



Centennial Coal

Agricultural Impact Statement

Mandalong Mine

Mandalong Southern Extension Project

Centennial Mandalong Pty Limited

August 2013

CCC14-015



GSS Environmental a Division of
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Prepared on behalf of Centennial Mandalong Pty Limited



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Mandalong Southern Extension Project Agricultural Impact Statement

Prepared for Centennial Mandalong

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Executive Summary

GSS Environmental was commissioned by Centennial Mandalong Pty Limited to prepare an Agricultural Impact Statement (AIS) to accompany an application under Part 4 of the *Environmental Planning and Assessment Act 1979* for the proposed Mandalong Southern Extension Project (the Project). An AIS is required under the *NSW Strategic Regional Land Use Policy 2012* to accompany all new mining and petroleum project applications. It will form part of the Environmental Impact Statement (EIS) and its purpose is to ensure that a focused assessment of the potential impacts of the Project on agricultural resources and industries is undertaken.

In summary, the Project proposes to extend Mandalong Mine's existing underground mining operations into the area covered by Exploration Licence 6317 (EL 6317) in order to access, develop and extract additional coal reserves. In addition, the Project proposes to utilise existing and proposed new surface infrastructure integral to the mining operation. The Study Area for this AIS comprises the entire area within EL 6317 (4,466 hectares (ha)), referred to as the Southern Extension Area, along with a small adjacent area (147 ha) covering longwall panels proposed to extend into Mandalong Mine's existing mining lease area.

The Study Area is within a temperate climate zone dominated by native woodland, with some cleared area where grazing and hobby farms are the main agricultural enterprises. It lies within the catchment areas of Lake Macquarie and Wyong River. There are five sub-catchments across the Study Area, with Morans Creek, Wyee Creek and Mannering Creek draining into Lake Macquarie, and Buttonderry Creek and Jilliby Creek draining into the Wyong River. There are three Water Sharing Plans regulated by the NSW Office of Water that apply within the Study Area, being those for the *Hunter Regulated and Unregulated Water Sources*, *Central Coast Unregulated Water Sources* and *Jilliby Creek Water Source*. The Project is unlikely to impact the quality or quantity of surface water resources within the Study Area or further downstream (Umwelt, 2013). Impact on groundwater resources from the proposed mining and surface facilities is predicted to be below the Level 1 minimal impact considerations from the *NSW Aquifer Interference Policy* (GHD, 2013a).

Seven soil landscape units are found within the Study Area, these being the Mandalong, Watagan, Woodbury's Bridge, Doyalson, Gorokan, Wyong and Yarramalong soil landscapes (GSSE, 2013a). Wyong and Yarramalong soil landscape units have the least agricultural limitations as described by Murphy (1993). The Doyalson soil landscape unit has moderate inherent fertility, whilst the remaining soil landscape units within the Study Area are rated as having moderately low inherent fertility. The *Land and Soil Capability Assessment* (GSSE, 2013a) prepared for the Project confirmed 157 ha of Class 4 land, 2,112 ha of Class 5 land and 2,344 ha of Class 7 land, with no Biophysical Strategic Agricultural Land within the Study Area.

The potential production value of the Study Area using Land and Soil Classification (LSC) (GSSE, 2013a) is \$385,000 per annum. The total area of agricultural land across the Wyong and Lake Macquarie Local Government Areas (LGAs) is 9,611 ha, with 8,936 individuals employed in agricultural related enterprises (Australian Bureau of Statistics (ABS), 2006). Total gross agricultural production across the two LGAs is \$61.3 million per annum. The Project will result in 20 ha of surface disturbance associated with the proposed Mandalong South Surface Site and access road, and a further 3.6 ha of remnant ponding as a result of subsidence (Umwelt, 2013). The total potential loss to agricultural enterprises as a result of the Project impact upon agricultural land is \$2,098 per annum. Given that the Mandalong South Surface Site will be decommissioned and the disturbed land rehabilitated back to native bushland following the completion of mining (25 year life of mine), the Project will not permanently remove any land from agriculture.

In summary, any impacts upon agricultural resources as a result of the Project can be readily mitigated and will not be of a permanent nature. In conjunction with Centennial Mandalong's commitment to stakeholder engagement and progressive rehabilitation, it is anticipated the Project will have negligible impact on agricultural resources, enterprises or related industries.

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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
AIS	Agricultural Impact Statement
BOM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
CCC	Community Consultative Committee
Centennial	Centennial Coal Company
Centennial Mandalong	Centennial Mandalong Pty Limited
DAA	Disturbance Assessment Area
DGRs	Director-General's Requirements
DP&I	NSW Department of Planning and Infrastructure
DPI	NSW Department of Primary Industries
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Services
EC _e	Electrical conductivity in a saturated extract
EIS	Environmental Impact Statement
EL	Exploration Licence
EMS	Environmental Management System
I&I	NSW Industry and Investment
GM	gross margin
gm	gram
GSSE	GSS Environmental
ha	hectare
km	kilometre
L	litre
L/s	litres per second
LGA	Local Government Area
LSC	Land and Soil Classification
m	metre
m ²	square metres
mm	millimetre
mg	milligram
Mtpa	Million tonnes per annum
N/A	not applicable

NOW	NSW Office of Water
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
Project, the	Mandalong Southern Extension Project
ROM	run of mine
SAL	Strategic Agricultural Land
SRLUP	Strategic Regional Land Use Plan
t	tonne
µS/cm	micro Siemens per centimetre
°C	degrees Celsius

1.0 INTRODUCTION

GSS Environmental (GSSE) was engaged by Centennial Mandalong Pty Limited (Centennial Mandalong), a wholly owned subsidiary of Centennial Coal Company (Centennial), to prepare an Agricultural Impact Statement (AIS) for the proposed Mandalong Southern Extension Project (the Project). This AIS is intended to form part of the Environmental Impact Statement (EIS) to be submitted to the New South Wales Department of Planning and Infrastructure (DP&I) as part of the application for development consent under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979*.

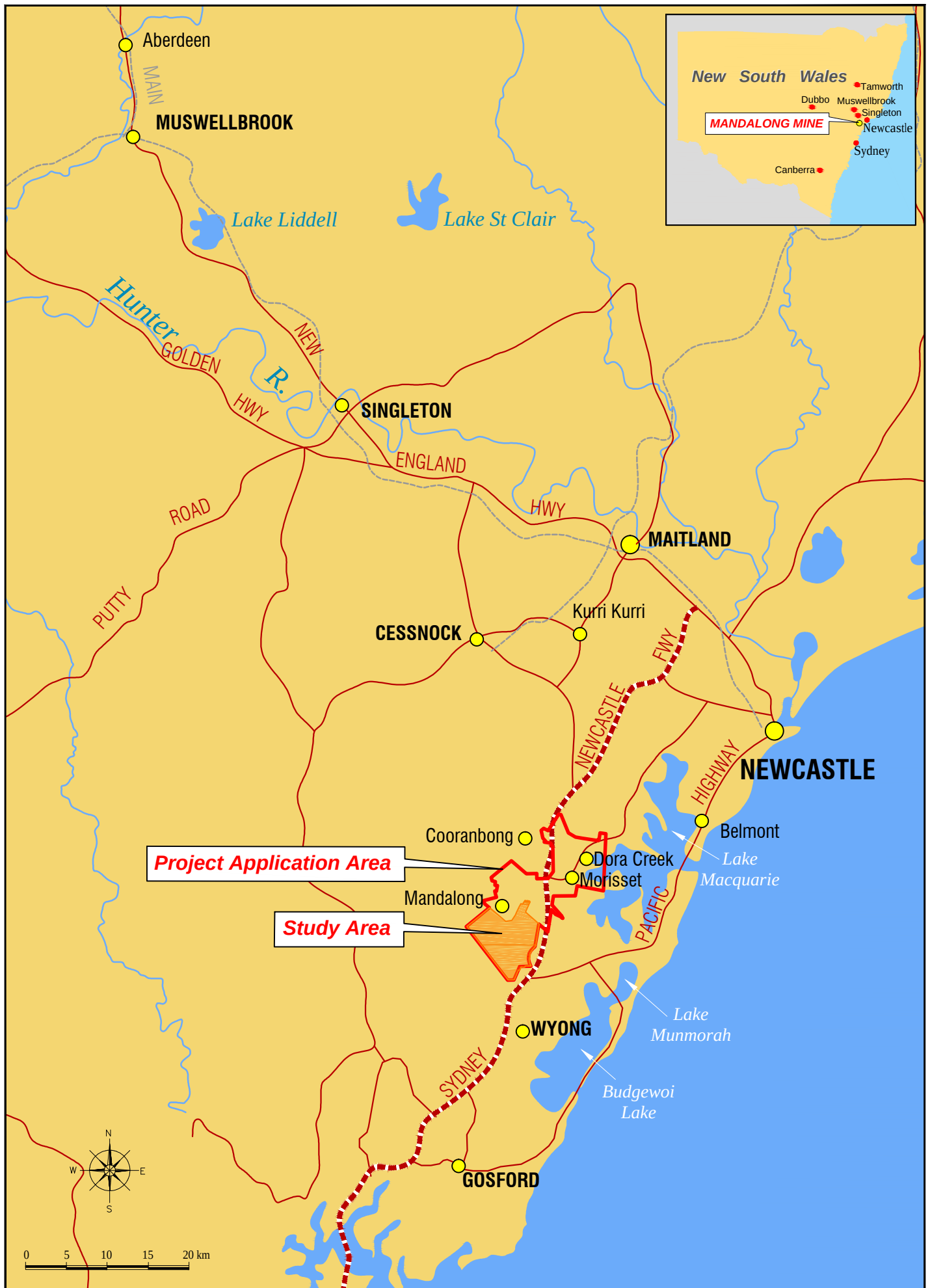
1.1 Project Overview

Mandalong Mine is an existing underground longwall coal mining operation located approximately 130 km north of Sydney near Morisset, NSW, as shown in **Figure 1.1**. The Project proposes to extend Mandalong Mine's existing underground mining operations into the area covered by Exploration Licence (EL) 6317 to access, develop and extract the additional coal reserves identified within the West Wallarah Seam and Wallarah-Great Northern Seam at a rate of up to 6 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. The Project also proposes to utilise existing and proposed new surface infrastructure integral to the mining operation.

The Project, in conjunction with Centennial's Newstan Extension of Mining Project and Northern Coal Logistics Project, stems from the long-term strategy Centennial has developed for its future operations in the Newcastle Coalfield to provide the infrastructure and flexibility required to meet future opportunities in both the domestic and export coal markets.

