um6.1, Uc) occur on levees and flats adjacent to the current river channel. Red Podzolic Soils and Lateritic Podzolic Soils (Dr2.11, Db2.41) are located on old terraces, with Non-calcic Brown Soils (Db1.13) and Yellow Sodolic Soils in some drainage lines. These soils are associated with a Land Capability of I – II.

Limitations to this unit include minor stream bank erosion on current watercourses and minor sheet and gully erosion on adjacent terraces.

2.3 Biophysical Strategic Agricultural Land (BSAL) Mapping

The Strategic Regional Land Use Plan for the Upper Hunter was released with a figure showing the 'trigger' mapped BSAL for the area. The broad scale mapping showed potential BSAL being associated with sections of Bowmans Creek. Preliminary desktop investigations calculated approximately 2.8 ha of 'trigger' mapped BSAL to be located within the Study Area. The BSAL is typically associated with the Hunter Soil Landscape and was investigated as part of this study in order to verify the presence within the Study Area.

2.4 Topography and Hydrology

The topography of the Study Area is characterised by gently undulating hills with local relief of up to 90 metres. The Study Area includes very gently inclined alluvial fans (1-3%), bordered by gently inclined rises (3-10 per cent) at elevations ranging from 100 m AHD to 185 m AHD. The proposed Entrance Pit Extension area is flanked by nearby Bowmans Creek, a southerly flowing drainage line along the eastern boundary of the current LCO DA boundary. Bayswater creek is a highly modified water system which runs from Lake Liddell along the south western LCO DA boundary.

The Bayswater Creek catchment below Lake Liddell is approximately 3,750 ha and is of insufficient size to maintain a continuous flow. The Bayswater Creek system is highly modified from its natural state, to allow it to take flow from Lake Liddell and the Hunter River Salinity Trading Scheme (HRSTS) in its upper reaches, with the lower reaches having been realigned to allow mining at Narama and Ravensworth South mines. Bowmans Creek runs along the eastern boundary of LCO and has a catchment of approximately 26,500 ha, which is of sufficient area to maintain flow under most climatic conditions. No diversions or realignments of the Bayswater or Bowmans Creeks are proposed by LCO as part of the modification.

2.5 Landuse and Vegetation

The Study Area and surrounding region has been extensively cleared of vegetation for grazing activities. Land within the Study Area has been highly disturbed in the past by land clearing for agriculture, and is now dominated by exotic pasture with isolated areas of native vegetation on some hill crests, mid slopes and drainage lines. Approximately half of the proposed South Pit extension area has been extensively cleared for approved mining related activities at LCO, including water storage dams, workshop and the mine infrastructure area. Both the proposed South pit and the Entrance Pit extension areas have previously been subject to underground mining.

An ecological survey of the remnant vegetation in the Study Area distinguished the following vegetation communities occurring in the disturbance area (Umwelt 2013).

- Central Hunter Box – Ironbark Woodland (22 ha)
- Central Hunter Box – Ironbark Woodland (Rough-barked Apple dominated) (1 ha)
- Central Hunter Box – Ironbark Woodland (Regrowth) (35.0 ha)
- Central Hunter Box – Ironbark Derived Native Grassland (74 ha)
- Central Hunter Swamp Oak Forest (5 ha)
- Central Hunter Bulloak Forest (62 ha)

Further details on the composition of these vegetation communities can be found in the Ecological Assessment – Liddell Coal Operations Extension Project (Umwelt, 2013).

3.0 SOIL SURVEY AND ASSESSMENT

This section outlines the methods used to conduct the soil survey component of the assessment and reporting of results.

3.1 Soil Survey Methodology

A desktop study and a two field surveys were undertaken for the Study Area. This process consisted of the stages described below;

3.1.1 Reference Mapping

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

- *Aerial photographs and topographic maps*

  Aerial photo and topographic maps were used as remote sensing tools allowing detailed analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the Study Area. Aerial and topographical maps were provided by LCO.

- *Reference information*

  Source materials were used to obtain correlations between pattern elements and soil properties that may be observable in the field. These materials included cadastral data, prior and current physiographic, geological, vegetation, and water resources studies.

- *Previous reports*

  Previous studies were taken into consideration for soils mapping and land assessment. These include the following:

  - *Soil Landscapes of the Singleton 1:250,000 Sheet* (Kovac and Lawrie 1991) (refer to Section 2.2 above);
  - Land Capability Spatial Data (Department of Natural Resources 1989).
  - Map 6 Strategic Regional Land Use Plan – Upper Hunter – Strategic Agricultural Land (NSW Department of Planning and Infrastructure, 2012)
  - *Liddell Colliery Continued Operations Environmental Impact Statement* (Umwelt 2001).

- *Stratified observations*

  Following production of a broad soil map, a desktop assessment of surface soil indicators, topography and vegetation throughout the Study Area was undertaken to verify potential soil types, delineate soil type boundaries and determine preferred locations for targeted subsurface investigations (hereafter referred to as soil pits).

3.1.2 Field Survey

3.1.2.1 Survey Approach

The field survey was undertaken over two separate site visits. The first fieldwork component of the survey was undertaken in May 2012, which focussed on soil landscapes, soil types and delineation of the alluvial boundary. In September 2012 the Strategic Regional land Use Plan for the Upper Hunter was released, which included a requirement for 'trigger' mapped BSAL to be verified. Several editions of the BSAL verification process were made available since November 2012. GSSE undertook further fieldwork in March 2013 in order to verify the existence of BSAL within the alluvial soil, also to confirm sodicity levels within the soil types previously mapped, to verify these soils were not considered BSAL.

3.1.2.2 Scale

The field survey was undertaken at a moderate intensity scale of 1:25,000. This survey scale enables the production of a detailed map that is suitable for intense land uses such as engineering works (*Guidelines for Surveying Soil and Land Resources* (McKenzie *et al*. 2008)). This survey scale was adopted to offer an adequate dataset of soil types within the Study Area and to assess the potential impact on these soils from the Project.

3.1.2.3 Survey Type

The field survey undertaken was an integrated survey and is a qualitative survey type. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (McKenzie *et al*. 2008). Background reference information derived from sources cited in **Section 3.1.1** were used to predict the distribution of soil attributes in the field. The characteristics evaluated to generate the correlated sets include vegetation type, landform and geology.

The specific type of integrated survey undertaken was a 'free survey' (McKenzie *et al*. 2008). A free survey is a conventional form of integrated survey and its strength lies in its ability to assess soil and land at medium to detailed-scales. Survey points are irregularly located according to the survey teams' judgement to enable the delineation of soil boundaries. Soil boundaries can be abrupt or gradual, and catena and topo sequences are used to aid the description of this variation.

3.1.2.4 Survey Observations

Survey observations undertaken comply with the 1:25,000 scale survey criteria prescribed in the *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al*. 2008).

The recommended observation density for 1:25,000 scale survey is one observation every 6.25 ha. For the Study Area of 199 ha of undisturbed land, this equates to a total of approximately 31 observations required. A minimum of 10-30% (3 – 10 observations) are to be Detailed Profile Descriptions (also referred to as Class I observations), 5% (2 observations) are to be Laboratory Assessed (also referred to as Class II observations), and the remainder are to be made up by Minor Class Observations (also referred to as Class IV observations).

The actual number of survey observations undertaken for the Study Area in Stage 1 of fieldwork in May 2012 was 8 Class I observations, 5 Class II observations and 22 Class IV observations. This slightly exceeds and therefore satisfies the observation requirements for a 1:25,000 survey scale. **Figure 3** illustrates the distribution of the survey observation points throughout the Study Area. A further 12 Class IV and 1 Class II observations were undertaken in March 2013 for Stage 2 as part of the BSAL verification program.

3.1.2.5 Detailed Soil Profile Observation

Across the Study Area soil profiles were assessed for soil type and distribution, with 2 to 5 samples taken from 6 profiles for laboratory analysis. Each soil profile exposure pit was excavated to the required depth and placed upon a presentation tray for the profile to be analysed and photographed. Holes were backfilled post analysis. Each location was selection in consultation with the archaeologist undertaking the Cultural Heritage assessment of the project to ensure any identified archaeology sites were avoided.

Soil profiles within the Study Area were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* soil classification procedures (National Committee on Soil and Terrain 2009). Detailed soil profile descriptions recorded information that covered the parameters as specified in **Table 1**. Soil profile logging was undertaken in the field using soil data sheets.

Global Positioning System (GPS) recordings were taken for all sites where detailed soil descriptions were made. Vegetation type and land use were also recorded. Soil exposures from cores were photographed during field operations as colour photography of profile sites is a useful adjunct to description of land attributes.

Soil layers at each profile site were also assessed according to a procedure devised by Elliot & Veness (1981) and Elliot and Reynolds (2007) for the recognition of suitable topdressing material. This procedure assesses soils based on grading, texture, structure, consistence, mottling and root presence. A more detailed explanation of this procedure is presented in **Section 4** of this report.

Table 1 – 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 & Size	Soil structure, root penetration, permeability, aeration
Stones – Amount & Size	Water holding capacity, weathering status, erosional / depositional character
Roots – Amount & Size	Effective rooting depth, vegetative sustainability
Ants, Termites, Worms etc.	Biological mixing depth

3.1.3 Soil Laboratory Assessment

Soil samples from 5 soil profile sites were utilised in the laboratory testing programme. Samples were analysed to:

- Classify soil taxonomic classes;
- Determine agricultural and land capacity classes; and
- Determine suitability of soil as topdressing material.

Soil samples of about 1 – 2 kilograms (kg) were collected from each soil layer where appropriate. In total, 19 soil samples were sent to the Department of Lands Scone Research Centre for analysis. A Certificate of Analyses for these results is contained in **Appendix 2**. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in **Table 2**.

Table 2 – Laboratory Analysis Parameters

Property	Application
Coarse fragments (>2mm)	Soil workability; root development; droughtiness
Particle-size distribution (<2mm)	Nutrient retention; exchange properties; erodibility; droughtiness; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Aggregate stability	Susceptibility to surface sealing under rainfall or irrigation; effect of raindrop

Property	Application
(Emerson Aggregate Test (EAT))	impact and slaking; permeability; infiltration; aeration; seedling emergence; correlation with other properties
Soil reaction (pH)	Nutrient availability; nutrient fixation; toxicities (especially Al, Mn); liming; sodicity; correlation with other physical, chemical and biological properties
Electrical conductivity (EC)	Appraisal of salinity hazard in soil substrates or groundwater, total soluble salts
Cation Exchange Capacity (CEC) and exchangeable cations	Nutrient status; calculation of exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
Available Water Capacity (AWC)	Ability of crop growing media to maintain adequate moisture within the soil profile.

The laboratory methods used by Scone Research Centre for each physical and chemical parameter are provided below in **Table 3**.

Table 3 – Laboratory Test Methods

Analyte	Method
Particle Size Analysis (PSA)	Sieve and hydrometer
pH	1:5 soil/water extract
EC	1:5 soil/water extract
Emerson Rating	Emerson Aggregate Test
CEC and exchangeable cations	(AgTU)+ extraction
AWC	P18B/3 AWC (FC 0.3bar, WP 15bar, AWC %)

3.1.4 Alluvial Survey Transects

A series of three survey transects were used to map the boundary of the alluvial material, targeting an area where alluvial material borders the soils of surrounding landscape. These transects, consisting of full profiles and observations, were numbered T1, T2 and T3, with individual survey points along the transects denominated by a decimal place (i.e., T1.1, T1.2, T1.3, etc.). Together with field observation, aerial photography and slope analysis, adequate mapping of the alluvial boundary was completed as per the specified requirement of the NSW Office of Water. Further confirmation of this boundary was undertaken in March 2013 during the BSAL verification process.

3.2 Soil Survey Results

Within the Study Area four soil types were identified. **Table 4** provides an overview of each soil type and their quantitative distribution within the Study Area. **Figure 3** illustrates their spatial distribution.

Table 4 – Soil Types

Soil Type No.	ASC Name	Study Area	
		Area (ha)	Area (%)
1	Brown Dermosol *(Upper Slopes and Crests)*	18.3	7
2.1	Brown Sodosol *(Mid Slope)*	151.1	59
2.2	Brown Sodosol *(Lower Slope)*	17.8	7
3	Brown Chromosol/Sodosol Complex *(Bowmans Ck Alluvials)*	6.6	3
n/a	Mining Disturbance	61.4	24
	Total	**255.2**	**100**

The physical and chemical characteristics of the soil types and management recommendations for each are described in the following sections.

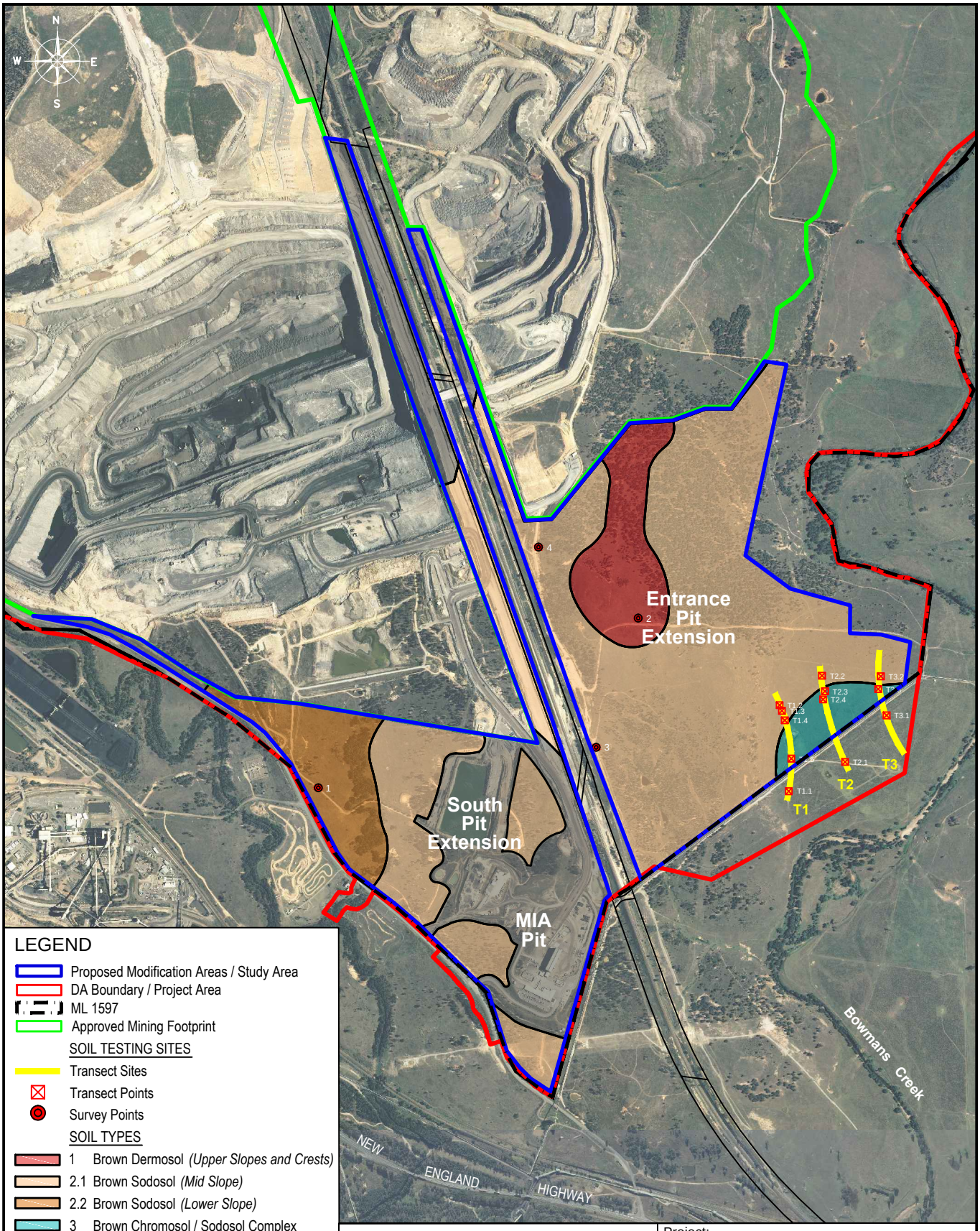

FIGURE 3

Soil Types

Project: LIDDELL SOILS & LAND RESOURCE

Client: LIDDELL COAL OPERATIONS

Version	Date:	Author:	Checked:	Approved:
1	21/5/2012	ZJ	MH	MH
2	26/6/2012	ZJ	MH	MH
3	06/8/2012	LH	MH	MH
4	15/4/2013	LF	CR	CR
5	18/4/2013	LH	CR	CR
6	6/6/2013	LF	CR	CR

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File: Fg3_XCN07-023_SoilTypes_V1

Projection: GDA94 MGA Zone 56

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3.2.1 Soil Type 1 – Brown Dermosol (Upper Slopes and Crests)

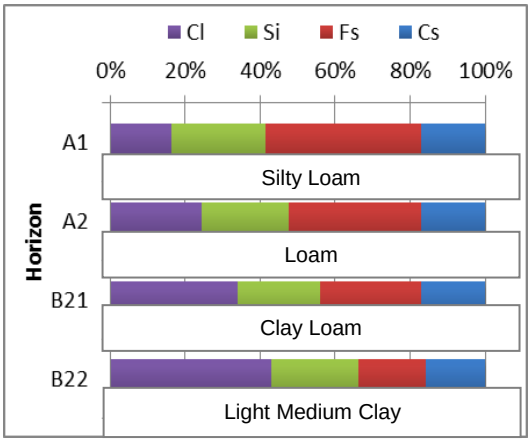
Soil Type Overview: Soil Type 1 is a Brown Dermosol. Dermosols are soils with structured B2 horizons and lacking a clear or abrupt texture contrast between the A and B horizons. This soil is characterised by gradual increases of clay portion with depth and a dominant B2 colour class of brown. These soils cover 7% or 18.3 ha of the Study Area and are found on upper slopes and crests (refer **Figure 3**). Site 2 from the Field Survey is the representative profile for this soil type.

Soil Type 1 consists of a very dark brown silty loam to a dark brown loam topsoil, overlying a dark brown clay loam to light medium clay. Fine sand is the dominant particle portion in the topsoil which decreases with an increase of clay with depth (refer **Graph 1**). The soil profile has a moderate structure grade in the topsoil of 10 – 20 mm sub angular blocky peds and a weak consistence, trending to a moderate structure grade in the subsoil of 10 – 30 mm sub angular blocky peds and moderate consistence. The profile is free of coarse fragments until approximately 80 cm where approximately 50% of material is sandstone debris of 100 – 200mm. The profile is well drained in the topsoil, becoming moderately drained at depth.

Management: The Brown Dermosol has few constraints and is generally suitable for stripping and reuse in rehabilitation. The profile has ideal structure and generally suitable texture. The A2 horizon is constrained by moderate to high dispersability; however amelioration of this characteristic will be justified in salvaging the material from lower in the profile. This soil should be stripped to 80 cm, or until coarse fragments are encountered.

Plate 2: Brown Dermosol

Plate 1: soil type 1 landscape setting



Graph 1: Site 2 PSA

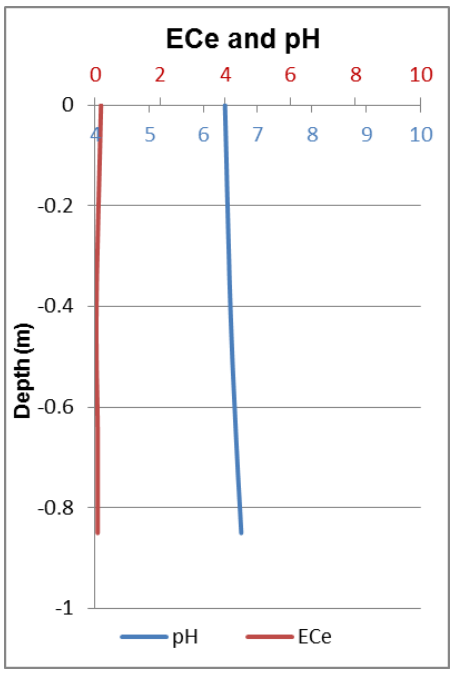
Physical and Chemical Characteristics:

Site 2 was used as a representative profile of Soil Type 1 and was subject to laboratory analysis. A summary of this is provided in **Table 5** below. The full data set can be found in **Appendix** 2.

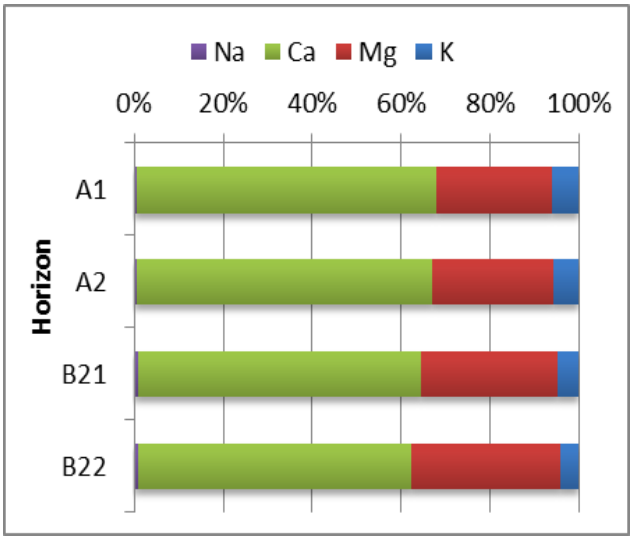
Table 5 – Site 2 Laboratory Analysis; Brown Dermosol

Depth	Colour	pH		ECe		CEC		ESP		EAT	
cm	Munsell	#	Rate	%	Rate	#	Rate	%	Rate	#	Rate
0-20	Very dark brown	6.4	Slightly acidic	0.2	Non saline	12	Low	0.8	Non sodic	7	Negligible
20-40	Dark brown	6.5	Slightly acidic	0.0	Non saline	11	Low	0.7	Non sodic	2(1)	High to Moderate
40-65	Dark brown	6.6	Neutral	0.1	Non saline	15	Moderate	1.0	Non sodic	3(1)	Slight
65-85	Dark brown	6.7	Neutral	0.1	Non saline	17	Moderate	0.9	Non sodic	3(1)	Slight

The pH and EC results are shown in **Graph 2** below. The topsoil is slightly acidic, but the profile has a neutral pH thereafter. **Graph 3** below shows the trend of exchangeable cations throughout the soil profile, and highlights the Ca/Mg ratio as low in calcium throughout. The CEC is low in the topsoil to moderate in the subsoil. These soils are non sodic and have an EAT rating of negligible in the A1, high to moderate in the A2, and slight in the subsoil. The K factor was rated moderate throughout.



Graph 2: Site 2ECe and PH



Graph 3: Site 2 Exchangeable Cations

3.2.2 Soil Type 2.1 – Brown Sodosol (Mid Slope)

Soil Type Overview: Soil Type 2.1 is a Brown Sodosol. Sodosols are soils that have strong texture contrast between the A and B horizons and sodic subsoil. This soil is characterised by an abrupt change between loamy sand and a light medium clay texture with a dominant B2 colour class of brown. These soils cover 59% or 151.1 ha of the Study Area and are found on midslopes (refer **Figure 3**). Site T2.2 from the Field Survey is the representative profile for this soil type.

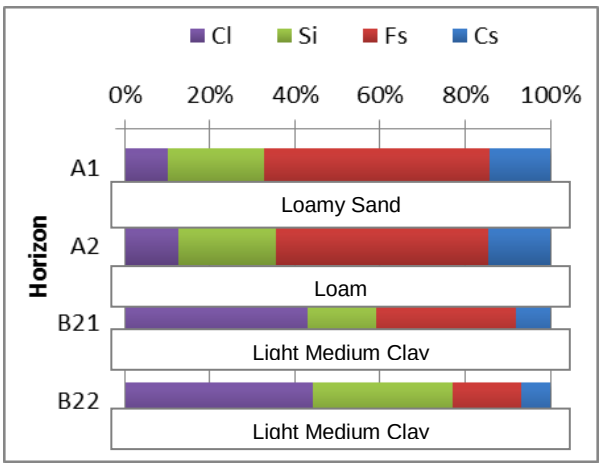
Soil Type 2.1 consists of a brown loamy sand to sand topsoil overlying a subsoil of yellowish brown light medium clay. Fine sand is the dominant particle portion in the topsoil, with an abrupt increase in the smaller particles of clay at 30 cm (refer **Graph 4**). The soil profile has a moderate structure grade in the A1 of 10 – 30 mm blocky peds and a moderate consistence, with an apedal A2, trending to a strong structure grade of 5 – 10 mm angular blocky peds in the topsoil, and moderate structure grade of 20 – 50 mm sub angular blocky peds with a strong consistence. The profile is free of coarse fragments and has moderate drainage in the topsoil, trending to poorly drained at depth.

Management: The Brown Sodosol is constrained by a strongly sodic subsoil, and problematic dispersability characteristics in the A2 and the B horizons. The sodic nature of the subsoils renders it unsuitable for stripping and the combination of high dispersability and an apedal structure would be problematic as a reuse material. The A1 poses no specific management risk and has suitable structural and chemical characteristics for reuse. This soil type can be stripped to 20cm.

Physical and Chemical Characteristics*:*

Plate 4: Brown Sodosol

Plate 3: Soil Type 2.1 Landscape Setting



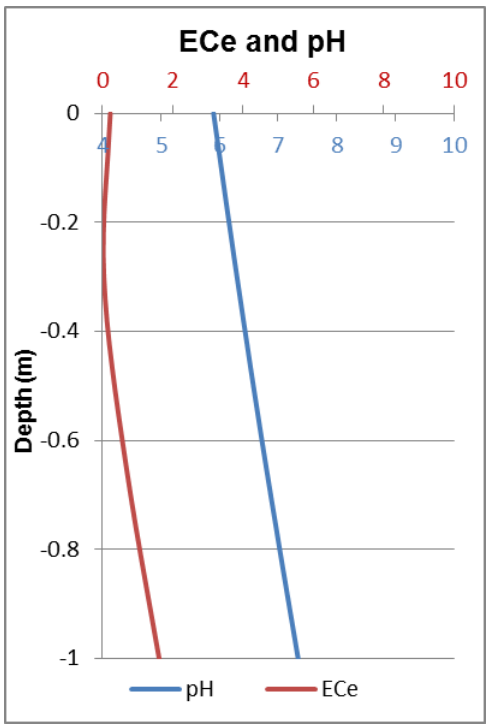
Graph 4: Site T2.2 PSA

Site T2.2 was used as a representative profile of Soil Type 2.1 and was subject to laboratory analysis. A summary of this is provided in Table 6 below. The full data set can be found in **Appendix 2**.

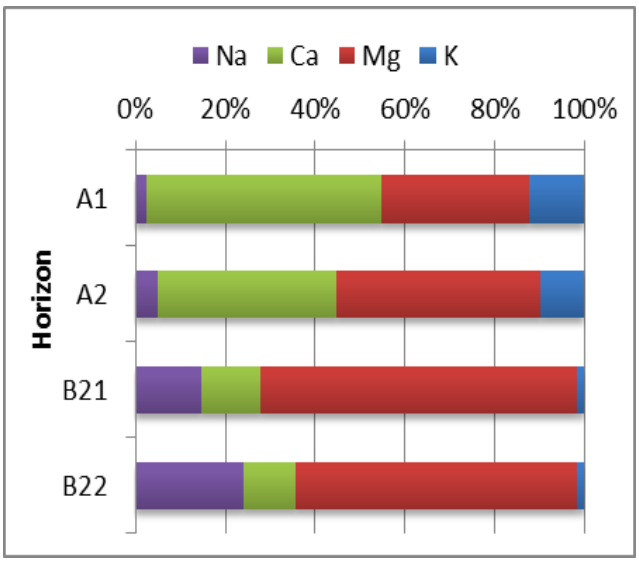
Table 6 – Site T2.2 Laboratory Analysis; Brown Sodosol

Depth	Colour	pH		ECe		CEC		ESP		EAT	
cm	Munsell	#	Rate	%	Rate	#	Rate	%	Rate	#	Rate
0-20	Brown	5.9	Moderately acidic	0.2	Non saline	4	Very Low	2.3	Non sodic	7	Negligible
20-30	Brown	6.3	Slightly acidic	0.0	Non saline	3.5	Very Low	4.9	Non sodic	2(2)	High
30-65	Yellowish brown	6.8	Neutral	0.7	Non saline	11	Low	15.5	Strongly Sodic	2(2)	High
65-110	Yellowish brown	7.5	Mildly alkaline	1.9	Non saline	13	Moderate	24.6	Strongly Sodic	2(3)	Very High

The pH and EC results are shown in Graph 5 below, which shows the pH variance of moderately acid in the topsoil to mildly alkaline at depth, while the profile is non-saline. Graph 6 below shows the trend of exchangeable cations throughout the soil profile, and highlights the Ca/Mg ratio as low in calcium in the A1, and deficient in calcium thereafter. The CEC is very low in the topsoil, trending to moderate at depth. These soils are non sodic in the topsoil, becoming strongly sodic in the subsoil, and have an EAT rating of negligible in the A1, which becomes high to very high thereafter. The K factor was rated as high in the topsoil and moderate in the subsoil.



Graph 5: Site T2.2 ECe and pH



Graph 6: Site T2.2 Exchangeable Cations

3.2.3 Soil Type 2.2 – Brown Sodosol (Lower Slope & Flats)

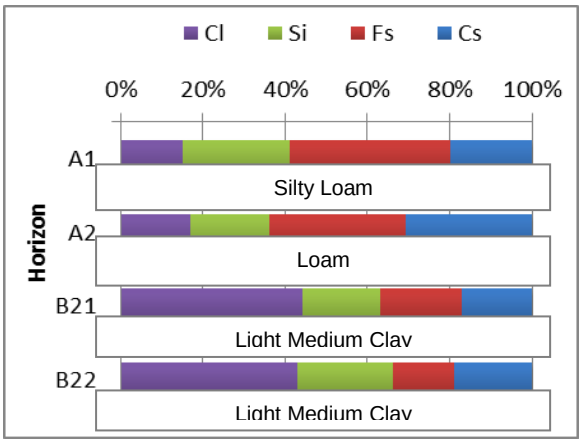
Soil Type Overview: Soil Type 2.2 is a Brown Sodosol. Sodosols are soils that have strong texture contrast between the A and B horizons and sodic subsoil. This soil is characterised by an abrupt change between a loam and heavy clay texture with a dominant B2 colour class of yellowish brown. These soils cover 7.0% or 17.8 ha of the Study Area and are found on flats and lower slopes characterised by gently undulating to flat terrain. Site 1 from the Field Survey is the representative profile for this soil type.

Soil Type 2.2 consists of a dark brown silty loam to loam topsoil overlying a subsoil of yellowish brown light medium clay. Fine sand is the dominant particle portion in the topsoil, with an abrupt increase in the smaller particles of clay at 35 cm (refer to **Graph 7**). The soil profile has a moderate structure grade in the A1 sub angular blocky peds and a strong consistence, with an apedal A2 layer trending to a subsoil of strong structure grade with a medium to strong consistence. The lower subsoil contains smooth, rounded coarse fragments at a 10% presence. The profile is moderately drained in the topsoil and poorly drained thereafter.

Management: The Brown Sodosol is constrained by subsoil that poses management risks. The subsoils limitations include slight to high salinity levels, a sodic nature and a dispersability rating of high to very high. This subsoil would be problematic as a material for rehabilitation, and should not be stripped. The topsoil is texturally and chemically appropriate, as topdressing. Recommended stripping depth is 35cm.

Plate 6: Brown Sodosol

Plate 5: Soil Type 2.2 Landscape Setting



Graph 7: Site 1 PSA

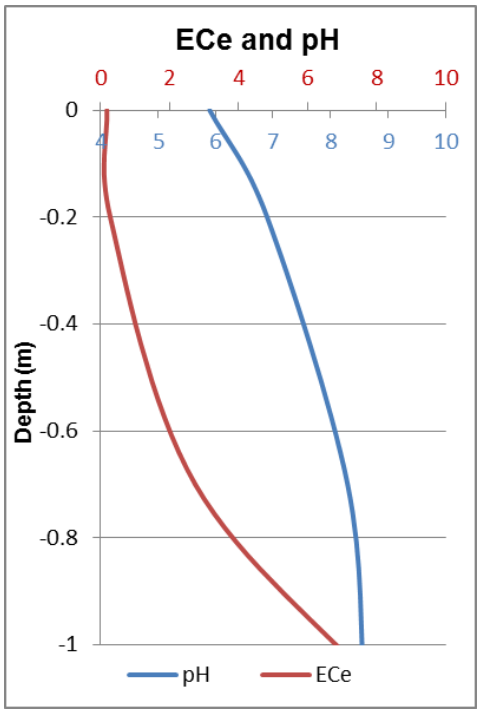
Physical and Chemical Characteristics:

Site 1 was used as a representative profile of Soil Type 2.2 **and** was subject to laboratory analysis. A summary of this is provided in **Table 7** below. The full data set can be found in **Appendix 2**.

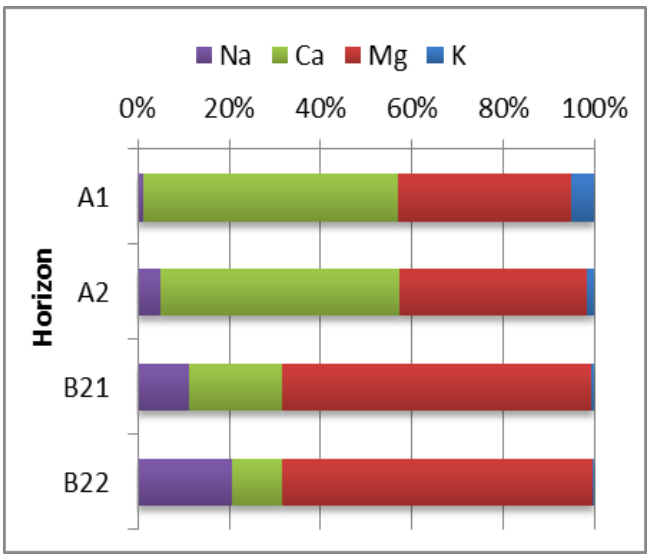
Table 7 – Site Laboratory Analysis; Salic Brown Sodosol

Depth	Colour	pH		ECe		CEC		ESP		EAT	
cm	Munsell	#	Rate	%	Rate	#	Rate	%	Rate	#	Rate
0-20	Dark brown	5.9	Moderately acidic	0.2	Non saline	9.8	Low	1.4	Non sodic	7	Negligible
20-35	Dark brown	6.9	Neutral	0.3	Non saline	11	Low	4.9	Non sodic	3(2)	Slight
35-70	Yellowish brown	8.3	Moderately alkaline	2.8	Slightly saline	17	Moderate	11.8	Sodic	2(2)	High
70-110	Yellowish brown	8.6	Strongly alkaline	8.3	Highly saline	5.9	Very Low	20.3	Strongly Sodic	2(3)	Very High

The pH and EC results are shown in **Graph 8** below, which shows the pH variance, from moderately acidic to neutral in the topsoil trending to strongly alkaline at depth, while the profile ranges from non-saline at the surface to highly saline at depth. **Graph 9** highlights the Ca/Mg ratio as low in calcium in the topsoil, to deficient in Calcium in the subsoil. The CEC is low in the topsoil, moderate in the upper subsoil and very low thereafter. These soils are non sodic in the topsoil, becoming sodic to strongly sodic in the subsoil, and have an EAT rating of negligible to slight in the topsoil and high to very high in the subsoil. The K factor was rated as moderate throughout.



Graph 8: Site 1 ECe and pH



Graph 9: Site 1 Exchangeable Cations

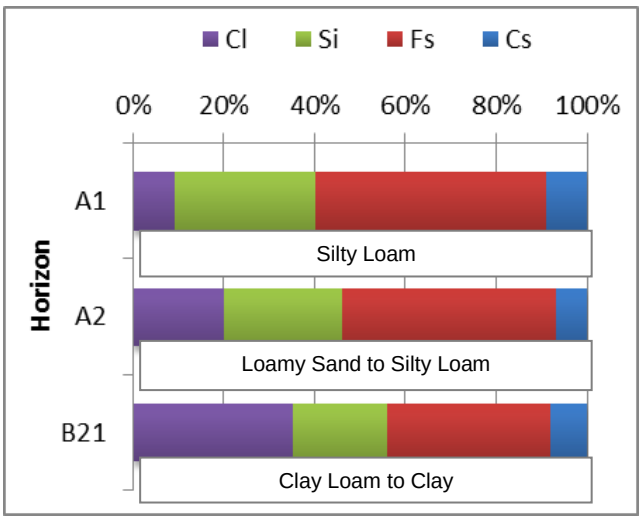
3.2.4 Soil Type 3 – Brown Chromosol/Sodosol Complex (Bowmans Ck Alluvials)

Soil Type Overview: Soil Type 3 is represented below by the Chromosol component of the Brown Chromosol/Sodosol Complex (Bowmans Ck Alluvials). These alluvial soils vary between being non sodic to marginally sodic in the B horizon, hence there is variability within the soil on the ESP threshold and therefore the label of Chromosol/Sodosol Complex has been used. The Sodosol component has generally the same characteristics as the Chromosol, however the B2 horizon ranges up to ESP 9 as shown in BSAL Assessment Site 7 in **Appendix 2**. These soils define the alluvial soils that are present within the Study Area. These soils cover 3% or 6.6 ha of the Study Area and are found on floodplains characterised by flat terrain (refer **Figure 3**). Site T2.4 from the Field Survey is the representative profile for this soil type. The separate mapping of these two soils was not possible at the scale the survey was undertaken.

Soil Type 3 consists of a very dark brown to brown silty loam to slightly bleached loamy sand topsoil, overlying a subsoil of reddish brown clay loam to clay (refer **Graph 10**). The soil profile has a moderate structure grade in the topsoil of 10 – 20mm blocky peds and a moderate consistence, trending to a strong structure grade of 20 – 50mm sub angular blocky peds and a moderate consistence in the subsoil. There are no coarse fragments present. The profile is well drained in the topsoil, and becomes moderately drained with increased clay fraction at depth.

Plate 8: Brown Chromosol/Sodosol

Plate 7: Soil Type 3 Landscape Setting



Graph 10: Site T2.4 PSA

Management: The Brown Chromosol/Sodosol topsoil component has few constraints and is generally suitable for stripping and reuse in rehabilitation. The profile has suitable structural, chemical and texture characteristics, and will successfully facilitate rehabilitation as long as erosion potential is managed. This soil is recommended to be stripped to 80cm, with the clay subsoil suitable as an intermediate layer between the overburden and topsoil to increase soil depth and water holding capacity.

Physical and Chemical Characteristics:

Site T2.4 was used as a representative profile of Soil Type 3 and was subject to laboratory analysis. A summary of this is provided in Table 8 below, with additional information provided to accommodate the Sodosol component of the mapped soil type. The full data set can be found in **Appendix 2**.

Table 8 – Site T2.4 Laboratory Analysis; Brown Chromosol

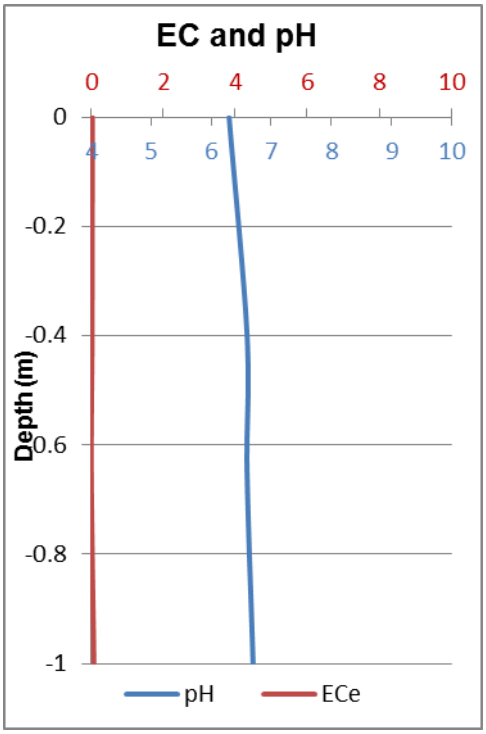
Depth	Colour	pH		ECe		CEC		ESP		EAT	
cm	Munsell	#	Rate	%	Rate	#	Rate	%	Rate	#	Rate
0-20	Very dark brown	6.2	Slightly acidic	0.1	Non saline	7.6	Low	1.0	Non sodic	7	Negligible
20-80	Brown	6.8	Neutral	0.0	Non saline	6.2	Low	1.4	Non sodic	3(1)	Slight
80-110	Reddish brown	7.1	Neutral	0.1	Non saline	11 to 18	Low to moderate	2.3 to 9.0	Non sodic to Marginally Sodic	5	Slight

The pH and EC results are shown in **Graph 11** below, which shows the minor pH variance of slightly acidic at the surface and neutral thereafter, while the profile is non-saline. **Graph 12** below shows the trend of exchangeable cations throughout the soil profile, and highlights the Ca/Mg ratio as low in calcium throughout the profile. CEC is a measure of fertility and is low to moderate. These soils are non sodic to marginally sodic and have an EAT rating of negligible in the topsoil and slight in the subsoil. The K factor analysis was rated as high to very high throughout.

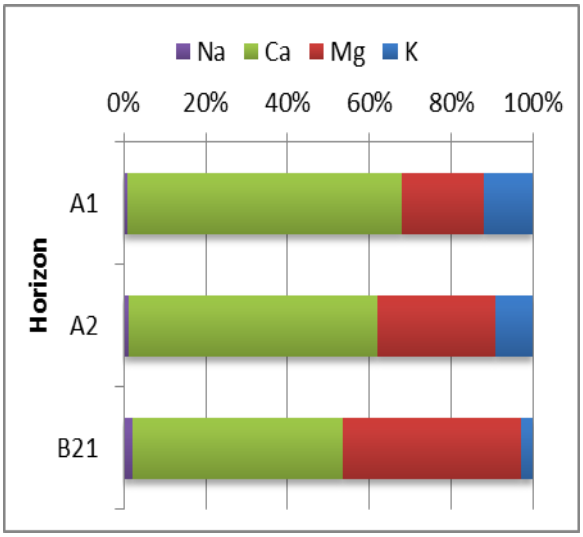
Alluvial Description: The Chromosol/Sodosol complex is considered alluvial soil and has been created from a combination of transported colluvial material from the adjacent surrounding hills, and alluvial from upstream landforms via Bowmans creek. The alluvial material has undergone enough soil development to form the current duplex profiles. Also identified in the soil survey was a thin strip of deep sandy to gravelly material layered with river rocks. Whilst this thin strip of material was not large enough to map out at the survey scale, it was located around the base of the adjacent hills, and is thought to be the remnants of a previous flow path for Bowmans Creek. The ancient path acts as a definitive border between the sodosols of the lower slopes and the alluvials.

The alluvial soil is considered to be capable of productive agricultural use, however the splitting of the area by the conveyer and associated access track may reduce the efficient utilisation of the land. The soil is not considered to be BSAL according to the *Interim Protocol for Site verification and mapping of biophysical strategic agricultural land – V7* (OEH 2013), as the relative fertility of Sodosols are considered moderately low, which fails the BSAL criteria. However it is worth noting that this marginally sodic material with an ESP of 9, whilst categorised as a Sodosol, is not considered to be limited by this ESP level for effective plant root function. An ESP >15 is listed as the threshold at

which the soil is considered to be a physio-chemical limitation to effective rooting depth. Therefore the Chromosol/Sodosol complex of alluvial soil is not considered BSAL, but is potentially suited to moderate to high agricultural production.



Graph 11: Site T2.4 ECe and pH



Graph 12: Site T2.4 Exchangeable Cations

4.0 LAND ASSESSMENT

The Study Area has been assessed for both rural land capability and agricultural suitability. The methods and results for these assessments are presented in this section fulfilling report Objectives 2 and 3. During the time of this assessment, the new Land and Soil Capability assessment scheme was not released, hence the use of the land capability and agricultural suitability systems.

4.1 Land Capability and Agricultural Suitability Relationship

In NSW, rural lands have been mapped according to two different land classification systems. The first of these was developed by the former Soil Conservation Service of NSW and classifies land into eight classes (I-VIII) known as rural land capability classes. The second system used by the former NSW Department of Agriculture classifies land into five classes (1-5) known as agricultural suitability classes. A brief overview of their relationship to each other is discussed here with further detail provided in **Sections 4.2** and **4.3** respectively.

The aim of the land capability classification system is to delineate the various classes of rural lands on the basis of their capability to remain stable under particular land uses. This system classifies the land in terms of its inherent physical characteristics or physical constraints and denotes measures needed to protect the land from soil erosion and other forms of land degradation. It therefore considers the optimum use of land rather than the maximum use. The land capability classification system does not imply any aspect of agricultural suitability which can involve connection to markets, availability of water and other facilities. The agricultural suitability classification system aims to satisfy these agricultural suitability aspects.

The agricultural suitability system incorporates other specific factors such as local infrastructure, closeness to markets, cultural factors, land location and adverse market demand to determine the appropriate agricultural suitability class. Consequently, a site's agricultural suitability classification may change over time due to market forces and changes to site-specific infrastructure. In contrast, the land capability of a site generally will not change, however, some change may occur in conjunction with improvements in agricultural farming methodology that reduce erosion risk.

4.2 Land Capability

4.2.1 Land Capability Methodology

The land capability system applied to the Study Area is in accordance with OEH guidelines (formerly the NSW Soil Conservation Service). The relevant guideline followed is S*ystems Used to Classify Rural Lands in New South Wales* (Cunningham *et al*., 1988).

This system classifies the land on its potential for sustainable agricultural use if developed, rather than its current land use, and includes three types of land uses:

- land suitable for cultivation;
- land suitable for grazing; and
- land not suitable for rural production.

The system consists of eight classes, which classify the land based on the severity of long-term limitations. Limitations are the result of the interaction between physical resources and a specific land use. A range of factors are used to assess this interaction. These factors include climate, soils, geology, geomorphology, soil erosion, topography and the effects of past land uses.

The principal limitation recognised by these capability classifications is the stability of the soil mantle and classes are ranked on their increasing soil erosion hazard and decreasing versatility of use. A description of the eight land capability classes is provided in **Table 9**.

Table 9 – Rural Land Capability Classes

Class	Land Use	Management Options
I	Regular Cultivation	No erosion control requirements
II	Regular Cultivation	Simple requirements such as crop rotation and minor strategic works
III	Regular Cultivation	Intensive soil conservation measures required such contour banks and waterways
IV	Grazing, occasional cultivation	Simple practices such as stock control and fertiliser application
V	Grazing, occasional cultivation	Intensive soil conservation measures required such contour ripping and banks
VI	Grazing only	Managed to ensure ground cover is maintained
VII	Unsuitable for rural production	Green timber maintained to control erosion
VIII	Unsuitable for rural production	Should not be cleared, logged or grazed

Source: Cunningham et al., 1988

4.2.2 Pre-Disturbance Land Capability Results

The Study Area has been assessed and classified into the Land Capability Classes described below. The relevant Land Capability Classes for the Study Area are displayed in **Table 10** and shown on **Figure 4.**

Class II Land

Class II land consists of Soil Type 3 (refer **Figure 3**). This classification indicates the land is capable of regular cultivation with simple management requirements such as crop rotation and minor strategic works. This land can be subject to sheet erosion as well as wind erosion and soil structure decline. To manage the limitations of this soil, cropping should be managed by reducing tillage and retaining stubble. This low-lying land is derived from colluvial and alluvial material. The primary constraints are low to moderate fertility and slightly bleached A2 horizon indicating moderate to poor drainage in the subsoil, localised sodicity and moderate to high wind erosivity.

Class IV Land

Class IV land is characterised by soils on the lower to mid and upper mid slopes of the Study Area, and consist Soil Type 2.2. This classification indicates that the land is capable of a range of land uses, such as grazing with occasional cultivation. However, for land uses such as cropping and intensive grazing, practices need to be able to manage moderate to severe limitations. This land is generally used for grazing, and is suitable for pasture improvement. This land is derived from the Salic Brown Sodosol. The primary constraints include a saline and sodic subsoil and an apedal A2 horizon. These characteristics limit cropping activities, however slope and dispersability indicate the land would be suitable for grazing.

Class V Land

Class V land is characterised by soils on slopes and crests, consisting of Soil Types 1 and 2.1. This classification indicates that the land is capable of some land uses, and management practices are necessary to overcome the limitations. The land should not be cultivated for cropping or for establishing pasture grasses; however, the land can be used for grazing with occasional grazing for pasture improvement, but also requires conservation works. The primary constraints to this land class are a slope of 25 – 33%, silty and sandy textured topsoils with rapid drainage characteristics, moderate to high K factor and high dispersability, occasionally shallow soils and a very low fertility associated with Soil Type 2.1.

Table 10 – Pre-Disturbance Land Capability Summary

Land Capability Class	Study Area	
	ha	%
II	6.6	3
IV	17.8	7
V	169.4	66
Mining Disturbance	61.4	24
Total	**255.2**	**100**

4.2.3 Post – Disturbance Land Capability Results

The post-disturbance Land Capability of the Study Area landforms is described in this section, and is based on the proposed final landform and rehabilitation proposed by LCO (refer Rehabilitation and Closure Chapter of the EA). The relevant Post-Disturbance Land Capability Classes for the Study Area, as well as the net change of Land Capability Classes from Pre-disturbance are displayed in **Table 11** and shown on **Figure 5.**

Class II Land

Class II land will remain post mining with no change. This will continue to be present in the south east of Study Area where the flat terrain of the Brown Chromosol/Sodosol Complex is located.

Class IV Land

Class IV land will have a net decrease of 11.2 ha. This is associated with the undisturbed pre mining areas.

Class V Land

Class V land will have a net decrease of 94.2 ha. This will be associated with the undisturbed pre mining areas. The majority of pre mining Class V land will become Classes VI, VII or VIII due to the slopes of the final landform and the location of the final void.

Class VI

An area of 10.1 ha of Class VI land will be created by the moderate slopes of the final landform, indicating potential opportunity for agricultural activity such as light grazing.

Class VII Land

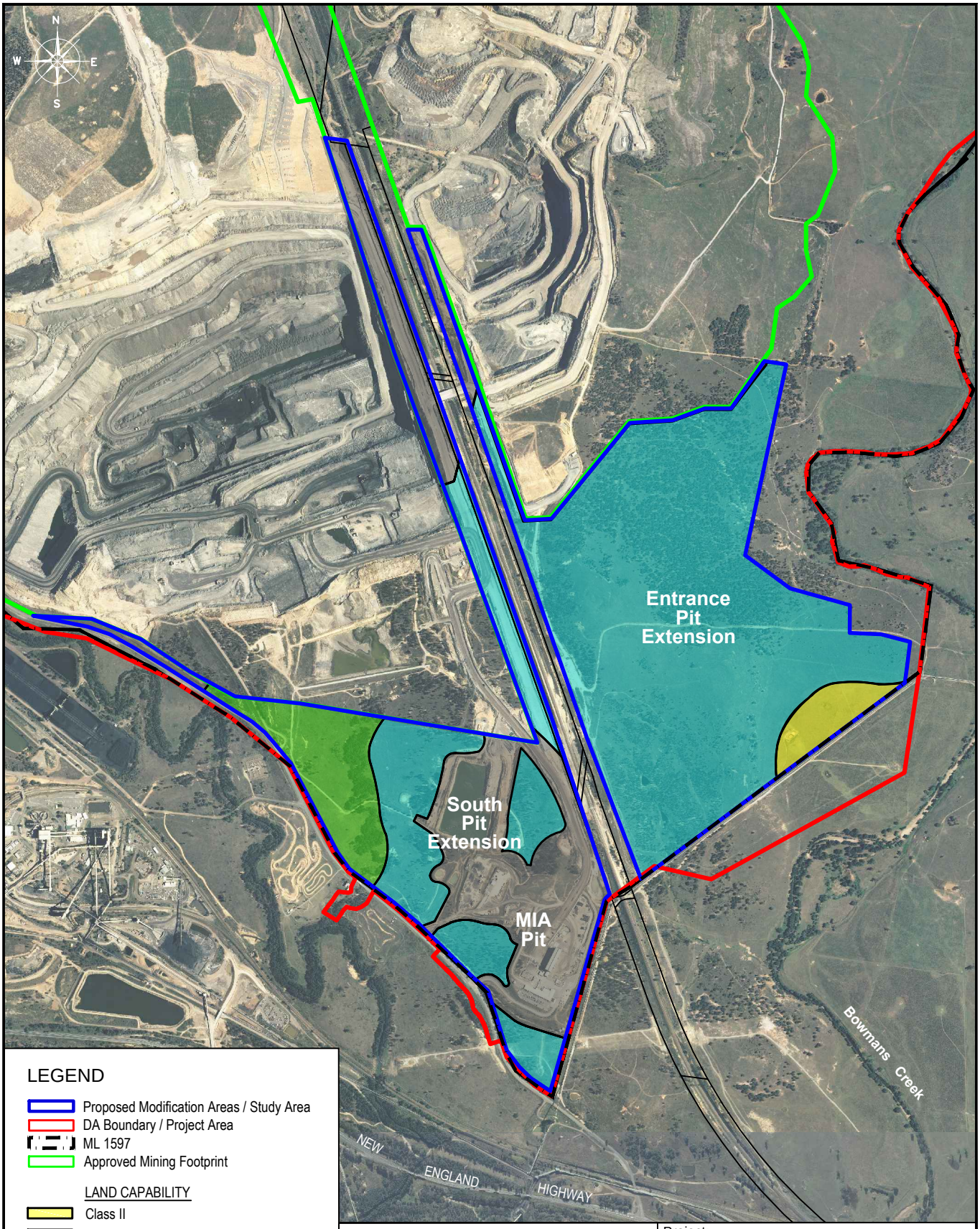
An area of 26.4 ha of Class VII land will be created by the steep slopes of the final landform, indicating limited to no opportunity for agricultural activity.

Class VIII Land

130.3 ha of Class VIII land will be created by the final void. This land is not capable of supporting any agriculture.

Table 11 – Post-Disturbance Land Capability Summary

Land Capability Class	Pre-Disturbance		Post-Disturbance		Change	
	ha	%	ha	%	ha	%
II	6.6	3	6.6	3	0	0
IV	17.8	7	6.6	3	-11.2	-4
V	169.4	66.1	75.2	29	-94.2	-37
VI	Nil	Nil	10.1	4	+10.1	+4
VII	Nil	Nil	26.4	10	+26.4	+10
VIII	Nil	Nil	130.3	51	+130.3	+51
Mining Disturbance	61.4	24	Nil	Nil	-61.4	-24
Total	**255.2**	**100**	**255.2**	**100**	**0.0**	**0.0**



LEGEND

- Proposed Modification Areas / Study Area
- DA Boundary / Project Area
- ML 1597
- Approved Mining Footprint

LAND CAPABILITY

- Class II
- Class IV
- Class V
- Mining Disturbance

0 0.5 1km

Scale 1:20000

FIGURE 4

Pre-disturbance Land Capability

Version	Date:	Author:	Checked:	Approved:
1	26/6/2012	ZJ	MH	MH
2	06/8/2012	LH	MH	MH
3	15/4/2013	LF	CR	CR
4	18/4/2013	LH	CR	CR
5	7/6/2013	LF	NA	NA

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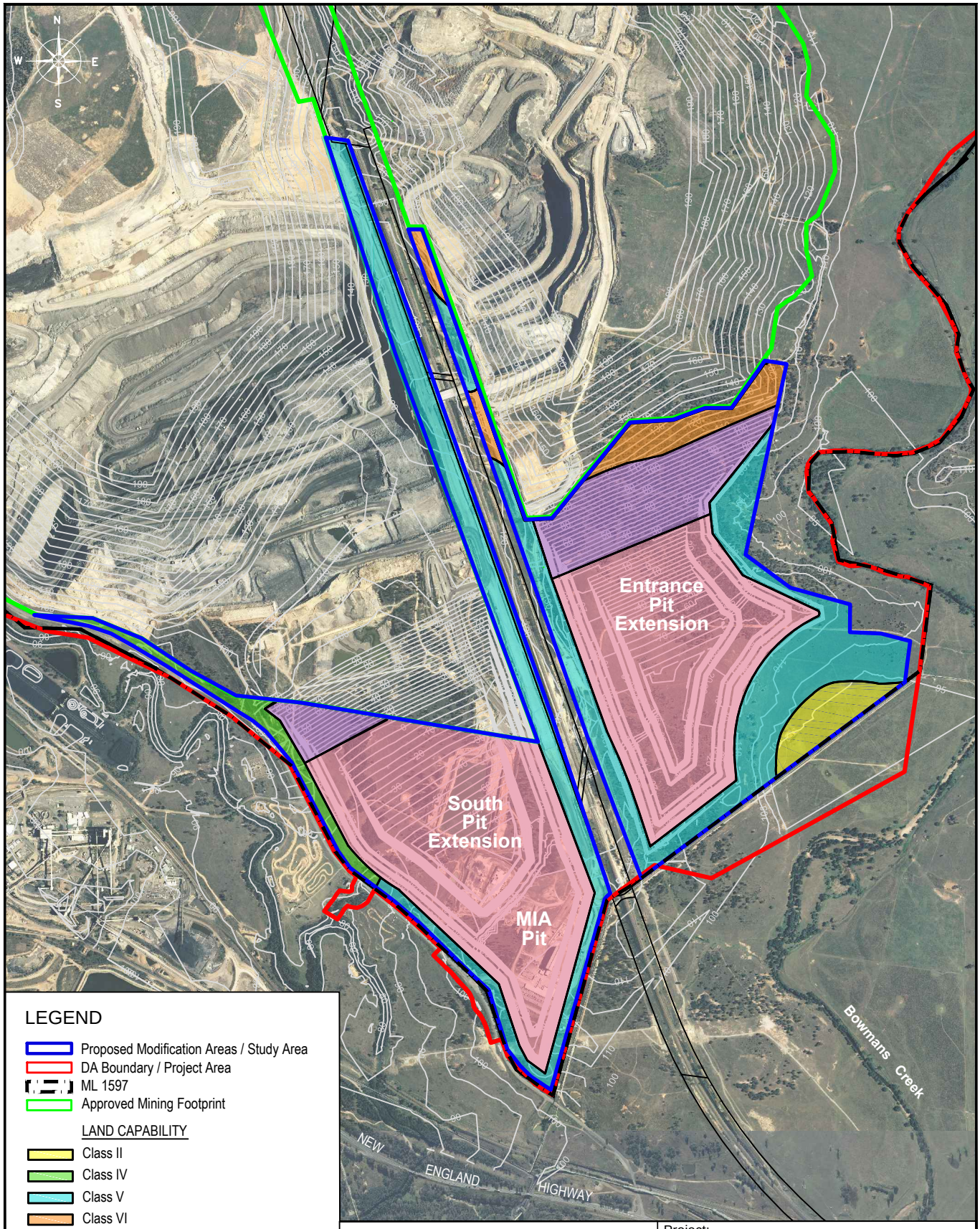

LEGEND

- Proposed Modification Areas / Study Area
- DA Boundary / Project Area
- ML 1597
- Approved Mining Footprint

LAND CAPABILITY

- Class II
- Class IV
- Class V
- Class VI
- Class VII
- Class VIII

0 0.5 1km

Scale 1:20000

FIGURE 5

Post-disturbance Land Capability

Version	Date:	Author:	Checked:	Approved:
1	26/6/2012	ZJ	MH	MH
2	06/8/2012	LH	MH	MH
3	15/4/2013	LF	CR	CR
4	18/4/2013	LH	CR	CR
5	7/6/2013	LF	NA	NA

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Projection: GDA94 MGA Zone 56

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4.3 Agricultural Suitability

4.3.1 Agricultural Suitability Methodology

The agricultural suitability system applied to the Modification is in accordance with Industry and Investment (I&I) NSW (formerly the NSW Agricultural & Fisheries). The relevant guideline is the *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries 1990). The system consists of five classes, providing a ranking of rural lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits. Class 1 ranks the land as most suitable for agricultural activities and Class 5 the least suitable. Classes 1 to 3 are generally considered suitable for a wide variety of agricultural production, whereas, Classes 4 and 5 are unsuitable for cropping however Class 4 is suitable for light grazing activities and Class 5 unsuitable for agriculture.

The main soil properties and other landform characteristics considered significant for the land suitability assessment are topsoil texture, topsoil pH, solum depth, external and internal drainage, topsoil stoniness and slope as well as bio-physical factors such as elevation, rainfall and temperature.

The overall suitability classification for each specific soil type is determined by the most severe limitation, or a combination of the varying limitations. A description of each Agricultural Suitability Class is provided in **Table 12**.

Table 12 – Agricultural Suitability Classes

Class	Land Use	Management Options
1	Highly productive land suited to both row and field crops.	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Highly productive land suited to both row and field crops.	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation.
3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation.	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture.
4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage.
5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land unsuitable for agriculture or at best suited only to light grazing.

Source: NSW Agriculture & Fisheries (1990)

4.3.2 Pre-Disturbance Agricultural Suitability Results

The pre-disturbance Agricultural Suitability of the Study Area is described in this section. The relevant classes for the Study Area are displayed in **Table 13** and shown on **Figure 6.**

Class 1 Land

Class 1 land consists of a portion of low-lying colluvial and alluvial derived soils from Soil Type 3 in the north west of the Study Area. This arable land is suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent. It has a high suitability for agriculture but soils factors such as sodicity may limit the productivity. There are no industry constraints due to the proximity to cropping land in the local region, however infrastructure

constraints such as being fragmented by a conveyor line may limit the commercial potential of this land. This land is currently being used for grazing.

Class 3 Land

Class 3 land is characterised by soils on the lower to mid and upper mid slopes of the Study Area, consisting of Soil Types 1, 2.1 and 2.2. This classification indicates the land is suited to grazing and pasture improvement. There is potential for this land to be cropped, however, this must be done in rotation with sown pasture. The overall production level is moderate due to soil factors such as sodicity, salinity and high erodibility. For grazing purposes, there are no industry or infrastructure constraints, and grazing is the current landuse in these areas.

Table 13 – Pre-Disturbance Agricultural Suitability Class Summary

Agricultural Suitability Class	Study Area	
	ha	%
1	6.6	3
3	187.2	73
Mining Disturbance	61.4	24
Total	**255.2**	**100**

4.3.3 Post – Disturbance Agricultural Suitability Results

The post-disturbance agricultural suitability of the Study Area landforms is described in this section, and is based on the proposed final landform and rehabilitation proposed by LCO (refer Rehabilitation and Closure Chapter of the EA). The relevant Post-Disturbance Agricultural Suitability Classes for the Study Area, as well as the net change of Agricultural Suitability Classes from Pre-disturbance are displayed in **Table 14** and shown on **Figure 7.**

Class 1 Land

Class 1 land will remain post mining with no change. This will continue to be present in the south east of Study Area where the flat terrain of the Brown Chromosol/Sodosol Complex is located.

Class 3 Land

Class 3 land will be reduced by 105.4 ha. This will occur in the south west of the study area where the slopes and the final void of the final landform will render the pre mining Class 3 land, to Class 4 or 5 land post mining.

Class 4 Land

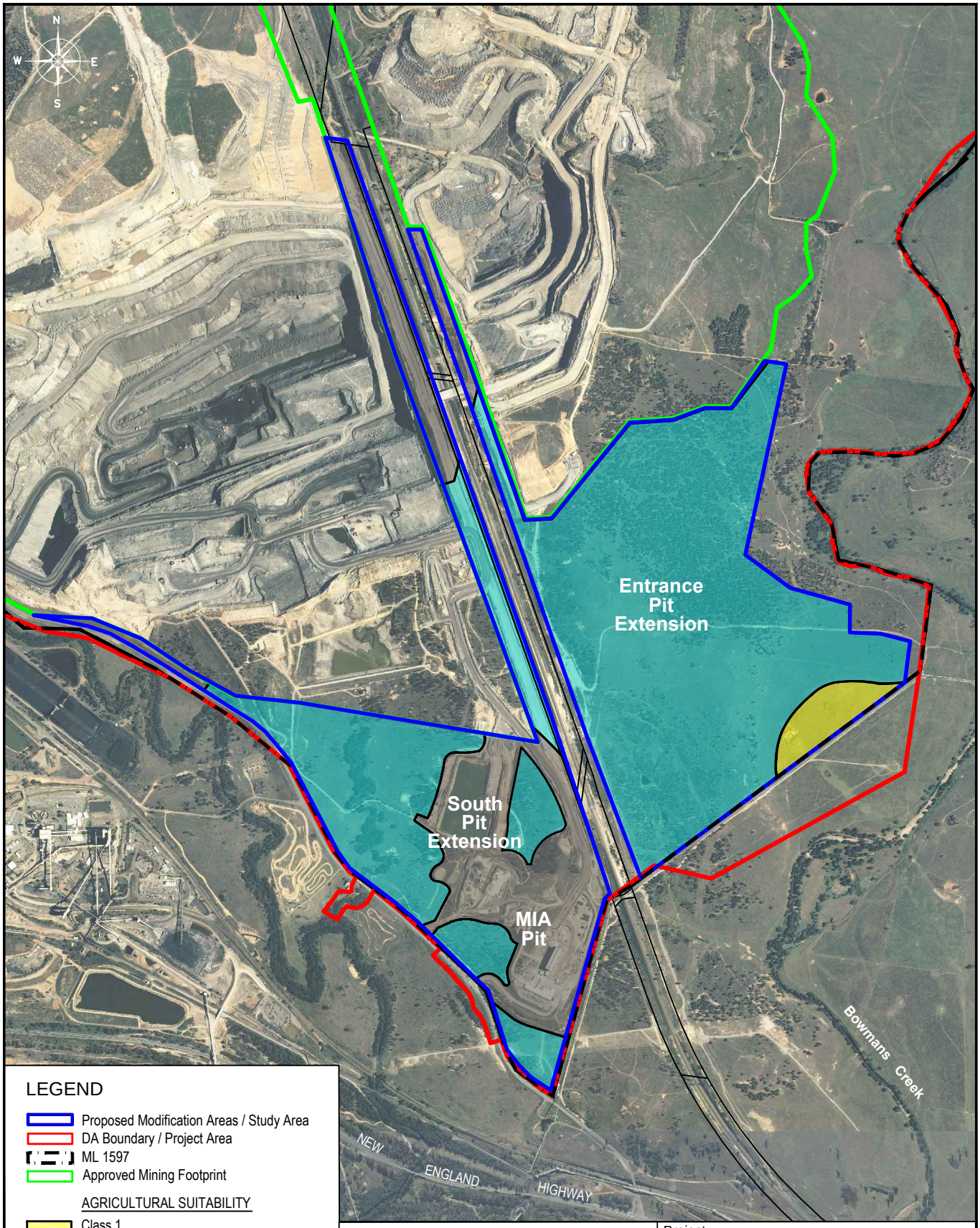
An area of 10.1 ha of Class 4 land will be created by the moderate to steep slopes of the final landform, indicating marginal suitability for agricultural use.

Class 5 Land

An area of 156.7 ha of Class 5 land will be created by the final void and steep slopes of the final landform. This land is not capable of supporting any agriculture.

Table 14 – Agricultural Suitability Class Disturbance Summary

Agricultural Suitability Class	Pre-Disturbance		Post-Disturbance		Change	
	ha	%	ha	%	ha	%
2	6.6	3	6.6	3	0	0
3	187.2	73	81.8	32	-105.4	-41
4	Nil	Nil	10.1	4	+10.1	+4
5	Nil	Nil	156.7	61	+156.7	+61
Mining Disturbance	61.4	24	Nil	Nil	-61.4	-24
Total	**255.2**	**100**	**255.2**	**100**	**0**	**0**



LEGEND

- Proposed Modification Areas / Study Area
- DA Boundary / Project Area
- ML 1597
- Approved Mining Footprint

AGRICULTURAL SUITABILITY

- Class 1
- Class 3
- Mining Disturbance

0 0.5 1km

Scale 1:20000

FIGURE 6

Pre-disturbance Agricultural Suitability

Version	Date:	Author:	Checked:	Approved:
1	26/6/2012	ZJ	MH	MH
2	06/8/2012	LH	MH	MH
3	15/4/2013	LF	CR	CR
4	18/4/2013	LH	CR	CR
5	7/6/2013	LF	NA	NA

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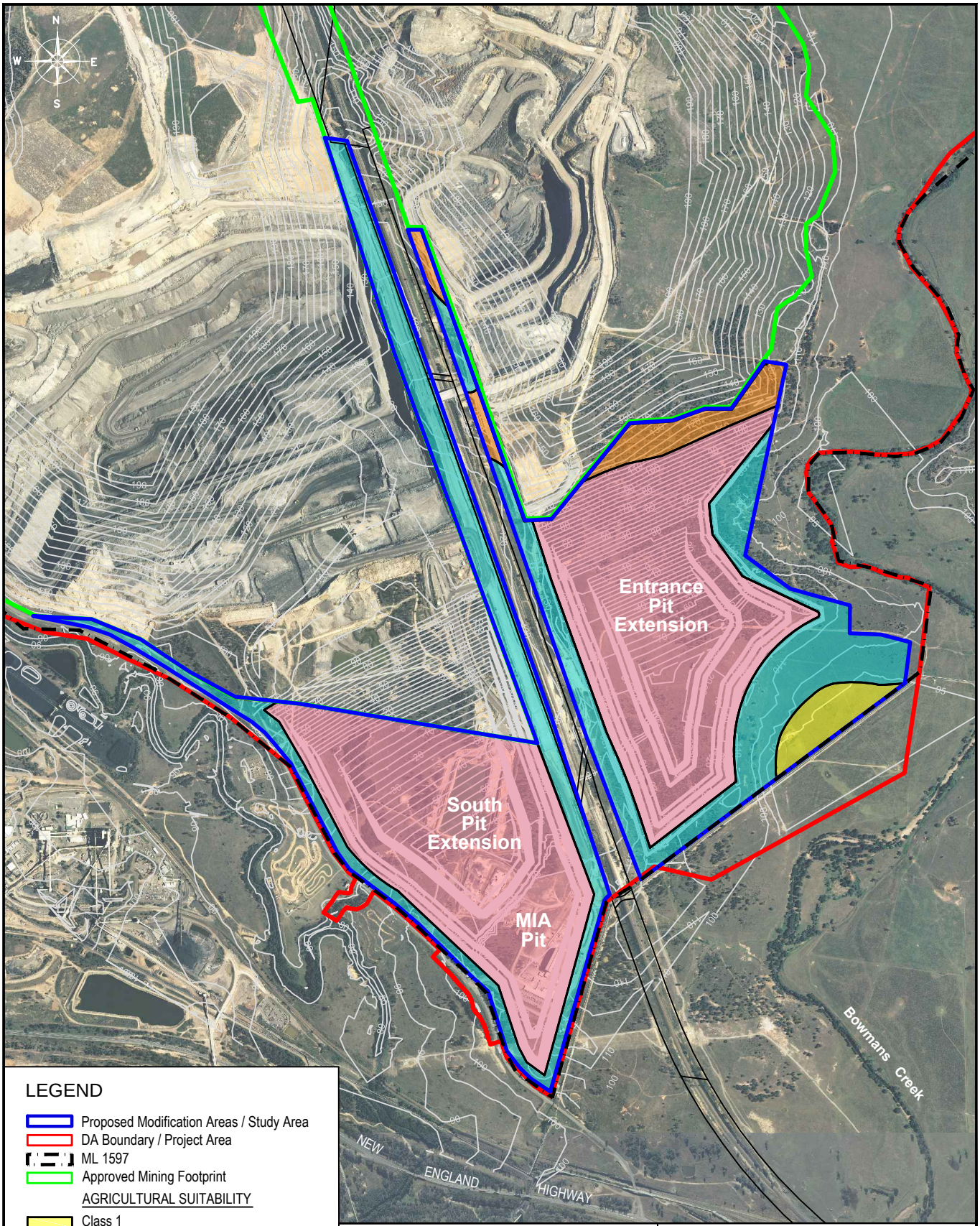

LEGEND

- Proposed Modification Areas / Study Area
- DA Boundary / Project Area
- ML 1597
- Approved Mining Footprint

AGRICULTURAL SUITABILITY

- Class 1
- Class 3
- Class 4
- Class 5

0 0.5 1km

Scale 1:20000

FIGURE 7

Post-disturbance Agricultural Suitability

Version	Date:	Author:	Checked:	Approved:
1	26/6/2012	ZJ	MH	MH
2	06/8/2012	LH	MH	MH
3	15/4/2013	LF	CR	CR
4	18/4/2013	LH	CR	CR
5	7/6/2013	LF	NA	NA

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Environmental, Land and Project Management Consultants

Project: LIDDELL SOILS & LAND RESOURCE

Client: LIDDELL COAL OPERATIONS

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Projection: GDA94 MGA Zone 56

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4.4 Land Resource Impacts Summary

The impacts of the Project on the land resources of the Study Area include:

- Reductions in current mining disturbance and Land Capability Classes IV and V land.
- Increases in areas of Land Capability classes VI, VII and VIII.
- No impact on Land Capability class II land on the alluvials.