The primary components of the Project are to:

- continue to utilise the existing surface infrastructure of the Mandalong Mine Access Site and Delta Entry Site;
- extract up to 6 Mtpa of ROM coal from the West Wallarah and Wallarah-Great Northern Seams within the current mining lease areas and the area covered by EL 6317;
- deliver ROM coal from the underground workings to the Cooranbong Entry Site at a rate of up to 6 Mtpa and to the Delta Entry Site at a rate of up to 6 Mtpa;
- continue to utilise the existing surface infrastructure of the Mandalong Mine Access Site and Delta Entry Site;
- install and operate surface infrastructure at the proposed Mandalong South Surface Site to service the extended underground mining operation;
- increase manning to 420 full-time employees and up to 50 contractors during longwall relocations;
- undertake ongoing exploration drilling activities within the bounds of Centennial Mandalong's mining leases and exploration licences;
- increase the life of mine to 25 years from the granting of a mining lease(s) over EL 6317; and
- continue to operate 24 hours per day, seven days per week.



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Mandalong Southern Extension Project
Regional Locality

FIGURE 1.1

1.2 Study Area and Disturbance Assessment Area

The Study Area for this AIS comprises a total of 4,613 ha, including the entire area within EL 6317 (4,466 ha), which is referred to as the Southern Extension Area, and a small area (147 ha) in the north adjacent to EL 6317 covering longwall panels proposed to extend into Mandalong Mines existing mining lease area. Refer to **Figure 1.2**.

The land within the Study Area with the potential to be disturbed by the Project comprises 3,181 ha and is termed the Disturbance Assessment Area (DAA). As shown on **Figure 1.2**, the DAA includes:

- the proposed new Mandalong South Surface Site and access road with a disturbance footprint of 20 ha; and
- the area of land potentially impacted by subsidence associated with the proposed underground mining, including the 26.5 degree angle of draw from the edge of the proposed longwalls, covering 3,177 ha. This includes 16 ha (of the 20 ha described above) of land that will be disturbed for the proposed Mandalong South Surface Site and access road.

The Study Area, which includes the DAA, is located in both the Wyong and Lake Macquarie Local Government Areas (LGAs).

1.3 Purpose of this Report

The Director-General's Requirements (DGR) for this Project issued by the DP&I on 20th March 2012 included an AIS. In addition to the DGRs, the *Strategic Regional Land Use Policy* (SRLUP) (DP&I, 2012a) also requires all state-significant mining development proposals, whether or not they are located on land mapped as Strategic Agricultural Land (SAL), to prepare an AIS for consideration at the development application stage.

GSSE has prepared this AIS to address the requirements of the final *Guideline for Agricultural Impact Statements* (DP&I, 2012b). The purpose of this AIS is to assess and report on the potential impacts of the Project on agricultural resources and/or industries within and surrounding the Study Area. The term 'agricultural resource' is used to describe the land on which agriculture is dependent and the associated water resources (quality and quantity) that are linked to that land.

1.3.1 Director-General's Requirements for Environmental Assessment

The DGRs for the Project specific to this AIS are listed in **Table 1.1**.

Table 1.1 Director-General Requirements

The EIS must address the following specific issues	Addressed in this document in:
Land resources – including an agricultural impact statement and a detailed assessment of the potential impacts on: • soils (including any acid sulfate soils) and land capability (including land contamination);	Section 2. Full details in <i>Soil and Land Capability Assessment</i> (GSSE, 2013a).
• landforms and topography, including cliffs, rock formations, steep slopes, etc.	Section 2. Full details in <i>Soil and Land Capability Assessment</i> (GSSE, 2013a).
• land use, including agricultural, forestry, conservation and recreational, with particular reference to state conservation areas and state forests – including any impacts on forestry resources and forestry activities and consideration of appropriate compensation in relation to forestry production.	Section 4.



1.4 Scope of this Report

This AIS, in accordance with the *Strategic Agricultural Land Use Policy: Guideline for Agricultural Impact Statements* (DP&I, 2012b), addresses the information listed in **Table 1.2**.

Table 1.2 AIS Requirements

This AIS must include the following information	Addressed in this document in:
Information Relating to the Site and Region	
<i>Detailed assessment of the agricultural resources and agricultural production of the project area</i>	
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 2
the location and area of land to be returned to agricultural use post-project, and its productive potential relative to pre-project;	Section 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 2
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.	Section 2
<i>Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the project area</i>	
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
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
Assessment of Impacts	
<i>Identification and assessment of the impacts of the project on agricultural resources or industries</i>	
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)	

This AIS must include the following information	Addressed in this document in:
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;	N/A; not in mapped area
• 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 5
• proposed monitoring programs to assess predicted versus actual impacts as the project progresses;	
• 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 6
• 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.	

2.0 AGRICULTURAL AND WATER RESOURCES

2.1 Climate

Representative rainfall data for the Study Area has been obtained from the nearest Bureau of Meteorology (BOM) weather station located at Cooranbong, approximately 6 km to the north-east of the Study Area (BOM, 2013). The Cooranbong BOM Station has recorded an average annual rainfall of 1,135 mm (based on records from 1903 – present).

The BOM classifies the Study Area as located in a temperate climate zone and can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs during warmer months. Summer winds are generally from the south or south-east, with a tendency for afternoon north-easterly winds. During winter, winds are predominantly from the south or south-west.

2.2 Topography

The Study Area is dominated by two ridgelines which trend generally north-west to south-east and from the south to the north-east corner; both are densely timbered. Elevations on these ridgelines can exceed 200 m Australian Height Datum (AHD). The small areas of relatively flat land surrounding these ridgelines have been cleared and used for rural production, as shown in **Figure 2.1**. The valleys are relatively low lying with surface elevations generally less than 50 m AHD. The Jilliby State Conservation Area is located in the north-west section of the Study Area and part of the Onley State Forest is located within the western and southern boundaries of the Study Area.

2.3 Hydrology

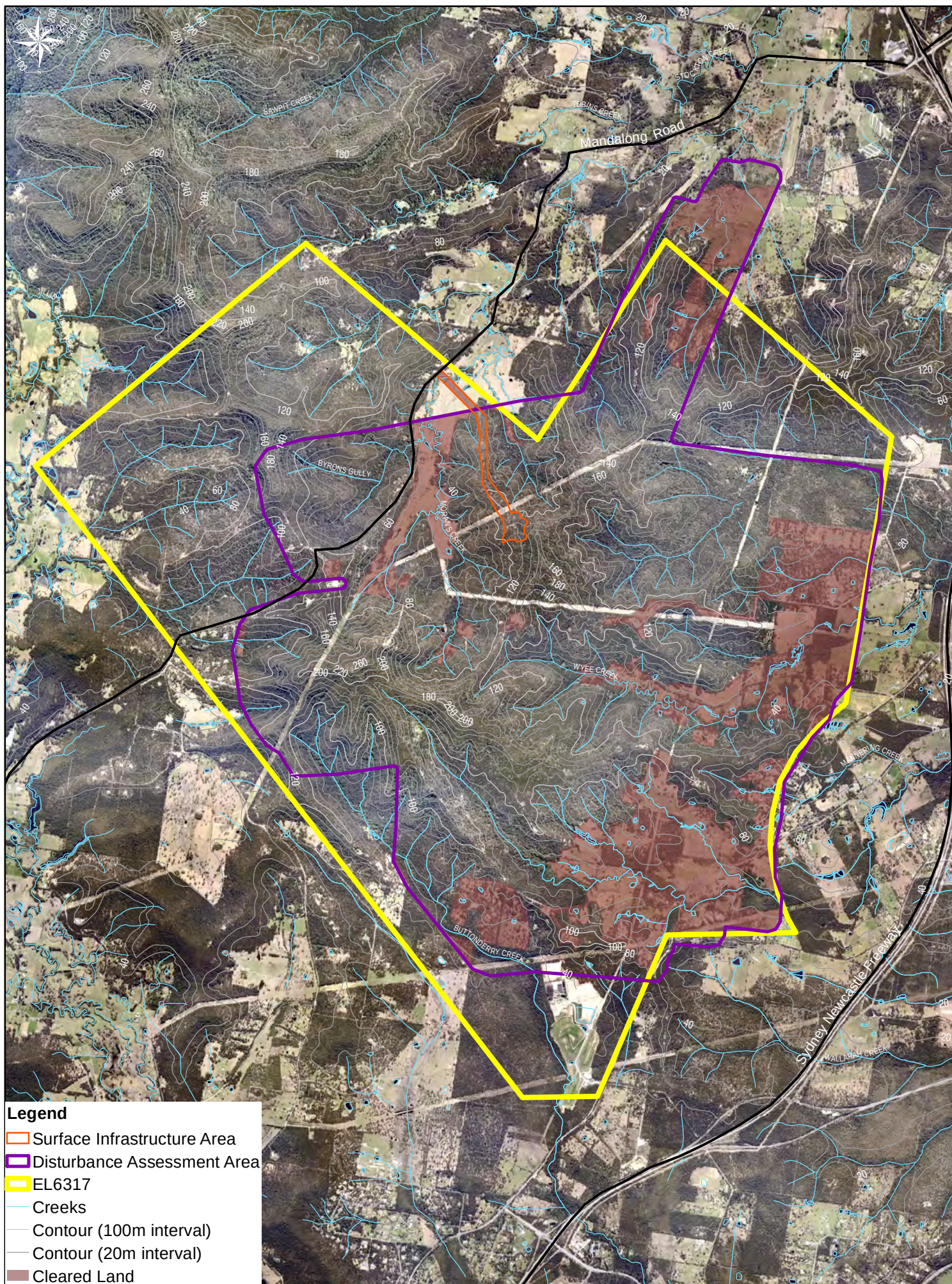
2.3.1 Surface Water

The majority of the Study Area lies within the catchment of Lake Macquarie with the southern portion being part of the Wyong River catchment, as described in the *Surface Water Assessment* (Umwelt, 2013).

A proportion of the Study Area is covered by low-lying creek valleys, as shown in **Figure 2.1**, which consist of 5 sub-catchment areas:

1. Morans Creek, which flows in a north-easterly direction towards Mandalong;
2. Wyee Creek, which flows in an easterly direction;
3. Mannering Creek, which flows in an easterly direction;
4. Buttonderry Creek, which flows in a south-easterly direction joining Jilliby Creek in the south of the Study Area; and
5. Jilliby Creek, which flows in a south-westerly direction.

Morans, Wyee and Mannering Creeks flow into Lake Macquarie, while Buttonderry and Jilliby Creeks join the Wyong River. **Table 2.1** shows the areas of these sub-catchments in relation to the Study Area.