The areas of the Study Area that were classified as Land Capability Classes II, IV and V, and Agricultural Suitability Classes 1 and 3, have previously been used for agricultural purposes. The Project will result in the majority of the area being limited to less productive Land Capability and Agricultural Suitability classes. An area of 156.7 ha will be rendered unsuitable for most to all agricultural enterprises. In this area, it is recommended that native vegetation is established above the predicted equilibrium water level in the void, so that land can be stabilised through vegetation establishment.

5.0 DISTURBANCE MANAGEMENT

Soil to be disturbed due to the Project has been specifically assessed to determine its suitability for stripping and re-use on rehabilitation sites. This assessment is an integral process for successful rehabilitation as per the sites rehabilitation objectives. This section provides information on the following key areas related to the management of the topsoil resources in the Study Area;

- Topsoil stripping assessment which provides a topsoil stripping strategy indicating recommended stripping depths for topsoil salvage and re-use as topdressing in rehabilitation; and

- Topsoil management for soil that is stripped, stored and used as a topdressing material for rehabilitation.

5.1 Topsoil Stripping Assessment

5.1.1 Topsoil Stripping Methodology

Determination of suitable soil to conserve for later use in rehabilitation has been conducted in accordance with Elliott & Reynolds (2007). This procedure involves assessing soils based on a range of physical and chemical parameters. **Table 15** lists the key parameters and corresponding desirable selection criteria.

Table 15 – Topsoil Stripping Suitability Criteria

Parameter	Desirable criteria
Structure Grade	>30% peds
Coherence	Coherent (wet and dry)
Mottling	Absent
Macrostructure	>10cm
Force to Disrupt Peds	≤ 3 force
Texture	Finer than a Fine Sandy Loam
Gravel & Sand Content	<60%
pH	4.5 to 8.4
Salt Content	<1.5 dS/m

Gravel and sand content, pH and salinity were determined for all samples using the laboratory test results. Texture was determined in the field and cross referenced with laboratory results, specifically particle size analysis. All other physical parameters outlined in **Table 15** were determined during the field assessment.

Structural grade is significant in terms of the soil's capability to facilitate water permeation and aeration. Good permeability and adequate aeration are essential for the germination and establishment of plants. The ability of water to enter soil generally varies with structure grade and depends on the proportion of coarse peds in the soil surface. Better structured soils have higher infiltration rates and better aeration characteristics. Structureless soils, without pores, are considered less suitable as topdressing materials.

The shearing test is used as a measure of the soil's ability to maintain structure grade. Brittle soils are not considered suitable for revegetation where structure grade is weak or moderate because peds are likely to be destroyed and structure is likely to become massive following mechanical work associated with the excavation, transportation and spreading of topdressing material. Consequently, surface sealing and reduced infiltration of water may occur which will restrict the establishment of plants.

The force to disrupt peds, when assessed on soil in a moderately moist state, is an indicator of solidity and the method of ped formation. Deflocculated soils are hard when dry and slake when wet, whereas flocculated soils produce crumbly peds in both the wet and dry state. The deflocculated soils are not suitable for revegetation and may be identified by a strong force required to break aggregates.

The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soils with low permeability however some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions. Reducing soils and poorly aerated soils are unsuitable for revegetation purposes.

5.1.2 Topsoil Stripping Depths

Soils are recommended to be stripped to the depths stipulated in **Table 16** below. The constraints of the Soil Types that are not recommended for reuse are outlined in **Section 3.0**. Although some chemical and physical characteristics of the material are not ideally suited to revegetation activities, these soils are generally suitable to facilitate germination and appropriate management of this soil and amelioration (such as treatment with lime, etc.) will provide an acceptable and stable media for revegetation.

All topsoil stripped to the depths stipulated in **Table 16** is appropriate for use as topdressing. Soil Type 1 subsoil may be stripped for reuse however the subsoil should only be used as an intermediate layer between overburden and topdressing. This intermediate layer is created to provide a developed soil profile and has a greater water holding capacity than a topdressing material overlaying overburden.

Table 16 – Stripping Depth for Each Soil Type

Soil Type	ASC	Recommended Soil Stripping Depth (m)		
		Topsoil	Subsoil	Total
1	Brown Dermosol *(Upper Slopes and Crests)*	0.40	0.45	0.80
2.1	Brown Sodosol *(Mid Slope)*	0.20	Nil	0.20
2.2	Brown Sodosol *(Lower Slope and Flats)*	0.35	Nil	0.35
3	Brown Chromosol/Sodosol Complex *(Bowmans Ck Alluvials)* *Note * this soil is not proposed for disturbance*	0.80*	0.30*	1.10*

5.1.3 Topdressing suitability Volume

The topsoil volumes discussed in this section have been generated from the recommended stripping depths of each soil type by disturbance element. The estimated total volume of topdressing material available for reuse across the Study Area is 459,983 m^3 (**Table 17**). (Note: The surface disturbance area accounts for areas that have previously been cleared for the development of roads and tracks.

This is an accepted variable of the topsoil stripping strategy as there is an excess of material available to respread to the depths recommended above).

Table 17 – Soil Volumes

Soil Type #	Total Stripping Depth (m)	Surface Disturbance Area (m^2)	Total Volume (m^3)
1	0.80	183,174	146,539
2.1	0.20	1,510,593	302,119
2.2	0.35	178,384	62,434
3	1.10	0	0
		Total Volume	511,092
		Total Volume with 10% handling loss	**459,983**

5.1.4 Topdressing Management

Where soil stripping and transportation is required, the following handling techniques are recommended to prevent excessive soil deterioration:

- Strip material to the depths stated in **Tables 16 - 17**, subject to further investigation as required.
- Ideally, topsoil should be maintained in a slightly moist condition during stripping. Wherever possible, material should not be stripped in either an excessively dry or wet condition.
- Grading or pushing soil into windrows with scrapers, graders or dozers for later collection for loading into rear dump trucks by front-end loaders, are examples of preferential less aggressive soil handling systems. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- The surface of soil stockpiles should be left in as coarsely structured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established, and to prevent anaerobic zones forming.
- As a general rule, maintain a maximum stockpile height of 3m.
- If long-term stockpiling is planned (i.e. greater than 6 months), seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward will provide sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.
- Prior to re-spreading stockpiled topsoil, an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or “scalping” of weed species prior to topsoil spreading.
- An inventory of available soil should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

5.1.5 Soil Re-Spreading and Seedbed Preparation

Soil should be re-spread directly onto reshaped areas where practical. Where resources allow, dressing should be spread to a nominal depth of 100 mm on all re-graded land. Dressing should be spread, treated with fertiliser and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion. Soil respreading on steep slopes at depths exceeding 200 mm can be deleterious because of the "sponge" effect which can cause slippage of the topsoil from the slope. Specific dressing respreading depths for different post mining landform elements will be specified in the Landscape Management Plan.

Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All dressing areas should be lightly contour ripped (after dressing spreading) to create a "key" between the soil and the spoil. Ripping should be undertaken on the contour. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing. The respread dressing surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

6.0 SUMMARY

This Soil and Land Resource Assessment has been conducted based on the findings of a field investigation and a desktop review of reference information. The findings of the study include the following;

a) Soils Types within the Study Area – Brown Dermosol – upper slopes and crests (7%), Brown Sodosol – mid slopes (59%), Brown Sodosol – lower slopes (7%), and Brown Chromosol/Sodosol Complex – Bowmans Creek alluvials (3%).

b) Land Resource Assessment of the Study Area – No change to land capability class II. A reduction of 61.4 ha of current mining disturbance, 11.2 ha of class IV and 94.2 ha of class V land. An increase of 10.1 ha of class VI land, 26.4 ha of class VII land and 130.3 ha of class VIII land.

c) Soil Stripping Assessment within surface disturbance area – Brown Dermosol – upper slopes and crests (0 – 80cm), Brown Sodosol – mid slopes (0 – 20cm), Brown Sodosol – lower slopes (0 – 35cm) and Brown Chromosol/Sodosol Complex – Bowmans Creek alluvials (0 – 110cm) if required, however no mining disturbance is proposed for the alluvial area, allowing a total volume of 459,983m^3 of salvageable material to be stripped and re-used in the rehabilitation program.

Management recommendations based on these findings are presented in this assessment, and are a guide to mitigating the potential impacts of the proposed development and enhance the success of rehabilitation.

7.0 REFERENCES

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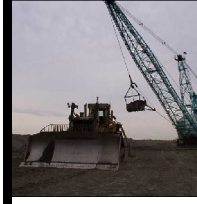
GLOSSARY








APPENDIX 1

Table A1.1 – List of Glossary Terms and Definitions[1]

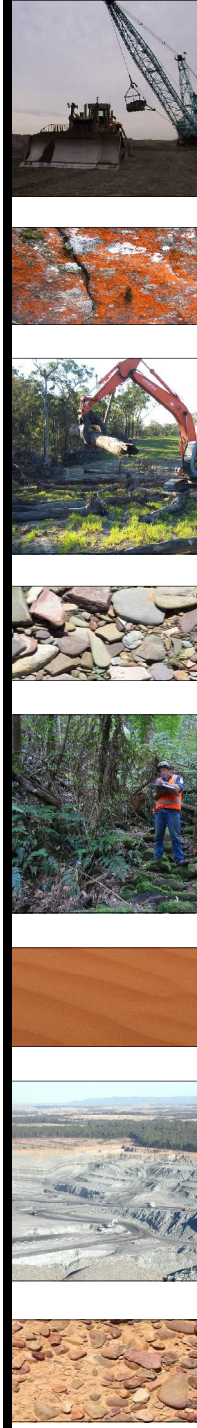
Term	Definition
Acidity	A property expressed by the pH value when this is below 7.0 in a soil/water suspension.
Aggregate	A unit of soil structure usually formed by natural processes in contrast with natural processes, and generally <10 mm in diameter.
Aggregate Stability	Refers to the stability of soil structural units (aggregates) when immersed in water.
Aglime	A soil amendment containing calcium carbonate, magnesium carbonate and other materials, used to neutralise soil acidity and furnish calcium and magnesium for plant growth.
Alkalinity	A property expressed by the pH value when this exceeds 7.0 in a soil/water suspension.
Anion	An element with a negative charge.
Availability	General expression referring to the ease with which plants can absorb a particular nutrient form the soil.
Available Water Capacity	The amount of water in the soil, generally available to plants, that can be held between field capacity and the moisture content at which plant growth ceases. Sometimes also known as the *Plant Available Water Capacity*.
Available Phosphorus	The amount of phosphorus in the soil available for plant uptake.
Base Saturation	Percentage of cation exchange capacity that is saturated with potassium, calcium, magnesium and sodium ions.
Bulk Density	The mass of dry soil per unit bulk volume; a measure of soil porosity, with low values meaning a highly porous soil and vice versa. It does not, however, give any indication of the number, sizes, shapes, distribution or continuity of soil pores.
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.
Crumb	A soft, porous, more or less rounded soil aggregate 1 to 5 mm in 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.

Term	Definition
Field Colour	The colour of soil material is determined by comparison with a standard Munsell colour chart.
Flocculation	The process by which colloidal or very fine clay particles, suspended in water, come together into larger masses or loose 'flocs' which eventually settle out of suspension.
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.
Massive	Refers to that condition of a soil layer (horizon) in which the layer appears as a coherent, or solid, mass which is largely devoid of peds, and is more than 6mm thick.
Metals	A metal is a chemical element that is a good conductor of both electricity and heat forms cation and ionic bonds with non metals.
Monitoring Unit	A monitoring and reporting unit is the result of stratification of the study area, it represents a unique combination of soil, climate, land use and land management practices.
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 form which the solumn 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 expresses 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.

Term	Definition
Soil Classification	The systematic arrangement of soils into groups or categories on the basis of similarities and differences in their characteristics.
Soil Coherence	The degree to which soil material is held together at different moisture levels, If two-thirds or more of the soil material, whether composed of peds or not, remain united at a given moisture level, then the soil is described as coherent.
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 or 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.
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.
Solumn	The upper part of a soil profile above the parent material, in which current processes of soil formation are active. The solumn 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 horizon
Topsoil	Refers to A1 and A2 soil horizons.

1 Definitions have been sourced from: Charman and Murphy, 1991; Peverill et al., 1999; Mckensie et al., 2004; NCST, 2009.

Certificate of Analysis



APPENDIX 2

NSW GOVERNMENT Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO12/164R1
REPORT TO:	Matt Hemingway GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Nineteen soil samples Ref: XCN07-014
REPORT STATUS:	Preliminary
DATE REPORTED:	5 June 2012
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO12/164R1 (Preliminary)
Client Reference: Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C2B/3
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)
1	LDL 1 0-20	15	26	39	20	<1	7	0.02	5.9	5.0
2	LDL 1 20-35	16	18	31	29	6	3(2)	0.03	6.9	5.5
3	LDL 135-70	44	19	20	17	<1	2(2)	0.32	8.3	7.2
4	LDL 1 70-110	43	15	23	19	0	2(3)	0.97	8.6	7.9
5	LDL 2 0-20	16	25	41	17	1	7	0.02	6.4	5.4
6	LDL 2 20-40	24	23	35	17	1	2(1)	<0.01	6.5	5.2
7	LDL 2 40-65	34	22	27	17	0	3(1)	0.01	6.6	5.4
8	LDL 2 65-85	43	18	23	16	0	3(1)	0.01	6.7	5.5
9	LDL T2.1 0-25	5	25	64	6	<1	7	0.01	6.6	5.6
10	LDL T2.1 25-50	12	21	62	5	<1	2(2)	<0.01	6.6	5.1
11	LDL T2.1 50-80	41	19	38	2	0	2(3)	0.08	6.9	5.7
12	LDL T2.1 80-110	32	19	47	2	0	2(3)	0.13	7.1	6.0

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	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)
13	LDL T2.2 0-20	10	22	52	14	2	7	0.01	5.9	4.8
14	LDL T2.2 20-30	12	22	48	14	4	2(2)	<0.01	6.3	4.9
15	LDL T2.2 30-65	43	16	33	8	<1	2(2)	0.08	6.8	5.5
16	LDL T2.2 65-110	44	16	33	7	0	2(3)	0.22	7.5	6.3
17	LDL T2.4 0-20	9	31	51	9	0	7	0.01	6.2	5.1
18	LDL T2.4 20-80	20	26	47	7	<1	3(1)	<0.01	6.8	5.4
19	LDL T2.4 80-110	35	21	36	8	0	5	0.01	7.1	5.9

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Lab No	Method	P7C/2 Particle Size Analysis – mech dis (%)					C6A/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	OC (%)	dry	moist
1	LDL 1 0-20	12	25	40	23	<1	3.29	7.5YR5/2	7.5YR3/2
2	LDL 1 20-35	13	22	30	19	6	1.20	7.5YR5/2	7.5YR3/2
3	LDL 135-70	46	17	19	18	<1	0.62	10YR5/3	10YR5/4
4	LDL 1 70-110	43	18	21	18	0	0.23	10YR5/3	10YR5/4
5	LDL 2 0-20	15	26	38	20	1	2.76	7.5YR4/3	7.5YR2.5/2
6	LDL 2 20-40	22	24	35	18	1	1.86	7.5YR4/3	7.5YR3/3
7	LDL 2 40-65	32	25	26	17	0	1.86	7.5YR4/3	7.5YR3/3
8	LDL 2 65-85	43	22	20	15	0	1.71	10YR4/3	10YR3/3
9	LDL T2.1 0-25	6	26	61	7	<1	1.59	7.5YR5/3	7.5YR3/3
10	LDL T2.1 25-50	9	26	60	5	<1	0.36	5YR6/3	5YR4/4
11	LDL T2.1 50-80	34	28	36	2	0	0.38	5YR5/4	5YR4/4
12	LDL T2.1 80-110	29	24	45	2	0	0.39	5YR5/4	5YR4/4

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Lab No	Method	P7C/2 Particle Size Analysis – mech dis (%)					C6A/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	OC (%)	dry	moist
13	LDL T2.2 0-20	7	26	51	14	2	1.66	7.5YR6/2	7.5YR4/2
14	LDL T2.2 20-30	10	25	47	14	4	0.74	10YR6/3	10YR4/3
15	LDL T2.2 30-65	43	19	30	8	<1	0.46	10YR6/4	10YR5/4
16	LDL T2.2 65-110	44	15	34	7	0	0.42	10YR6/4	10YR5/4
17	LDL T2.4 0-20	9	31	49	11	0	2.12	7.5YR5/3	7.5YR2.5/2
18	LDL T2.4 20-80	18	31	43	8	<1	0.28	7.5YR6/4	7.5YR4/4
19	LDL T2.4 80-110	32	28	32	8	0	0.22	5YR5/4	5YR4/4

END OF TEST REPORT

Soil Conservation Service
709 Gundy Road Scone NSW 2337

SCO12/164R1

Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Nineteen soil samples
Ref: XCN07-014

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C2B/3	P7C/2 Particle Size Analysis – mech dis (%)					C6A/2	Colour		Erodibility factor	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	clay	silt	f sand	c sand	gravel	OC (%)	dry	moist	K	Rating
1	LDL 1 0-20	15	26	39	20	<1	7	0.02	5.9	5	12	25	40	23	<1	3.29	7.5YR5/2	7.5YR3/2	0.034	Moderate
2	LDL 1 20-35	16	18	31	29	6	3(2)	0.03	6.9	5.5	13	22	30	19	6	1.2	7.5YR5/2	7.5YR3/2	0.039	Moderate
3	LDL 135-70	44	19	20	17	<1	2(2)	0.32	8.3	7.2	46	17	19	18	<1	0.62	10YR5/3	10YR5/4	0.022	Moderate
4	LDL 1 70-110	43	15	23	19	0	2(3)	0.97	8.6	7.9	43	18	21	18	0	0.23	10YR5/3	10YR5/4	0.025	Moderate
5	LDL 2 0-20	16	25	41	17	1	7	0.02	6.4	5.4	15	26	38	20	1	2.76	7.5YR4/3	7.5YR2.5/2	0.037	Moderate
6	LDL 2 20-40	24	23	35	17	1	2(1)	<0.01	6.5	5.2	22	24	35	18	1	1.86	7.5YR4/3	7.5YR3/3	0.037	Moderate
7	LDL 2 40-65	34	22	27	17	0	3(1)	0.01	6.6	5.4	32	25	26	17	0	1.86	7.5YR4/3	7.5YR3/3	0.029	Moderate
8	LDL 2 65-85	43	18	23	16	0	3(1)	0.01	6.7	5.5	43	22	20	15	0	1.71	10YR4/3	10YR3/3	0.023	Moderate
9	LDL T2.1 0-25	5	25	64	6	<1	7	0.01	6.6	5.6	6	26	61	7	<1	1.59	7.5YR5/3	7.5YR3/3	0.064	Very high
10	LDL T2.1 25-50	12	21	62	5	<1	2(2)	<0.01	6.6	5.1	9	26	60	5	<1	0.36	5YR6/3	5YR4/4	0.074	Very high
11	LDL T2.1 50-80	41	19	38	2	0	2(3)	0.08	6.9	5.7	34	28	36	2	0	0.38	5YR5/4	5YR4/4	0.042	High
12	LDL T2.1 80-110	32	19	47	2	0	2(3)	0.13	7.1	6	29	24	45	2	0	0.39	5YR5/4	5YR4/4	0.047	High

13	LDL T2.2 0-20	10	22	52	14	2	7	0.01	5.9	4.8	7	26	51	14	2	1.66	7.5YR6/2	7.5YR4/2	0.056	High
14	LDL T2.2 20-30	12	22	48	14	4	2(2)	<0.01	6.3	4.9	10	25	47	14	4	0.74	10YR6/3	10YR4/3	0.059	High
15	LDL T2.2 30-65	43	16	33	8	<1	2(2)	0.08	6.8	5.5	43	19	30	8	<1	0.46	10YR6/4	10YR5/4	0.028	Moderate
16	LDL T2.2 65-110	44	16	33	7	0	2(3)	0.22	7.5	6.3	44	15	34	7	0	0.42	10YR6/4	10YR5/4	0.027	Moderate
17	LDL T2.4 0-20	9	31	51	9	0	7	0.01	6.2	5.1	9	31	49	11	0	2.12	7.5YR5/3	7.5YR2.5/2	0.054	High
18	LDL T2.4 20-80	20	26	47	7	<1	3(1)	<0.01	6.8	5.4	18	31	43	8	<1	0.28	7.5YR6/4	7.5YR4/4	0.060	Very high
19	LDL T2.4 80-110	35	21	36	8	0	5	0.01	7.1	5.9	32	28	32	8	0	0.22	5YR5/4	5YR4/4	0.042	High

LIDDELL		Total Exchangeable Cation (or Cation Exchange Capacity) (cmol/kg)		Exchangeable Cations (cmol/kg)					ESP		Ca/Mg Ratio	
Site	Layer	Value	Rating	Al	Ca	K	Mg	Na	Value	Rating	value	rating
1	0-20	9.8	Low	0.18	5.4	0.49	3.7	0.14	1.4	Non sodic	1.5	Ca (low)
	20-35	11	Low	0.023	5.5	0.19	4.3	0.54	4.9	Non sodic	1.3	Ca (low)
	35-70	17	Moderate	0.055	3.6	0.12	12	2	11.8	Sodic	0.31	Ca deficient
	70-110	5.9	Very Low	0.044	0.63	0.033	3.9	1.2	20.3	Strongly Sodic	0.16	Ca deficient
2	0-20	12	Low	0.047	7.8	0.72	3	0.094	0.8	Non sodic	2.6	Ca (low)
	20-40	11	Low	0.044	7.5	0.64	3.1	0.077	0.7	Non sodic	2.5	Ca (low)
	40-65	15	Moderate	0.042	9.8	0.74	4.7	0.15	1.0	Non sodic	2.1	Ca (low)
	65-85	17	Moderate	0.033	11	0.78	6	0.16	0.9	Non sodic	1.8	Ca (low)
T2.1	0-25	7.6	Low	0.012	5	0.92	1.6	0.076	1.000	Non sodic	3.1	Ca (low)
	25-50	6.5	Low	0.089	4.1	0.46	1.6	0.25	3.846	Non sodic	2.7	Ca (low)
	50-80	20	Moderate	0.037	12	0.25	5.9	1.5	7.500	Marginally Sodic	2	Ca (low)
	80-110	19	Moderate	0.025	12	0.28	5.4	1.8	9.474	Marginally Sodic	2.2	Ca (low)
T2.2	0-20	4	Very Low	0.24	1.9	0.45	1.2	0.09	2.3	Non sodic	1.6	Ca (low)
	20-30	3.5	Very Low	0.18	1.3	0.32	1.5	0.17	4.9	Non sodic	0.88	Ca deficient
	30-65	11	Low	0.045	1.5	0.21	8	1.7	15.5	Strongly Sodic	0.19	Ca deficient
	65-110	13	Moderate	0.029	1.5	0.21	8.3	3.2	24.6	Strongly Sodic	0.18	Ca deficient
T2.4	0-20	7.6	Low	0.09	5	0.89	1.5	0.078	1.0	Non sodic	3.4	Ca (low)
	20-80	6.2	Low	0.038	3.8	0.57	1.8	0.089	1.4	Non sodic	2.1	Ca (low)
	80-110	11	Low	0.018	5.8	0.32	4.9	0.25	2.3	Non sodic	1.2	Ca (low)

NSW GOVERNMENT | Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO12/164R2
REPORT TO:	Matt Hemingway GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Nineteen soil samples Ref:XCN07-014
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	13 June 2012
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

G Holman
Snr TO(S)

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO12/164R2
Client Reference: Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P18B/2 AWC	
	Sample Id	0.3bar (%)	15bar (%)
1	LDL 1 0-20	28.6	12.9
2	LDL 1 20-35	20.7	8.4
3	LDL 135-70	37.1	18.4
4	LDL 1 70-110	34.8	17.0
5	LDL 2 0-20	31.2	13.3
6	LDL 2 20-40	25.2	12.3
7	LDL 2 40-65	28.6	15.3
8	LDL 2 65-85	32.1	17.6
9	LDL T2.1 0-25	26.9	8.4
10	LDL T2.1 25-50	20.9	8.2
11	LDL T2.1 50-80	35.5	18.8
12	LDL T2.1 80-110	32.5	17.4
13	LDL T2.2 0-20	23.6	8.4
14	LDL T2.2 20-30	18.3	7.5
15	LDL T2.2 30-65	30.4	16.8
16	LDL T2.2 65-110	30.6	18.0
17	LDL T2.4 0-20	32.6	11.2
18	LDL T2.4 20-80	21.8	9.9
19	LDL T2.4 80-110	26.9	15.8

AWC = moisture content (%) by weight

END OF TEST REPORT

NSW GOVERNMENT | Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO13/060R3
REPORT TO:	Clayton Richards SLR Consulting Australia Ltd PO Box 907 Hamilton NSW 2303
REPORT ON:	Six soil samples Ref: Liddell BSAL
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	26 March 2013
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

SR Young
(Laboratory Manager)

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

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO13/060R3
Client Reference: Clayton Richards
SLR Consulting Australia Ltd
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/5	C2A/4	C2B/4	C5A/4 CEC & exchangeable cations (me/100g)						
	Sample Id	EC (dS/m)	pH	pH ($CaCl_2$)	CEC	Na	K	Ca	Mg	Al	ESP
1	Site 5 0.3-0.4	nt	nt	nt	18.0	3.3	0.3	2.7	12.0	<0.3	18
2	Site 6 40-45 cm	nt	nt	nt	15.8	2.9	0.3	2.8	10.2	nt	18
3	Site 7 layer 1 5-10 cm	<0.01	6.3	5.1	5.3	0.1	0.7	3.2	1.5	0.4	2
4	Site 7 layer 2 30-35 cm	<0.01	6.4	4.9	4.5	0.2	0.8	2.7	1.7	<0.3	4
5	Site 7 layer 3 50-60 cm	0.10	6.2	5.1	18.2	1.7	0.9	7.7	6.3	<0.3	9
6	Site 12 subsoil 40-50cm	nt	nt	nt	20.9	2.9	0.8	9.1	7.2	nt	14

nt=not tested

SOIL CONSERVATION SERVICE
Scone Research Centre

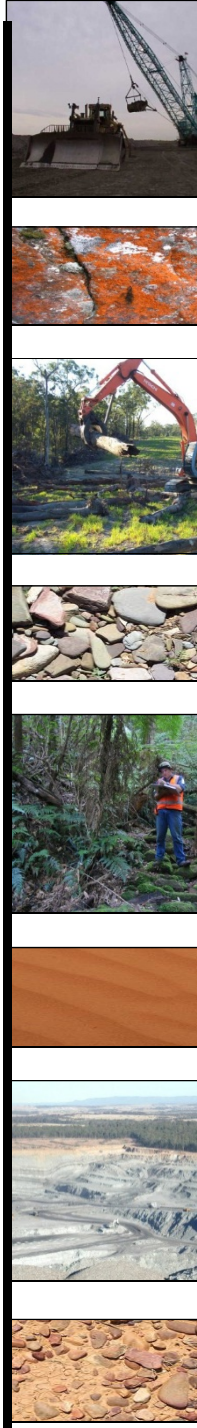
Report No: SCO13/060R3
Client Reference: Clayton Richards
SLR Consulting Australia Ltd
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P18B/3 AWC		
	Sample Id	clay	silt	f sand	c sand	gravel	FC 0.3bar (%)	WP 15bar (%)	AWC (%)
1	Site 5 0.3-0.4	nt	nt	nt	nt	nt	nt	nt	nt
2	Site 6 40-45 cm	nt	nt	nt	nt	nt	nt	nt	nt
3	Site 7 layer 1 5-10 cm	10	27	54	9	0	23	7	16
4	Site 7 layer 2 30-35 cm	10	23	57	10	0	19	6	13
5	Site 7 layer 3 50-60 cm	37	10	34	19	0	30	16	14
6	Site 12 subsoil 40-50cm	nt	nt	nt	nt	nt	nt	nt	nt

nt = not tested
AWC = moisture content (%) by weight

END OF TEST REPORT

Liddell Coal Operations
Landscape Management Plan
(LCO, 2013)



APPENDIX 3

LCO SD PLN 0034

LANDSCAPE MANAGEMENT PLAN

1. INTRODUCTION

Liddell Colliery is an open cut coal mine located approximately 25 kilometres north-west of Singleton, NSW, refer **Figure 1.1**. Liddell Colliery is operated by Liddell Coal Operations Pty Ltd (LCO) on behalf of the Liddell Joint Venture between Xstrata Coal Australia Pty. Ltd (Xstrata) and Mitsui Matsushima Australia Pty Ltd (MMA).

LCO operates under NSW development consent (DA 305-11-01) and Environmental Protection Licence (EPL No. 2094) administered under the *Protection of the Environment Operations Act 1997*. Mining operations at LCO are approved until December 2023, with production of up to 8 million tonnes per annum (Mtpa) run-of-mine (ROM) coal from its open cut operations. Existing Mining Operations are displayed in **Figure 1.2**.

1.1 Purpose

The current Liddell Colliery Landscape Management Plan (LMP) has been developed to satisfy schedule 3, conditions 30, 31, 32 and 33 of the LCO development consent (DA 305-11-01). As such, the structure of the document has been designed to incorporate Liddell Coal's strategy for mine closure, rehabilitation and final void management.

The existing LMP for Liddell Colliery was developed and approved by the Director-General of the NSW Department Planning and Infrastructure (DP&I) on 4 February 2009. This document has been developed as a revision of the approved Liddell Colliery LMP.

1.2 Commitments and Statutory Requirements

Appendix 1 outlines relevant development consent conditions 30, 31, 32 and 33, the applicable sections of the Statement of Commitments from the Environmental Assessment (EA) and the relevant section of the LMP which addresses each condition and commitment.

In addition to satisfying the relevant consent conditions, this LMP has been prepared in accordance with the relevant Xstrata Coal New South Wales (XCN) standards (refer to **Section 3.4.6**). In particular, XCN's relevant standards for mine closure planning, closure criteria development and rehabilitation monitoring as well as biodiversity management. The plan also incorporates the requirements for bushfire management.

In accordance with Schedule 5 Condition 4 of Development Consent DA 305-11-01, an Independent Environmental Audit of LCO was undertaken during 2012. While there were no non-conformances recorded for Land Management requirements, several recommendations were made and have been addressed in this revised Landscape Management Plan. The recommendations and the relevant section of the plan where they have been addressed are presented in **Table 1**.

Table 1.2: 2012 Independent Audit Rehabilitation Recommendations

Recommendation	Section where addressed in the LMP
Current vegetation strategy does not reflect the intention of the Synoptic Plan to establish connecting bushland corridors.	**3.35, 5.11, 5.53**
The rehabilitation Completion Criteria need to be refined and integrated into the existing rehabilitation Monitoring programs	**3.6, 5.277, Appendix 3,**
Topsoil management could be improved by shaping topsoil dump east of the Durham pit to gently rounded mounds and sowing a pasture crop. All topsoil dumps should be signposted.	**5.22**
A more systematic clarification of limiting soil characteristics such as pH, EC and ESP across Liddell would be beneficial and will help relate vegetation performance. This in turn will help guide soil amelioration methodology.	**5.23, 5.276**
Improvements to the waterside habitat in reservoir block can be made through the placement of large logs around the perimeter of water storages. Along with tree plantings, this would greatly enhance the habitat value of the Blue-billed duck and other dams.	**5.23, 5.522**
It would be beneficial top add two new weed species (African Olive and Acacia saligna) to the spraying program. The sprayed areas could then be sown with pasture grasses to reduce the potential for the weeds to return.	**5.43**
Other general recommendations include removal of existing rocks, erosion control in the reservoir block, provenance seed collection and aerial fertilisation programs.	**5.251, 5.23, 5.276, 5.42**

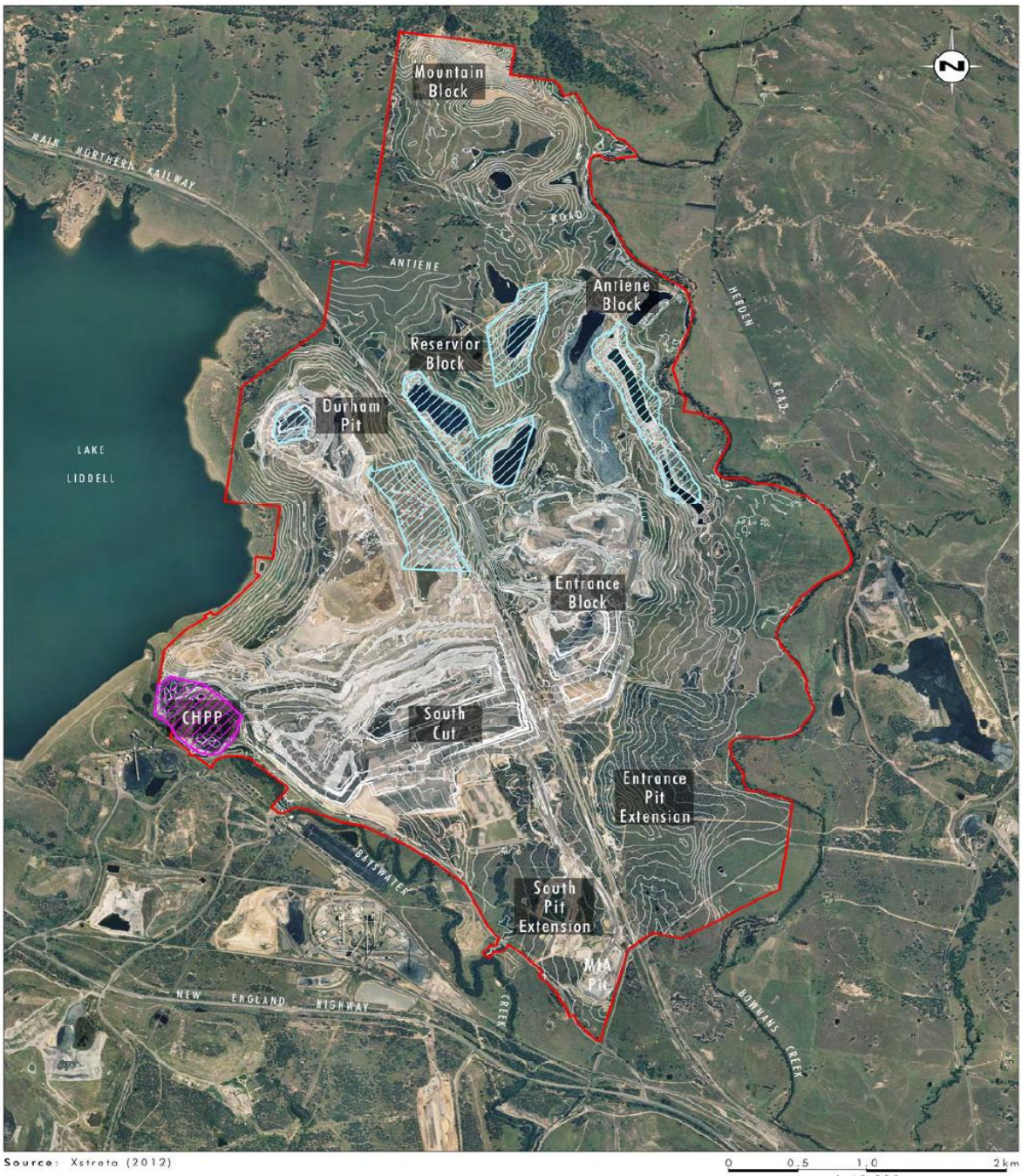
1.3 Authority Consultation

In accordance with schedule 3, condition 30 (c) this management plan has been developed in consultation with Department of Resources and Energy (DRE), NSW Office of Water (NOW), NSW Office of Environment and Heritage (OEH), Muswellbrook Shire Council (MSC), Singleton Council (SC) and the Rural Fire Service (RFS). Each authority was provided with a letter requesting comments in regards to the development of the original LMP. A copy of the correspondence with the agencies is provided in **Appendix 2**. This version of the plan is a minor revision to the original approved document and full consultation with the listed stakeholders has not been undertaken. A new Landscape Management Plan with stakeholder consultation will be prepared following the determination of the current development approval modification (MOD 5).

FIGURE 1.1

Locality Map

File Name (A4): R03_V1/2511_001.dgn
20121113 15.07



Legend
- DA Boundary
- Approved Tailings Areas
- CHPP

FIGURE 1.2
Existing Mining Operations

File Name (A4): R01/3116_003.dgn
20121011 15.17

1.4 Scope

In accordance with the XCN's mine closure standards, this document contains the Conceptual Mine Closure Plan for Liddell Colliery (**Section 3.**), which will be continually revised throughout the operational phase of the mine. The Rehabilitation Management Plan (**Section 5.**) has been designed to progressively achieve the mine closure objectives. At five years prior to mine closure, LCO will commence a detailed mine closure planning process, which will include investigations to provide that the full scope of closure issues are identified, appropriate solutions (e.g. engineering) are developed so that past mining land use objectives are met. Opportunities for alternative post mining sustainable land use options may also be investigated and a Final Void Management Plan is provided (**Section 4.**). Following the completion of these investigations, a Mining Operations Plan for Mine Closure will be prepared and submitted to the relevant government agencies for approval at least two years from the planned cessation of mining operations. The LMP also contains the Bushfire Management Plan (**Section 6.)**.

1.5 History of Operations

Liddell Colliery encompasses the former Liddell, Durham, Hazeldene and Foybrook mines, which commenced underground mining in 1923 and open cut mining in 1946. Liddell Colliery has been in continuous operation, using open cut and underground mining methods since the 1950's.

When the *Environmental and Planning Assessment Act* (EP&A Act) was gazetted in 1979, the former Liddell and Foybrook mines were actively engaged in underground and open cut mining operations which were subject to existing use rights.

In 1980, SC granted development consent to Clutha Development Pty Ltd to extend open cut mining operations at the Foybrook Open Cut Mine, with a further development consent granted two months later by MSC for mining in Foybrook North. Ownership of Foybrook Open Cut mine was transferred to BP Coal Australia in the early 1980s. In 1987 the Foybrook Open Cut mine was further extended to the north.

Underground mining operations at Hazeldene Colliery ceased in 1987 around the same time that the Foybrook Open Cut mine was transferred to Novacoal Australia. In 1989 the Liddell Joint Venture purchased the Liddell Colliery, which was granted development consent twelve months later to extend operations to the north and south using both open cut and underground mining methods. In 1993, the Liddell Joint Venture acquired the Foybrook leases, excluding the Antiene Void which was retained by Novacoal Australia for use as a tailings emplacement area for the Newdell Coal Preparation Plant.

In 1993, the Liddell Joint Venture consolidated the Foybrook and Liddell operations to form the Liddell Colliery Holding. Further development consent were granted in 1994, 1995 and 1996 for the continuation of open cut operations in the Foybrook lease and extension of operations following changes to mining permissibility under the *Mining Act 1992* which allowed for mining within 15 metres of the surface covered by surface ownership rights in the Liddell lease.

In 2002, LCO was granted development consent DA305-11-01 to continue operations and to consolidate the large number of development consent approvals. On 18 July 2007, LCO was granted a modification to this development consent under Section 75W of the EP&A Act. The modification included, but was not limited to, an increase in production, construction of a new coal handling and preparation plant (CHPP), construction of a new office and workshop complex, expansion to open cut mining areas and the creation of a new mine water dam. The following modifications have been approved since that time:

Mod 3 (February 2008) – This modification included alteration of the approved Old New England Highway office and workshop complex access road intersection and the realignment of the development consent boundary in this area. This modification also encompassed re-use of treated effluent from the office and workshop complex in Dam 13/13B to enable recycling of the treated effluent onsite; and

Mod 4 (October 2009) - This modification included minor changes to the Mining Infrastructure Area (MIA) including the construction of additional machinery workshop bays, storage sheds and compounds and an extension to the existing fuel farm including additional fuel and oil tanks.

1.6 Existing Environmental Setting

1.61 Regional Environmental Setting

The upper and central Hunter Valley has been largely cleared of native vegetation, primarily for agriculture and other land uses including mining, power generation and urban development. The predominant land uses in the vicinity of the Liddell Colliery are mining and power generation with the Mt Owen Coal Complex to the east, Lake Liddell and the Liddell and Bayswater Power Stations to the west and Ravensworth Underground Mine and associated CHPP, Ravensworth Coal terminal and the former Cumnock No.1 Colliery to the south. Other land uses in the surrounding area include rural-residential holdings, the Main Northern Railway and rail loops and the Ravensworth State Forest. The private residences surrounding Liddell Colliery are located to the north and north-east of the site. Prior to mining, the predominant land use was grazing. An area of remnant native woodland is located to the north of the Mountain Block.

The nominated end land use for Liddell Colliery is primarily grazing. However, because of the long history of clearing and the degradation of floristic diversity and fauna habitat in the central Hunter Valley, there is a strong commitment to rehabilitating the land with viable woodland as well as pasture land suitable for grazing. Reinstatement of forest, woodland and wildlife corridors is in keeping with the Department of Resources and Energy (DRE) (1999) *Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW.*

1.62 Local Environmental Setting

1.621 Flora and Fauna

The vegetation within the Liddell Colliery development consent area has been heavily modified and fragmented by agricultural and mining activities. The site is dominated by the Derived Grassland vegetation community which comprises a mixture of native and introduced grasses and small herbs. Seven other vegetation communities occur within the Liddell Colliery development consent area, Central Hunter Bulloak Forest Regeneration, Central Hunter Grey Box-Ironbark Woodland endangered ecological community (EEC), Swamp Oak Forest, River Oak Riparian Woodland, riparian vegetation, aquatic vegetation and rehabilitation. One flora species listed as an endangered population, tiger orchid (*Cymbidium canaliculatum*), has been recorded at a flora monitoring site located near the Mountain Block area.

The nature of the remnant woodland areas directly surrounding Liddell Colliery is not well known. The proposed habitat corridors which form a key part of the Liddell Colliery rehabilitation strategy, will provide links between these areas of unknown remnant vegetation communities. To provide that the habitat corridors provide a functional link between these remnant vegetation areas, additional investigations will be conducted to determine the nature of the remnant vegetation areas. As discussed in **Section 5.272**, one control or analogue sites have been established within remnant vegetation in order to collect the relevant baseline information required to monitor the functionality of the habitat corridors and assist with the development of closure criteria for rehabilitation areas on-site.

Six threatened bird species, the speckled warbler (*Pyrrholaemus sagittatus*), the grey-crowned babbler (*Pomatostomus temporalis temporalis*), blue-billed duck (*Oxyura australis*), brown treecreeper (*Climacteris picumnus victoriae*), hooded robin (*Melanodryas cucullata cucullata*) and the little eagle (*Hieraaetus morphnoides*) and seven threatened mammal species the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), the eastern freetail-bat (*Mormopterus norfolkensis*), the eastern cave bat (*Vespadelus troughtoni*), eastern false pipistrelle (*Falsistrellus tasmaniensis*), greater broad-nosed bat (*Scoteanax rueppellii*), large-footed myotis (*Myotis adversus*) and spotted-tailed quoll (*Dasyurus maculatus*) have been recorded within the development consent area. With the exception of the blue-billed duck, all other threatened species records are relatively commonly recorded threatened species in the Hunter region where suitable habitat exists. The blue-billed duck sightings are significant records of the species in the Hunter region, with the nearest known record occurring in the Newcastle area. No records of the blue-billed duck are known from nearby Lake Liddell.

1.622 Surface and Groundwater

Liddell Colliery is located within three catchments, Lake Liddell to the west, Bowman's Creek to the east and Bayswater Creek to the south. Bowman's Creek and Bayswater Creek drain to the Hunter River. Bowman's Creek catchment has been substantially disturbed by agricultural and mining activities. Bowman's Creek is a natural system, with significant riparian and aquatic communities, which is subject to variable water quality and flow based on fluctuations within the catchment. The catchment of Bayswater Creek has also been substantially disturbed by agricultural and mining activities and significantly reduced by the construction of Lake Liddell. The Bayswater Creek catchment downstream of Lake Liddell is estimated to be one quarter of the former catchment area. This catchment area is insufficient to maintain continuous flow in Bayswater Creek. The creek is a highly modified system engineered in its upper section to accept discharges from Lake Liddell under the Hunter River Salinity Trading Scheme (HRSTS), providing the primary source of stream flow.

The development consent area contains two forms of groundwater aquifer, the alluvial aquifers of Bowman's and Bayswater Creeks and the hard rock aquifer associated with the Wittingham Coal Measures. The underground workings located within the development consent area also contain substantial water. As mining progresses through these workings, the water is pumped from the workings to enable mining to progress.

1.623 Water Quality

This section uses the data from the 2008 LMP as it reflects a baseline level for the site.

The Liddell Colliery Surface Water Monitoring Program (Umwelt 2008) outlines the surface water monitoring required to be undertaken at Liddell Colliery to ensure compliance with statutory requirements at Liddell Colliery. Water quality has been monitored at Liddell Colliery since July 2004 at locations on Bayswater Creek and Bowman's Creek. The water quality of surface water dams and water discharged from Dam 13 has been monitored in accordance with the HRSTS. Monitoring indicates that pH levels across Bayswater and Bowman's creeks generally range from 7.3 to 8.4, with pH levels in the dams located on-site at Liddell Colliery ranging from 7.5 to 10.3. Conductivity in the creeks generally ranged from 244 µS/cm to 6080 µS/cm, with samples collected in Bayswater Creek recording levels up to 7110 µS/cm (AEMR, AECOM 2011). The results of the surface water monitoring program have indicated that despite fluctuations in some water quality parameters, water quality at Liddell Colliery has remained fairly consistent at each sampling location throughout the period of monitoring.

Monitoring of groundwater levels undertaken in piezometers in Bowman's Creek alluvium between 2002 and 2007 indicates that groundwater levels have exhibited an overall downward trend. Groundwater levels generally fluctuated over a two to five metre range. The exceptions were piezometers PGW5 Large, LC1, Haz 4, Haz 6 and Mt Owen Bore which have the same general pattern of fluctuation as the other piezometers but with greater variability associated with periods of pumping from groundwater storages.

Groundwater levels generally decreased over the monitoring period, with the exception of two alluvium piezometers located adjacent to Bowman's Creek (ALV2 and ALV8) which experienced an increase in groundwater levels from May to June 2007 associated with heavy rainfall. The overall decrease in water levels in the majority of the piezometers is likely to be related to continued low levels of rainfall throughout the monitoring period. The results of this monitoring indicate that dewatering of underground workings is not having a discernible impact on water levels in the alluvial aquifers.

The groundwater quality at Liddell Colliery has been monitored at a series of piezometers every two months since October 2002. The groundwater quality of the alluvial aquifer has been monitored at seven locations using dual piezometers and the groundwater quality of the hardrock aquifer has been monitored at five locations. This monitoring has found that the pH of the alluvial aquifer ranged from 6.7 to 9.1 excluding outliers and conductivity generally ranged from 648 µS/cm to 4890 µS/cm. pH levels in the hardrock aquifer ranged from 7.3 to 8.8 excluding outliers and conductivity in the hardrock aquifer generally ranged from 23.2 µS/cm to 5840 µS/cm (LMP, Umwelt 2008).

1.624 Land Capability

Six land capability classes (Classes IV to VIII and M) occur within the Liddell Colliery development consent area. Classes IV, V and VI dominate the majority of the Liddell Colliery development consent area, with some minor areas of Class VII land. The current mining operations have been identified as Class M.

The highest land capability class within the Liddell Colliery development consent area is Class IV which is predominately located along areas of alluvial deposits including Bowman's Creek, Chain of Ponds Creek and Bayswater Creek. The remainder of the site is dominated by Class VI land.

1.7 Preliminary Final Land Use Options and Rehabilitation Strategy

The nominated end land use for Liddell Colliery is grazing, with habitat corridors consisting of trees, shrubs and groundcover. The rehabilitation strategy aims to emulate the pre-mining grazing areas, enhance local and regional ecological linkages and provide for a sustainable land use option (Umwelt 2006). The pre-mining land capability of the site was assessed as Classes IV, V, VI and VII. The rehabilitation strategy aims to rehabilitate the site to an equivalent land capability.

The end land use and landscape design for Liddell Colliery is intended to be compatible with adjoining lands, the DRE's Synoptic Plan and more recently the Strategic Regional Land Use Plan for the Upper Hunter (Department of Planning and Infrastructure 2012).

Alternative sustainable land use options may also be investigated as part of the detailed mine closure planning phase. Where alternative options are considered both environmentally and economically feasible, consultation will be undertaken with relevant stakeholders and approvals sought (if required) prior to implementation.

2. MINE CLOSURE AND REHABILITATION STAKEHOLDER CONSULTATION STRATEGY

2.1 Stakeholder Identification Analysis

A range of stakeholders have been identified as part of the EA (Umwelt 2006). A list of these stakeholders and their potential needs pertaining to rehabilitation and mine closure is outlined in **Table 2.1**.

Table 2.1 – Stakeholder Needs Analysis

Stakeholder	**Information Requirements and Method of Consultation**
Local community	To be informed and provided with the opportunity to provide feedback in relation to rehabilitation objectives/criteria and progress throughout the life of the mine and at closure. Communication will be undertaken via periodic newsletters and face to face meetings.
Community Consultative Committee (CCC)	To be informed and provided with the opportunity to provide feedback in relation to rehabilitation objectives/criteria and progress throughout the life of the mine and at closure. Communication will be undertaken via CCC scheduled meetings.
Division of Resources and Energy (DRE)	Refer to **Sections 1.3, 2.2 and 3.33**
Environment Protection Authority (EPA)	Refer to **Sections 1.3, 2.2 and 3.37**

Stakeholder	Information Requirements and Method of Consultation
Rural Lands Protection Board	To be notified of potential impacts and remediation progress of rural lands or in relation to weed or feral animal control measures to be implemented on site. Communication will be undertaken as required.
NSW Rural Fire Service	Refer to **Sections 1.3 and 2.2**
Department of Planning & Infrastructure	Refer to **Sections 1.3, 2.2 and 3.3**
NSW Office of Water (NOW)	Refer to **Sections 1.3, 2.2 and 3.3**
Singleton Council	Refer to **Sections 1.3 and 2.2**
Muswellbrook Council	Refer to **Sections 1.3 and 2.2**
Minewatch	To be informed and provided with the opportunity to provide feedback in relation to rehabilitation objectives/criteria and progress throughout the life of the mine and at closure. Communication will be undertaken via periodic newsletters.
Surrounding land users – mines, power stations	To be informed and provided with the opportunity to provide feedback in relation to rehabilitation objectives/criteria. In particular, the potential for synergies between the mine area and these land uses (i.e. linkage of conservation corridors etc.). Communication will be undertaken as part of ongoing rehabilitation planning process.
Xstrata Coal	As per Xstrata and XCN internal communication standards.
Potential Final land user	If identified, land user should be consulted through the detailed mine closure development process in order to maximise potential opportunities to value add to the land.
Aboriginal groups	Consultation as required pertaining to the management of Aboriginal heritage sites.
Local business community	To be consulted regarding any Social Impact Assessments that may be required prior to mine closure (refer to **Section 2.4**).
Employees	Likely timing of mine closure and implications for future employment. To be communicated via Liddell Coal's internal communication procedures.

2.2 Regulatory Authorities

The closure, decommissioning and rehabilitation process for Liddell Colliery will be regulated by the DRE. The consultation strategy with the DRE will include the following:

- annual environmental inspections following the submission of the Annual Environmental Management Report (AEMR);
- submission of a Mining Operations Plan for Mine Closure;
- periodic inspections with Departmental representatives throughout the closure process; and
- the supply of 'as-constructed' drawings of the final landform for submission to the DRE on completion of closure.

Throughout the operational phase of Liddell Colliery, copies of the AEMR will be distributed to other relevant regulatory authorities to enable feedback on Liddell Coal's rehabilitation strategy and progress. If requested, the MOP for Mine Closure will also be forwarded to the other relevant regulatory authorities (SC and MSC, EPA, DP&I and NOW) for review.

During the mine closure phase, it is envisaged that each of these authorities will be invited to attend an annual status meeting to discuss the progress of closure, decommissioning and rehabilitation works until there is regulatory consensus on the successful closure of the site.

2.3 Other Relevant Stakeholders

Liddell Colliery actively seeks to engage and consult with the community to provide information relating to the rehabilitation and mine closure strategies for Liddell Colliery and to enable the community to provide feedback.

Liddell Colliery employs a variety of strategies to facilitate effective stakeholder communications including the distribution of community newsletters and one on one meetings where required. Public access to information relating to Liddell Colliery operations is available through the website: www.liddellcoal.com.au.

The Liddell Colliery Community Consultative Committee (CCC) enhances the mine's relationship with the community by providing a formal forum for interaction between the community and mine management. The CCC includes members of the local community and local government. These representatives share information from the meetings with the rest of the community and bring back items for discussion at the CCC meetings. The CCC reviews and provides advice on the environmental performance of the development, including any construction or environmental management plans, monitoring results, audit reports or complaints. The CCC will be continued during the mine closure process.

2.4 Social Impact Assessment

As per the Xstrata and XCN Mine Closure Planning Standards, a social impact assessment will be required leading up to the development of a Mining Operations Plan for Mine Closure (e.g. within five years of life of mine). The following issues may be included as part of the scope of the social impact assessment includes:

- an assessment of Liddell Colliery's expenditure patterns in the local area, community contributions, location of the residence of employees as well as potentially affected local businesses and suppliers. The aim being to identify the dependence of the local community on the mine;
- level of dependence between employees/contractors, and local/regional community such as their use of local infrastructure, e.g. where do employees send their children to school, what health facilities do they use? etc.;

- the proportion of local business provided by Liddell Colliery to local businesses/suppliers;
- potential impacts on service providers as a result of eventual closure and potential relocation of staff, e.g. schools;
- community/stakeholder views on closure options to be investigated; and
- identification of growth industries within the LGAs and other possible industries of future employment for employees following closure.

The outcomes of the social impact assessment will be utilised by LCO to determine whether there may be feasible opportunities to minimise negative social impacts of mine closure (e.g. re-training for employees; redundancy packages; building skill base in community).

The social impact assessment may also identify opportunities where LCO can provide a positive social legacy following closure. Examples may include the implementation of a sustainable final land use that will provide ongoing employment opportunities. However, any alternative final land use options would be the subject of the approval from the relevant government agencies.

3. MINE CLOSURE PLAN

The Liddell Colliery Mine Closure Plan has been developed in consideration of economic, social and environmental factors to provide that LCO meets the relevant statutory obligations, establishes a sustainable post-mining land use and achieves successful relinquishment of leases and licences.

3.1 Issues/Risks to Achieve Successful Mine Closure

A list of issues and risks that may impact upon Liddell Coal's ability to achieve successful mine closure and where they are addressed within this document is outlined in **Table 3.1**.

Table 3.1 – Issues/Risks that may affect successful Mine Closure and where they are addressed in this Plan

Issue/Risk	**Section of Report Addressed**
Failure to comply with Xstrata Standards	**Section 3.43** – Xstrata Standards and Guidelines
Failure to meet government and community guidelines and expectations	**Section 3.2** – Mine Closure Socio Economic Risks and Opportunities **Section 3.5** – Mine Closure Objectives and Criteria **Section 2.** – Stakeholder Consultation Strategy
Inadequate provision to meet the cost of both planned and unexpected mine closure	**Section 3.11** – Mine Closure Cost Estimates
Delayed relinquishment of lease due to poor rehabilitation	**Section 3.43** – Xstrata Standards and Guidelines **Section 3.82** – Care and Maintenance Period **Section 7.** – Lease and Licence Relinquishment Process
Lost opportunity on most feasible/sustainable land use option	**Section 3.43 –** Xstrata Standards
Delays in closure project	**Section 3.11** – Mine Closure Cost Estimates

Issue/Risk	Section of Report Addressed
Availability of contractors, equipment etc	**Section 3.10 -** Management of Risks Associated with Mine Closure
Inefficient use of machinery during closure	**Section 3.10 -** Management of Risks Associated with Mine Closure
Legal implications due to termination of site contracts	**Section 3.3 –** Legal and Other Requirements
Not having proper permits/approvals in place for closure activities	**Section 3.3 –** Legal and Other Requirements
Asset theft	**Section 3.10 -** Management of Risks Associated with Mine Closure
Loss of Corporate History during or after transition	Whole of Plan
Inability to maintain Operations due to extremely high turnover in workforce	**Section 3.10 -** Management of Risks Associated with Mine Closure
Delay in final closure due to extended time in asset disposal	**Section 3.10 -** Management of Risks Associated with Mine Closure

3.2 Mine Closure Socio Economic Risks/Opportunities

There are approximately 377 employees at Liddell Colliery, comprised of 342 LCO employees and 35 contractors. Employment provided by Liddell Colliery and the benefits of indirect employment have significant economic flow on effects in the local and regional communities. Substantial industry expenditure occurs locally, in the townships of Singleton and Muswellbrook, but is also directed to the broader Hunter and NSW regions.

In consideration of Liddell Colliery's contribution to the socio economic status of the community, the closure of the site may require the development of social impact mitigation strategies as part of the Mining Operations Plan for Mine Closure. Details regarding the scope of a social impact assessment that may be undertaken leading up to planned mine closure in order to identify any necessary social impact mitigation strategies is outlined in **Section 2.4**.

3.3 Implications of Legal and Other Requirements for Mine Closure

This plan has been developed to address a range of legal and other requirements, specifically in relation to rehabilitation and mine closure. A description of these legal and other requirements are detailed in the sections below.

3.31 Development Consent

Liddell Colliery is operated in accordance with development consent DA305-11-01. The development consent is valid until 31 December 2023. From that date, the consent will continue to apply in all other respects other than the right to conduct further mining operations until the site has been rehabilitated to a satisfactory standard.

Development consent conditions with relevance to mine closure are those that impose restrictions or requirements on final rehabilitation and require post-mining monitoring. Specific consent conditions relating to the preparation of this LMP are outlined in A**ppendix 1**.

3.32 Mining Leases

Liddell Colliery operates primarily under one consolidated mining lease, ML 1597. ML 1597 expires on 5 November 2028. Small parts of other leases detailed in **Table 3.2** also apply.

Table 3.2 – Leases and Licences

Instrument	Authority	Approval/Expiry
Mining Lease 1597	Division of Resources and Energy	Expires 5 November 2028
Consolidated Coal Lease No. 708	Division of Resources and Energy	Expires 30/12/2023
Mining Lease No. 1313	Division of Resources and Energy	Expires 13/10/2023
Mining lease No. 1552	Division of Resources and Energy	Expires 10/03/2025

3.33 DRE Guidelines

DRE have several guidelines and policies relevant to mine closure available on their website: www.resources.nsw.gov.au/environment. These documents have been considered in the development of this Closure Strategy.

3.34 Mining Operations Plan

The Liddell Colliery MOP (Umwelt 2007) details the continuance of mining activities during the period of 2008 to 2015. Prior to the cessation of mining operations, a new MOP detailing mine closure activities will be required to be submitted to the DRE for approval.

3.35 DRE Synoptic Plan

The DRE Synoptic Plan aims to provide a basis for the development of a long term integrated strategy for rehabilitation of mines. The rehabilitation strategy for Liddell Colliery has been developed to fulfill the Synoptic Plan and considers the potential regional outcomes for visual amenity, biodiversity and sustainable post closure use. The final landform aims to provide habitat corridors which are consistent with the intent of the broader regional corridor system outlined within the Synoptic Plan.

3.36 Strategic Regional Land Use Plan for the Upper Hunter (DP&I 2012)

The Strategic Regional Land Use Plan for the Upper Hunter has been developed to provide a strategic framework for delivering the necessary context for government investment priorities, servicing strategies and local environmental plan making for the Upper Hunter. Amongst the various land use types, the Strategy outlines the importance of the protection of biodiversity through strategic land use planning. It recognises that post mining rehabilitation has the potential to contribute to biodiversity conservation in the longer term, but will require effective design and planning to maximise its landscape in the future.

The Strategic Regional Land Use Plan has provided a regional conservation assessment and has identified and mapped areas of high (Tier 1) and moderate (Tier 2) terrestrial and aquatic values. Several pockets of Tier 2 Terrestrial Biodiversity areas have been identified within the Ravensworth area. It is considered that the proposed final land use within Liddell Colliery will be consistent with these values, with vegetation corridors designed to facilitate linkages with the biodiversity values of the broader area.

3.37 Environment Protection Licence

Liddell Colliery operates under Environmental Protection Licence (EPL) 2094. The licence is held by Liddell Coal.

Fees for the EPL are based on production levels of saleable material. The current production level category for the EPL is 3.5 to 5 Million tonnes per annum (Mtpa) of saleable material. During operation, this will be increased to 5 Mtpa of saleable material at peak production, and then reduced as the productions level decline.

The EPL specifies monitoring 'points' and these are detailed in **Table 3.3** and **Figure 3.1**.

Table 3.3 – Monitoring Points Specified in Liddell Colliery EPL 2094 (14 Dec 2011 version)

Monitoring Point	Pollutant/ parameter measured	Units of Measure	Frequency	Location
1 – Total Suspended particulate network, PM10 and Total Suspended Particles	PM_{10}	$\mu g/m^3$	Every 6 days	At locations where the level of particulate matter being sampled is representative of emissions from the operation of the mine taking into account prevailing wind direction and the location of residential properties or other sensitive receivers
	TSP	$\mu g/m^3$	Every 6 days	
2 - Hunter River Salinity Trading Scheme discharge and monitoring point	Conductivity	µS/cm	Continuous during discharge	Discharge point located at Dam 13, south of siphons, upstream of discharge flume and labelled 'Licence Discharge Point' on plan no. LOC/A4/253 titled 'LCO Operations Licence Discharge Points and Downstream Sampling Location' dated 24/2/00.
	Total Suspended Solids	mg/L	Daily when wastes discharged	
	pH	pH	Daily when wastes discharged	
3 - Dust Deposition Network	Deposited Matter	$g/m^2/month$	Once a month (min of 4 weeks)	Dust deposition monitoring sites as shown on drawing titled 'Figure 1 LCO Noise, Dust and Blast Monitoring Locations' on file 270051A14 with NEF14618 dated 17 June 2004.

Monitoring Point	Pollutant/ parameter measured	Units of Measure	Frequency	Location
4 – Weather Monitoring	Rainfall Wind speed @10m Wind direction @10m Temperature @ 2m Temperature @10m Sigma Theta @10m	mm m/s degrees Deg C Deg C Degrees	Continuous	At a location where the parameters being sampled are representative of the prevailing weather conditions of the licence area.
5 – Discharge to waters. Discharge quality monitoring	Faecal coliforms	Once a month (min of 4 weeks)	Grab sample	Discharge from the wastewater treatment plant to Dam 13/13B shown on figure 2.1 of the "SEE for Liddell Colliery Modification to Development Consent" dated February 2008.

Legend

- DA Boundary
- CHPP Infrastructure
- Depositional Dust Monitoring site
- High Volume Air Sampler - PM10
- High Volume Air Sampler - TSP
- Private Residence
- Mine Owned Tenanted Residence

File Name (A4): R01/3116_004.dgn
20121005 12.00

FIGURE 3.1

Liddell Colliery EPL Monitoring Points

In most cases following mine closure, the EPA will generally not relinquish the EPL until such time that DRE has signed-off on the successful rehabilitation of the site. Measures to provide for compliance with the EPL have been considered as part of this document and an annual return for the EPL will be required until the licence is relinquished.

It is likely that EPA will require that monitoring of air quality and any discharge water be continued during active decommissioning works and potentially as part of post mine closure until the site is fully decommissioned and rehabilitated. The exact scope of ongoing monitoring will be confirmed with EPA as part of the development of the Mining Operations Plan for Mine Closure.

Upon the cessation of mining operations, LCO will seek a variation to the existing licence to reflect mine closure activities as opposed to an operating mine (e.g. monitoring conditions, licence fee activity scale).

At the completion of closure or at such time that EPA has confirmed that an EPL is no longer required for the site, following the approval of XCN and application to relinquish the EPL will be submitted to EPA. The application will need to be accompanied with support documentation to demonstrate that there will be no ongoing pollution issues associated with the site.

Further to the EPL, Liddell Colliery also holds a licence in regards to the management of density gauges on site that contain radioactive materials (refer to **Table 3.4**).

Table 3.4 - Radiation Density Gauge Licences

Radionuclide	EPA Registration Number	Nominal Activity
Am-241	1259 exp 23/6/14	1100MBq
Cs-137	1260 exp 23/6/14	370 MBq
Cs-137	20152 exp 1/12/14	7.4GBq
Cs-137	20153 exp 1/12/14	7.4GBq
Cs-137	20148 exp 1/12/14	370 MBq

Prior to the decommissioning of the CHPP infrastructure at closure, LCO will be required to either dispose of the gauges in an EPA approved manner or through consultation with EPA, transfer the licence if sold for use by another operation.

3.38 Water Licences

A list of the water licences that are held for Liddell Colliery is provided in **Tables 3.5** and **3.6**.

Table 3.5 – Liddell Colliery Surface Water Licences

Site	Instrument	Authority	Issue Date	Expiry Date
Bowman's Creek	Licence No. WAL 18320 Irrigation – 50ML annually	NOW	5/04/2002	Ongoing
Bayswater Creek	Licence No. WAL 18306 Industrial – 100 ML annually	NOW	5/11/2001	Ongoing
Hunter River	Licence No. WAL 13387 Industrial – 20 ML annually	NOW	N/A	N/A
Hunter River via Macquarie Generation	Licence No. WAL 7815 Industrial – 20ML annually	NOW	13/08/2008	Ongoing
Bowmans Creek	WAL 18304 Irrigation – 32 ML annually	NOW	N/A	N/A
Bowmans Creek	WAL 18318 Irrigation – 55 ML annually	NOW	N/A	N/A
Bowmans Creek	WAL 18302 5ML annually	NOW	1/8/2009	31/7/2019

Note: N/A – Information not available

Table 3.6 – Liddell Colliery Groundwater Licences

Site	Instrument	Authority	Issue Date	Expiry Date
Haz 6	Licence No. 20BL168066 Monitoring Bore	NOW	28/05/2002	In perpetuity
Dur 3	Licence No. 20BL168065 Monitoring Bore	NOW	28/05/2002	In perpetuity
LC1	Licence No. 20BL168064 Monitoring Bore	NOW	27/05/2002	In perpetuity
Durham 1	Licence No. 20BL168063 Mine Dewatering – 6000ML annually	NOW	22/09/2004	21/09/2014
8 South 1 & 2	Licence No. 20BL168062 Mine Dewatering – 6000 ML annually	NOW	22/09/2004	21/09/2014
Durham 2 & 4	Licence No. 20BL168061 Mine Dewatering – 1000 ML annually. Dur 4 redundant	NOW	22/09/2004	21/09/2014
Haz 1 & 2	Licence No. 20BL168060 Mine Dewatering – 5500ML annually	NOW	22/09/2004	21/09/2014
ALV1, ALV2, ALV3, ALV4, ALV7, ALV8	Licence No. 20BL168053 Monitoring Bores	NOW	23/03/2001	In perpetuity
463 Hebden Road, Ravensworth	Licence No. 20BL020923 Irrigation	NOW	N/A	N/A
M49	Licence No. 20BL172293 Mine Dewatering	NOW	5/02/07	12/2/2014
Middle Liddell	Licence No. 20BL172588	NOW	16/9/2010	15/9/2015

Note: N/A – Information not available

There are no specific conditions within these licences that relate to mine closure however, at mine closure, the mine dewatering boreholes will be sealed in accordance with the DRE's guidelines. Where no longer required, groundwater monitoring boreholes will also be sealed.