Legend

- Surface Infrastructure Area
- Disturbance Assessment Area
- EL6317
- Creeks
- Contour (100m interval)
- Contour (20m interval)
- Cleared Land

Table 2.1 Study Area Catchments

Catchment	Sub-Catchment
Lake Macquarie	Morans Creek
	Wye Creek
	Mannering Creek
Wyong River	Buttonderry Creek
	Jilliby Creek

Source: Umwelt, 2013

The major sub-catchments are Morans and Wye Creek, whilst Mannering, Buttonderry and Jilliby Creeks are minor sub-catchments.

Three Water Sharing Plans, which are regulated by the NSW Office of Water (NOW), apply to land within the Study Area, as identified in the *Surface Water Assessment* (Umwelt, 2013):

1. *Hunter Unregulated and Alluvial Water Sources* (NOW, 2009a).
2. *Central Coast Unregulated Water Sources* (NOW, 2009b), and
3. *Jilliby Creek Water Source* (NOW, 2003);

Table 2.2 shows water extraction amounts for each of the water sharing plans, both basic landholder rights and licenced extraction allowed from these water sources.

Table 2.2 Surface Water Extraction Rights

Water Sharing Plan	Associated Waterway	Basic Landholder Rights	Licensed Extraction
Hunter Unregulated and Alluvial Water Sources (2009a)	Lake Macquarie	0.07 ML/day	169 ML/year
Central Coast Unregulated Water Sources (2009b)	Wyong River	0.24 ML/day	42,766 ML/year
Jilliby Creek Water Source (2003)	Jilliby Creek	0.51 ML/day	1,016 ML/year

Source: Umwelt, 2013

Whilst there are considerable extraction rights under the provisions of the above Water Sharing Plans, Umwelt (2013) states that water courses within the Study Area are ephemeral, with limited or zero flow during low rainfall periods. This suggests that strong dependence by downstream agricultural users on flows from these watercourses would be limited.

2.3.2 Groundwater

The *Groundwater Impact Assessment* (GHD, 2013a) found the groundwater sources within the Study Area are predominantly within the Quaternary alluvium, weathered and/or fractured sandstone and coal seams. Due to the relatively high silt and clay content of the alluvium, the groundwater sources are generally low yielding and are classified as 'less productive' according to the *NSW Aquifer Interference Policy* (NOW, 2012).

The interception and extraction of surface water and alluvial groundwater within the Study Area is regulated under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*. The coal seam and sandstone groundwater sources are not currently managed under any Water Sharing Plans.

2.3.2.1 Alluvial Groundwater

Alluvial groundwater within the Study Area is found in an unconfined shallow aquifer with a water table ranging in depth from less than 1 m to about 3 m below ground level, with aquifer thickness less than 20 m (GHD, 2013a). Groundwater quality ranges from moderately acidic to slightly alkaline, brackish to saline, extremely hard and of sodium chloride type. Electrical conductivity throughout the Study Area exceeds 10,000 $\mu\text{S}/\text{cm}$ at some locations, and yields are low at typically less than 1 L/s (GHD, 2013a). As a result of the low yield and relatively poor water quality, there are very few registered private alluvial groundwater bores in the vicinity of the Study Area (GHD, 2013a).

2.3.2.2 Porous and Fractured Rock Groundwater

Groundwater inflows into the existing Mandalong Mine workings from the coal seam and adjacent strata are reported by Centennial Mandalong to be relatively low. This underground water is slightly alkaline and brackish to saline (GHD, 2013b). Groundwater within the overburden rock above the West Wallarah Seam primarily occurs within weathered or fractured Triassic sandstone.

Based on the groundwater monitoring program for the current Mandalong Mine operations, groundwater within the sandstone/siltstone of the Tuggerah Formation and Munmorah Conglomerate has been found to be saline and slightly acidic to strongly alkaline. The groundwater sources exhibit considerable variability in quality, particularly in terms of pH (GHD, 2013b).

The electrical conductivity of the groundwater in the porous and fractured rock aquifers typically ranges from 6,000 $\mu\text{S}/\text{cm}$ to over 10,000 $\mu\text{S}/\text{cm}$ (GHD, 2013a), which is outside the recommended limits (4,000 $\mu\text{S}/\text{cm}$ to 6,000 $\mu\text{S}/\text{cm}$) for cattle and horses according to *Measuring Water Salinity* (NSW Industry and Investment (I&I), 2009).

2.3.3 User Extraction Points

A search of the NSW Groundwater Bore Database was undertaken by GHD (2013a) to identify registered bores within a three km radius of the proposed Mandalong Southern Extension workings. The search identified 68 bores, with the majority (40) registered as monitoring/test bores and the remainder (28) being registered for domestic, irrigation and / or stock use.

The registered domestic and stock bores that were identified primarily extract groundwater from the Triassic sandstone and conglomerate formations, with yields generally less than 1 L/s. Domestic and stock bores are mostly located to the south and east of the Study Area, while the majority of bores to the north of the Study Area are Mandalong Mine's groundwater monitoring bores.

There is one registered bore (GW078601) located within the northern extent of the Study Area. This bore is registered for stock and domestic supply drawing shallow groundwater from sandstone at a depth of approximately 15-16 m below ground level (GHD, 2013a). The groundwater at this bore has a salinity reading of 2,496 $\mu\text{S}/\text{cm}$ (GHD, 2013a), which is within acceptable limits for cattle and horses, however at the 2,500 $\mu\text{S}/\text{cm}$ threshold limit for human consumption (I&I, 2009).

Given there is only one licenced extraction bore within the Study Area this would indicate that groundwater usage and reliance for livestock, domestic and irrigation is very limited.

2.4 Geology

The Study Area is located in the south-western part of the Newcastle Coalfield, which occupies the north-eastern portion of the Sydney Basin. The target coal seams are the Wallarah seam and the Great Northern seam, which together form the upper part of the Permian Newcastle Coal Measures.

Above the Wallarah and Great Northern Seams lies the Narrabeen Group, which are comprised of variable sequences of interbedded claystones, siltstones and fine to coarse-grained sandstones. The Munmorah Conglomerate is a sandstone-dominated formation within the Narrabeen Group, which typically occurs between 60–140 m above the Newcastle Coal Measures.

One igneous sill, six igneous dykes (trending generally north-west to south-east), and two diatremes have been interpreted within the Study Area from aerial and ground magnetic surveys (Centennial Mandalong 2012). The south-western boundary of the area is defined by an adjacent sub-parallel dyke swarm.

2.5 Soil Landscape Units

The soil landscapes units within the Study Area have been mapped by the former NSW Department of Land and Water Conservation, incorporating the NSW Soil Conservation Service (now part of NSW Department of Primary Industries (DPI)), at the scale of 1:100,000 (Murphy, 1993) as shown in **Figure 2.2**. As detailed in the *Soil and Land Resource Assessment* (GSSE, 2013a) prepared for the Project:

- As listed in **Table 2.3**, seven soil landscapes occur in the Study Area.
- The majority of the Study Area (91.8%) and DAA (91%) is highly to severely constrained for cultivation (cropping) enterprises.
- Land that is highly to severely constrained for any agricultural enterprises includes the Mandalong and Watagan Soil Landscape Units, which together cover 50.8% and 51.3% of the Study Area and DAA, respectively.
- Agricultural land best suited to grazing enterprises includes the Woodbury's Bridge, Doyalson and Gorokan Soil Landscape Units, which together cover 41% and 39.7% of the Study Area and DAA, respectively.
- Agricultural land suited to cultivation enterprises includes the Wyong and Yarramalong Soil Landscape Units, which together cover 8.2% and 9% of the Study Area and DAA, respectively.

Table 2.3 Soil Landscape Units

Soil Landscape	Study Area		Disturbance Assessment Area		Agricultural Limitation Rating	
	ha	%	ha	%	Grazing	Cultivation
Mandalong	2047	44.4	1392	43.8	High – Severe	High – Severe
Watagan	298	6.5	238	7.5	High – Severe	High – Severe
Subtotal	2344	50.8	1631	51.3		
Woodbury's Bridge	581	12.6	528	16.6	Moderate	High – Severe
Doyalson	60	1.3	59	1.9	Moderate	High – Severe
Gorokan	1251	27.1	676	21.2	Low	High – Severe
Subtotal	1892	41.0	1263	39.7		
Wyong	281	6.1	240	7.5	Low – Moderate	Low – Moderate
Yarramalong	96	2.1	48	1.5	Low – Moderate	Low – Moderate
Subtotal	377	8.2	288	9.0		
Total	4613	100	3181	100		

Figure 2.2 shows the distribution of the seven soil landscapes across the Study Area. Full descriptions of each soil landscape can be found in the Project's *Soil and Land Capability Assessment* (GSSE, 2013a).

2.6 Dominant Soil Types and Inherent Fertility

The dominant soil types within the Study Area were ground-truthed at the scale of 1:100,000 by GSSE as part of the *Soil and Land Capability Assessment* (GSSE, 2013a). These are summarised in **Table 2.4**, and the major points listed below.

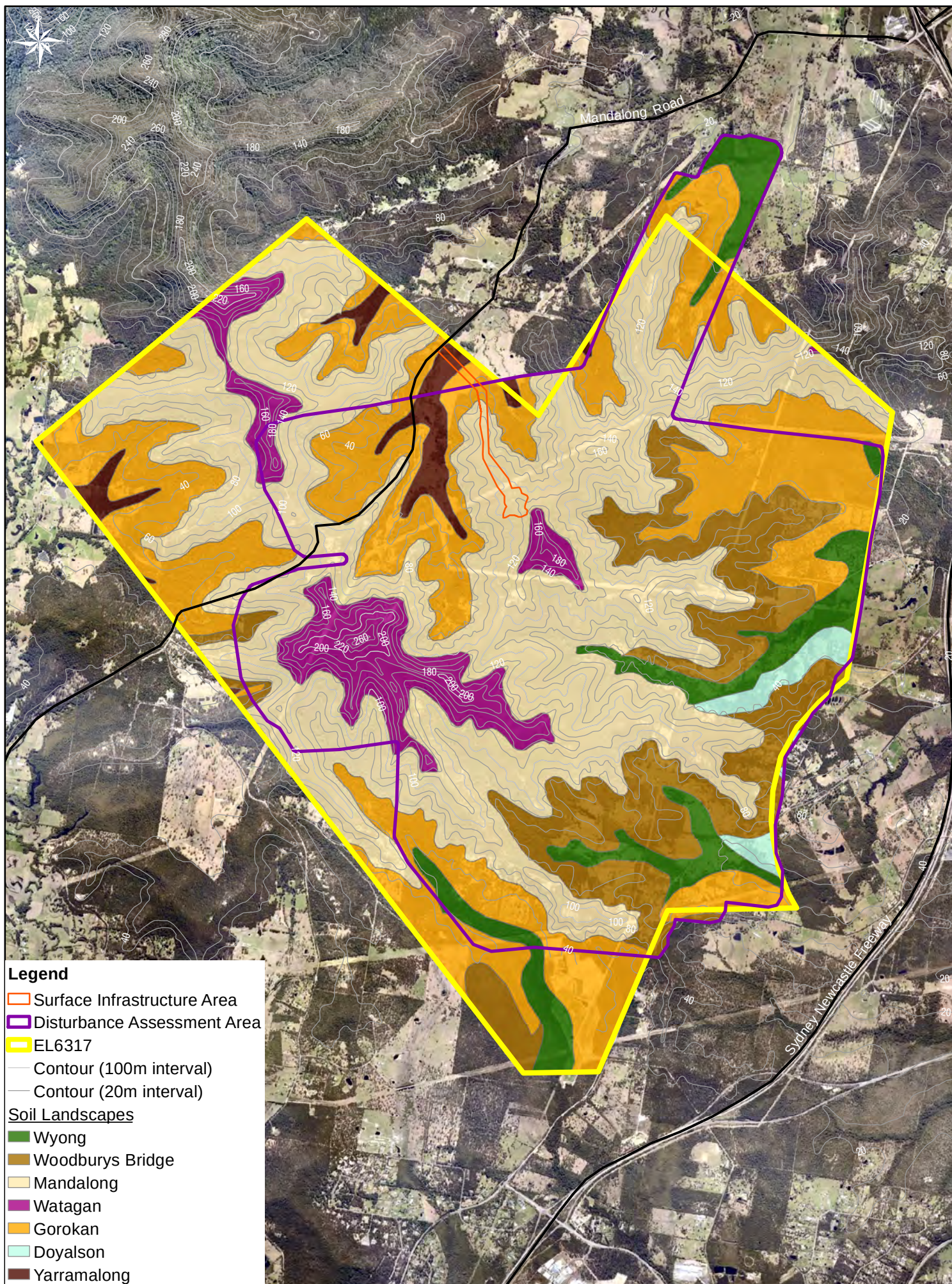
- Three major soil orders are present in the Study Area: Kurosols, Chromosols, and Sodosols.
- Kurosols are soils that have a strong texture contrast between the topsoil and subsoil horizons and contain a strongly acidic subsoil.
- Chromosols are soils that have a strong texture contrast between the topsoil and subsoil horizons and are not strongly acidic or sodic at depth.
- Sodosols are soils that have a strong texture contrast between the topsoil and subsoil horizons and contain a sodic subsoil.
- All soil types within the Study Area are classed as having moderately low inherent fertility.

Table 2.4 Dominant Soil Types and Inherent Fertility

Australian Soil Classification Soil Type		Associated Soil Landscape	Study Area		Disturbance Assessment Area		Fertility*
Order	Full Reference	Name	ha	%	ha	%	
Kurosol	Magnesian – Natric, Brown Kurosol	Mandalong	2047	44.4	1392	43.8	Moderately low
Chromosol	Eutrophic, Brown Chromosol	Watagan	298	6.5	238	7.5	Moderately Low
Subtotal			2344	50.8	1631	51.3	
Kurosol	Magnesian – Natric, Brown Kurosol	Woodbury's Bridge	581	12.6	528	16.6	Moderately low
Kurosol	Mesotrophic, Brown Kurosol	Doyalson	60	1.3	59	1.9	Moderately low
Sodosol	Mesonatric, Brown Sodosol	Gorokan	1251	27.1	676	21.2	Moderately low
Subtotal			1892	41.0	1263	39.7	
Kurosol	Natric Brown Kurosol	Wyong	281	6.1	240	7.5	Moderately low
Sodosol	Yellow Sodosol	Yarramalong	96	2.1	48	1.5	Moderately low
Subtotal			377	8.2	288	9.0	
Total			4613	100	3181	100	

Source: *Soil and Land Capability Assessment* (GSSE, 2013a)

* Fertility is correlated with the Great Soil Groups. Table 10 in Appendix 2 of the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012) was used for the BSAL assessment.



Mandalong Sth Extension Project
Soil Landscape

Figure 2.2

2.7 Acid Sulfate Soils

The likelihood of acid sulfate soils occurring within the Study Area is very low due to the Study Area's position away from the coast and potential acid sulfate landform type. This is supported by the Wyong (Wyong Shire Council, 2012) and Lake Macquarie (Lake Macquarie City Council, 2012b) Local Government acid sulfate soil maps.

The Wyong Soil Landscape Unit, which covers just over 6% of the Study Area, is the only soil landscape unit within the Study Area that has acid sulfate soil potential. As evident on **Figure 2.2**, the relevant small areas of the Wyong Soil Landscape Unit have been mapped in the northern, southern and eastern extents of the Study Area primarily along drainage lines and significantly removed from the proposed Mandalong South Surface Site

2.8 Vegetation and Land Use

Assessment of recent aerial images shows that the majority of the DAA remains under native vegetation (approximately 73%), as shown in **Figure 2.1**. The remainder is land that has been previously cleared and may be suitable for agricultural enterprises. A site inspection in August 2012 by GSSE's Senior Agronomist, in conjunction with a desktop assessment, has shown that small scale grazing is the dominant agricultural enterprise. No intensive cropping activities were observed at the time of the assessment.

The commercial Charolais stud "Douglasdale" has a minor portion of its area located within the eastern edge of the DAA. Other than the "Douglasdale" operation, grazing within the DAA appears to be used as a grass and vegetation management tool rather than an income generating agricultural enterprise. Overall farm size is considered small and many would be classified as hobby farms with a very low potential to produce agricultural income.

The Study Area encompasses a minor part of the Jilliby State Conservation Area (166 ha) and Olney State Forest (740 ha) (refer to **Figure 2.3**), and the existing native vegetation includes 11 vegetation communities, which are described in detail in the *Flora and Fauna Assessment* (RPS, 2013).

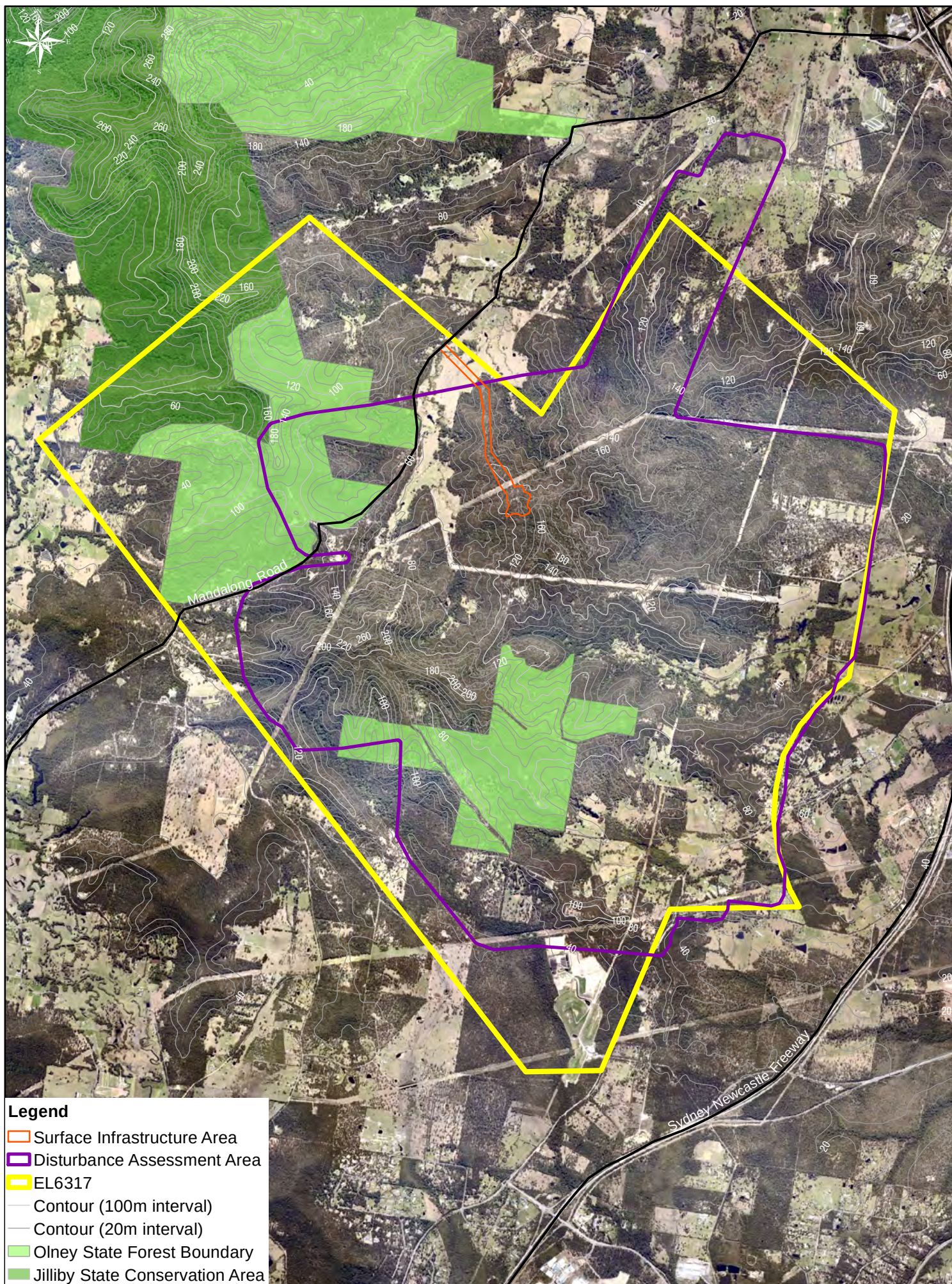
2.9 Land and Soil Classification

In NSW, two broad systems had been widely used to evaluate the agricultural potential of the land:

- (i) Rural Land Capability System developed by the former NSW Soil Conservation Services (Emery, 1986); and
- (ii) Agricultural Suitability System (NSW Department of Agriculture, 1983).