3.4 Planning Requirements

3.41 State Planning Policies

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (the Mining SEPP) applies to mining and associated activities at Liddell Colliery. Section 10 of the Mining SEPP outlines a range of exempt development, which does not require approval under the EP&A Act. Exempt development listed under the Mining SEPP that specifically relates to the decommissioning process includes the demolition of a building or structure that is carried out in accordance with *AS 2601 – 2001 Demolition of Structures*. However, this is only if the building or structure is not or is not part of a heritage item, or in a heritage conservation area identified by an environmental planning instrument.

3.42 Local Environmental Plans

Liddell Colliery is divided between the Singleton and Muswellbrook Local Government Areas (LGAs). As a result both the Singleton Local Environmental Plan (LEP) 1996 and the Muswellbrook LEP 2012 apply. The rehabilitation and closure strategy has been developed in consideration of the objectives of each of these LEPs. Amendments that may occur to these LEPs will be evaluated as part of ongoing revisions to this LMP and in the development of the Mining Operations Plan for Mine Closure.

3.421 Singleton Local Environmental Plan 1996

The Liddell Colliery area within the Singleton LGA is classified as 1(a) Rural Zone. The objectives of 1(a) Rural zone are:

- to protect and conserve agricultural land and to encourage continuing viable and sustainable agricultural land use;
- to promote the protection and preservation of natural ecological systems and processes;
- to allow mining where environmental impacts do not exceed acceptable limits and the land is satisfactorily rehabilitated after mining;
- to maintain the scenic amenity and landscape quality of the area;
- to provide for the proper and co-ordinated use of rivers and water catchment areas; and
- to promote provision of roads which are compatible with the nature and intensity of development and the character of the area.

3.422 Muswellbrook Local Environmental Plan 1985

The Liddell Colliery area within the Muswellbrook LGA is classified as RU1 Primary Production, with the CHPP area classified as SP2 Infrastructure.

The objectives of zone RU1 Primary Production are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To protect the agricultural potential of rural land not identified for alternative land use, and to minimise the cost to the community of providing, extending and maintaining public amenities and services.

- To maintain the rural landscape character of the land in the long term.
- To ensure that development for the purpose of extractive industries, underground mines (other than surface works associated with underground mines) or open cut mines (other than open cut mines from the surface of the flood plain), will not:
  a) destroy or impair the agricultural production potential of the land or, in the case of underground mining, unreasonably restrict or otherwise affect any other development on the surface;
  b) detrimentally affect in any way the quantity, flow and quality of water in either subterranean or surface water systems; or
  c) visually intrude into its surroundings, except by way of suitable screening.
- To protect or conserve (or both):
  a) soil stability by controlling development in accordance with land capability;
  b) trees and other vegetation;
  c) water resources, water quality and wetland areas, and their catchments and buffer areas, and
  d) valuable deposits of minerals and extractive materials by restricting development that would compromise the efficient extraction of those deposits.

The key objectives of SP2 Infrastructure zone that are relevant to Liddell Colliery are to:

- To provide for infrastructure and related uses.
- To prevent development that is not compatible with or that may detract from the provision of infrastructure.
- To recognise existing railway land and to enable future development for railway and associated purposes.
- To recognise major roads and to enable future development and expansion of major road networks and associated purposes.
- To recognise existing land and to enable future development for utility undertakings and associated purposes.

3.43 Xstrata Standards and Guidelines

Further to the legal requirements as outlined above, Xstrata has undertaken a pro-active approach to rehabilitation and mine closure by developing a range of standards that are to be implemented across its business units. This plan has been prepared to address the requirements of these standards that are outlined in the sections below.

3.431 Xstrata Plc Standard – Planning, Resources and Targets

It is an Xstrata Plc Standard requirement that an Annual HSEC Plan (for internal purposes only) is to include a closure plan that:

- provides an assessment of all operational closure impacts;
- includes a fully costed closure plan, which is reviewed on an annual basis; and
- includes operational provisioning for closure.

3.432 Xstrata Plc Standard – Biodiversity and Land Management

It is an Xstrata Plc Standard requirement that:

- biodiversity considerations shall be addressed when determining post-closure land use and the rehabilitation or restoration of ecosystems as appropriate; and
- all disturbed and contaminated land shall be progressively rehabilitated and wastes generated by operations shall be effectively managed to a planned post-closure land use.

3.433 Xstrata Coal and XCN Mine Closure Standards

The XCN Mine Closure Standard has been developed to be consistent with the Xstrata Coal Mine Closure Planning Standard; the Xstrata Coal Project Management Manual, which outlines the process for project planning and approvals; and the Xstrata Coal Life of Mine Planning Process. The XCN mine closure planning process includes the trigger points and associated timeframes for the phases of mine closure planning, which includes:

- The development and review of a Conceptual Mine Closure Plan.

  A Conceptual Closure Plan is required where a reserve has a Life of Mine (LOM) greater than five years and includes all new operations. Conceptual closure planning commences during the feasibility, project planning and operational phases of a mine until a Detailed Project Closure Plan is required.
- The process of Detailed Closure Planning, which involves both Pre-feasibility and Feasibility phases to define and develop the scope of a Project Closure Plan.

  The Detailed Closure Planning process is required to be initiated where a reserve has a LOM of less than 5 years. The process requires detailed investigations to provide that the full scope of closure issues are identified, appropriate solutions (e.g. engineering) are developed and adequate provisions are accrued so that post mining land use objectives are met following the execution of a Project Closure Plan (i.e. MOP for Mine Closure).

The XCN Mine Closure Planning Standard also defines the requirements for the development of closure costing and outlines the pathway for obtaining sign-off for lease and licence relinquishment (refer to **Sections 3.11** and **7.0** respectively).

As the life of mine for Liddell Colliery is greater than five years, this document has been prepared in accordance with the requirements of the XCN Mine Closure Standard in relation to the preparation of conceptual mine closure plans.

3.434 XCN Standard for Closure Criteria Development and Rehabilitation Monitoring

This XCN Standard provides guidance to XCN business on developing site specific rehabilitation monitoring programs that will:

- provide the scientific basis for defining rehabilitation objectives and for developing closure criteria and a rehabilitation program that will facilitate lease relinquishment following mine closure;
- assess the long-term stability and functioning of re-established ecosystems on mine affected land; and
- facilitate continuous improvement in rehabilitation practices.

Details regarding the implications of the standard on the development of closure criteria and rehabilitation monitoring for Liddell Colliery are outlined in **Sections 5.1** and **5.27** respectively.

3.44 Other Approvals, Standards and Guidelines

3.441 Strategic Framework for Mine Closure

The Strategic Framework for Mine Closure (ANZMEC and MCA 2000) has evolved as a cooperative development between the Australian and New Zealand Minerals and Energy Council (ANZMEC) and the Australian Minerals Industry represented by the Minerals Council of Australia (MCA) that provides a framework of issues to be considered as part of a mine closure plan. The strategy for mine closure as outlined in this document has been developed in consideration of the six key objectives as identified by this framework document. Each of these objectives is outlined in **Table 3.7**, along with the relevant section of this document where they are addressed.

Table 3.7 – Key Objectives from the Strategic Framework to be addressed in MOP for Mine Closure Document

Key Objectives	Relevant Section of Document
To enable all stakeholders to have their interests considered during the mine closure process	2.1
To ensure the process of closure occurs in an orderly, cost-effective and timely manner	3.
To ensure that the cost of closure is adequately represented in company accounts and that the community is not left with a liability	3.11
To ensure there is clear accountability and adequate resources for the implementation of the closure plan	1.2
To establish a set of indicators which will demonstrate the successful completion of the closure process	3.5
To reach a point where the company has met agreed completion criteria to the satisfaction of the responsible authority	3.5

3.442 Australian Minerals Industry Code for Environmental Management

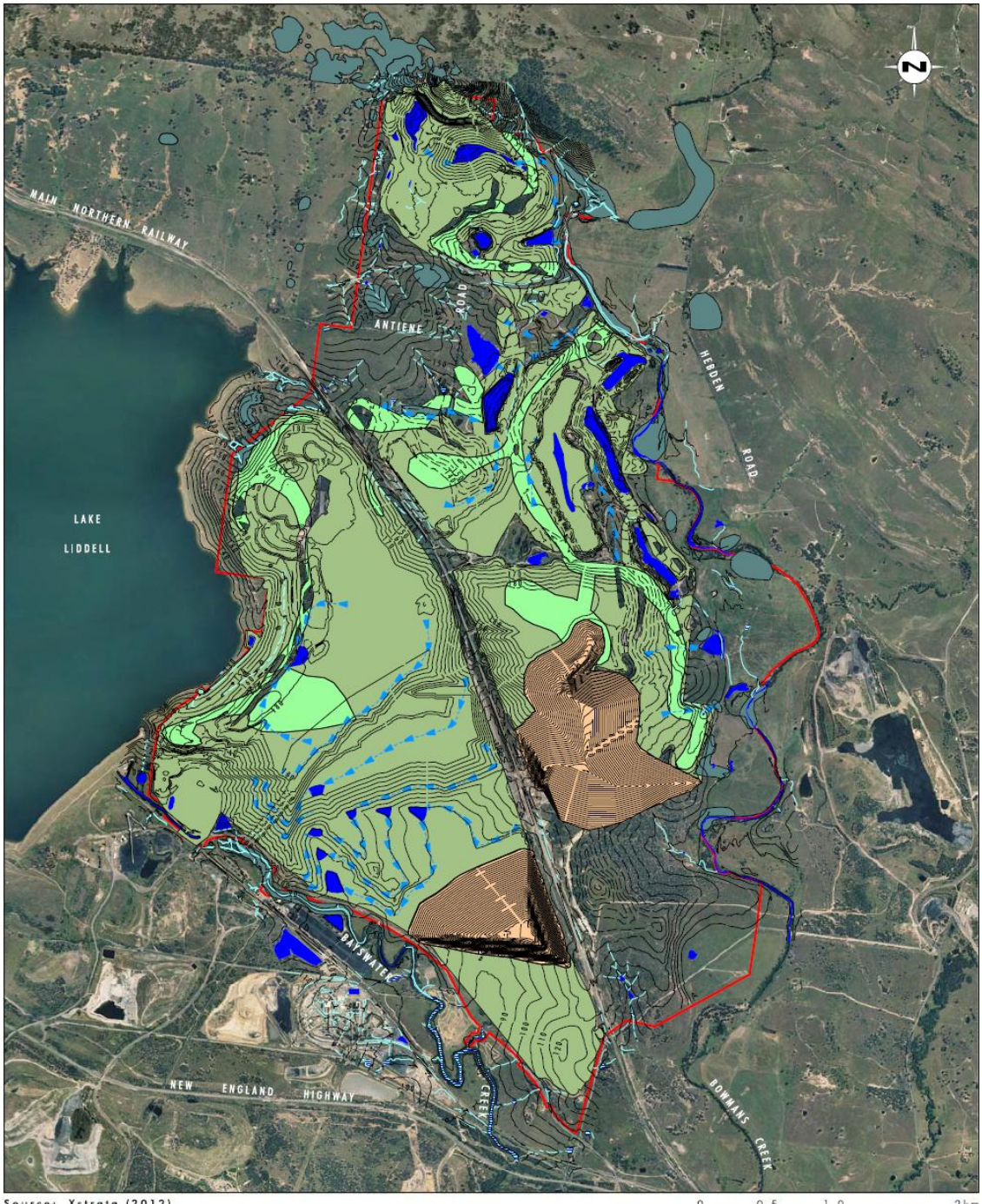
Enduring Value is the Australian Minerals Industry Framework for Sustainable Development. Enduring Value outlines 10 principles that outline the industries commitment to sustainable development. As a business unit of XCN, a signatory to Enduring Value, LCO is committed to adhering to these principles. The objectives relating to mine closure within Enduring Value (contained within Principle 6) are included in **Table 3.8**, along with the relevant section of this document where they are addressed.

Table 3.8 – Key Objectives from Enduring Value Relating to Mine Closure

Enduring Value Objective	**Relevant Section of Document**
Rehabilitate land disturbed or occupied by operations in accordance with appropriate post-mining land uses.	
Consult relevant stakeholders and develop a closure plan that clearly defines the post closure land use.	2.1 and 3.
Where appropriate, rehabilitate progressively over the life of the operation.	5.
Undertake and support research into land and water rehabilitation practices.	5.
Use appropriate technologies to reduce negative environmental impacts and improve site rehabilitation techniques.	5.
Manage and, where appropriate, rehabilitate historical disturbances to an appropriate standard.	5.
Design and plan all operations so that adequate resources are available to meet the closure requirements of all operations.	
Plan operations to minimise costs and risks; comply with relevant laws, standards and guidelines; maximise sustainable development opportunities; and deliver post closure landforms that are safe and stable from physical, geotechnical and ecological perspectives.	3.3, 3.10, 4.
Provide adequate resources to achieve social objectives of closure including any costs associated with community dislocation.	2.4
Set aside funds externally held and not accessible for other purposes to implement the closure plan and to undertake post closure monitoring and maintenance, taking risk into account.	3.11
Periodically review closure plans in the light of changing regulatory requirements and community expectations.	7.

3.5 Mine Closure Objectives

The EA (Umwelt 2006) identified the nominated end land use for Liddell Colliery following rehabilitation as pasture designed to emulate the pre-mining grazing areas. The end land use also includes habitat corridors to enable the protection and preservation of natural ecological systems and processes by linking existing areas of vegetation in surrounding areas. The conceptual final landform and rehabilitation strategy for Liddell Colliery is shown in **Figure 3.2**.



Source: Xstrata (2012)
Note: Contour Interval 5m

0 0.5 1.0 2km
1:40 000

Legend

- DA Boundary
- Remnant Vegetation
- Rehabilitation Habitat Corridors
- Rehabilitation Pasture
- Final Void
- Clean Water Dam
- Stabilised Drainage Line

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FIGURE 3.2

Conceptual Final Landform and Rehabilitation Strategy

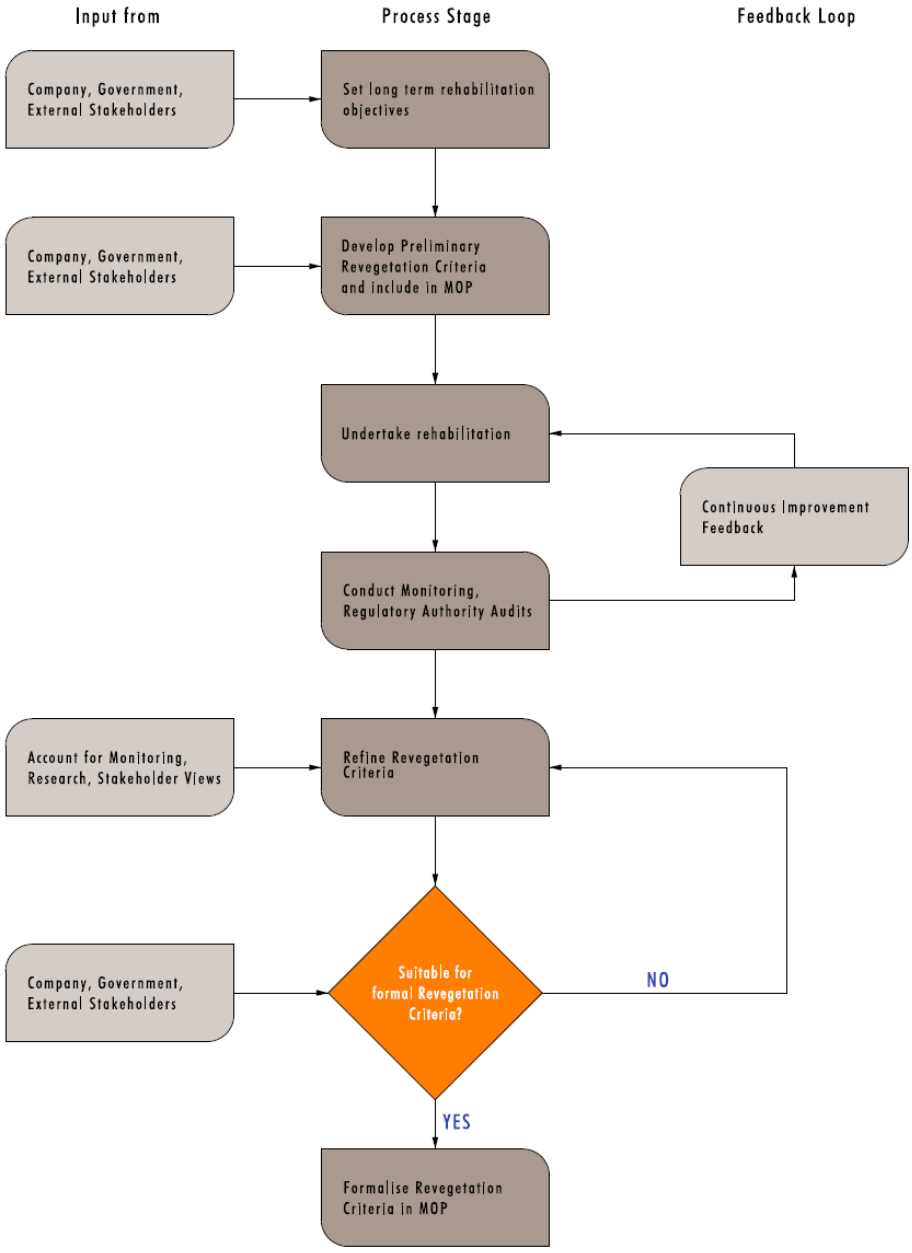

FIGURE 3.3

XCN Process for Developing and Refining Rehabilitation Closure Criteria

Source: Adapted from Nichols 2006

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20120828 14.04

3.6 Closure and Rehabilitation Completion Criteria

Completion criteria are objective target levels or values assigned to a variety of indicators (i.e. slope, species diversity, groundcover etc.), which can be measured against to demonstrate progress and ultimate success of rehabilitation. As such, they provide a defined end point, at which point in time rehabilitation can be deemed successful and the lease relinquishment process can proceed.

Completion criteria, determined in consultation with the relevant stakeholders, will be utilised to demonstrate achievement of rehabilitation objectives. The achievement of the completion criteria will be monitored and reported within the AEMR.

The preliminary closure and rehabilitation completion criteria for the Project are outlined in **Appendix 3**. The criteria have been developed considering site specific issues and objectives, and the relevant XCN Standard.

As illustrated in **Figure 3.3**, the preliminary closure completion criteria will be reviewed and revised throughout the mine life and used as the basis for further refinement following the commencement of rehabilitation activities; consideration of the results of rehabilitation monitoring programs and research trials; and consideration of stakeholder feedback. The completion criteria will be refined and finalised following the completion of the detailed mine closure planning process and presented in the Mining Operations Plan for Mine Closure for approval by the relevant government agencies.

The gradual achievement (or otherwise) of these completion criteria will be assessed and discussed in the annual documentation of monitoring results, which will include the identification of any failures of the criteria, and measures taken to address any such issue. Rehabilitation monitoring is discussed in **Section 5**.

The annual rehabilitation monitoring program will be modified whenever the completion criteria are revised. In 2012, the annual rehabilitation monitoring program was reviewed and updated to ensure the current completion criteria are being assessed appropriately.

3.7 Life of Mine Closure Schedule

During the operational phase, rehabilitation will be undertaken progressively to minimise the total disturbed area at closure.

The current Life of Mine schedule for Liddell Colliery involves the cessation of coal mining in 2023. At this point in time, the decommissioning phase will include activities such as building and infrastructure demolition, capping of tailings dams, overburden reshaping and revegetation activities. The likely duration of the decommissioning phase will be confirmed following the completion of the Mining Operations Plan for Mine Closure. However, given the size of the operation, a two to three year period may be required.

Following the completion of decommissioning works, a rehabilitation care and maintenance program (refer to **Section 3.82**) will be implemented. The aim of this program is to provide that rehabilitated areas are maintained and monitored with the goal of achieving completion criteria and DRE sign off.

3.8 Phases of Mine Closure

3.81 Decommissioning and Rehabilitation Phase

The decommissioning and rehabilitation phase of mine closure will commence upon completion of mining activities in 2021. The details of the decommissioning and rehabilitation phase will be documented as part of a Mining Operations Plan for Mine Closure. The decommissioning and rehabilitation phase will involve:

- the progressive decommissioning of all on-site infrastructure, including the CHPP, administration buildings and train loading facilities;
- removal and rehabilitation of haul roads and rail crossings;
- the completion of contamination studies for relevant areas and subsequent decontamination where required;
- shaping of remaining overburden areas and lowwalls;
- stabilisation of highwall treatments and establishment of safety features (e.g. safety berm and fence);
- capping of tailings dams;
- revegetation activities; and
- maintenance of existing rehabilitation.

Appropriate pollution control measures will be incorporated in decommissioning works to minimise potential impacts on noise, air quality, visual amenity and erosion.

3.82 Rehabilitation Care and Maintenance Phase

Dependent upon the outcomes of the rehabilitation and environmental monitoring programs, the scope of the rehabilitation care and maintenance phase may include the following:

- weed and feral animal control of rehabilitation and offset areas;
- erosion control works and or modification to surface water drains;
- re-seeding/planting of rehabilitation areas that may have failed;
- maintenance fertilising; and
- repair of fence lines, access tracks and other general related land management activities.

It is envisaged that an employee will be required to project manage the care and maintenance phase post-closure to provide for the achievement of lease relinquishment in a timely and cost effective manner.

3.9 Environmental Monitoring

Liddell Colliery has an extensive environmental monitoring network. The requirements of all environmental monitoring are recorded in the Liddell Colliery Environmental Monitoring Program. It is anticipated that various aspects of the environmental monitoring program will continue to be implemented throughout decommissioning works as well as post closure. The exact scope of environmental monitoring will be developed in consultation with the appropriate regulatory authority and included in the Mining Operations Plan for Mine Closure prior to the commencement of decommissioning activities.

During the decommissioning period, a range of pollution control measures will need to be adopted to minimise the potential of escalating noise levels and dust impacts, particularly as machinery will be working at the surface and will not be shielded within the confines of the mining pit, which provides a buffer against noise and dust generation. The continuation of an environmental monitoring program during this period will allow LCO to measure the effectiveness of pollution control measures adopted on site. Based on the outcomes of environmental monitoring, changes to surface activities and or pollution control measures may be required to reduce pollution levels. Following the completion of decommissioning works, further consultation will be undertaken with the appropriate regulatory authorities to tailor an environmental monitoring program for the rehabilitation care and maintenance phase. Proposed variations to the monitoring program may include a reduction and or removal of environmental monitoring points (such as dust and noise monitoring).

An overview of the environmental monitoring requirements that may apply through active decommissioning works and potentially into the rehabilitation care and maintenance phase are outlined below. The results of environmental monitoring will be included in the AEMR.

3.91 Surface Water Monitoring

The requirements of the Liddell Colliery Surface Water Monitoring Program (refer to the Liddell Colliery Water Management Plan) developed in accordance with the development consent and the EPL include the requirement to monitor the following:

- volume and quality of water discharged from the site under the Hunter River Salinity Trading Scheme;
- surface water flows and quality upstream and downstream of the development in Bowman's Creek and Bayswater Creek; and
- surface water quality in on site dams.

Surface water monitoring locations are shown on **Figure 3.4**.

FIGURE 3.4

Liddell Colliery Surface and Groundwater Monitoring Locations

3.92 Groundwater Monitoring

The requirements of the Liddell Colliery Groundwater Monitoring Program (refer to the Liddell Colliery Water Management Plan) developed in accordance with the development consent, requires LCO to monitor:

- the volume of groundwater seeping into the open cut mine workings;
- regional groundwater levels and quality in the surrounding aquifers; and
- the groundwater pressure response in the surrounding coal measures.

Groundwater monitoring locations are shown on **Figure 3.4**.

3.93 Noise Monitoring

The requirements of the Noise Monitoring Program, developed in accordance with the development consent, requires LCO to undertake attended and unattended noise monitoring at the locations shown on **Figure 3.5**.

3.94 Air Quality Monitoring

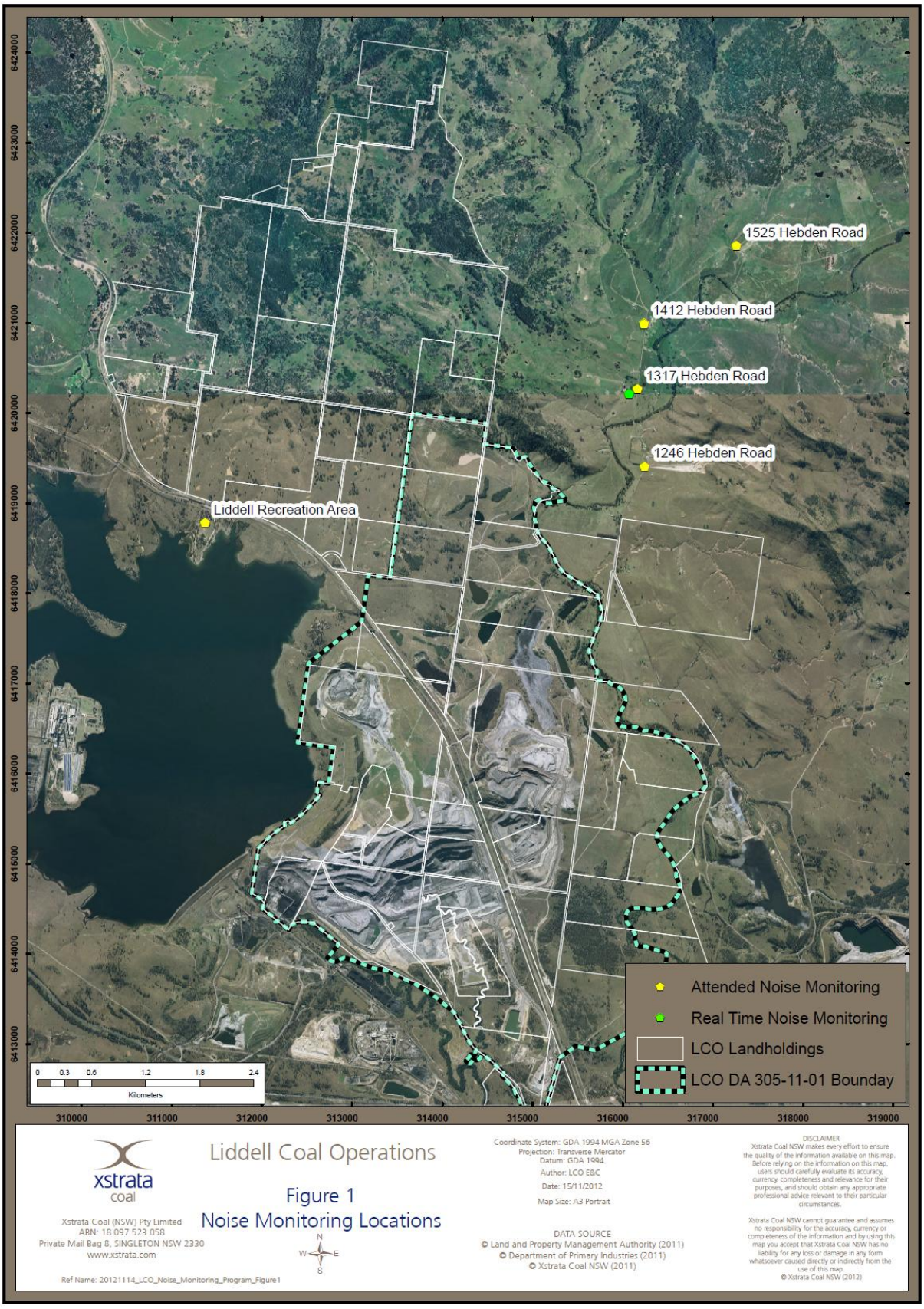
The Liddell Colliery EPL and Air Quality Monitoring Program developed in accordance with the development consent require LCO to undertake air quality monitoring of depositional dust, PM_{10} and TSP. Ambient air monitoring is required to determine representative emissions from the operation of the mine and is required to continue until rehabilitation works at Liddell Colliery have ceased. The current air quality monitoring locations are provided on **Figure 3.1**.

3.95 Meteorological Monitoring

The Liddell Colliery weather station is utilised for measuring rainfall, temperature, wind direction and wind speed. It is envisaged that the weather station would be maintained until lease relinquishment with the aim of providing meteorological support data to other environmental and rehabilitation monitoring programs on site.

3.96 Rehabilitation Monitoring

Rehabilitation monitoring will continue throughout the care and maintenance period. Monitoring to be undertaken in the post rehabilitation phase of the mine operation is outlined in **Section 5.27**.


1525 Hebden Road
1412 Hebden Road
1317 Hebden Road
1246 Hebden Road
Liddell Recreation Area
Attended Noise Monitoring
Real Time Noise Monitoring
LCO Landholdings
LCO DA 305-11-01 Bounday
0 0.3 0.6 1.2 1.8 2.4
Kilometers
6424000
6423000
6422000
6421000
6420000
6419000
6418000
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6415000
6414000
6413000
310000
311000
312000
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316000
317000
318000
319000
Liddell Coal Operations
Figure 1
Noise Monitoring Locations
Xstrata Coal (NSW) Pty Limited
ABN: 18 097 523 058
Private Mail Bag B, SINGLETON NSW 2330
www.xstrata.com
Ref Name: 20121114_LCO_Noise_Monitoring_Program_Figure1
Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Author: LCO E&C
Date: 15/11/2012
Map Size: A3 Portrait
DATA SOURCE
© Land and Property Management Authority (2011)
© Department of Primary Industries (2011)
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3.10 Management of Risks Associated with Mine Closure

The Mining Operations Plan for Mine Closure and associated cost estimates (refer to **Section 3.11**) will be developed to address the key issues/risks that may affect successful mine closure. Amongst the issues to be addressed include:

- delays in closure project;
- availability of contractors, equipment;
- inefficient use of machinery during closure;
- legal implications due to termination of site contracts;
- site security/asset theft;
- inability to maintain operations due to extremely high turnover in workforce; and
- delay in final closure due to extended time in asset disposal.

3.11 Mine Closure Cost Estimates

As per the XCN Mine Closure Standard, LCO has developed cost estimates for the following two mine closure scenarios:

- Planned mine closure at 2023.

  LCO has prepared a cost estimate for planned mine closure, which has been used as the basis for the implementation of a mine closure accrual system. The objective of this accrual system is to provide that sufficient funds are available to undertake and satisfactorily complete mine closure activities.

  Costs for planned mine closure are calculated on the costs incurred following the cessation of coal mining. All costs incurred up until this time, including progressive rehabilitation, are considered as operational costs.

  As per XCN requirements, these costs are to be reviewed internally only by XCN and LCO on an annual basis and closure accruals adjusted accordingly. As the scope of mine closure activities become more defined closer to the closure date, cost estimates will be further refined based on the outcomes of detailed closure planning.
- Imminent mine closure, which is the basis for the self-calculated security deposit required by DRE.

  This estimate, which is calculated in accordance with the DRE's Security Calculation Tool, is reviewed annually and if substantial change has occurred (+/- 10%) a revised estimate is submitted to DRE.

4. FINAL VOID MANAGEMENT PLAN

The proposed final landform at Liddell Colliery will contain two final voids. The final voids will be located within the South Pit and Entrance Pit areas. The depth and area of the final voids will be dependent on the timing of mine closure and decommissioning, and the extent of mining conducted on the site at the time of closure. The conceptual final voids are shown on the final landform plan, refer to **Figure 3.2**.

The main objectives of final void management will be to:

- minimise the area of disturbance and maximise the area of land restored to its former land capability;
- provide a landform which is stable and able to be maintained in the long term; and
- provide for a minimal risk to public safety.

Specific rehabilitation criteria/requirements for the highwall and lowwalls of the final voids will include the following:

- where practical, bulk earthworks on internal benches and lowwalls will be undertaken to achieve a final landform of 18º or less;
- material recovered from highwalls will be used to cover exposed coal seams and other carbonaceous material; and
- a geotechnical assessment will be undertaken on the remaining highwall to determine the extent of stabilisation works required. At a minimum, a safety berm, trench and security fence will be established along the remaining highwall to provide for public safety.

The current proposed use for the final voids at Liddell Colliery is for water storage. However, during the life of the mine and during the detailed mine closure planning process (e.g. at least five years from closure) LCO will undertake a review of opportunities for final void use in consultation with the appropriate government agencies. Other potential opportunities for utilisation of the final voids at Liddell Colliery, which will require further investigation will include:

- storage of fly ash from nearby power stations or as a coal reject disposal area for other nearby mining operations; and
- access to potential future underground coal reserves.

Further detailed assessment will be required prior to determining the most suitable post mining land use for the final voids. Amongst the issues to be assessed would include:

- groundwater and surface water management;
- long term geotechnical stability of the void walls;
- sealing of coal seams in the final highwall and end wall to prevent any spontaneous combustion;
- rehabilitation and revegetation for visual amenity and long term stability;
- public safety, including construction of engineered barriers or bunds;
- access requirements; and
- monitoring requirements.

Monitoring of the final voids would be undertaken as part of ongoing monitoring during the care and maintenance period. In addition to the monitoring requirements outlined in **Section 3.9**, specific monitoring of erosion, runoff volumes and geotechnical stability would be undertaken until such time that it could be determined that the final voids pose minimal risk to public safety.

Details regarding final void management will be finalised as part of the Mining Operations Plan for Mine Closure, which will be submitted to the appropriate government agencies at least two years prior to the cessation of mining operations.

5. REHABILITATION MANAGEMENT PLAN

5.1 Rehabilitation Strategy

Rehabilitation activities are undertaken as soon as possible following the completion of mining activities. Details of the proposed schedule and type of rehabilitation works during the mine life will be included in the Liddell Colliery Mining Operations Plan. Details of rehabilitation undertaken annually are reported in the AEMR.

The proposed final landform and rehabilitation strategy for Liddell Colliery is shown in **Figure 3.2**.

The rehabilitation strategy aims to emulate the pre-mining grazing areas, enhance local and regional ecological linkages and provide for a sustainable final land use option. The pre-mining land use (refer to **Section 1.6**) was primarily agricultural with areas of remnant vegetation. The rehabilitation strategy includes the establishment of primarily pasture with habitat corridors which have been designed to provide a functional link between remnant vegetation areas. Habitat corridors consisting of trees, shrubs and groundcover will be established in visually prominent areas in order to reduce the visual impact of the mining operations.

5.11 Rehabilitation Strategy for Next Three Years

The rehabilitation strategy for the next three years will include:

- continued rehabilitation maintenance of the Mountain Block;
- further habitat corridor establishment within the Railway Block area;
- pasture and habitat corridor establishment within the Southern Tailings Dam area;
- establishment of a habitat corridor within the Reservoir Pit area;
- monitoring and maintenance of the blue-billed duck habitat enhancement measures; and
- maintenance of existing rehabilitation.

This strategy aims to minimise the extent of disturbed areas and improve the visual amenity of the site. A plan providing the location and sequencing of rehabilitation during the next three years at Liddell Colliery is provided in the Liddell Colliery MOP (2008-2015) (Umwelt 2008) (refer to Plans 5A and 5B). Rehabilitation undertaken is reported in the AEMR.

5.2 Rehabilitation Methodology

5.21 Landform Design

The post-mining landform design of Liddell Colliery has been undertaken in accordance with the Synoptic Plan.

Overburden dumps will be generally reshaped to less than 10 degrees slope with a maximum of 18 degrees. Where steep slopes are constructed, suitable erosion control structures such as contour banks, drop structures may be utilised to provide for stability.