These two systems have been largely replaced by the new Land and Soil Classification (LSC) assessment scheme developed for NSW: *The Land and Soil Capability Assessment Scheme: Second Approximation* (OEH, 2012a). The LSC scheme builds on the Rural Land Capability system and retains the eight class system, however places additional emphasis on specific soil limitations and management. The LSC classes are described in **Table 2.5**; their definition has been based on the:

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



Legend

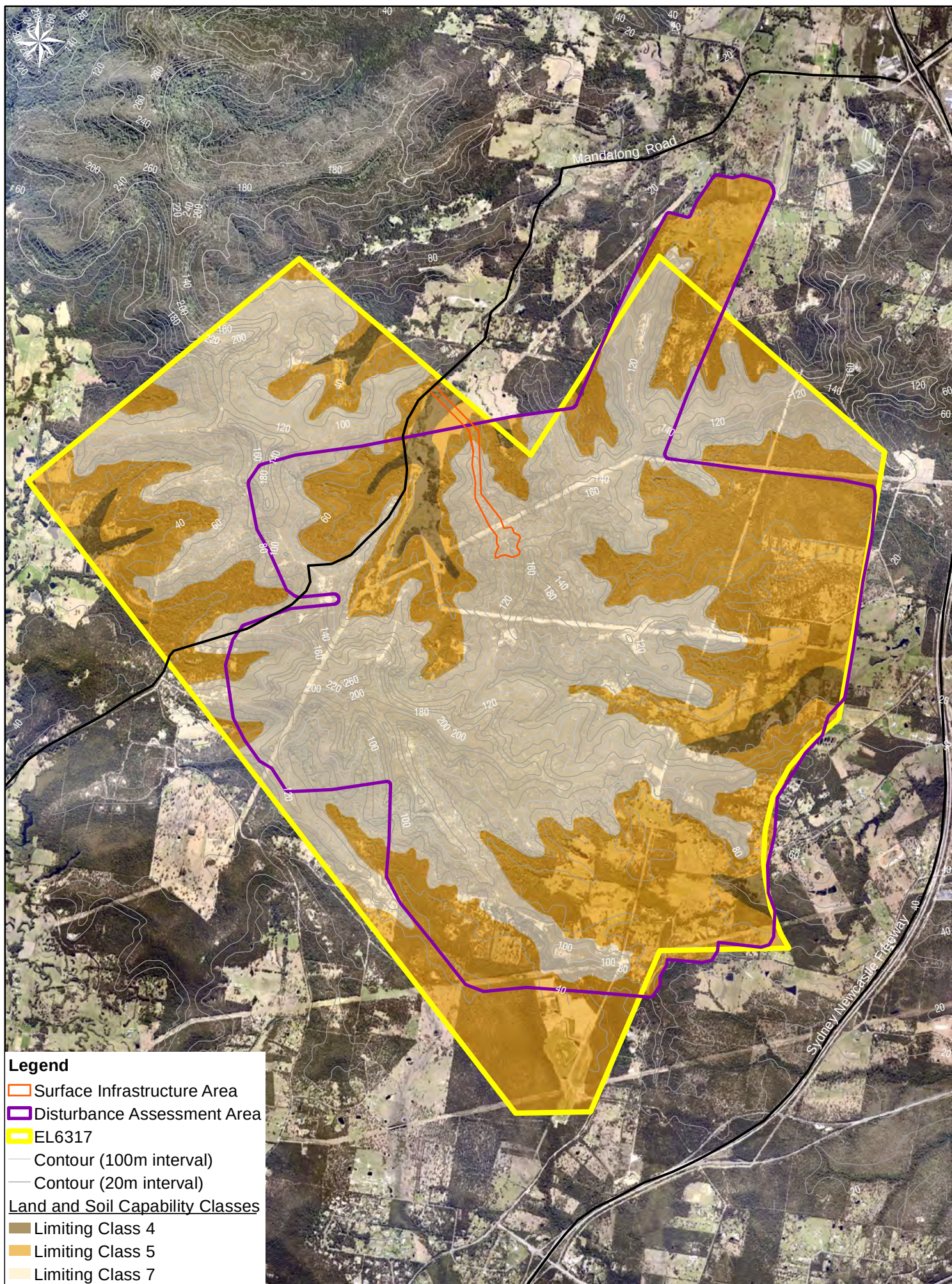
- Surface Infrastructure Area
- Disturbance Assessment Area
- EL6317
- Contour (100m interval)
- Contour (20m interval)
- Olney State Forest Boundary
- Jilliby State Conservation Area

Table 2.5 LSC Class Definition

LSC Class	General Definition	
Land capable of a wide variety of land uses (cropping, grazing, horticulture forestry, conservation, nature conservation)		
1	Extremely high capability land No limitations	No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land Slight limitations	Limitations can be managed by readily available, easily implemented management practices land is capable of most land uses and land management practices including intensive cropping with cultivation.
3	High capability land Moderate limitations	Is capable of sustaining high-impact land uses, such as cropping, with cultivation using more intensive and widely accepted management practices. However, careful management of the limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture forestry, nature conservation)		
4	Moderate capability land Moderate to high limitations for high-impact land uses.	Limitations will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate-low capability land High limitations for high-impact land uses.	Limitations will restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable of a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	Low capability land Very high limitations for high-impact land uses.	Land restricted to low-impact land uses such as grazing, forestry and nature conservations, Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)		
7	Very low capability land Severe limitations that restrict most land uses.	Limitations generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations are not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability land	Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The LSC Assessment for the Study Area and DAA is summarised in **Table 2.6** and shown in **Figure 2.4**. Full details regarding the LSC assessment are provided in the Project's *Soil and Land Capability Assessment* (GSSE, 2013a). The major assessment points are listed below.

- Three dominant LSC classes present in the Study Area are Classes 4, 5 and 7, comprising 157 ha, 2,112 ha and 2,344 ha, respectively, as shown in **Figure 2.4**.
- Class 4 land is associated with the Yarramalong and Doyalson Soil Landscape Units and is considered to be moderately capable land primarily suited to pasture cropping and grazing enterprises. The land has moderate to high limitations for high-impact activities (e.g. regular cultivation). It covers a minor part of the Study Area and DAA, with coverage of 3.4% in both.
- Class 5 land is associated with the Woodbury's Bridge, Wyong and Gorokan Soil Landscape Units and is considered to have a moderate to low capability that is primarily suited to grazing enterprises only. The land has high limitations for high-impact activities and covers a major part of the Study Area and DAA, with coverage of 45.8% and 45.3%, respectively.



- Class 7 land is associated with the remainder of the Study Area and is considered to have a very low capability for agricultural enterprises and is suitable for green timber coverage with native vegetation. This class covers a major part of the Study Area and DAA, with coverage of 50.8% and 51.3%, respectively.

Table 2.6 Land and Soil Classification

LSC	Associated Soil Landscape	Study Area		Disturbance Assessment Area		Capability
Class	Name	ha	%	ha	%	
4	Yarramalong	97	2.1	48	1.5	Moderate capability land
4	Doyalson	60	1.3	59	1.9	
Subtotal		157	3.4	107	3.4	
5	Wyong	281	6.1	240	7.5	Moderate-low capability land
5	Gorokan	1251	27.1	676	21.2	
5	Woodbury's Bridge	580	12.6	528	16.6	
Subtotal		2112	45.8	1444	45.3	
7	Mandalong	2046	44.4	1392	43.8	Very low capability land
7	Watagan	298	6.4	238	7.5	
Subtotal		2344	50.8	1631	51.3	
Total		4613	100	3181	100	

2.10 Biophysical Strategic Agricultural Land Assessment

The NSW Government recently released the *Strategic Regional Land Use Policy* to assist the development of a long-term strategy for continued progress of the mining industry that also ensures local community sustainability and on-going viability of existing industries. Part of this policy is the development of Strategic Regional Land Use Plans (SRLUPs), which includes the determination of Biophysical Strategic Agricultural Land (BSAL), defined as areas with unique natural resource characteristics highly suited for agriculture.

The SRLUP for the Study Area has not been released at this point in time; therefore, no BSAL mapping is available for the Study Area. Notwithstanding, and adopting a precautionary approach, GSSE (2013a) assessed the Study Area against the BSAL criteria contained in the *Upper Hunter Strategic Regional Land Use Plan* (DP&I, 2012c) and the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012b). The first BSAL assessment was undertaken using the criteria from the *Upper Hunter Strategic Regional Land Use Plan* (DP&I, 2012c), as per **Tables 2.7** and **2.8**.

Table 2.7 Biophysical Strategic Agricultural Land Criteria

Criteria
- Land that falls under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH, 2011), and - land capability classes 1,2 or 3 under the Land and Soil Capability Mapping of NSW (OEH, 2012a), and - reliable water of suitable quality, characterised by having rainfall of 350 mm or more per annum (9 out of 10 years); or properties within 150 m of a regulated river, or unregulated rivers where there are flows for at least 95% of the time (ie the 95th percentile flow of each month of the year is greater than zero) or 5th order and higher rivers; or groundwater aquifers (excluding miscellaneous alluvial aquifers, also known as small storage aquifers) which have a yield rate greater than 5 L/s and total dissolved solids of less than 1,500 mg/L.
OR
- land that falls under soil fertility classes 'moderate' under the Draft Inherent General Fertility of NSW (OEH, 2011), and - land capability classes 1 or 2 under the Land and Soil Capability Mapping of NSW (OEH, 2012a), and - reliable water of suitable quality as described above.

Source: *Upper Hunter Strategic Regional Land Use Plan* (2012c)

The minimum requirement for rainfall reliability for the region was met for the Study Area (mean rainfall 1,135 mm, refer **Section 2.1**); therefore, only the LSC and fertility class were further assessed by GSSE (2013a). To do this, this assessment compares the LSC Classes against the soil types fertility attributes to determine if the BSAL criteria, as specified in **Table 2.7**, are met in the Study Area. The soil fertility and the outcomes of the BSAL assessment are shown in **Table 2.8**.

Table 2.8 Applied Biophysical Strategic Agricultural Land Criteria

Soil Landscape	Soil Name	LSC	Fertility	BSAL	BSAL Limitation
Unit	ASC	Class	Class	Yes/No	Description
Yarramalong	Yellow sodosol	4	Moderately low	No	LSC class & fertility
Doyalson	Mesotrophic, Brown Kurosol	4	Moderately low	No	LSC class & fertility
Woodbury's Bridge	Magnesian – Natric, Brown Kurosol	5	Moderately low	No	LSC class & fertility
Wyong	Natric Brown Kurosol	5	Moderately low	No	LSC class & fertility
Gorokan	Mesonatric, Brown Sodosol	5	Moderately low	No	LSC class & fertility
Mandalong	Magnesian – Natric, Brown Kurosol	7	Moderately low	No	LSC class & fertility
Watagan	Eutrophic, Brown Chromosol	7	Moderately low	No	LSC class & fertility

Source: GSSE (2013a)

Whilst the Study Area met the minimum rainfall criteria, the fertility class and LSC classifications for each soil type indicate that the soil resources do not qualify as BSAL under the *Upper Hunter Strategic Regional Land Use Plan* (DP&I, 2012c).

The second BSAL assessment undertaken by GSSE (2013a) used the criteria from the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012b), as per **Tables 2.9** and **2.10**.

Table 2.9 Twelve Step Site Verification Criteria According to Interim Protocol

Step Number	Criteria	BSAL Definition
1	Reliable Water Supply	Greater than 350 mm annual rainfall (9 out of 10 years), or underlain by ground water aquifer with yield greater than 5L/s and total dissolved solids less than 1,500 mg/L
2	Slope	Slope of less than or equal to 12%
3	Rock Outcrop	Rock outcrop of less than 30%
4	Soil Type	Soil which has naturally high, moderately high or moderate fertility
5	Surface Rockiness	Less than 20% of the area has unattached rock fragments greater than 60 mm diameter
6	Gilgai	Less than 50% of the area has gilgai depression that are deeper than 500 mm
7	Soil Depth	Soil depth greater than 750 mm
8	Drainage	Soil must not be poorly or very poorly drained soils
9	pH	pH within range of 5.0 to 8.9 when measured in water or pH within range of 4.2 to 8.1 when measured in calcium chloride.
10	Soil Salinity	Electrical conductivity in a saturated extract (ECe) less than or equal to 4 dSm/m or if gypsum is present, chlorides less than 800 mg/kg
11	Soil Water Storage	Soil must be able to store more than or equal to 75 mm of water to effective soil depth of 1 m or less
12	Minimum Area	Soil must have a contiguous area of greater or equal to 20 Ha

As evident in **Table 2.10**, the minimum requirement for Step 1 was met for all soil types in the Study Area with an average annual rainfall of 1,135 mm (**Section 2.1**). Soil Types 3 and 4 did not meet the criteria for Step 2 with slopes greater than 12%. All remaining soil types met the criteria for Step 3 with less than 30% rock outcrop.

Soil Types 1, 2, 5, and 7 are all classed as 'moderately low' fertility according to the *Interim Protocol* and did not meet the minimum criteria for Step 4.

Soil Type 6 did not meet the criteria for Step 7 as its soil depth was 650 mm, and therefore did not meet the minimum of 750 mm.

Table 2.10 Applied BSAL Criteria: Interim Protocol for Site Verification

Soil Type		Site Verification Step							BSAL
No.	Name	1	2	3	4	5	6	7	
1	Natric, Brown Kurosol	✓	✓	✓	✗	-	-	-	No
2	Magnesian – Natric, Brown Kurosol	✓	✓	✓	✗	-	-	-	No
3	Magnesian – Natric, Brown Kurosol	✓	✗	-	-	-	-	-	No
4	Eutrophic, Brown Chromosol	✓	✗	-	-	-	-	-	No
5	Mesonatric, Brown Sodosol	✓	✓	✓	✗	-	-	-	No
6	Mesotrophic, Brown Kurosol	✓	✓	✓	✓	✓	✓	✗	No
7	Yellow Sodosol	✓	✓	✓	✗	-	-	-	No

On the basis of the information presented in **Table 2.10**, all soil types were rejected as BSAL at various steps of the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012b).

According to the precautionary assessment undertaken by GSSE (2013a), there is no potential BSAL present within the Study Area with none of the soil types meeting the BSAL criteria under either the *Upper Hunter Strategic Regional Land Use Plan* (DP&I, 2012c) or the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012b).

3.0 LOCAL AND REGIONAL AGRICULTURAL ENTERPRISES

The Study Area is located within both the Wyong and Lake Macquarie LGAs, and therefore both LGA's were considered in the assessment of 'local' and 'regional' impacts on agricultural enterprises.

3.1 Agricultural History

The Mandalong locality was settled in the mid 1850's, with farming and timber cutting being the mainstays of employment. Farming consisted of cattle and sheep grazing and some crop growing. In the late 1800's the timber industry declined and the poor soil could not sustain farming on a commercial scale. Mandalong is now regaining popularity as a hobby farming area (Lake Macquarie City Council (LMCC), 2012a).

Within the Study Area, most agricultural enterprises have traditionally been small farm enterprises conducted in pockets of cleared native bushland, reliant upon off-farm income to be sustainable. Cattle grazing, pleasure horse agistment and small orchard areas are the main agricultural activities in the area.

3.2 Agricultural Enterprises and Associated Industries

3.2.1 Land Use

The agriculture land uses for the Lake Macquarie and Wyong LGAs are displayed in **Table 3.1**. The major points are summarised below.

- Agriculture is a minor land use for the regional area, accounting for 7.0% of land use.
- Agricultural land is almost exclusively used for grazing, utilising 93.8% of all agricultural land. The primary enterprise is meat cattle farming, which accounts for 88.7% of livestock numbers, followed by milk cattle (10%) and sheep farming (1.3%).
- Cropping enterprises comprise a minor portion of agricultural activities. The primary crops grown are vegetables, fruit and other non-cereal crops. No cereals for grains are grown in the region.
- Minimal irrigation cropping is carried out, comprising only 10.4% of the agricultural land in the region. Agriculture is a minor water user in the Lake Macquarie and Wyong LGAs, with 2,524 ML used to irrigate approximately 1,000 ha of agricultural land and an additional 363 ML utilised for other agricultural uses, such as poultry and egg production.

Table 3.1 Regional LGAs – Agricultural Land Use

	Units	Wyong	Lake Macquarie	Total
Agricultural Land Area				
Total land area within LGA	ha	74,010	64,020	138,030
Area of agricultural land	ha	5,847.2	3,763.3	9,610.5
Proportion of agricultural land	%	7.9	5.9	7.0
Agricultural Enterprise				
Land under cropping activities	ha	575.9	18.2	594.1
Land under grazing activities	ha	5271.3	3745.1	9016.4
Proportion of agricultural land used for grazing	%	90.2	99.5	93.8

	Units	Wyong	Lake Macquarie	Total
Grazing Enterprises				
Sheep and lambs	no.	45	0	45
Meat cattle	no.	2,290	776	3,066
Milk cattle (excluding house cows)	no.	18	328	346
Pigs	no.	1	0	1
Total	no.	2,354	1,104	3,458
Proportion of sheep as total stock	%	1.9	0	1.3
Proportion of Meat cattle as total stock	%	97.3	70.3	88.7
Cropping Enterprises				
Cereals for grain	ha	0	0	0
Vegetables for human consumption	ha	116.3	6.6	122.9
Orchard trees (including nuts)	ha	224.9	5.5	230.4
All fruit (excluding grapes)	ha	226.1	6.1	232.2
Non-cereal broad acre crops	ha	8.6	0	8.6
Total land cropped	ha	575.9	18.2	594.1
Proportion of cropping land used for cereals	%	0	0	0
Irrigation				
Area irrigated	ha	1,000	0	1,000
Irrigation volume applied	ML	2,199	325	2,524
Other agricultural uses	ML	184	179	363
Total water use	ML	2,382	504	2,886
Proportion of agricultural land irrigated	%	16.7	0	10.4

Source: ABS, 2006

3.2.2 Employment

A summary of the total employment within the Lake Macquarie and Wyong LGAs and the proportion of agriculture related employment is shown in **Table 3.2**. Employment in the agriculture related sectors is broken down in **Table 3.3**. Agriculture is not a major employer within the region, accounting for only 6.8% of the total employed population. The following points are made in relation to this 6.8%:

- Agriculture-related wholesaling and retailing is responsible for 68.6% of total agricultural-related employment, followed by processing and manufacturing (24.1%), and agricultural production (7.3%).
- The major agricultural production employers are nursery and floriculture production and poultry farming. All other sectors are minor employers in the region.
- The main agriculture-related processing and manufacturing is related to cereal, pasta, baking mix and other grain-mill manufacturing, followed by poultry processing.
- Supermarkets and grocery stores account for the vast majority of wholesaling and retailing.

Detailed agricultural employment figures are not available for the Study Area; however, income generated from agricultural enterprises within the Study Area is minimal due to the small average holding size, with landholders relying on off-farm income. It is therefore assumed that there are minimal individuals directly employed within agriculture.

Table 3.2 Regional (Wyong and Lake Macquarie LGAs) Employment Related to Agriculture

Total Regional Employment (No. of Persons)	130,588
Total Regional Employment Related to Agriculture (No. of Persons)	8,936
Proportion of Regional Employment Related to Agriculture (%)	6.8

Table 3.3 Regional (Wyong and Lake Macquarie LGAs) Agricultural Related Employment by Sector

Agriculture Related Sectors		
Agricultural Production	No. Person	Proportion of Agricultural Employment (%)
Beef Cattle Farming and Feedlots (Specialised)	83	<1
Beekeeping	3	<1
Dairy Cattle Farming	7	<1
Fishing, Hunting and Trapping (All)	62	<1
Grain-Sheep or Grain-Beef Cattle Farming	12	<1
Horse Farming	46	<1
Nursery and Floriculture Production	121	1.4
Poultry Farming (All)	128	1.4
Sheep Farming (Specialised)	15	<1
Sheep, Beef Cattle and/or Grain Farming	6	<1
Turf Growing	26	<1
Vegetable Growing	42	<1
Other Crop, Fruit and Nut Growing (Incl. Grains, Citrus and Stone Fruit, Grape, Berry and Olive)	41	<1
Other Livestock Farming	7	<1
Agriculture, Forestry and Fishing - Not Further Defined	56	<1
Subtotal	655	7.3
Agriculture Related Processing and Manufacturing	No. Person	%
Alcoholic Beverage Manufacturing (Incl. Beer and Wine)	63	<1
Bakery Product and Bread Manufacturing	458	5.1
Biscuit Manufacturing (Factory based)	15	<1
Cake and Pastry Manufacturing (Factory based)	265	3.0
Cereal, Pasta, Baking Mix and Other Grain Mill Manufacturing	697	7.8
Cigarette and Tobacco Product Manufacturing	4	<1
Cured Meat and Smallgoods Manufacturing	13	<1
Dairy Product Manufacturing	81	<1
Fruit and Vegetable Processing	204	2.3
Ice Cream Manufacturing	3	<1
Logging, Log Sawmilling and Timber Dressing	100	1.1
Meat Processing	25	<1
Oil and Fat Manufacturing	29	<1
Potato, Corn and Other Crisp Manufacturing	17	<1

Agriculture Related Processing and Manufacturing continued	No. Person	%
Poultry Processing	536	6.0
Pulp, Paper and Paper Product Manufacturing	37	<1
Sugar Manufacturing	4	<1
Wood Product Manufacturing	7	<1
Other Agricultural Manufacturing (Incl. Machinery, Equipment, Pesticide and Fertiliser)	117	1.3
Other Food Product Manufacturing	280	3.1
Subtotal	2,154	24.1
Agricultural Related Wholesaling and Retailing	No. Person	%
Agricultural and Construction Machinery Wholesaling	72	<1
Cereal Grain Wholesaling	10	<1
Dairy Produce Wholesaling	51	<1
Flower Retailing	80	<1
Fresh Meat, Fish, Seafood, Poultry and Smallgoods Wholesaling and Retailing	531	5.9
Fruit and Vegetable Wholesaling and Retailing	288	3.2
Liquor and Tobacco Product Wholesaling and Retailing	409	4.6
Specialised Food Retailing	725	8.1
Supermarket and Grocery Stores	3,868	43.3
Timber Wholesaling	84	<1
Wool Wholesaling	9	<1
Other Grocery and Food Wholesaling and Retailing	529	5.9
Other Non-defined Agricultural Related Wholesaling and Retailing	221	2.5
Subtotal	6,127	68.6
Total Agricultural Related Employment	8,936	100

3.3 Agricultural Production Value - Regional

Agricultural production values for the Wyong and Lake Macquarie LGAs total \$61.3 million, detailed in **Table 3.4**. The main agricultural production by value is from nurseries and cut flowers, along with poultry (meat and eggs). In the Lake Macquarie LGA these two industries account for over 95% of the value of agricultural commodities produced, while in the Wyong LGA they contribute almost 90% of the total value. Vegetables are the other main agricultural commodity in the Wyong LGA, contributing 11% to the value of agricultural products produced.