Elements such as drainage paths, contour drains, ridgelines, and emplacements are shaped into undulating informal profiles in keeping with natural landforms of the surrounding environment and allowing for a greater diversity of plant species over time.

5.22 Topsoil Management

Where topsoil is available, the following measures will be adopted to protect its quality and enhance rehabilitation outcomes:

- where possible, topsoil will be stripped when moist to help maintain soil structure and to reduce dust generation;
- topsoil stockpiles are to be located away from mining, traffic areas and watercourses;
- level or gently sloping areas will be selected as stockpiles sites to minimise erosion and potential soil loss;
- appropriate sediment controls will be installed at the base of stockpiles to prevent soil loss;

- stockpiles will be generally less than three metres high and will be set out in windrows to maximise surface exposure and biological activity. They will be shaped to gently rounded mounds including existing stockpiles east of the Durham Pit;
- stockpiles to be kept longer than three months will be sown with a suitable pasture or cover crop to minimise soil erosion and invasion of weed species;
- weed growth will be monitored and subsequently controlled if necessary;
- prior to re-spreading, weed growth will be scalped from the top of the stockpiles to minimise the transport of weeds into rehabilitated areas; and
- stockpiles will be appropriately sign-posted to identify the area and minimise the potential for unauthorised use or disturbance.

5.23 Surface Preparation

Surface preparation activities for rehabilitated areas are commenced as soon as possible following the completion of mining activities. A general overview of surface preparation activities undertaken at Liddell Colliery include:

- prior to revegetation activities, spoils and topsoils will be characterised to determine the type and application rate that may be required for the addition of soil ameliorants (e.g. gypsum, Cal-S, fertiliser, biosolids, organic composts, OGM etc.). Analysis may include pH, Electrical Conductivity and ESP;
- appropriate soil ameliorants will be applied for incorporation into the final shaped surface;
- where direct tree seeding is planned in overburden, final shaped surfaces will be deep ripped parallel with the contour prior to the application of seed to provide for an adequate seed bed;
- where pasture seeding is planned the surface will be harrow/tilled across the contour to provide for an adequate seed bed;
- suitable erosion control measures (e.g. silt fences, mulches etc.) will be implemented to minimise soil loss from areas undergoing rehabilitation; and
- where appropriate and practical, structures such as tree hollows and logs may be incorporated into the final landform to augment the habitat value of proposed habitat corridors or waterside habitat.
- Large rocks will be removed or placed into habitat piles on rehabilitated areas.

5.24 Aboriginal Cultural Heritage

Where it is identified that specific rehabilitation activities have the potential to interact with Aboriginal Cultural Heritage sites or Archaeologically Sensitive Areas (as defined in the Liddell Colliery Aboriginal Heritage Management Plan), LCO will undertake the rehabilitation activities in accordance with the Liddell Colliery Aboriginal Cultural Heritage Management Plan.

5.25 Revegetation

Revegetation activities will generally be undertaken in spring and autumn, however, opportunistic revegetation may be practised if areas become available for sowing in summer and winter. After surface soil amelioration and tillage is completed for any given area, revegetation will commence as soon as practicable.

Primarily, revegetation will involve sowing of pasture species and direct seeding of native tree species. A range of other techniques may also be utilised where appropriate over isolated areas associated with steep slopes.

Revegetation techniques will be continually developed and refined over the life of the mine through a continual process of research, trialling, monitoring and improvement.

5.251 Establishment of Native Vegetation Habitat

The establishment of the native vegetation will be undertaken using a native species seed mix. The seed mix will generally be selected from the following tree and shrub species while additional native grass and groundcover species may be added.

Local native tree and shrub species

- Acacia falcate
- Acacia longissima
- Acacia brownii
- Allocasuarina luehmannii
- Allocasaurina torulosa
- Angophora floribunda
- Brachychiton populneum
- Bursaria spinosa
- Casaurina glauca
- Corymbia maculata
- Eremphila debilis
- Eucalyptus albens
- Eucalyptus crebra
- Eucalyptus dawsonii
- Eucalyptus molucanna
- Eucalyptus punctata
- Eucalyptus tereticornis
- Exocarpus cupressiformis
- Indigofera australia

Local native groundcovers and grasses

- Aristida personata
- Aristida ramosa
- Bothriochloa macra
- Chloris truncate
- Danthonia richardsonii
- Danthonia tenuiur
- Desmodium brachypodum
- Desmodium varians
- Dichelachne micrantha
- Glycine tabacina
- Hardenberfia violacea
- Lomandra filiformis
- Stipa aristiglumis
- Themeda australia

The native revegetation will be constructed to produce habitat corridors with the aim of providing a functional and sustainable ecosystem which will be consistent with the rehabilitation closure criteria.

The species to be utilised within native revegetation habitat corridors will be continually assessed following the completion of monitoring of reference and trial sites with the aim that the species are endemic to the area. Where possible, native seed collection will be undertaken in the local area, and will assist in maintaining local genetic diversity and the genetic integrity of the region. However, dependent upon seed availability, the seed mix may need to be supplemented with stocks sourced from outside of the local area.

Tree and shrub seed will be applied at a rate determined appropriate to site conditions this will generally be a total of approximately 6 kg/ha. Where required, seed will be appropriately pre-treated to provide for germination and will be evenly mixed and spread.

5.252 Pasture Establishment

Areas to be rehabilitated to pasture will generally include, but not necessarily limited to, the following species (refer LCO SD PRO 0008 - Land Rehabilitation):

Species	**Variety**	**Sowing Rate kg/ha**
Cocksfoot	Greenly	5
Annual Ryegrass	Wimmera	6
Perennial Ryegrass	Kangaroo Valley	6
Setaria	Narok	1
Rhodes Grass	Callide	3
Couch	(Un-hulled)	2
Lucerne	Aurora	5
White clover	Haifa	3
Medic	Sephi	1
Subclover	Seaton Park	3
Woolly Pod Vetch	Namoi	4
Chicory	Puna II	1
Tonic	Tonic Plantain	1
Brassica	Winfred	1
Rye-corn	N/A	6
TOTAL		**48**

The seed mix may vary dependent upon the season and other species may be utilised where appropriate. Similar to direct seeding of native tree species, the sowing application rate for pasture species will be determined upon a review of site conditions.

5.26 Rehabilitation Trials

In order to determine the most appropriate method of reinstating Endangered Ecological Communities (EEC's) LCO has commenced trials aimed at establishing two EEC's, being Central Hunter Grey Box – Ironbark Woodland and Central Hunter Ironbark – Spotted Gum Grey Box Forest. The species selected were representative of the communities found in the Hunter valley and consisted of the following species:

Grey Box- Ironbark Woodland Forest Community

- Acacia pendula
- Allocasuarina leuhmanii
- Angophora floribunda
- Austrostipa scabra
- Bothriochloa decipiens
- Brachychiton populneus subs. populeus
- Bursaria spinosa subs spinosa
- Calotis lappulacea
- Callitris endlicheri
- Cassinia quinquefaria
- Chrysocephalum apiculatum
- Cyperus gracillis
- Dodonaea viscosa
- Eragrostis leptostachya
- Einadia nutans
- Eremophila debilis
- Eucalyptus crebra
- Eucalyptus moluccana
- Glycine tabacina
- Microlaena stipodes var. stipoides

Ironbark – Spotted Gum Forest Community

- Acacia falcate
- Acacia parvipinnula
- Allocasuarina luehmanii
- Bursaria spinosa subsp spinosa
- Corymbia maculate
- Daviesia ulicifolia subsp. ulicifolia
- Dianella revoluta var. revoluta
- Eremophila debilis
- Eucalyptus crebra
- Eucalyptus fibrosa
- Eucalyptus tereticornis

- Eucalyptus fibrosa
- Eucalyptus moluccana
- Hakea sericea
- Microlaena stipoides var stipoides
- Paspalidium distans
- Pultenaea spinosa
- Themeda australis

Rehabilitation monitoring will be conducted in accordance with the Closure Criteria Development and Rehabilitation Monitoring Standard to gauge the performance of the trials and the germination of the many species involved in order to refine the seed mix for future ecological community rehabilitation. The two trial sites will form the native vegetation rehabilitation monitoring areas as discussed in **Section 5.27**.

5.27 Rehabilitation Monitoring

In accordance with the XCN Standard for Closure Criteria Development and Rehabilitation Monitoring, LCO have developed an annual flora and fauna rehabilitation monitoring program. The results of annual monitoring are considered when determining the extent of maintenance works (e.g. weed management) required within each rehabilitation area.

5.271 Pre-Mining Baseline Surveys

As per the XCN Standard for Closure Criteria Development and Rehabilitation Monitoring, baseline monitoring is to be conducted prior to any site disturbance. Details regarding baseline monitoring that has been undertaken to date across Liddell Colliery are outlined in **Section 1.6** and is typically assessed in the site environmental assessment flora and fauna surveys. This information has been used to develop Liddell Colliery's Mine Closure Criteria (refer to **Appendix 3**) and to assess the performance of rehabilitation on site.

5.272 Control or Analogue Sites

Monitoring within rehabilitation areas is also compared with carefully selected control or analogue sites within the surrounding locality. The methodology used for the flora plots will be in accordance with previous flora monitoring at Liddell Colliery and will involve the following parameters being recorded within a permanent plot at each site:

- full floristics (including cover abundance);
- general health of vegetation;
- evidence of natural regeneration;
- occurrence and abundance of weed species;
- signs of disturbance either by stock or humans;
- evidence of feral animals;
- any impacts from mining activities; and
- Percentage of bare ground, logs and rocks present

In 2012 a review of the Liddell Coal Rehabilitation Monitoring was conducted by Eco Logical Australia Pty Ltd (ELA) and the program developed by ELA addresses flora and fauna monitoring on two control or "analogue" native vegetation sites.

5.273 Active Mining

During active mining operations, LCO will maintain records of processes that may have the potential to affect the success of rehabilitation on site. This information will provide a valuable baseline for comparison with later rehabilitation monitoring outcomes. At a minimum, records include:

- detailed rehabilitation procedures;
- a register of contaminated sites;
- records of production wastes and other waste streams and where they are located on site;
- environmental monitoring records, including surface and groundwater quality;
- a register of topsoil and or soil substitute stockpiles (e.g. biosolids); and
- environmental incident records.

5.274 Rehabilitation Methodology Records

LCO will record the details of each rehabilitation campaign so that they are available for later interpretation of rehabilitation monitoring results with the aim of continually improving rehabilitation standards on site. Amongst the key monitoring parameters to be included in the program relate to the following:

- landform design details;
- drainage design details;
- substrate characterisation;
- site preparation techniques (e.g. topsoil and source, time of sowing, soil ameliorants used etc.);
- revegetation methodologies (e.g. rate and type of fertiliser, cover crop and rate, seed viability including watering and weed management);
- weather conditions;
- photographic records; and
- initial follow-up care and maintenance works (including watering and weed management).

5.275 Post-Rehabilitation

As per the XCN Standard Closure Criteria Development and Rehabilitation Monitoring, LCO's approach to post-mining rehabilitation monitoring includes undertaking the following:

- Annual Rehabilitation Inspection; and
- Long Term Rehabilitation Monitoring

5.276 Annual Rehabilitation Inspection

LCO undertakes an internal annual rehabilitation inspection to evaluate how successful the rehabilitation on site has been. These inspections incorporate existing and recently completed rehabilitation areas at the Liddell Colliery.

Outcomes of the annual rehabilitation inspection are recorded and any corrective actions that are identified as part of the inspection are to be entered into the sites action database for implementation. Where necessary, rehabilitation procedures will be amended to improve rehabilitation standards.

In the event that the annual inspection indicates a failure of a rehabilitated area, further investigations to establish the cause and appropriate remediation strategy(s) are undertaken. Issues to consider during the investigation may include the following:

- nutrient availability;
- pH, salinity and metal toxicity;
- shallow root depth;
- other soil limitations;
- insect attack;
- lack of N-fixing legumes;
- lack of organisms involved in litter breakdown (e.g. fungal fruiting bodies) and nutrient cycling (e.g. puff balls);
- excessive grazing;
- predation;
- evidence of drought effects or storm damage;
- poor soil preparation;
- weed competition; and
- Based on the results of soil analysis, maintenance fertilisation may be undertaken through spreading of fertilisers or ameliorants. This may include aerial fertiliser application.

5.277 Long Term Rehabilitation Monitoring

Long term rehabilitation monitoring is undertaken at Liddell Colliery to evaluate the success of rehabilitation and the sites progress towards fulfilling long term land use objectives. The monitoring program will be continued within rehabilitation areas until they have satisfied the rehabilitation closure criteria. Plot-based sampling of vegetation is undertaken in accordance with the XCN Standard for Closure Criteria Development and Rehabilitation Monitoring.

Outcomes of this monitoring program are detailed in a report and any mitigation actions entered into LCO's action based reporting tool Xstrasafe for implementation. The outcomes of this monitoring are reported in the AEMR.

In 2012 a review of the Liddell Coal Rehabilitation Monitoring was conducted by Eco Logical Australia Pty Ltd (ECA) and the program developed by ECA addresses flora and fauna monitoring on two rehabilitated and two control or "analogue" sites.

5.278 Monitoring for Native Habitat Establishment

Plot-based sampling of vegetation is undertaken to assess:

- plant community structural attributes;
- cover, species density, height and structural diversity;
- species richness (the number of plant species present in each structural layer of each vegetation community);
- the presence and abundance of any weed species; and
- assessment of natural regeneration/recruitment of new species.

The monitoring survey will continue to be conducted within both rehabilitation areas and analogue sites over the life of the mine. The number of sites surveyed will depend on size of the study area and the number of vegetation communities. The results of this monitoring will also be utilised to provide feedback as to the success of revegetation methodologies as well as to support justification for sign off with completion criteria.

5.279 Monitoring for Pasture Establishment

The pasture rehabilitation monitoring site locations will be confirmed during the 2012 monitoring program. The monitoring methodology for these sites will follow methodology outlined within LCO's Annual Flora and Fauna Monitoring 2012 (ELA, 2012) and will include a flora plot and LFA transect at each site. In subsequent years, additional sites will be added to this program to account for future rehabilitation activities. The data collected from monitoring sites will be compared to benchmark values to ensure that the rehabilitation is progressing towards a satisfactory condition.

5.3 Rehabilitation Reporting

A summary of rehabilitation activities and progress against the Liddell Colliery rehabilitation schedule and completion criteria will be reported annually in the Liddell Colliery AEMR. The results of ongoing rehabilitation will also be provided to the Liddell Colliery CCC.

5.4 Land Management

5.41 Grazing Management

LCO has historically allowed limited grazing activities to occur on site. Prior to undertaking broad scale grazing activities on site LCO will complete a grazing trial to assess whether there is sufficient ground cover within rehabilitation areas to sustain grazing activities. Depending upon the outcome of these trials, the following measures may be undertaken to manage grazing activities at Liddell Colliery:

- manage stocking rates to prevent grasses from being overgrazed;
- limit stock access to lakes, dams and creeks to prevent bank erosion and excess water turbidity;
- prevent stock access into habitat corridors by fencing;
- allow adequate time between grazing of land for grasses to regenerate (development of a stock rotation plan); and
- provide for adequate amounts of endemic trees are established to provide shade and shelter for livestock.

5.42 Erosion and Sediment Controls

LCO will establish adequate erosion and sediment controls across the operation to minimise erosion of land surfaces and the impacts from sedimentation. Typical controls to be implemented at Liddell Colliery include but are not limited to:

- appropriately designed final landform drainage structures;
- diverting clean water from disturbed areas, and redirecting sediment-loaded water into sedimentation basins;
- utilisation of cover crops to provide quick re-establishment of ground cover over reshaped emplacement areas for protection against wind and water erosion;
- construction of sediment control structures where required (e.g. silt fences, hay bales etc); and
- rehabilitating overburden emplacement areas as close as practical behind active mining areas.
- Repairs to older rehabilitation areas where erosion is evident eg Reservoir block and the Mountain Block

5.43 Weeds

Weed control will be conducted in accordance with the existing LCO management practices, which require:

- regular site inspections to identify areas of weed infestation and type of weed species;
- development and implementation of an eradication plan applicable to the circumstances, which may include manual removal, spot spraying, boom spraying, aerial spraying or biological control;
- regular contact with neighbouring property owners to attempt to eradicate weed species from the surrounding area;
- early establishment and maintenance of vigorous grasses and native trees particularly during rehabilitation of overburden dumps; and
- regular maintenance of topsoil stockpiles to eradicate weed infestation.

Galenia (*Galenia pubescens*) occurs in areas throughout the Liddell Colliery development consent area. This weed has a vigorous growth habitat which results in it smothering native groundcovers and inhibiting regeneration. LCO will continue to target this species for eradication in areas that it has been recorded as well as implement measures (e.g. application of herbicide) to prevent it from establishing in new rehabilitation areas.

In 2012, the weeds African Olive and Acacia saligna were added to the weed species identified on site and are subject to weed control activities.

If a substantial increase in the density of any known weed species, or the occurrence of a previously unrecorded weed species, is discovered, LCO will seek advice on the management and control options for that species and endeavour to minimise its impact on native flora and fauna. Where weeds have been controlled, suitable pasture species will be sown to prevent weed regrowth.

Weed management activities are reported in the AEMR.

5.44 Vertebrate Pest Control

Programs to control vertebrate pests include the determination of appropriate control practices, consultation with appropriate authority, obtaining appropriate approvals, implementing control practice and undertaking follow-up monitoring and control as required. If monitoring shows a substantial increase in the density of any known feral fauna species, or the occurrence of a previously unrecorded feral fauna species, is discovered, LCO will seek expert advice on the management and control options for that species and endeavour to minimise its impact on native flora and fauna.

5.45 Bushfire Management

Section 6 contains the Bushfire Management Plan (BMP) for Liddell Colliery including detail on fire prevention and control measures, monitoring and reporting.

5.5 Flora and Fauna Management

This section details the management strategies that will be adopted at Liddell Colliery to promote the conservation of biodiversity throughout its operations. Flora and Fauna management strategies to be implemented at Liddell Colliery will include:

- management of remnant vegetation;
- management of vegetation clearance;
- enhancement of habitat for the blue billed duck; and
- rehabilitation and development of habitat corridors.

As committed in the EA, no works or machinery are to impact upon the Bayswater Creek bed environment.

5.51 Management of Remnant Vegetation

The remnant woodland occurring within the Liddell Colliery development consent area will be managed during the life of the project to maintain its ecological values and promote biodiversity. Strategies include management of grazing impacts, weeds, feral animal control, erosion and sediment control and encouragement of natural regeneration.

One of the aims of remnant vegetation management is to improve connectivity of remnant vegetation patches within the Liddell Colliery development consent area to provide improved habitat corridor function. The locations of the habitat corridors are shown on **Figure 3.2**. The habitat corridors provide for the connection of remnant vegetation located on Bowman's Creek, the shore of Lake Liddell and to the north of the Mountain Block.

Grazing within remnant vegetation areas will be prohibited to enable tree, shrub and ground cover species to regenerate and enhance fauna habitats.

Annual inspections of remnant woodland areas will be undertaken by suitably qualified persons to identify any weed or feral animal issues, identify any areas affected by erosion and to assess the extent of natural regeneration occurring. Actions will be taken to address any issues identified.

The need for bushfire management controls will also be assessed by the Liddell Colliery Environment and Community Coordinator to restrict the occurrence of high intensity burns. Where required and practical, infrequent burns of moderate intensity will be undertaken within remnant vegetation areas to manage fuel loads and allow native species to set seed in consultation with the local Rural Fire Service.

5.511 Vegetation Clearance

Prior to any site clearing activities, the following mitigation measures will be undertaken:

- a Ground Disturbance Permit will be obtained from the Liddell Colliery Environment and Community Department in accordance with Liddell Colliery Environmental Procedure – LCO SD PRO 0007- Land Clearing & Topsoil Stripping;
- areas to be cleared should be clearly marked in the field to avoid any unnecessary clearing of native vegetation;
- any machinery used for the clearing activities should be kept in the disturbance areas and not placed in adjacent remnant vegetation;
- a pre-clearance survey will be conducted by the Liddell Colliery Environment and Community Superintendent or his/her delegate, prior to any clearing being carried out to identify potential habitat trees. During the pre-clearance survey all hollow-bearing or other identified habitat trees will be marked;

- the vegetation surrounding any habitat trees will be removed at least one day prior to those trees being cleared to encourage any fauna to relocate;
- trees are to be felled as gently as is practicable. Felled trees should be positioned on the ground to ensure that hollows are not blocked. Felled habitat trees are to be left undisturbed for a period of 24 hours to allow any native fauna present to relocate;
- native fauna detected during vegetation clearance should be relocated to areas of appropriate habitat;
- during any clearance works, where practical, any habitat structures (such as rocks, logs and stumps) removed from the disturbance areas should be relocated to rehabilitation areas;
- where practical, nest boxes will be installed ahead of clearing;
- Nest boxes will be established in nearby rehabilitation areas to compensate for the loss of hollows in habitat trees. The number and designs of nest boxes required should be determined by a supervising ecologist prior to clearing activities following assessment of the number and type of tree hollows removed during clearing;and
- no works or machinery will be allowed to impact upon the Bayswater Creek bed environment.

5.52 Management of Threatened Species

5.521 Threatened Flora

Only one threatened flora species has been recorded within the Liddell Colliery development consent area, the tiger orchid (*Cymbidium canaliculatum*). This species is listed as an endangered population under the *Threatened Species Conservation Act 1995* (TSC Act) for the Hunter catchment. One individual clump was recorded near the Mountain Block plot. LCO will continue to monitor the tiger orchid during annual flora and fauna monitoring onsite to provide for its ongoing viability.

In the event a previously unrecorded threatened flora species is discovered, or a recorded species is newly listed under the TSC Act 1995 or the EPBC Act, LCO will seek the advice of a suitably qualified and experienced ecologist on the appropriate management options for that species.

5.522 Threatened Fauna

The previous fauna surveys identified six threatened fauna species in the study area, comprising the grey-crowned babbler (*Pomatostomus temporalis temporalis*), the blue-billed duck (*Oxyura australis*), the speckled warbler (*Pyrrholaemus sagittatus*), the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), the eastern freetail-bat (*Mormopterus norfolcensis*) and the eastern cave bat (*Vespadelus troughtoni*).

The ecological assessment conducted for previously approved modifications identified 16 threatened fauna species that may potentially occur within the study area (Umwelt, 2006). An assessment of the significance of the impacts of the modifications on these 16 threatened fauna species was undertaken. The results of assessment under both the EP&A Act and the EPBC Act (where relevant) revealed that the development would have a significant impact on only one of the 16 fauna species potentially occurring within the study area, namely, the blue-billed duck.

In the event that a previously unrecorded threatened fauna species is discovered, or a recorded species is newly listed under the TSC Act 1995 or the EPBC Act (1995*)*, LCO will seek the advice of a suitably qualified and experienced ecologist on the appropriate management options for that species.

LCO will continue to monitor these threatened fauna species during the annual fauna monitoring undertaken onsite.

Blue-Billed Duck Management

In accordance with schedule 3, condition 28 of the development consent, LCO has undertaken habitat enhancement measures to Dam 3. Habitat enhancement works of the Mountain Block Dam were also to be undertaken, however subsequent investigations revealed that this dam was unlikely to provide suitable habitat for the blue-billed duck. In order to compensate for this, in February 2011 LCO constructed two blue-billed duck habitat dams on site. The dams were designed and constructed to provide suitable habitat for the blue-billed duck with half of the dam's surface area having a depth of less than 5 metres. Suitable revegetation was carried out on the dam's gentle slopes using indigenous species including *Typha orientalis* (broadleaf cumbungi), *Eleocharis sphacelata* (tall spike rush), *Bolboschoenus caldwellii* (club rush), and *Baumea juncea* (common twig rush).

To assist LCO in implementing appropriate habitat enhancement measures, LCO will continue to implement a management strategy for the blue-billed duck as detailed within Liddell Colliery's Blue-Billed Duck Management Strategy (Umwelt, 2008).

Improvements to the waterside habitat in the Reservoir Block will be made by the placement of logs around water storages. This will enhance the habitat value of the Blue billed duck and other dams.

5.53 Habitat Management

During clearance activities, where practical, any habitat structures (such as rocks, logs and stumps) removed from the disturbance areas will be relocated to rehabilitation areas. Clearing activities will be undertaken according to LCO SD PRO 0007 - Land Clearing & Topsoil Stripping to minimise the impacts of felling activities on tree nesting and denning species.

Habitat corridors will be established through the rehabilitation area (**Figure 3.2**) generally in accordance with the Synoptic Plan (DRE, 1999). The habitat corridors will replace areas of woodland vegetation that are to be removed during the life of Liddell Colliery and will link areas of remnant vegetation to the north of the development consent area to habitat areas along Bowman's Creek. The corridors will facilitate fauna movement between the vegetation remnants and rehabilitated areas on adjacent land holdings.

Flora and Fauna Monitoring

LCO currently undertakes a variety of flora and fauna monitoring activities across its operation. These activities will be continued throughout the life of the mine. The details of each monitoring activity are outlined below.

Flora Monitoring

Up until 2012, monitoring of vegetation was conducted annually within four plots located within the Entrance Block and Mountain Block. Each plot is marked with a metal stake in each corner and a metal tag showing the plot number. The location of the flora monitoring plots is shown on **Figure 5.1**. Due to changes to the active mining areas, 4 new sites were selected for monitoring from the 2013 survey. These are:

Site 1: Within remnant woodland patches south-east of Dam 5.

Site 2: Within remnant woodland south of Barrier Pit

Site 3: Within riparian vegetation along Bowmans creek north of Dam 1.

Site 4: Within riparian vegetation along Bowmans Creek (previous site 5).

The exact locations have not yet been determined and will be provided in the 2013 Flora and Fauna Monitoring Report

The following information is recorded for each plot:

- cover-abundance value;
- general health of vegetation;
- evidence of natural regeneration;
- occurrence and abundance of weed species;
- signs of disturbance, either by stock or humans;
- evidence of feral animals;
- any observable impacts of the mining operations, such as the effectiveness of sediment and erosion control structures;
- the percentage of bare ground present, density of log cover and percentage of rock cover; and
- a photograph of each site is taken from a fixed bearing at the photo monitoring point to enable changes in vegetation health and structure to be visually recorded and compared.

Monitoring of these plots will be undertaken on an annual basis to determine the impact of Liddell Colliery on species diversity, composition and health. Other criteria will also be assessed and includes:

- species and habitat losses or gains;
- factors that impact upon biodiversity;
- security of protected areas;
- management of biological resources such as topsoil and the use of cleared vegetation;
- on-going rehabilitation and restoration of ecosystems; and
- resilience of ecosystems.

Where required, additional plots may be monitored to assess vegetation located in other areas within the Liddell Colliery development consent area.

As discussed in **Section 5.27.2**, analogue sites representative of remnant vegetation will be established during 2012 to gather baseline data which will assist in the refinement of rehabilitation closure criteria.

5.531 Fauna Monitoring

Fauna monitoring is undertaken annually at Liddell Colliery and includes terrestrial fauna monitoring, water bird monitoring and nest box monitoring. Fauna monitoring is undertaken in late summer/early autumn each year to coincide with the breeding activity of the blue-billed duck. Where it is considered to be beneficial, the monitoring period may be altered, or additional monitoring may be carried out.

Up until 2012, LCO undertook annual fauna monitoring at five nominated monitoring sites. The fauna monitoring sites were established in 2005 by HLA-Envirosciences (HLA-Envirosciences 2005). The five monitoring sites were located within the Entrance Block, Mountain Block (two sites), Dam 13 and Bowman's Creek (refer to **Figure 5.1**). Due to changes to the active mining areas, 4 new sites were selected for monitoring from the 2013 survey. These are:

Site 1: Within remnant woodland patches south-east of Dam 5.

Site 2: Within remnant woodland south of Barrier Pit

Site 3: Within riparian vegetation along Bowmans creek north of Dam 1.

Site 4: Within riparian vegetation along Bowmans Creek (previous site 5).

The exact locations have not yet been determined and will be provided in the 2013 Flora and Fauna Monitoring Report

At each of the monitoring sites a range of techniques will be used to determine the fauna utilisation of the Liddell Colliery development consent area, including the identification of threatened species. Methods which will continue to be utilised include, spotlighting, diurnal bird census; diurnal herpetological survey, nocturnal herpetological surveys and Anabat surveys.

A habitat assessment of each fauna monitoring site will be undertaken, and will include an assessment the following:

- evidence of fire;
- nature of and extent of erosion;
- extent of weed species;
- presence of feral animals;
- type of ground cover (e.g. litter, rock, soil);
- degree of dieback;
- presence of mistletoe;
- structure and floristics of vegetation cover; and
- number of habitat trees.

Annual monitoring targeting water birds will be undertaken at dams 1, 3 and 13 and the two blue-billed duck habitat dams, "New Dam" and "Mountain Block Dam" that were established in February 2011. In particular the monitoring is aimed at identifying habitats utilised by the blue-billed duck.

Water bird monitoring will consist of:

- two one hour diurnal bird census points over two days; and
- habitat assessment at each of the dams.

5.532 Nest Box Monitoring

Prior to 2008 ten nest boxes were erected in the Entrance Block area and were monitored annually however, due to advancing mining activities, these boxes were removed in 2011. In 2011 14 new nest boxes were installed, five nest boxes were erected north-west of Dam 1 and nine nest boxes were erected west of Dam 3. Annual monitoring of these nest boxes will continue to be undertaken to determine the level of usage by native fauna species and to determine if the boxes have been successful in the provision of alternative habitat for arboreal species. Each nest box will be assessed for:

- the condition of the nest box;
- the presence of fauna or whether they are being used by target fauna species;
- predator use of the nest box; and
- the condition of the nest box and tree attachment and any additional design features that may aid the future use of un-used boxes.

5.533 Monitoring of Blue-billed duck Habitat Enhancement Measures

As discussed in **Section 5.522**, LCO will continue to implement a blue-billed duck management strategy. The management strategy includes a baseline survey and ongoing monitoring of the success of the habitat enhancement measures at Dam 3 and the two blue-billed duck habitat dams that were established in February 2011.

The baseline survey of Dam 3 and the blue-billed duck habitat dams will assess:

- the general health, densities and species diversity of the existing terrestrial and aquatic vegetation associated with the dams;
- the water quality, including current levels of turbidity, nutrients and dissolved oxygen; and
- the species diversity and abundance of aquatic macro-invertebrates.

Following the completion of the habitat enhancement measures, an annual monitoring program of the two dams will be implemented. The monitoring program will focus on the presence of blue-billed ducks, vegetation health, water quality and the diversity and abundance of aquatic macro-invertebrates.

6. BUSHFIRE MANAGEMENT PLAN

6.1 Introduction

This Bushfire Management Plan documents the bushfire management measures to be implemented at Liddell Colliery to limit impacts on the surrounding area, in accordance with the conditions of development consent.

6.2 Purpose and Scope

The purpose of this Bushfire Management Plan is to define the mechanisms to be implemented for the control of fire hazard and potential ignition sources at Liddell Colliery. This Plan applies to all land within the area of mining operations (**Figure 1.2**). It has been developed to comply with the conditions of development consent and to provide guidance on preparedness and response to a bushfire at Liddell Colliery.

The Bushfire Management Plan complies with the *Rural Fires Act* 1997 (RFA) and the Rural Fires Regulation 1997 (RFR). Under section 63 of the RFA, Liddell Coal is required to take all practical steps to prevent bushfires and minimise the danger of the spread of bushfires on or from land under its control.

6.3 Objectives

The objectives of this plan are to:

- prevent the occurrence of unplanned bushfire;
- suppress unplanned bushfires;
- minimise the potential spread of bushfire in, from, or into the area of continued Liddell Colliery operations;
- protect persons, property and assets (including those of heritage value) on, or immediately adjacent to, the Colliery from bushfire;
- work cooperatively with neighbours, lessees and rural fire brigades in managing bushfires;
- maintain ecosystem processes associated with remnant native species and communities in the area;
- identify fuel types in the area which may constitute a hazard;
- serve as a guide in the setting of strategies for the management of fire and fuel accumulation; and
- consider possible environmental effects of such management strategies.

6.4 Existing Environment in Respect to Bushfire Management

6.41 Climate

The climate of the Hunter Valley, as recorded at Muswellbrook and Singleton, is warm temperate and the seasonal climate varies from hot, wet summers to cool, mild winters. The mean daily maximum temperatures ranged from 16.5 °C in July to 32 °C in January (2010). Mean daily minimum temperatures ranged from 4.9 °C in July to 18.2 °C in January (2010). Mean daily maximum and minimum temperatures are listed in **Table 6.1**.

Table 6.1 – Mean Daily Temperature Recorded at Singleton (Station 061397)

Month	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°C)
January	32	18.2
February	30	18.6
March	28.3	15.5
April	25.5	10.9
May	21.1	6.6
June	17.7	5.2
July	16.5	4.9
August	17.7	4.4
September	22.0	8.2
October	24.4	11.4
November	26.3	14.2
December	28.6	16.3
Annual	**24.2**	**11.2**

Source: Bureau of Meteorology, December 2010.

The closest Bureau of Meteorology data collection station to Liddell Colliery is at Muswellbrook, approximately 13 kilometres northwest of the site. Rainfall data were collected at Muswellbrook between 1870 and 2011. Mean rainfall based on this data is shown in **Table 6.2**.

Table 6.2 – Rainfall Data – Muswellbrook (Station 61053)

Month	Mean Rainfall (mm)
January	69.6
February	66.5
March	52.5
April	43.6
May	41.7
June	51.4
July	43.9
August	38.8
September	40.7
October	48.6
November	56.1
December	67.3
Annual	**620.4**

Source: Bureau of Meteorology, December 2011 (20/12/2011).

Seasonal variation in wind speed and direction at the Ravensworth weather station, which is located 0.5 kilometres to the southeast of Liddell Colliery. During the period July 1999 to September 2001 the prevailing winds were from the northwest during the winter and from the southwest during the summer months. The highest wind speed of 22.0 m/s was recorded on 17 September 1999. September is generally the windiest month of the year with a mean monthly wind speed of 4.25 m/s. September typically has the greatest percentage of winds over 10 m/s. April is the calmest month, with a mean monthly wind speed of 2.4 m/s. The annual average wind speed is 3.3 m/s.

6.42 Topography

The general topography of Liddell Colliery is characterised by gently undulating hills with a relief of up to 90 metres. The Colliery is located on very gently inclined alluvial fans (1 to 3%), bordered by gently inclined rises (3 to 10 %) at elevations ranging from 100 mAHD to 185 mAHD. At the northern end of the colliery the elevation increases to 280 mAHD and slopes up to 10% occur.

6.43 Vegetation Communities

Five vegetation communities were recorded in the area of Liddell Coal Operations; pastoral grassland, *Eucalyptus creba/E. moluccana* woodland, *Allocasuarina luehmannii* woodland, riparian vegetation and aquatic vegetation. Each of the community areas shows relatively high levels of disturbance, with evidence of past and ongoing grazing activities. All communities contain a significant number of weed species. In addition, a significant portion of the area of mining operations is disturbed by existing mining operations and devoid of vegetation.