Table 3.4 Regional Agricultural Production

Agricultural Production Gross Value	Wyong LGA (\$ M)	Lake Macquarie LGA (\$ M)	Total (\$ M)
Crops	5.0	0.0	5.0
Nurseries and cut flowers	13.2	11.2	24.4
Livestock slaughtering	14.9	2.4	17.3
Livestock products (including eggs)	0.9	13.7	14.6
Total gross agricultural production	34.0	27.3	61.3

Source: ABS 2006 Census

3.4 Potential Agricultural Production Value of the Study Area

Potential agricultural productivity was determined using Department of Trade and Investment, Regional Infrastructure and Service (DTIRIS) agricultural productivity data for agricultural enterprises suitable for each of the LSC classes (see **Section 2.9**) that will be impacted. This analysis has been undertaken on the potential capability of the land rather than current land use. If potential agricultural production values were to be pursued, significant investment in land management and agricultural infrastructure would be required. However this information can be used to approximate potential farm incomes.

The *Beef Cattle Gross Margin Budget Yearling Southern/Central NSW* (DPI, 2012) and the *NSW Department of Primary Industries Beef Stocking Rates & Farm Size* (DPI, 2006) have been applied to this assessment. Full agricultural productivity information is contained in **Appendix 1**.

Table 3.5 summarises the gross margins (GM) for each applicable agricultural enterprise per LSC Class. The major points are listed below.

- Class 4 land has the potential to generate approximately \$164/ha from beef cattle grazing enterprises.
- Class 5 land has the potential to generate approximately \$109/ha from beef cattle grazing enterprises.
- Class 7 land has the potential to generate approximately \$55/ha from beef cattle grazing enterprises.

Table 3.5 Gross Margin per LSC Class

LSC	Livestock-carrying Capacity	Cow and Calf	Revenue	Variable Costs	Gross Margin
Class	Dry sheep equivalent	Per ha	Per ha	Per ha	Per ha
4	8	0.47	\$263.91	\$99.78	\$164.13
5	4	0.24	\$134.76	\$25.63	\$109.13
7	2	0.12	\$67.38	\$12.82	\$54.56

Based on the nominated gross margins, and assuming the required agricultural capital costs and fixed costs are outlaid (not included in the calculations in **Table 3.5**), the Study Area has the capacity to generate an estimated gross margin of \$385,000 per annum (see **Table 3.6**). It is important to note that these figures are derived from the optimum potential uses and are likely to be much higher than the actual incomes being achieved at the time of publication.

Table 3.6 Annual Gross Margins (Pre-mining)

Land and Soil Capability	Gross Margin (GM)	Study Area	
Class	\$/ha	ha	GM (\$ '000)
4	164.13	156	26
5	109.13	2113	231
7	54.56	2344	128
Total		4,613	385

3.5 Agricultural Support Infrastructure

Agricultural support infrastructure within the Lake Macquarie and Wyong LGAs includes the Sydney-Newcastle F3 Freeway as the major arterial road, and rail infrastructure providing transport from agricultural areas in the west and north of the state.

The main purpose-built agricultural support infrastructure is a number of large poultry sheds, which are used for raising meat chickens and egg production. There are a number of small retail agricultural suppliers that service the numerous hobby farms in the region. Outside of this, there is little formal infrastructure for the support of agricultural industries in either the Lake Macquarie or Wyong LGA.

Poultry processing is conducted outside the Wyong and Lake Macquarie LGAs. The Inghams Enterprises poultry processing facility (abattoir) is located at Mangrove Mountain in the Gosford LGA, processing the majority of meat chickens grown in the Wyong LGA, while other poultry processors are located at in the Newcastle LGA (Baiada Poultry), Cessnock LGA (Valley Feeds) and Blacktown LGA (Red Lea).

4.0 ASSESSMENT OF POTENTIAL IMPACTS

As outlined in **Section 1.2**, the land within the Study Area with the potential to be disturbed (DAA) by the proposed Project totals 3,181 ha and, as shown on **Figure 1.2**, includes:

- the proposed new Mandalong South Surface Site and access road with a disturbance footprint of 20 ha; and
- the area of land potentially impacted by subsidence associated with the proposed underground mining, including the 26.5 degree angle of draw from the edge of the proposed longwalls, covering 3,177 ha. This includes 16 ha (of the 20 ha described above) of land that will be disturbed for the proposed Mandalong South Surface Site and access road.

4.1 Land Resources

4.1.1 Land Temporarily Removed From Agriculture

4.1.1.1 Surface Disturbance: Social and Economic Impact

The proposed Mandalong South Surface Site and access road will temporarily remove 20 ha of land from potential agricultural production during the life of the Project (25 years). The LSC classes within this 20 ha are listed in **Table 4.1**. Following cessation of mining at the end of the Project the surface infrastructure will be decommissioning and the land rehabilitated to a mixture of native bushland and grazing areas that are generally consistent with pre-mining conditions (GSSE, 2013b).

Table 4.1 Temporary Surface Disturbance – Mandalong South Surface Site and Access Road

Land and Soil Capability	Land Impacted		Gross Margin	
Class	ha	%	\$/ha	Total (\$)
4	2.1	10.5	164.13	345
5	3.4	17	109.13	371
7	14.5	72.5	54.53	791
Total	20	100	-	1,507

Using potential agricultural productivity information described in **Section 3.4**, the estimated net annual economic impact on potential agricultural productivity as a result of the temporary loss of land is \$1,507 per annum. The flow-on effects to employment and local business are considered to be minimal as the quantity of land to be disturbed and relative agricultural productivity is low.

4.1.1.2 Underground Disturbance: Social and Economic Impact

Mine subsidence has the potential to impact upon agricultural enterprises by affecting:

- Fencing and farm gates;
- Farm dams; and
- Water reticulation (hydrology) and ponding.

Such impacts are readily managed through mitigation measures, as summarised in **Section 5**.

According to subsidence assessment and ponding predictions for the Project (Ditton Geotechnical Services (DGS), 2013; and Umwelt, 2013) there is the potential for 3.6 ha of remnant ponding within the DAA as a result of subsidence.

Using a precautionary impact assessment it has been assumed that the area impacted is 3.6 ha of land, which is classified as LSC Class 4. The area's most likely to be impacted by this ponding are generally along watercourses and associated with the better land and soil capability classes.

Table 4.2 Remnant Ponding from Underground Mining

Land and Soil Capability	Area of Land Impacted		Gross Margin	
Class	ha	%	\$/ha	\$ Total
4	3.6	0.13	164.13	590.87

The estimated net annual economic impact on potential agricultural productivity as a result of the remnant ponding associated with predicted subsidence is approximately \$591 per annum.

Total potential loss to agricultural enterprises due to the proposed surface infrastructure and remnant ponding is \$2,098 per annum. When compared to the gross annual value of agricultural production for the Wyong LGA (\$34 million) and the Lake Macquarie LGA (\$27.3 million), \$2,098 is considered a negligible impact on agricultural enterprises and related industries.

Part of the DAA encompassing "Douglasdale" Charolais stud is not expected to be impacted as a result of the Project as there is no proposed surface disturbance and location is on the eastern edge of the subsidence 26.5° degree angle of draw.

4.1.2 Land Permanently Removed From Agriculture

There is no land within the Study Area that will be permanently removed from agriculture as a result of the Project. While there may be an increase in remnant ponding as a result of subsidence, this can be readily mitigated as discussed in **Section 5**.

As advised above, the Mandalong South Surface Site and access road will be decommissioned following the cessation of mining and the land rehabilitated to a mixture of native bushland and grazing land generally consistent with pre-mining land and soil capability and agricultural suitability classes (GSSE, 2013b).

4.1.3 Acid Sulfate Soils

As outlined in **Section 2.7**, the Wyong Soil Landscape Unit, which covers just over 6% of the Study Area, is the only soil landscape within the Study Area that has acid sulfate soil potential. As evident on **Figure 2.2**, all areas of the Wyong Soil Landscape Unit are significantly removed from the proposed Mandalong South Surface Site and will not be subject to surface disturbance as part of the Project.

4.2 Water Resources

4.2.1 Surface Water

Five creeks traverse through the Study Area, these being Morans Creek, Wyee Creek, Buttonderry Creek, Mannering Creek and a small tributary of Jilliby Creek (refer **Section 2.3.1**). The *Surface Water Assessment* (Umwelt, 2013) states that predicted subsidence impacts indicate the catchment boundaries of the creek systems to be undermined will not change significantly. Further to this it was found the potential for any significant change to remnant ponding or storage of surface run-off will be minimal.

Flood modelling by Umwelt (2013) indicates the impact of flooding on agricultural areas, roads and transport as a result of the Project will be minimal, with limited changes to modelled flood extents and out of bank flood duration.

The existing environment has already experienced scouring of watercourse beds and banks due to construction of features such as bridges and culverts which have resulted in impacts on water quality (turbidity). However, there is potential for changes in watercourse stability to result in further scouring, resulting in increased turbidity downstream. Monitoring of watercourses within the Study Area and the application of appropriate mitigation measures are proposed to reduce the potential of additional scouring as a result of the Project.

Umwelt (2013) concludes that the Project is unlikely to cause long term impacts on surface water quality or quantity within the Study Area or further downstream.

4.2.2 Groundwater

4.2.2.1 Alluvial Groundwater

The *Groundwater Impact Assessment* (GHD, 2013a) found that alluvial groundwater levels should not reduce by more than the 0.1 m as a result of the Project throughout the proposed period of mining. Compared to the typical climatic variation of approximately 1 m, this is considered a minor variance.

Any reductions in alluvial groundwater levels as a result of the Project are expected to be temporary and localised, and are expected to be less than the Level 1 minimal impact considerations from the *NSW Aquifer Interference Policy* (NOW, 2012), and are therefore considered acceptable by GHD (2013a).