The identified *Eucalyptus creba/E. moluccana* woodland, *Allocasuarina luehmannii* woodland and riparian vegetation communities are consistent with the Woodland vegetation classification provided in Table A2.1 of *Planning for Bushfire Protection*, whilst the pastoral grassland is consistent with the Grassland (pasture) vegetation classification. On this basis, the predominant 'vegetation groups' of the continued operations area and surrounds is Vegetation Group 2 (Woodlands and Heaths) and Vegetation Group 3 (Grasslands).

6.5 Fire History

Information relating to the frequency and intensity of bush fires within the Liddell Colliery Holding is anecdotal only; however, this evidence indicates that most outbreaks have been minor in nature and restricted to small spot fires in heavily grassed areas adjacent to major trafficked areas such as roads. As stated in the 2003 revision of this document it was noted that over the previous two to five years there have been at most two instances when fire has threatened operations. On these occasions however, mine personnel in conjunction with the [then] Rural Bush Fire Brigade have been able to contain and extinguish the outbreaks, without damage to site infrastructure or injury to personnel.

6.6 Fire Hazard and Risk

The bushfire hazard pertaining to a particular area is assessed by rating two main land based factors of fire, these being vegetation (fuel) and terrain (slope), and their relative contributions to a potential fire. The intention of bushfire protection is to prevent flame contact on a structure, reduce the radiant heat to below ignition thresholds for the various elements of a building, to minimise the potential for embers to cause ignition and to reduce the effects of smoke on residents and fire fighters. Bushfire has the potential to cause damage or harm to neighbours, personnel, facilities and installations, mine infrastructure, biodiversity and archaeological heritage.

Two land units occur at the Colliery: woodland on slopes ranging from 4 to 13 per cent and native and improved pasture on slopes ranging from 5 to 18 per cent. Fire burning uphill poses the most significant hazard. Rehabilitated lands are vulnerable to fire, with uphill slope lengths of 170 to 730 metres.

Liddell Colliery and surrounds has been rated as having a low risk of bushfire in the Bush Fire Risk Management Plan (Muswellbrook, Scone and Singleton Bush Fire Management Committee, 2000). The Colliery is located in the Eastern fire zone. In this fire zone, forest and shrub fires predominate and the main fire season is from September or October through to January or February (Luke and McArthur 1978).

Continued mining is not expected to increase the fire hazard in the locality, as areas will be disturbed and rehabilitated progressively, with similar areas of pasture and woodland available to fuel fires at any given time. Due to its nature as a mine site, Liddell Colliery's emergency preparedness is high and fire fighting equipment is readily available during the life of the operation.

6.7 Liddell Colliery Assets Requiring Protection from Fire

6.71 Site Equipment and Infrastructure

Site equipment and infrastructure that will be protected under the Bushfire Management Plan include:

- Liddell Coal Preparation Plant, including ROM coal stockpiles, ROM Coal Receival Facility, product coal stockpiles, Rail Loadout Bin, workshops and fuel depot;
- active mine areas;

- major mine infrastructure and installations including tailings disposal line;
- rehabilitated lands;
- coal haulage contractor facilities;
- mining contractor facilities and open cut administration; and
- water cart filling station.

6.72 Heritage Sites

An assessment of the historic heritage within and in the vicinity of the management area identified three historic sites. Two of these sites: the former Chain of Ponds Hotel and Police Lock-up are of high significance; the other, the former Foybrook open cut mine office, is of low significance.

All reasonable effort will be made to protect the Chain of Ponds Hotel and Police Lock-up from fire using appropriate prevention and control measures.

6.73 Archaeology Sites

Archaeological investigations undertaken in 2001 identified 37 Aboriginal sites that have not been previously recorded, and re-recorded five previously identified sites. No particular protection of these sites is required, as they will not be damaged by exposure to fire. The location of firebreaks and other controls will be selected to avoid these sites where possible.

6.74 Natural Assets

Specific control measures (refer to **Section 6.10**) will be implemented in order to protect patches of remnant vegetation, to promote and maintain biological diversity within Liddell Colliery.

The proposed habitat corridors, where established, and existing trees (refer to **Figure 3.2**) are considerable natural assets which will be protected under the Bushfire Management Plan in order to maintain both flora and fauna habitat.

6.8 Bushfire Management Strategies

6.81 Identification of Ignition Sources

Ignition sources as identified in Umwelt "*Liddell Colliery Landscape Management Plan 2008",* include natural occurrences such as lightening strikes, while other occurrences include sparks from powerlines and human ignition sources. Traffic on Antiene Road, Hebden Road, New England Highway and the Main Northern Railway can be considered a fire hazard. Possible on-site ignition sources also include sparks and fire from machinery and fuel storage areas.

Areas of native pasture have been identified as having a medium fire hazard rating and are likely ignition sources. Ignition sources and areas of potential fire hazard also include the habitat corridor areas. These areas will be the focus of fire hazard reduction measures to minimise fuel levels.

Fire bans, as determined by the Rural Fire Service, will be adhered to by all personnel and enforced by the mine management. Potential ignition sources such as those resulting from hot work practices including welding and cutting will be restricted where possible to workshop areas or within active parts of the mine where vegetation is non-existent. From time to time, however, due to the remoteness of plant and infrastructure, this may not be possible and work within vegetated areas may need to occur. In such cases, all due care and caution will be employed to minimise the potential for fire ignition.

6.82 Control Measures

6.821 On-Site Fire Fighting Equipment

Liddell Colliery maintains a fire tender as well as two water carts equipped with fire fighting equipment and capable of extinguishing fire outbreaks. This fire fighting equipment, together with graders and bulldozers used for mining, provides effective bushfire fighting capability. In addition, emergency preparedness training for mine-site personnel enhances the responsiveness.

The trucks are fully equipped with both rear and side sprays, and front monitor nozzle with a spaying capacity of 25 metres. Each cart is fitted with a 64 millimetre stortz coupling, to which a standard fire hose can be fitted. The trucks have a carrying capacity of 70 kilolitres and 20 kilolitres respectively each with a fill time of between two to four minutes.

6.822 Asset Protection Zones

Planning for Bushfire Protection (NSW Rural Fire Service 2006) states that Asset Protection Zones (APZ) are to be identified, installed and "*managed progressively to minimise fuel loads and reduce potential radiant heat levels, flame, ember and smoke attack".* An Asset Protection Zone (APZ) as defined in the Planning for Bushfire Protection (NSW Rural Fire Service 2006) aims to "*protect human life, property and highly valued public assets and values".*

Planning for Bushfire Protection (NSW Rural Fire Service 2006) defines an APZ as being a buffer zone between bushfire hazard and buildings, which is managed progressively to minimise fuel loads and reduce potential radiant heat levels, flame, ember and smoke attack. Although these guidelines were specifically developed for protecting residential developments, they can also be used and applied as a guide to the level of protection required to protect Liddell Colliery assets from fire such as monitoring stations and all mining infrastructure.

An APZ consists of an Inner Protection Area (IPA), maintained to minimal fuel loads and an Outer Protection Area (OPA), where fuel loads are maintained at less than 8 tonnes per hectare. The IPA provides a fuel free space around the assets that allow them to be defended from bushfires. It also reduces the risk of wind-blown burning embers starting spot fires close to assets.

Table A2.2 of *Planning for Bushfire Protection* was used to determine the appropriate setback requirements for the Colliery. As outlined in **Section 6.52** of this plan, the topography of the site is described as gently sloping terrain with slopes generally less than 8°. Group 2 (Woodland Vegetation) and Group 3 (Grassland Vegetation) were identified throughout and immediately adjacent to the area of continued operations.

Based on the guidelines *Planning for Bushfire Protection 2006* an APZ should be established around all Liddell Colliery Assets located within 30 metres of the identified Group 2 and Group 3 vegetation areas, which have been rated as low risk in the Bushfire Risk Management Plan (Muswellbrook, Scone and Singleton Bush Fire Management Committee 2000).

Liddell Colliery Assets located within 30 metres of identified Group 2 vegetation, require a 40 metre APZ, consisting of a 30 metre IPA and a 10 metre OPA on the hazard side of the asset. Liddell Colliery Assets located within 30 metres of identified Group 3 vegetation require a 20 metre APZ, consisting of a 20 metre IPA on the hazard side of the asset.

The APZ provides for:

- minimal separation for safe fire fighting;
- minimised radiant heat;
- reduced influence of convection column driven winds; and
- reduced ember viability thereby limiting the impact of ember attack.

It is not intended to establish any APZs within the Liddell Colliery Holding, however the guidelines for establishment of such zones will be used as a reference to ensure that fuel loads are minimised and clearances to assets and infrastructure are maintained at appropriate distances.

6.823 Existing Fire Barriers

Firebreaks are to be maintained around the Liddell Colliery area of continued operations to prevent the spread of bushfires onto or from adjacent properties.

6.824 Proposed Fire Management

The proposed fire management for mining operation of Liddell Colliery includes creating and maintaining fire breaks using ploughing, chain sawing and slashing methods. This method ensures that fire does not spread both into and from the Liddell Colliery operations.

Any incident of unplanned bushfire will be reported directly to the Environment and Community Superintendent who will initiate Emergency Response Procedures. If required, the Environment and Community Superintendent will notify the Singleton or Muswellbrook Rural Bushfire Service to be on standby. Should the fire be deemed significant or spread outside the area of Liddell Colliery operations (**Figure 1.2**) the Environment and Community Superintendent will contact the relevant Rural Bushfire Service office for action.

The Team Co-ordinator's office at the LCPP and OCE's office at the Open Cut Administration area, as appropriate to each respective site, will be the emergency fire fighting control unit (EFFU). Topographic maps of the area at a scale of 1:25,000 or other suitable drawings and a radio communications system will be made available at the EFFU. Fire management resources include:

- road and helipad access areas;
- water carts equipped with fire fighting equipment;
- dams and maintained water fill points;
- portable radios;
- emergency phones and fire extinguishers (where appropriate to the threat) provided at vantage points within the surface facilities; and
- earthmoving equipment.
- Emergency response will be undertaken in accordance with the Liddell Colliery Emergency Response Plan.
- Preventative Measures
- Fuel Management

A number of mechanical methods may be used to achieve a reduction in fuel levels. Such methods include mowing, slashing, ploughing and manual removal. Fuel load measurements are to be assessed on a yearly basis by the Environment and Community Superintendent with any fuel reduction works required to maintain fuel levels to a minimum or an equivalent measure (as recommended previously by the Rural Fire Service)

However as a best practise it was advised in Hunter Land Management's "*Liddell Annual Bushfire Monitoring and Inspections 2011-2012"* - fuel loads in grazing areas are to be inspected monthly with fuel levels to be kept to a "low" rating along firebreaks and tracks. Fuel load management will be determined by the Environment and Community Superintendent.

6.825 Suppression Activities

Fire suppression will be co-ordinated at the EFFU on site or as directed by the Environment and Community Supervisor. Keys to all gates within Liddell Colliery, topographic maps or other suitable drawings illustrating all access trails, and emergency fire fighting equipment will be available within the EFFU.

Details of the location and personnel involved in emergency fire suppression will be held by the Environment and Community Supervisor, with an additional copy in the EFFU.

Trained personnel of the EFFU will continue fire suppression, in collaboration with the Singleton and Muswellbrook Rural Bushfire Service units, outside the immediate area, if required, should the fire spread to adjoining properties.

The containment of fire may be achieved using earthmoving equipment, hand implements, water carts, aerial and ground-based chemical retardants (where available), back burning and/or burning out.

The habitat corridors may also be used as windbreaks to slow wind speeds and to intercept flying embers. In order for the habitat corridors to be effective trees will be planted evenly at medium density to avoid high turbulent effects. Fire tolerant species such as smooth barked eucalypts are recommended for such breaks, and these have been included in site revegetation.

6.826 Vehicular Access

Main access to Liddell Colliery will be provided via Pikes Gully Road and along the Old New England Highway. A network of roads surrounding and traversing the area of mining operations (**Figure 1.2**) are to be maintained to allow access for fire fighting trucks, ensuring all areas are accessible.

6.827 Water Supply

Fire fighting within the Liddell Colliery operations rely on water stored on-site in dams or at defined water fill points. Ready access will be available for vehicles to engage in water abstraction at these points. Outlets should be compatible with fire fighting equipment including all hose fittings.

As the electricity supply may fail during a bushfire, it is recommended that a minimum 3 kW (5 hp) portable petrol or diesel powered fire pump with hose be made available for emergency use at water storage locations. Diesel dewatering pumps used for mine dewatering, which could be used to fill water carts can be made available for use in these emergency situations.

6.828 Landscaping

General recommendations for site landscaping include:

- maintenance of mown lawns or bare ground (paths etc) immediately adjacent to infrastructure;
- avoid continuous tree canopies;
- removal of any existing trees that overhang the infrastructure/asset; and

- use of fire resistant trees and shrubs for future landscaping that do not retain dead material in their canopies, deposit large quantities of litter in a short period or have rough fibrous or shedding bark.
- The plants selected for site revegetation have been chosen to suit the conditions of the local environment, with fire as an important consideration. The selection of species to be planted in areas of moderate risk will be undertaken with additional emphasis on fire control.

6.83 Monitoring and Communication

6.831 Monitoring

Annual inspections will be undertaken of identified ignition source areas prior to the bushfire season and appropriate action taken, as necessary, to ensure that fuel levels are maintained to a "low" risk ranking.

The Environment and Community Superintendent will liaise with the Singleton and Muswellbrook Rural Fire Service as required, to ensure that both parties are aware of fires in and adjoining the area of mining operations.

Fire weather conditions will be monitored regularly and all fires identified on or near the area of mining operations will be immediately reported to the Environment and Community Superintendent.

6.832 Reporting

Liddell Colliery employees and contractors will report all fires, regardless of the size, and take appropriate action in accordance with the Emergency Response Plan. Bushfire management performance, including monitoring, incidents, corrective action and preventative measures, is to be reported in the AEMR.

6.833 NSW Rural Fire Service Report and Corrective Actions

For fires in which the NSW Rural Fire Service are involved, the Environment and Community Superintendent may receive a report from the Rural Fire Service regarding the cause of ignition and any difficulties encountered during bushfire suppression. Problems associated with the source of bushfire ignitions and fire suppression activities will be addressed by the Environment and Community Superintendent and appropriate mitigation measures adopted, in consultation with the Operations Manager.

7. LEASE AND LICENCE RELINQUISHMENT PROCESS

Once compliance with the agreed closure completion criteria is achieved, LCO will seek to relinquish existing leases and licences in accordance with the XCN Mine Closure Standard which involves the following process:

1. The completion of a Closure Report including a compilation of supporting documentation that demonstrates that the closure completion criteria have been met. Supporting documentation includes all relevant records, monitoring and research data and long-term rehabilitation monitoring reports. The Closure Report will be supported by a final rehabilitation inspection report completed by a suitably qualified and experienced person. The Closure Report will be prepared and submitted in accordance with the DRE – Mineral Resources' Reporting Requirements for Mine Closure and Lease Relinquishment (this guideline is currently under review).
2. Arrange a meeting with DRE to discuss any outcomes of its review of the Closure Report, in order to identify and address any potentially outstanding issues that may exist.

3. Depending on the Closure Plan's stakeholder communication strategy, the closure report may need to be circulated to other relevant government agencies for review.
4. Arrange a site inspection by DRE and other relevant stakeholders to verify the findings of the Closure Report. Following inspection and consensus among stakeholders that closure completion criteria have been met, DRE will submit a recommendation to the Minister for relinquishment of mining tenements. As part of the lease relinquishment process, where required a suitable caveat may be developed to provide that potential constraints to post-mining land uses are readily identifiable for future land holders.
5. Submit formal application for the relinquishment of leases and licences etc. regulated under various other statutory instruments, such as the submission of an application for Cancellation of Authority under the Mining Act 1992 as well as an Environment Protection Licence Surrender Application Form to EPA.

8. REVIEW

A review of the Landscape Management Plan is to be undertaken every three years.

9. ACCOUNTABILITIES AND TRAINING

9.1 Roles and Responsibilities

Responsibilities for review and approval of various aspects of the LMP are provided below. The responsibilities have been developed to be consistent with the relevant XCN standards as outlined in **Section 3.43.**

Role	Accountabilities for this document
Operations Manager	Provide that sufficient resources are allocated for the implementation of this LMP. Authorise internal and external reporting requirements as well as subsequent revisions of this program.
Manager Mining Engineering	Integrate mine rehabilitation into the short and long term mine planning process to provide that it is effectively implemented.

Role	Accountabilities for this document
Environment & Community Superintendent	Coordinating the implementation of this LMP. Review and analyse rehabilitation monitoring data and assess progress against mine closure objective and criteria. Develop and implement care and maintenance programs to progress rehabilitation areas towards meeting the closure criteria in a timely manner. Review rehabilitation methodologies based on the outcomes of monitoring programs to facilitate continual improvement. Complete reporting requirements relating to rehabilitation in the Annual Environmental Management Report and MOP. Provide that all relevant records are effectively maintained on site. Monitor all fire fighting equipment and ensure hose connections to suit the Rural Fire service are available. Monitor fuel loads to ensure a "low" risk ranking is maintained around infrastructure/assets and access tracks.
Technical Services Manager	Schedule rehabilitation activities as per the Mining Operations Plan (MOP). Coordinate updates to the MOP as required including information on mine rehabilitation.
Commercial Manager	Provide that adequate provisions are available for mine closure by implementing and updating an accrual system over the life of the mine.
Environment & Community Officer	Have a sound understanding of the Landscape Management Plan. Implement, monitor and review programs, systems and procedures linked to the LMPP. Monitor and review the data that is being collected for the LMP. Monitor, document and communicate progress against LMP objectives and targets as per the Communication and Reporting Schedule.

9.2 Awareness and Training

LCO provides training commensurate with the roles and responsibilities of personnel outlined above.

Training implemented at LCO with respect to landscape management includes the following:

- Site Familiarisation Inductions provided to all new employees and contractors;
- General Environmental Awareness provided to all existing employees and permanent contractors; and

- Issue specific training sessions provided to employees and contractors as required.
- Other methods used to communicate the responsibilities of LCO employees and contractors relating to landscape management include:
- Communication sessions;
- Tool-Box Talks;
- Electronic site notice boards; and
- Site newsletters.
- auditing and review provisions

The LMP and related procedures and systems will be reviewed at least every three years or earlier as required following changes to the sites internal or external context. The objective of the scheduled review process being primarily to:

- Monitor and report on compliance with Objectives and Targets which cover statutory requirements and other commitments;
- Account for changes in environmental requirements, technology or operational procedures; and
- Identify opportunities to drive continuous improvement and to reduce the overall risk profile of the operation.

10. DEFINITIONS

Term	Definition
Annual Environmental Management Report	A report prepared by each mining operation in NSW as a condition of its mining lease and accepted by DRE. The report is prepared on an annual basis and reports on the performance of the leaseholder and 'fine tunes' the Mining Operations Plan.
Closing Mine Site	A mining operation where cessation of operations is anticipated within less than five years.
Conceptual Closure Plan	The plan includes the progressive conceptual plan for site rehabilitation along with indicative closure costs. The Conceptual Closure Plan forms part of the LOM plan.
Life of Mine (LOM)	The period for which a mine operates until economic reserves are exhausted. This may change with changing economic environment or increased understanding of the resource.
Life of Mine Plan	Production and financial plan for the operation over the LOM period.
Mine Closure	Generally, a whole of mine life process that typically culminates in tenement relinquishment (usually occurs after a legally binding sign-off of liability). Closure (generally) is deemed to be complete at the end of decommissioning and rehabilitation and where all current appropriate regulatory obligations have been satisfied. Within this document, the definition will be extended as indicated above.

Term	Definition
Mine Decommissioning	The process that begins near, or at, the cessation of mineral production. This term is often used interchangeably with Mine Closure but here refers to a transition period and activities between cessation of operations and final closure.
Mining Operations Plan (MOP)	A plan prepared by each mining operation in NSW as a condition of its mining lease and accepted by DRE. The plan outlines the proposed sequence of mining activities, infrastructure associated with the mining operations as well as progressive and final rehabilitation programs. Prior to the cessation of mining operations, a MOP for Mine Closure will need to be submitted to the DRE for approval.
Rehabilitation (Reclamation)	The return of the disturbed land to a stable, productive and/or self sustaining condition, taking into account beneficial used of the site and surrounding land.

11. REFERENCES

- Australian and New Zealand Minerals and Energy Council (ANZMEC) and Minerals Council of Australia (2000) Strategic Framework for Mine Closure
- HLA Enviroscienes (2005) Liddell Colliery Flora and Fauna Monitoring
- Hunter-Central Rivers Catchment Management Authority (2002) Hunter Catchment Management Blueprint
- Minerals Council of Australia (2005) Enduring Value - Australian Minerals Industry Framework for Sustainable Development
- Muswellbrook Shire Council (1985) Local Environmental Plan
- NSW Department of Mineral Resources (DRE) (1999) Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW
- NSW Department of Mineral Resources (1997) Environmental Management Guidelines for Industry – Borehole Sealing Requirements on Land: Coal Exploration
- NSW Department of Primary Industries (2006) Environmental Management Guidelines for Industry - Guidelines to the Mining, Rehabilitation and Environmental Management Process
- NSW Department of Primary Industries (2006) Environmental Management Guidelines for Industry – EDG 13 Exploration Licence: Rehabilitation and Relinquishment Report.
- NSW Department of Primary Industries. Environmental Management Guidelines for Industry- EDG 14 – Reporting Requirements for Mine Closure and Lease Relinquishment
- NSW Department of Primary Industries (2006) Guideline ESB 20 – Rehabilitation Security Deposit Requirements for Mining and Petroleum Titles
- NSW Department of Primary Industries. Rehabilitation Cost Calculation Tool v1.7
- NSW Department of Primary Industries. Policy EDP 05 – Rehabilitation and Mine Closure)
- NSW Department of Primary Industries Policy EDP 07 – Criteria for Cancellation or Non renewal of Mining Leases
- NSW Department of Primary Industries Policy EDP 11 – Rehabilitation Security Deposit Policy
- NSW Rural Fire Service (2006) Planning for Bushfire Protection

- Singleton Council (1996) Local Environmental Plan
- Umwelt (Australia) Pty Limited (2006) Environmental Assessment for Liddell Colliery Modification to Development Consent
- Umwelt (Australia) Pty Limited (2008) Liddell Colliery Mining Operations Plan, 2008 to 2015
- Umwelt (Australia) Pty Limited (2008b) Liddell Colliery Water Management Plan
- AECOM (2011), LCO Annual Environmental Management Report
- Eco Logical (2012) LCO Monitoring Program Review
- Eco Logical (2012) LCO Annual Flora and Fauna Monitoring 2012
- Hunter Land Management, 2011, *Liddell Annual Bushfire Monitoring and Inspections 2011-2012,* prepared for Xstrata Liddell Coal Operations.
- NSW Rural Fire Service, 2006, *Planning for Bushfire Protection: A Guide for Councils, Planners, Fire Authorities and Developers.*
- NSW Rural Fire Service, 2001, *Planning for Bushfire Protection: A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners.*
- Umwelt Australia Pty Limited, 2008, *Liddell Colliery Landscape Management Plan,* prepared for Liddell Coal Operations Pty Limited.
- Umwelt Australia Pty Limited, 2001, *Liddell Colliery Continued Operations Environmental Impact Statement*, prepared for Liddell Coal Operations Pty Limited.
- LCO SD PRO 0007 - Land Clearing & Topsoil Stripping
- LCO SD PRO 0008 - Land Rehabilitation

12. APPENDIX 1 – DEVEOPMENT CONSENT CONDITIONS

LCO Development Consent Conditions Relevant to the Landscape Management Plan

Table A.1 – Development Consent Conditions

Development Consent Condition	**Plan Section**
30. The Applicant shall prepare and implement a Landscape Management Plan for the site to the satisfaction of the Director-General and DRE. This Plan must:	
be submitted by 31 January 2008 to the Director-General and DRE for approval;	**Appendix 2**
be prepared by suitably qualified expert/s whose appointment/s have been endorsed by the Director-General;	**Section 1.1** **Appendix 2**
be prepared in consultation with NOW, OEH, MSC, SSC and the Rural Fire Service; and	**Section 1.3** **Appendix 2**
include a: Rehabilitation Management Plan; Final Void Management Plan; and Mine Closure Plan.	**Sections 3.,4.,5.,6.**
31. The Rehabilitation Management Plan must include:	
the rehabilitation objectives for the site;	**Sections 3.5 and 3.6, 5.1**
a strategic description of how the rehabilitation of the site would be integrated with land surrounding the site, with a view to improving or enhancing the regional landscape and flora and fauna habitat values;	**Sections 5.21 and 5.25**

Table A.1 – Development Consent Conditions (Cont.)

Development Consent Condition	Plan Section
a general description of the short, medium and long term measures that would be implemented to rehabilitate the site;	**Sections 5.1 and 5.2**
a detailed description of the measures that would be implemented over the next three years to rehabilitate the site, including the measures to be implemented for:	**Section 5.11**
progressively rehabilitating areas disturbed by mining operations on the site;	**Section 5.1**
managing the remnant vegetation and habitat on site;	**Section 5.51**
minimising impacts on threatened fauna;	**Section 5.5**
minimising visual impacts;	**Sections 5.11**
conserving and reusing topsoil;	**Section 5.22**
collecting and propagating seeds for rehabilitation works;	**Section 5.251**
salvaging and reusing material from the site for habitat enhancement;	**Section 5.53**
controlling weeds, feral pests, and access;	**Sections 5.43 and 5.44**
managing bushfires; and	**Section 5.45 and 6.**
managing any potential conflicts between the rehabilitation works and Aboriginal cultural heritage.	**Section 5.24**
detailed performance and completion criteria for the rehabilitation of the site;	**Section 3.6 5.27, Appendix 3**
a detailed description of how the performance of the rehabilitation works would be monitored over time to achieve the stated objectives and against the relevant performance and completion criteria; and	**Section 5.27**
details of who is responsible for monitoring, reviewing and implementing the plan.	**Section 9.**

Table A.1 – Development Consent Conditions (Cont.)

Development Consent Condition	Plan Section
32. The Final Void Management Plan must describe what actions and measures would be implemented to:	
minimise any potential adverse impacts associated with final voids on the site; and	**Section 4.**
manage and monitor the potential impacts of final voids over time.	**Section 4.**
33. The Mine Closure Plan must:	
define the objectives and criteria for mine closure;	**Sections 3.5 and 3.6**
investigate options for the future use of the site, including the final voids;	**Sections 1.4,1.7 and 4.**
investigate ways to minimise the adverse socio-economic effects associated with mine closure, including reduction in local and regional employment levels;	**Section 3.2**
describe the measures that would be implemented to minimise or manage the on-going environmental effects of the development; and	**Sections 3.8.1 and 3.8.2**
describe how the performance of these measures would be monitored over time.	**Sections 3.9 and 5.27**

Table A.2 – Statement of Commitments Relevant to the Development of a Landscape Management Plan for Liddell Colliery

Commitment No.	Statement	Plan Section
1.16	Liddell will develop a Final Void Management Plan as part of the Landscape Management Plan and review and update the Final Void Management Plat at least five years prior to the cessation of mining.	**Section 4.**
1.19	Liddell will incorporate the management outcomes provided in Section 6.5 of the EA into the Biodiversity and Land Management Plan.	Refer to **Table A.3** (below)

Table A.3 – Mitigation Measures to Limit the Degree of Impact from Mining on Native Vegetation and Threatened Flora and Fauna Species

(Section 6.5.4 of the EA)

Mitigation Measure	**Plan Section**
The proposed development areas should be clearly marked in the field to avoid any unnecessary clearing of native vegetation.	**Section 5.511**
Any machinery used for the proposed development should be kept in the disturbance areas and not placed in adjacent remnant vegetation	**Section 5.511**
No works or machinery should impact upon Bayswater Creek bed environment	**Section 5.511**
Weed and pest species should be managed as described in the Liddell Coal Flora and Fauna Management Plan (Umwelt 2003);	**Section 5.43**
During any clearance works, where practical, any habitat structures (such as rocks, logs and stumps) removed from the disturbance areas should be relocated to rehabilitation areas	**Section 5.53**
Nest boxes should be established in nearby rehabilitation areas to compensate for the loss of hollows in habitat trees. The number and designs of nest boxes required should be determined by a supervising ecologist prior to clearing activities following assessment of the number and type of tree hollows removed during clearing	**Section 5.511**
Clearing activities should be undertaken according to the EMS Procedure LC-EP01-Site Clearing as detailed in the Liddell Coal Flora and Fauna Management Plan to minimise the impacts of felling activities on tree nesting and denning species	**Section 5.511**
Habitat enhancement actions will be carried out at Dam 3 and the Mountain Block Dam as described in Section 6.5.3.3 to provide potential alternative habitat for the blue-billed duck, for when Dams 7 and 13 are removed	**Section 5.522**

13. APPENDIX 2: REGULATORY CONSULTATION

RECEIVED
18 JAN 2008

All communications to be addressed to:

Headquarters
NSW Rural Fire Service
Locked Mail Bag 17
GRANVILLE NSW 2142

Telephone: (02) 8741 5555
e-mail: developmentcontrol@rfs.nsw.gov.au

Headquarters
NSW Rural Fire Service
15 Carter Street
HOMEBUSH BAY NSW 2127

Facsimile: (02) 8741 5550

Umwelt (Australia) PTY Ltd
PO Box 838
TORONTO NSW 2283

Your Ref: 2493/BC?AS?12122007
Our Ref: D07/0001
G07/3965 GB

Attention: Allison Sharp

9 January 2008

Dear Madam,

RE: Liddell Colliery Landscape Management Plan

I refer to your letter dated 12 December 2007 seeking comments on the requirements for the preparation of a landscape management plan for the rehabilitation Liddell Colliery site.

It is noted that in general the site has not been mapped as bush fire prone land and no residential areas exist within the site. However suitable asset protection zones in accordance with *Planning for Bush Fire Protection 2006* should be provided for the existing infrastructure in any revegetation plan for the site.

For any enquiries regarding this correspondence please contact Garth Bladwell.

Yours faithfully,

Nika Fomin
Development Control Co-ordinator

The RFS has made getting additional information easier. For general information on *Planning for Bush Fire Protection 2006*, visit the RFS web page at www.rfs.nsw.gov.au and search under *Planning for Bush Fire Protection 2006*.

1 of 1

Muswellbrook Shire Council

ENQUIRIES
PLEASE ASK FOR Samantha Spicer
DIRECT 02 6549 3775
OUR REFERENCE File 140.001
YOUR REFERENCE

MUSWELLBROOK SHIRE COUNCIL
ADMINISTRATION CENTRE
MUSWELLBROOK NSW 2333
ABN 86 864 180 944

10 December 2007

Ms Barbara Crossley
Umwelt Australia Pty Ltd
PO Box 838
TORONTO NSW 2283

RECEIVED
12 DEC 2007

Dear Ms Crossley,

Re: Liddell Colliery Landscape Management Plan

Council has received your letter dated 29th November 2007 regarding the matters to be included in the completion of the Liddell Colliery Landscape Management Plan.

Please find below some additional matters suggested by Council which should be considered during the completion of the document:

- Maintenance program of rehabilitated areas and planted vegetation, including proposed irrigation of the vegetation;
- Management of water in regards to the rehabilitated areas;
- Sediment and erosion control;
- The integration of the proposed rehabilitated areas with the details of Synoptic Plan produced by Department of Primary Industries.

Additional to these items, Council also requests that during the assessment of the visual impacts, that the view points from the highway and railway corridor be equally considered along with other relevant view points.

If you have any enquiries regarding this matter please contact me on (02) 6549 3775.

Yours faithfully

Samantha Spicer
Section Leader
Environment & Natural Resources

ALL COMMUNICATIONS TO BE ADDRESSED TO THE GENERAL MANAGER PO BOX 122 MUSWELLBROOK NSW 2333
TELEPHONE: (02) 6549 3700 FAX: (02) 6549 3701 EMAIL: council@muswellbrook.nsw.gov.au WEB: www.muswellbrook.nsw.gov.au

Umwelt (Australia) Pty Limited
2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Umwelt
Environmental Consultants

ph. 02 4950 5322
fax. 02 4950 5737
ABN 18 059 519 041

Our Ref: 2493/BC/AS/291107

29 November 2007

POSTED

Mitch Bennett
Department of Environment and Climate Change
PO Box 488
NEWCASTLE NSW 2300

Dear Mitch

Re: Liddell Colliery Landscape Management Plan

Liddell Coal Operations Pty Limited (Liddell Coal) was granted approval for a modification to development consent (DA305-11-01) by the Minister for Planning on 18 July 2007. Condition 30, schedule 3 of the development consent requires that a Landscape Management Plan be prepared and submitted to the Director-General and the Department of Primary Industries (DPI) by 31 January 2008. Liddell Coal has engaged Umwelt (Australia) Pty Ltd to prepare the Landscape Management Plan.

The Landscape Management Plan will incorporate the requirements of consent conditions 31, 32 and 33, schedule 3 which require the inclusion of a rehabilitation management plan, final void management plan and a mine closure management plan.

In accordance with conditions 31, 32 and 33, the Landscape Management Plan will include:

- the rehabilitation objectives for the site;
- a strategic description of how the rehabilitation of the site would be integrated with land surrounding the site, with a view to improving or enhancing the regional landscape and flora and fauna habitat values;
- a general description of the short, medium and long term measures that would be implemented to rehabilitate the site;
- a detailed description of the measures that would be implemented over the next three years to rehabilitate the site, including the measures to be implemented for:
  - progressively rehabilitating areas disturbed by mining operations on the site;
  - managing the remnant vegetation and habitat on site;
  - minimising impacts on threatened fauna;
  - minimising visual impacts;
  - conserving and reusing topsoil;
  - collecting and propagating seeds for rehabilitation works;
  - salvaging and reusing material from the site for habitat enhancement;
  - controlling weeds, feral pests, and access;
  - managing bushfires; and

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- managing any potential conflicts between the rehabilitation works and Aboriginal cultural heritage;

- detailed performance and completion criteria for the rehabilitation of the site;
- a detailed description of how the performance of the rehabilitation works would be monitored over time to achieve the stated objectives and against the relevant performance and completion criteria;
- details of who is responsible for monitoring, reviewing and implementing the plan;
- minimise any potential adverse impacts associated with final voids on the site;
- manage and monitor the potential impacts of final voids over time;
- define the objectives and criteria for mine closure;
- investigate options for the future use of the site, including the final voids;
- investigate ways to minimise the adverse socio-economic effects associated with mine closure, including reduction in local and regional employment levels;
- describe the measures that would be implemented to minimise or manage the on-going environmental effects of the development; and
- describe how the performance of these measures would be monitored over time.

To provide for effective integration of the Landscape Management plan with Liddell's mining operation, the Landscape Management plan will also be prepared in accordance with Xstrata Standards for Mine Closure Planning, Biodiversity and Land Management and Rehabilitation Monitoring.

In accordance with the condition 30, schedule 3, Liddell Coal must prepare the Landscape Management Plan in consultation with the DECC. We are seeking your comments or matters for consideration in the preparation of the Landscape Management Plan. It would be appreciated if you could provide any comments or matters for consideration regarding the preparation of the Landscape Management Plan by 21 December 2007. If you do not respond by that time, we will assume that you have not comments in relation to this matter.

If you would like to discuss any aspect of this request further, please do not hesitate to contact Allison Sharp or myself on (02) 4950 5322.

Yours faithfully

Barbara Crossley
Director

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Umwelt (Australia) Pty Limited
2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Umwelt
Environmental Consultants

Ph. 02 4950 5322
Fax 02 4950 5737
ABN 18 059 519 041

Our Ref: 2483/BC/AS/29110f

29 November 2007

POSTED

Steve McGrath
General Manager
Singleton Council
PO Box 314
SINGLETON NSW 2330

Dear Steve

Re: Liddell Colliery Landscape Management Plan

Liddell Coal Operations Pty Limited (Liddell Coal) was granted approval for a modification to development consent (DA305-11-01) by the Minister for Planning on 18 July 2007. Condition 30, schedule 3 of the development consent requires that a Landscape Management Plan be prepared and submitted to the Director-General and the Department of Primary Industries (DPI) by 31 January 2008. Liddell Coal has engaged Umwelt (Australia) Pty Ltd to prepare the Landscape Management Plan.

The Landscape Management Plan will incorporate the requirements of consent conditions 31, 32 and 33, schedule 3 which require the inclusion of a rehabilitation management plan, final void management plan and a mine closure management plan.

In accordance with conditions 31, 32 and 33, the Landscape Management Plan will include:

- the rehabilitation objectives for the site;
- a strategic description of how the rehabilitation of the site would be integrated with land surrounding the site, with a view to improving or enhancing the regional landscape and flora and fauna habitat values;
- a general description of the short, medium and long term measures that would be implemented to rehabilitate the site;
- a detailed description of the measures that would be implemented over the next three years to rehabilitate the site, including the measures to be implemented for:
  - progressively rehabilitating areas disturbed by mining operations on the site;
  - managing the remnant vegetation and habitat on site;
  - minimising impacts on threatened fauna;
  - minimising visual impacts;
  - conserving and reusing topsoil;
  - collecting and propagating seeds for rehabilitation works;
  - salvaging and reusing material from the site for habitat enhancement;
  - controlling weeds, feral pests, and access;

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- managing bushfires; and
- managing any potential conflicts between the rehabilitation works and Aboriginal cultural heritage;

- detailed performance and completion criteria for the rehabilitation of the site;
- a detailed description of how the performance of the rehabilitation works would be monitored over time to achieve the stated objectives and against the relevant performance and completion criteria;
- details of who is responsible for monitoring, reviewing and implementing the plan;
- minimise any potential adverse impacts associated with final voids on the site;
- manage and monitor the potential impacts of final voids over time;
- define the objectives and criteria for mine closure;
- investigate options for the future use of the site, including the final voids;
- investigate ways to minimise the adverse socio-economic effects associated with mine closure, including reduction in local and regional employment levels;
- describe the measures that would be implemented to minimise or manage the on-going environmental effects of the development; and
- describe how the performance of these measures would be monitored over time.

To provide for effective integration of the Landscape Management plan with Liddell's mining operation, the Landscape Management plan will also be prepared in accordance with Xstrata Standards for Mine Closure Planning, Biodiversity and Land Management and Rehabilitation Monitoring.

In accordance with the condition 30, schedule 3, Liddell Coal must prepare the Landscape Management Plan in consultation with Singleton Council. We are seeking your comments or matters for consideration in the preparation of the Landscape Management Plan. It would be appreciated if you could provide any comments or matters for consideration regarding the preperation of the Landscape Management Plan by 21 December 2007. If you do not respond by that time, we will assume that you have not comments in relation to this matter.

If you would like to discuss any aspect of this request further, please do not hesitate to contact Allison Sharp or myself on (02) 4950 5322.

Yours faithfully

Barbara Crossley
Director

2499/SC_McGrath_20071128e-ltr

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Umwelt (Australia) Pty Limited
2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Umwelt
Environmental Consultants

Ph: 02 4950 5322
Fax: 02 4950 5737
ABN 18 059 519 041

Our Ref: 2483/BC/AS/291107

29 November 2007

Mark Mignanelli
Manager, Major Projects and Mining Assessments
Department of Water and Energy
PO Box 2213
DANGAR NSW 2309

POSTED

Dear Mark

Re: Liddell Colliery Landscape Management Plan

Liddell Coal Operations Pty Limited (Liddell Coal) was granted approval for a modification to development consent (DA305-11-01) by the Minister for Planning on 18 July 2007. Condition 30, schedule 3 of the development consent requires that a Landscape Management Plan be prepared and submitted to the Director-General and the Department of Primary Industries (DPI) by 31 January 2008. Liddell Coal has engaged Umwelt (Australia) Pty Ltd to prepare the Landscape Management Plan.

The Landscape Management Plan will incorporate the requirements of consent conditions 31, 32 and 33, schedule 3 which require the inclusion of a rehabilitation management plan, final void management plan and a mine closure management plan.

In accordance with conditions 31, 32 and 33, the Landscape Management Plan will include:

- the rehabilitation objectives for the site;
- a strategic description of how the rehabilitation of the site would be integrated with land surrounding the site, with a view to improving or enhancing the regional landscape and flora and fauna habitat values;
- a general description of the short, medium and long term measures that would be implemented to rehabilitate the site;
- a detailed description of the measures that would be implemented over the next three years to rehabilitate the site, including the measures to be implemented for:
  - progressively rehabilitating areas disturbed by mining operations on the site;
  - managing the remnant vegetation and habitat on site;
  - minimising impacts on threatened fauna;
  - minimising visual impacts;
  - conserving and reusing topsoil;
  - collecting and propagating seeds for rehabilitation works;
  - salvaging and reusing material from the site for habitat enhancement;
  - controlling weeds, feral pests, and access;

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- managing bushfires; and
- managing any potential conflicts between the rehabilitation works and Aboriginal cultural heritage;

- detailed performance and completion criteria for the rehabilitation of the site;
- a detailed description of how the performance of the rehabilitation works would be monitored over time to achieve the stated objectives and against the relevant performance and completion criteria;
- details of who is responsible for monitoring, reviewing and implementing the plan;
- minimise any potential adverse impacts associated with final voids on the site;
- manage and monitor the potential impacts of final voids over time;
- define the objectives and criteria for mine closure;
- investigate options for the future use of the site, including the final voids;
- investigate ways to minimise the adverse socio-economic effects associated with mine closure, including reduction in local and regional employment levels;
- describe the measures that would be implemented to minimise or manage the on-going environmental effects of the development; and
- describe how the performance of these measures would be monitored over time.

To provide for effective integration of the Landscape Management plan with Liddell's mining operation, the Landscape Management plan will also be prepared in accordance with Xstrata Standards for Mine Closure Planning, Biodiversity and Land Management and Rehabilitation Monitoring.

In accordance with the condition 30, schedule 3, Liddell Coal must prepare the Landscape Management Plan in consultation with the DWE. We are seeking your comments or matters for consideration in the preparation of the Landscape Management Plan. It would be appreciated if you could provide any comments or matters for consideration regarding the preparation of the Landscape Management Plan by 21 December 2007. If you do not respond by that time, we will assume that you have not comments in relation to this matter.

If you would like to discuss any aspect of this request further, please do not hesitate to contact Allison Sharp or myself on (02) 4950 5322.

Yours faithfully

Barbara Crossley
Director

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NSW GOVERNMENT
Department of Planning

Contact: Paul Freeman
Phone: (02) 9228 6436
Fax: (02) 9228 6466
Email: paul.freeman@planning.nsw.gov.au

Our ref:

Ms Barbara Crossley
Director
Umwelt (Australia) Pty Limited
PO Box 836
TORONTO NSW 2283

RECEIVED
18 DEC 2007

Dear Barbara

Liddell Colliery – Landscape Management Plan

I refer to your letter dated 29 November 2007, seeking the Department's endorsement of nominated personnel from Umwelt (Australia) Pty Limited as suitably qualified experts to undertake the preparation of the landscape management plan required by condition 30 of schedule 3 of the Minister's approval for the Liddell Colliery.

The Department has considered the qualifications and experience of the nominated personnel and believes that they are suitable for appointment. Accordingly, the Director-General has endorsed the following personnel to prepare the Liddell Colliery Landscape Management Plan:

- Mr Matthew Newton;
- Mr Travis Peake; and
- Ms Allison Sharp.

If you have any queries on this matter, please contact Paul Freeman on the details listed above.

Yours sincerely,

Howard Reed 11-12-07
A/Manager
Mining and Extractive Industries
as Delegate for the Director-General

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ABN 18 059 519 041

Our Ref: 2493/BC/MN/AS/291107

29 November 2007

POSTED

Howard Reed
Manager, Mining and Extractive Industries
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Dear Howard

Re: Landscape Management Plan for Liddell Colliery, NSW

Liddell Coal Operations Pty Limited (Liddell Coal) was granted approval for a modification to development consent (DA305-11-01) by the Minister for Planning on 18 July 2007. Condition 30, schedule 3 of the development consent requires that a Landscape Management Plan be prepared and submitted to the Director-General and the Department of Primary Industries (DPI) by 31 January 2008. The Plan is required to include a rehabilitation management plan, final void management plan and a mine closure management plan. Liddell Coal has engaged Umwelt (Australia) Pty Limited (Umwelt) to prepare the Landscape Management Plan.

Condition 30 (b), schedule 3 requires that the Landscape Management Plan be prepared by suitably qualified expert/s whose appointment/s have been endorsed by the Director-General. The Landscape Management Plan will be prepared by Matthew Newton B Env Sc (Hons), Associate and Travis Peake B Nat Res (Hons), Ecology Manager, Associate, with project support provided by Allison Sharp B Env Sc, Senior Environmental Scientist. Strategic direction and review will be provided by Barbara Crossley B Nat Res (Hons), Director of Umwelt. A summary of Matthew, Travis and Allison's relevant experience is outlined below, with their Statements of Experience and Expertise attached for your information. Could you please confirm that the Director-General approves the appointment of these personnel to prepare the Landscape Management Plan as required by condition 30(b), schedule 3 of DA 305-11-01.

Matthew Newton, B Env Sc (Hons)
Associate

Matthew has eleven years experience in environmental management within the coal mining industry, particularly with decommissioning and rehabilitation issues. The most notable projects have involved the development and implementation of mine closure plans right through to completion of closure activities including Xstrata Coal Australia's New Wallsend No.2 Colliery and Great Greta Colliery. Both of these projects have been recognised by industry peers and community groups as being a benchmark for other closure projects with New Wallsend No.2 Colliery being awarded the inaugural NSW Minerals Council Environmental Excellence Award in 2006 and Great Greta Colliery being announced as a finalist in the Hunter Coal Industry Environmental Management Awards in 2001.

Matthew continues to have an ongoing coordination role with the post closure care and maintenance of both of these sites.

Based on his extensive experience in closure and rehabilitation planning, Matthew has prepared both mine closure and rehabilitation monitoring standards for one of Umwelt's key corporate clients to be applied across their world-wide operations.

Throughout the various mine closure projects, Matthew was involved in:

- developing and presenting mine closure papers at a number of industry workshops including the Minerals Council of Australia and ACMER;
- the preparation of conceptual and detailed mine closure plans, which include cost estimates for closure activities;
- the development of mine closure and rehabilitation standards;
- development of mine closure objectives and criteria;
- future land use planning;
- final landform design including water management design;
- development of post-closure groundwater management strategies;
- providing rehabilitation advice and assessment;
- design and implementation of rehabilitation monitoring and assessment programs;
- operational support and environmental management supervision of multi-disciplinary closure and rehabilitation activities including contamination remediation, creek line re-establishment, revegetation, sediment and erosion control, acid mine drainage treatment, hazardous substances management, bulk earthworks and subsidence remediation;
- facilitating community involvement programs as part of mine closure including community meetings and preparing community information brochures;
- understanding relevant policy and regulatory frameworks relating to mine closure, including development of good working relationships with government authorities;
- rehabilitation security calculations and negotiation with government authorities;
- preparing both internal and statutory environmental reporting documentation including the close-out reports for sign-off by government authorities on successful closure; and
- development of post-closure rehabilitation care and maintenance programs.

Other major closure, decommissioning and rehabilitation projects that Matthew has been involved in include:

- preparation of a conceptual mine closure strategy for a BHP Billiton mining project, situated in the Hunter valley, which is in the pre-feasibility stage;
- preparation of Pre-Feasibility Constraints and Opportunities Analysis for Mine Closure for Cumnock No.1 Colliery;
- preparation of conceptual closure plans for the Oceanic Coal group of mines, including two underground mines, an open cut and coal washery. This included providing advice on strategic land use planning as well as indicative land evaluation analysis on potential future site land uses;
- a rehabilitation cost review for a Rubies project within the Gloucester area;
- facilitation of a mine closure workshop for Cumnock No.1 Colliery underground operations;
- the rehabilitation of an abandoned coal stockpile area at Powercoal's Cooranbong Colliery. This project formed the basis of his honours degree which focused on the use of biosolids and seed treatment techniques on re-establishing native trees on a coal mine spoil pile. Based on his

honours thesis, Matthew has written and presented a number of papers at Environmental Conferences including the Newcastle Geological Symposium (1997, 1998);

- the rehabilitation of gaswell and borehole sites as well as access tracks in areas of native bushland contained within Oceanic Coal freehold and leasehold land; and
- utilising biosolids for revegetation to promote visual screening of the coarse refuse emplacement area at Oceanic Coal's Macquarie Coal Preparation Plant.

Travis Peake, B Nat Res (Hons)
Ecology Manager, Associate

Travis provides expertise in ecological assessment and management, drawing on 12 years of experience in consultancy and catchment management authority positions. His experience underpins strengths in the technical aspects of ecological survey design, implementation and significance assessment for complex projects, and also in the preparation of clear management guidelines for community, local government and state government audiences.

He has an excellent understanding of the structure, function, conservation significance and management opportunities associated with diverse vegetation communities and habitats across the Hunter Region, Central Coast and Lower North Coast, as well as an appreciation of the types of management strategies that are practical for implementation in local government planning contexts.

Travis has extensive experience in ecological assessments and management, particularly in the Hunter Region, lower North Coast and the Central Coast of New South Wales. Over the last 12 years, Travis has undertaken numerous specialist vegetation studies, in addition to managing complete ecological assessments for specific developments, including ecological assessments at Newcastle, Lake Macquarie, Muswellbrook, Scone, Tamworth, Gunnedah, Moree, Armidale, Coffs Harbour, Taree, Forster, Port Stephens, the Central Coast, Sydney and Goulburn. Travis' latest published report is the benchmark 2-volume *The Vegetation of the Central Hunter Valley, New South Wales*, reporting on the outcomes of the Hunter Remnant Vegetation Project, a 3200 km^2 study of vegetation in the Hunter Valley. This has enabled him to develop a thorough and expert knowledge of the distribution and conservation status of vegetation throughout the Hunter Region. His previous consultancy and Hunter Catchment Management Trust experience enables Travis to efficiently conduct complex ecological survey, analysis and assessment, and to consider practical management approaches at the property, local and regional scales. Travis was extensively involved in the Hunter Regional Vegetation Committee, and was for two years a member of its Expert Panel on High Conservation Value Vegetation. Travis is also the secretary of the Hunter Rare Plants Committee, a subcommittee of the Hunter Region Botanic Gardens, which is compiling a database of the regionally significant plants of the Hunter, Port Stephens and Central Coast regions. Travis was the author of the Hunter Catchment Management Trust's *Hunter Bushland Resource Kit*, which presents all relevant ecological information for the management of property by private landholders, local and state government throughout the Hunter Region.

Allison Sharp, B Env Sc
Senior Environmental Scientist

Allison is an Environmental Scientist with six years experience in the environmental management field. She has a wide range of experience in environmental impact assessment, site contamination assessment and remediation and environmental monitoring. Prior to joining Umwelt in late 2005, Allison was employed by URS Australia for a period of four years. During that time Allison undertook a wide variety of Phase 1 and 2 site contamination assessments and environmental monitoring programs for noise, groundwater and air quality.

Since joining Umwelt, Allison has been involved in a wide range of projects, including environmental impact assessments, pre-feasibility environmental studies, mining operations plans and environmental auditing for the mining industry. More recently, Allison has been responsible for managing multidisciplinary projects from inception through to completion and is competent in all aspects of project management, from project planning, reporting writing and review, subcontractor management and project completion. Allison has successfully managed the submission of multiple environmental

assessments on behalf of the mining operations and utility suppliers. Allison is regularly involved in the development of management reports and plans for the mining industry including mining operations plans, environmental management plans, auditing of onsite environmental management and environmental monitoring.

If you have any questions or require any additional information relating to the preperaton of the Landscape Management Plan please contact me on (02) 4950 5322.

Yours faithfully

Barbara Crossley
Director

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14. APPENDIX 3: LIDDELL COLLIERY SD FORM 0120 – MINE CLOSURE CRITERIA

LCO SD FRM 0120

MINE CLOSURE CRITERIA

INSTRUCTIONS

Mine Closure Criteria were developed for Liddell Coal Operations to monitor rehabilitation progress in line with internal XCN requirements and external relinquishment goals. Further revisions of the Closure Criteria will be required during the life of the operation as criteria and goals become more refined as LCO approached closure.

PRELIMINARY COMPLETEION CRITERIA

Rehabilitation Phase	Aspect or Ecosystem Component	Domain Objective	Indicator	Completion Criteria	Justification / Source
INFRASTRUCTURE AREAS: DOMAIN 1 – Underground Admininstration Office and Coal Preparation Plant DOMAIN 2 – Open Cut Facilities					
Decommissioning	Decommissioning and/or removal of infrastructure	All non-heritage infrastructure removed to ensure the site is safe and free of hazardous materials	Disconnect, terminate and remove all services (power, water, communications, roads, bridges)	Yes / No	Environmental Assessment /Mining Operations Plan (MOP)
			Remove the CHPP and all associated conveyors and structures	Yes / No	Environmental Assessment / MOP Section 5.2
			Demolition and removal of all offices and workshop related facilities, including refuelling facilities, sewage treatment plant and car parks.	Yes / No	Environmental Assessment / MOP Section 5.2
			All demolition works to be carried out in accordance with Australian Standard AS 2601-2001 or latest version.	Yes/No	Development Consent DA 305-11-01
			Removal of associated water management infrastructure – pumps, pipes and power.	Yes / No	Environmental Assessment / MOP Section 5.2
			Removal of all plant and equipment from laydown areas and graveyards	Yes / No	Environmental Assessment
		Adits and shafts sealed to the satisfaction of I&I NSW	Ensure all underground entries sealed as per DPI standards (DPI Document 07C/2008 / MDG 6001 - Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams – Draft)	Yes / No	Mining Lease
Landform establishment	Landform development consistent with final landuse	Landform suitable for final landuse and compatible with surrounding landscape as predominantly grazing land with sustainable native ecosystem corridors	Maximum slope of final landform (including ROM pad)	10 degrees	MOP / LCO Landscape Management Plan (LMP)
			Maximum longitudinal grade of contour drains designed in accordance with the Blue Book.	Yes/No	Managing Urban Stormwater: Soils and Construction Manual Vol 2E Mines and Quarries (DECC 2008) (the Blue Book Vol 2E)
			Waste rock compaction has been relieved through deep ripping on the contour to a minimum depth of 600mm	Yes / No	MOP
	Erosion	Minimal active accelerated erosion	Gully erosion: No areas of active gully erosion	Yes / No	MOP
			Tunnel erosion: No evidence of tunnel erosion	Yes / No	MOP
			Rill erosion: Limited to isolated areas of minor rilling up to 200mm deep	Yes / No	MOP
		Minimal susceptibility to erosion	Continuous slope length < 100m	Yes / No	AMIC Mine Rehabilitation Handbook

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Sustainable Development **Form**

			All surface water management infrastructure has been designed in accordance with an industry leading practice standard.	Yes / No	The Blue Book Vol 2E
			All soils with >5% ESP mapped	Yes / No	Charman and Murphy (2007): Soils: their properties and management.
			Top surface layer soils with >5% ESP treated with gypsum (>10% gypsum w/w)	Yes / No	Charman and Murphy (2007): Soils: their properties and management.
		Continued viability and stability of constructed surface drainage system	Graded banks designed in accordance with the Blue Book. No significant loss of freeboard or bank channel capacity (e.g. bank slumping, accumulation of sediments or excessive vegetation)	minus 200mm	The Blue Book Vol 2E
			Chutes, flumes and grade control structures: No damage to structures by overflow, outflanking, slumping or loss of rock. No significant loss of capacity due to deposition of accumulated sediments or vegetation; no active scour around inlets or outlet.	Yes / No	The Blue Book Vol 2E
	Water quality	No water pollution from site, and water discharge quality in accordance with requirements of EPL 2094	Total suspended solids	120 mg/L	EPL 2094
			Water pH	pH 6.5-9.0	EPL 2094
			Runoff water electrical conductivity	<1000 µs/cm (after 5 yrs)	LCO Rehabilitation Monitoring Strategy (GSS)
			Runoff water quality in accordance with the ANZECC Guidelines	Yes / No	ANZECC Guidelines for Fresh and Marine Water Quality (2000)
	Contamination	No residual soil contamination onsite	Soil parameters in accordance with relevant guidelines	Yes/No	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites 1992
			The surface layer to be free of any hazardous material to a depth of at least 1 metre	Yes / No	LCO Rehabilitation Monitoring Strategy (GSS)
	Health and Safety	No latent community / environmental health and/or safety hazards	Dangerous areas removed. Absence of shafts, holes, tunnels, adits or unstable areas, mine entries sealed.	Yes / No	Environmental Assessment / MOP
Growth medium development	Soil profile development	Provide soil chemical and physical properties that are comparable with the reference sites, or alternate growth medium that is suitable for the establishment and maintenance of the selected vegetation species.	Topsoil replacement depth where topsoil resources available.	150mm	MOP - Section 4.5.1
			Surface soil pH	pH 6.0 – 8.0 (after 5 years)	LCO Rehabilitation Monitoring Strategy (GSS)
			Conductivity of surface material	below 900 uS/cm after 5 years	
			The surface layer to be free of any hazardous material to a depth of at least 1m.	Yes / No	
			Exchangeable sodium percentage	No more than 20% higher than for the analogue plot soil after 5 years.	
			Cation exchange capacity	No less than 20% of analogue site after 5 years.	
			Soil loss after 5 years	<40 tonnes/ha/ year	
			Soil N, P, K and S levels	Within 20% of levels in adjacent analogue site after 10 years	
			Total organic carbon percentage	No less than 20% of analogue site value after 10 years	
Ecosystem Development	Native Ecosystem establishment	Native Ecosystem (habitat corridor) established	Specified hectares (Area of land subject to rehabilitation)	Domain 1: 7ha Domain 2: 7.5ha	MOP Rehabilitation Liability calculation
			The presence of at least two overstorey and two understory species in each 10m × 20m plot at all ages.	Yes / No	LCO Rehabilitation Monitoring Strategy

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Liddell Coal Operations

Sustainable Development **Form**

			Stem densities - minimum total tree/shrub densities for seeded areas.	Year 1 – 1,000 stems/ha Year 5 – 500 stems/ha Year 10 – 400 stems/ha	LCO Rehabilitation Monitoring Strategy
			Natural Regeneration. Evidence of natural regeneration at Year 10 for at least one species.	Yes / No	LCO Rehabilitation Monitoring Strategy
			The return of agreed land capability consistent with commitments in the EA, MOP and relevant consent conditions.	Yes / No	LCO Rehabilitation Monitoring Strategy
			Criteria to be researched and agreed upon within 5 years		
			Minimum canopy cover in native ecosystem areas	To be determined	Recommended in LCO Rehabilitation Monitoring Strategy (GSS)
			Minimum tree height and girth standards for the indicator species Corymbia maiculata for 1,5 and 10 years.	To be determined	Recommended in LCO Rehabilitation Monitoring Strategy (GSS)
			Log density	m2 per hectare to be determined	Analogue reference site community
			Rock pile density	m2 per hectare to be determined	Analogue sites
			Number of artificial hollows	m2 per hectare to be determined	Analogue reference site community
		Habitat areas comparable with reference sites	Water storage, exposed rocks, groundcover, exotic species present to be in line with reference site community. Ecosystem Function Analysis (EFA) performed.	Yes / No	Analogue reference site community
		Ecosystem developed to a point of sustainability	Litter cover (%)	To be determined	Analogue sites
			Percentage of plants affected by negative health indicators (nutrient deficiency, shallow root development, excessive grazing)	To be determined	Analogue sites
			Groundcover %	To be determined	Analogue sites
			Canopy cover %	To be determined	Analogue sites
			Number of native flora species recorded	To be determined	Analogue sites
			Number of native fauna species recorded or evidenced	To be determined	Analogue sites
			Percentage cover of environmental weeds	To be determined	Analogue sites
			Percentage cover of noxious weeds	To be determined	Analogue sites
			Feral fauna species recorded and reported within rehabilitated area	none	
	Pasture/Rural Land Use establishment	Pasture established	Specified hectares (Area of land subject to rehabilitation)	Domain 1: 17ha Domain 2: 17ha	MOP (rehabilitation liability calculation)
			Pasture species to consist of grasses and legumes appropriate to the district and recognised as suitable for beef cattle grazing.	Yes / No	LCO Rehabilitation Monitoring Strategy (GSS)
			Minimum vegetative cover to be established over a minimum of 95% of areas treated after one year.	80% vegetative cover	LCO Rehabilitation Monitoring Strategy (GSS)
			Weeds. Max cover of Galenia secunda.	5 m2 within any 100m2 area. 5% over any one hectare area	LCO Rehabilitation Monitoring Strategy (GSS)
		Pasture/Rural area comparable with reference sites	Water storage and access to water so as to support low intensity grazing activities	Yes/No	Environmental Assessment
			Appropriate fencing and other infrastructure (e.g. stockyards) for managing stock and controlling stock movements.	Yes / No	Analogue sites

		Pasture/Rural area developed to a point of sustainability	Demonstrated carrying capacity of a specified head of stock per ha accounting for a range of climatic conditions e.g.: drought, average rainfall etc.	Yes/No	Analogue sites
			Percentage of plants affected by negative health indicators (nutrient deficiency, shallow root development, excessive grazing)	<X% to be determined	Analogue sites
	Ecosystem health and structure	Floral composition comparable with reference sites	Evidence that projected foliage cover is developing in structure and complexity comparable with reference sites	Yes / No	Analogue sites
		Faunal composition comparable with reference sites	Population number: Not significantly less than 30% below target range from reference sites and demonstrating a sustained positive trend towards target values	Yes / No	Analogue sites
		Flora/Fauna species assemblages	Ecological monitoring identifies no loss of native flora/fauna species diversity within areas of retained vegetation. (Considering natural events or influences such as drought and bushfire).	Yes / No	Analogue sites
			Weeds are addressed as part of the Ecological Management Plan.	Yes / No	Analogue sites
			Nest boxes will be maintained in suitable abundance, position and condition throughout the life of the mine, and beyond. Monitoring of nest boxes identifies usage by target native species.	Yes / No	Analogue sites
	Habitat Corridors	Habitat corridors are shown to be successfully established and consistent with desired vegetation community compositions.	Monitoring of flora/fauna species identifies increasing levels of corridor function in terms of species movement.	Yes / No	
	Ecosystem Function Analysis	EFA comparable with reference sites	Positive results of ecosystem function analysis	Yes / No	
	Residual Risks	Risk Assessment conducted in accordance with Australian & New Zealand Standard for Risk Management AS/NZS 4360:2004	Risk Management: All residual risks identified and provision made for any ongoing management requirements	Yes / No	XCN HSEC STD 5.12 Mine Closure Planning
			Residual Risks: Residual Risks acceptable to Government with an overall rating of no greater than 'moderate.'	Yes / No	XCN HSEC STD 5.12 Mine Closure Planning
OPEN CUT MINING AREAS: DOMAIN 3 – South Pit DOMAIN 6 – Entrance Pit DOMAIN 4 – Railway Pit DOMAIN 9 – Mountain Pit					
Decommissioning	Decommissioning and/or removal of infrastructure	All non-heritage infrastructure removed to ensure the site is safe and free of hazardous materials	Disconnect, terminate and remove all services (power, water, communications, roads, and bridges). Includes ripping of haul roads.	Yes / No	Environmental Assessment /MOP
			Removal of associated water management infrastructure - pumps, pipes and power.	Yes / No	Environmental Assessment /MOP Section 5.2
		Adits and shafts sealed to the satisfaction of I&I NSW	Design specification: Adits sealed as per DPI standards (DPI Document 07C/2008 / MDG 6001 - Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams – Draft)	Yes / No	Mining Lease
		Plant and equipment Laydown areas	Removal of all plant and equipment from laydown areas and graveyards	Yes / No	Environmental Assessment
Landform establishment	Landform development consistent with final landuse	Landform suitable for final landuse and compatible with surrounding landscape as predominantly grazing land with sustainable native ecosystem corridors	Maximum slope of final landform – overburden dumps	10 degrees	MOP/LMP
			Maximum longitudinal grade of contour drains designed in accordance with the Blue Book.	Yes/No	The Blue Book Vol 2E

			Waste rock compaction has been relieved through deep ripping on the contour to a minimum depth of 600mm	Yes / No	MOP
		No unstable slopes or high walls	Geotechnical assessment report has identified negligible risk of highwall failure	Yes / No	MOP
			All low walls < 18 degrees	Yes / No	Environmental Assessment (Umwelt, 2006) Section 6.1.2.2 / MOP
	Erosion	Minimal active accelerated erosion	As per domain 1		
		Minimal susceptibility to erosion	As per domain 1		
	Drainage	Continued viability and stability of constructed surface drainage system	As per domain 1		
	Water quality	No water pollution from site, and discharge water quality in compliance with requirements of EPL 2094	As per domain 1		
	Contamination	No residual soil contamination onsite	As per domain 1		
	Health and Safety	No latent community / environmental health and/or safety hazards	Dangerous areas removed. Absence of unprotected highwalls, voids, shafts, holes, tunnels, adits or unstable areas, mine entries sealed.	Yes / No	Environmental Assessment
Growth medium development	Soil profile development	Provide soil chemical and physical properties that are comparable with the reference sites, or alternate growth medium that is suitable for the establishment and maintenance of the selected vegetation species	Topsoil replacement depth on shaped overburden areas	150 mm where topsoil available	MOP - Section 4.5.1
			As per domain 1		
Ecosystem Establishment	Native Ecosystem establishment	Native Ecosystem established	Specified hectares (Area of land subject to rehabilitation)	Domain 3 - 66 ha Domain 4 – 97ha Domain 6 – 22ha Domain 9 – 46ha	MOP (Rehabilitation Liability Calculation) Domain 4 and 9 – assumed 30% trees/70% pasture
			As per domain 1		
		Habitat areas comparable with reference sites	As per domain 1		
		Ecosystem developed to a point of sustainability	As per domain 1		
	Pasture/Rural land use establishment	Pasture established	Specified hectares (area of land subject to rehabilitation	Domain 3 - 153 ha Domain 4 – 226ha Domain 6 – 254ha Domain 9 – 108ha	MOP (Rehabilitation Liability Calculation)
	Ecosystem health and structure	Floral composition comparable with reference sites	As per domain 1		
		Faunal composition comparable with reference sites	As per domain 1		
		Flora/Fauna species assemblages	As per domain 1		
	Habitat Corridors	Habitat Corridors are shown to be successfully established and consistent with desired vegetation community compositions.	As per domain 1		
	Ecosystem Function Analysis	EFA comparable with reference sites	As per domain 1		
	Residual Risks	Risk Assessment conducted in accordance with Australian & New Zealand Standard for Risk Management AS/NZS 4360:2004	As per domain 1		
TAILINGS DISPOSAL AREAS:		**DOMAIN 4A – Fines area**	**DOMAIN 7 – Antiene tailings dam**	**DOMAIN 5 – Reservoir area**	**DOMAIN 8 Antiene void area**
Decommissioning	Decommissioning and/or removal of infrastructure	All non-heritage infrastructure removed to ensure the site is safe and free of hazardous materials	As per Open Cut Mining Areas		

		Fines/tailings areas to be decommissioned and capped to the satisfaction of I&I NSW	Decommissioning of the facility in accordance with approval granted under s100 of the *Coal Mines Health and Safety Act 2002* and the requirements of Xstrata Coal under the HSEC STD 8.1 *Tailings Storage Management*. Area to be capped at 2m thick.	Yes / No	Section 101 Decommissioning Approval (I&I NSW) MOP
Landform establishment	Landform development consistent with final landuse	Landform suitable for final landuse and compatible with surrounding landscape as pasture	Maximum slope of final landform	10 degrees	MOP
			Maximum Longitudinal grade of contour drains	2%	MOP
			Waste rock compaction has been relieved through deep ripping on the contour to a minimum depth of 600mm	Yes / No	MOP
		No unstable slopes	Geotechnical assessment report has identified negligible risk for failure	Yes / No	MOP
			All low walls < 18 degrees	Yes / No	Environmental Assessment
	Erosion	Minimal active accelerated erosion	As per Open Cut Mining Areas		
		Minimal susceptibility to erosion	As per Open Cut Mining Areas		
	Drainage	Continued viability and stability of constructed surface drainage system	Ensure capped tailings disposal areas are free draining Other indicators as per Open Cut Mining Areas	Yes/No	
	Water quality	No water pollution from site, and discharge water quality in compliance with requirements of EPL 2094	As per Open Cut Mining Areas		
	Contamination	No residual soil contamination onsite	As per Open Cut Mining Areas		
	Health and Safety	No latent community / environmental health and/or safety hazards	As per Open Cut Mining Areas		
Growth medium development	Soil profile development	Provide soil chemical and physical properties that are comparable with the reference sites, or alternate growth medium that is suitable for the establishment and maintenance of the selected vegetation species	As per Open Cut Mining Areas		
	Pasture/Rural Land use establishment	Pasture established	Specified hectares (Area of land subject to rehabilitation)	Domain 4a – 28 ha Domain 5 – 110 ha Domain 7 – 105 ha Domain 8 – 76ha	MOP rehabilitation liability calculation
			As per domain 1		
	Ecosystem health and structure	Floral composition comparable with reference sites	As per domain 1		
		Faunal composition comparable with reference sites	As per domain 1		
		Flora/Fauna species assemblages	As per domain 1		
	Habitat Corridors	Habitat Corridors are shown to be successfully established and consistent with desired vegetation community compositions.	As per domain 1		
	Ecosystem Function Analysis	EFA comparable with reference sites	As per domain 1		
	Residual Risks	Risk Assessment conducted in accordance with Australian & New Zealand Standard for Risk Management AS/NZS 4360:2004	As per domain 1		

15. CONTROL AND REVISION HISTORY

15.1 Document information

Property	Value
Approved by	Operations Manager
Document Owner	Environment and Community Superintendent
Effective Date	24/05/2013
Keywords	Land, Management, environment, flora, fauna, final, void, rehabilitation, native, leave, licence, bush, fire, mine, closure

For a complete list of document properties, select **View Properties** from the document's context menu on the intranet.

15.2 Revisions

Version	Date reviewed	Review team (consultation)	Nature of the amendment
1	18/3/2013	B de Somer, Colin Davies (Carbon Based)	This document supersedes LCO SD EXT 0077 Landscape Management Plan (Including Mine Closure Plan, Rehabilitation Management Plan & Final Void Management Plan). Prepared as per 2012 Independent Environmental Audit Recommendations
2			
3			