4.2.2.2 Porous and Fractured Rock Groundwater

The one registered extraction bore (GW078601) within the Study Area draws shallow groundwater from sandstone. The maximum predicted drawdown within this zone at this location is approximately 2 m (GHD, 2013a). The Project is not expected to reduce the beneficial use categorisation of the porous and fractured rock groundwater sources within the Study Area (GHD, 2013a). Predicted impacts are expected to be less than the Level 1 minimal impact considerations from the *NSW Aquifer Interference Policy* (NOW, 2012), and are therefore considered acceptable (GHD, 2013a).

4.2.3 Water Reallocation

Underground water management will be undertaken as part of the Project and will consist of water transfers within the underground workings of the Mandalong Mine, including the proposed Study Area, the proposed Mandalong South Surface Site and the existing Cooranbong Entry Site (part of Centennial's Northern Coal Logistics Project).

Under the provisions of the *Water Act 1912*, Centennial Mandalong holds a licence for groundwater monitoring and groundwater production (extraction of groundwater from the coal measures encountered during mining). This licence permits Centennial Mandalong to dewater the underground coal measures, at a rate of up to 365 ML per year, via a submersible dewatering pump located at the Cooranbong Entry Site.

Interference and extraction of alluvial groundwater as a result of the Project, along with the installation of alluvial monitoring bores within the Study Area, will likely require interference approval and/or an access licence under the provisions of the *Water Management Act 2000* and the *Water Sharing Plan for the Central Coast Unregulated Water Sources* (NOW, 2009).

GHD (2013a) predicts that the loss of groundwater from the porous and fractured rock groundwater sources into the proposed underground mine workings over the period of mining will be approximately 3 ML/day peaking up to 5.9 ML/day in 2035.

4.2.3.1 Agricultural Productivity Impact

There is the possibility the groundwater extracted via Centennial Mandalong's current extraction licence could be used for agricultural activities, dependent on suitable water quality. Applying a precautionary

assessment and assuming that all of this water could have been used for irrigated cropping, the gross margin for the production of spray-irrigated lucerne has been calculated. Spray-irrigated lucerne uses on average 8 ML/ha/annum; therefore, a maximum of 45 ha could be irrigated using the 365 ML extraction licence. Assuming five cuts of lucerne per season, at 2.5 tonnes per cut, is achievable, the total annual revenue and gross margin for this enterprise is \$2,613/ha and \$1,405/ha, respectively, this. Gross margins were determined using *Dryland Lucerne Hay Gross Margin Budget Northern Zone Summer 2010-11* (I&I, 2010) and *Surface Irrigated Lucerne – Established Stand Summer 2011-2012* (DPI, 2011).

Whilst there is not land suitable for irrigation within the Study Area (LSC Class 1, 2 or 3), there is land suited to irrigation within the locality. With a potential 365 ML not being available for agriculture it is assumed that the land would otherwise be used for dryland cropping with productivity levels represented by LSC Class 3 (**Table 4.3**). The estimated net annual economic impact on potential agricultural productivity as a result of using this land for dryland cropping rather than irrigated cropping is an estimated potential gross income of \$40,140 per annum.

Table 4.3 Annual Gross Margins (Pre-mining)

LSC	Farming Type	Lucerne	Revenue	Variable Costs	Gross Margin	Total \$
Class		Tonnes per ha	Per ha	Per ha	\$ Per ha	45 ha
3	Dryland	5	1,440	927	513	23,085
3	Irrigation	12.5	2,613	1,208	1,405	63,225

The above assumptions consider water removed from the Mandalong Mine through de-watering would otherwise be available for agricultural use. The *Water and Salt Balance Assessment* (GHD, 2013b) undertaken for the Project uses a mine water electrical conductivity (EC) of 5,882 $\mu\text{S}/\text{cm}$ as one of its modelling parameters, which according to *Measuring Water Salinity* (I&I, 2009) is above the level desirable limit for healthy growth in cattle and horses, and suitable only for crops with a high tolerance to saline water.

Therefore, whilst the Mandalong Mine currently holds a water extraction licence for 365 ML, this water would not be considered as being taken from potential agricultural use as it is not considered suitable for general agricultural production.

4.2.3.2 Long-term Use of Reallocated Water

At the completion of mining operations and following rehabilitation, water licences held by Centennial Mandalong, which are surplus to requirements, may be sold on the water transfer market. This means the water will again be available for agriculture or some other beneficial use.

4.3 Impact on Biophysical Strategic Agricultural Land

The *Soil and Land Capability Assessment* (GSSE, 2013a) did not identify any potential BSAL within the Study Area; therefore the Project will not have an impact upon BSAL.

4.4 Impact on Agricultural Resources from Biodiversity Offsets

Centennial Mandalong is not proposing to provide a direct biodiversity offset strategy. Rather, as a substantial landholder in the Mandalong Valley, Centennial Mandalong will develop a Land Management Plan for land owned by Centennial in the Valley. This plan will include the continuation of the following land management activities:

- Management of weeds and feral animals;
- Establishment and maintenance of suitable fencing for the exclusion of stock from riparian areas;

- Bushfire management;
- A rehabilitation program for riparian areas where an assessment has determined that rehabilitation activities will improve water quality in the creek systems;
- Provision of a nominal funding value towards research over the life of the Project into the habitat values of species likely to be impacted by the Project; and
- Provision of a nominal dollar amount for future maintenance of the land. This is to provide incentive to any future purchaser of the land to continue the land management activities.

Centennial Mandalong will report on the progress of works associated with the Land Management Plan annually in the Annual Review.

As Centennial Mandalong is not proposing a direct biodiversity offset strategy, there will be no impact upon agricultural resources as a result of any biodiversity offsets.

Furthermore, any impacts upon agricultural resources as a result of the proposed Land Management Plan are likely to be positive, including weed and feral animal control, bushfire management and improved water quality as a result of riparian area rehabilitation.

4.5 Impact on State Forests and Conservation Areas

The Study Area and DAA encompass a small part of the Olney State Forest (740 ha and 394 ha, respectively) as shown on **Figure 2.3**. The impact of the underground mining and subsidence in this area has been assessed as being negligible, with the *Flora and Fauna Assessment* (RPS, 2013) stating that minor subsidence impacts are expected to have a minor or temporary effect on ponding within local watercourses and are not likely to significantly impact riparian vegetation, endangered ecological communities or threatened species or their habitat within the Study Area.

While the Jilliby State Conservation Area accounts for 166 ha of the Study Area (as shown in **Figure 2.3**), the proposed mine extension does not extend under this State Conservation Area and is therefore unlikely to be affected by the Project.

4.6 Other Impacts

4.6.1 Visual Amenity and Landscape Values

The Project aims to maximise the use of existing surface infrastructure, and there is no new surface infrastructure proposed to be installed on agricultural land. The *Visual Impact Assessment* (Green Bean Designs, 2013) undertaken for the Project to have a negligible to low visual impact. Among other reasons, this can be attributed to the proposed Mandalong South Surface Site to be located within a landscape context of sloping and ridgeline formations with moderate to dense tree cover and a high visual absorption capacity. On this basis, the Project will have negligible impact on visual amenity and landscape value relied upon by local and regional agricultural enterprises.

4.6.2 Tourism

The impact assessment has not identified any tourism infrastructure in the local area upon which agricultural enterprises are reliant. Therefore the Project is not anticipated to have an impact on local agriculture-related tourism.

4.6.3 Weed Management and Biosecurity

There is moderate risk from weed infestation during the construction and operational phases of the Project through vehicle continued vehicle movements on and off site. Weeds are currently managed within the frameworks of the Mandalong Mine Environmental Management System (EMS), which includes issue-specific environmental management plans and monitoring programs. Continued inspection for weed germination will be conducted during the construction phase of the Project.

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. The Project is unlikely to represent any increased risk to the biosecurity of agricultural resources and enterprises within the region.

4.6.4 Dust

There is potential for the Project to generate dust primarily as a result of construction activities and mine ventilation fans. The *Air Quality Impact Assessment* (SLR, 2013a) undertaken for the Project advised incremental and cumulative annual average dust deposition rates at all the identified sensitive receptors are predicted to be well below the criterion of 2 g/m²/month (incremental increase in dust deposition) and below 4 g/m²/month (cumulative dust deposition) during all modelling assessment scenarios. On this basis, the Project will have a negligible impact on agricultural resources and enterprises.

Mitigation measures to minimise dust generation are discussed in **Section 5**.

4.6.5 Noise

Generally, agriculture is only impacted by noise when constantly high noise levels or sudden loud noise leads to a decrease in animal production through increased livestock stress. Results of the operational noise modelling assessment undertaken by SLR (2013b) indicates that the relevant intrusive and amenity noise criteria will be achieved at all the nearest residential locations. On this basis, noise is unlikely to impact agricultural production within the area.

4.6.6 Traffic

Noise and dust emissions generated by the Project, including those associated with traffic movements, are anticipated to have a negligible impact on agricultural resources and enterprises within the area (SLR, 2013a; SLR, 2013b). Importantly, the only increase in road traffic as a result of the Project will be from the construction phase and additional employees in the operational phase. The transportation of coal extracted from the Study Area will be via underground conveyor systems and will therefore not result in increased road traffic.

The *Traffic Impact Assessment* (Intersect Traffic, 2013) found that the Project will not adversely impact on the local road network. On this basis, and considering there are few agricultural enterprises within the Study Area or the immediate surrounds, the impact to agricultural resources and enterprises as a result of increased traffic movements associated with the Project is considered negligible.

4.7 Other Agricultural Regional Community Impacts

Other impacts which may affect the regional community include bushfire risk, social impact, greenhouse gas production and economic impact, all of which are addressed fully in the EIS with specialist studies assessing these regional impacts and the recommended mitigation measures and management strategies to ensure impact to the regional community as a result of the Project is minimised. These specialist studies include:

- Bushfire Risk Assessment (Ecobiological, 2012)

- Economic Impact Assessment (Aigis Group, 2013)
- Social Impact Assessment (James Marshall & Co., 2013)
- Greenhouse Gas Emissions Report (HHM, 2012)

5.0 MITIGATION MEASURES

5.1 Review of Project Design

As part of the pre-feasibility and feasibility phases undertaken for the Mandalong Southern Extension Project, a detailed mine design exercise was undertaken by Centennial Mandalong in parallel with the exploration drilling program, baseline environmental surveys and the development of the subsidence model. Various mine layouts were developed and assessed in response to information being received on geological, geotechnical, environmental, surface infrastructure and mining constraints.

After assessing various other mine layouts, it was concluded that a mine plan with longwall panels of 200 m wide and less, even though it will be harder to maintain a production level of six Mtpa, should be adopted in order to reduce surface subsidence impacts. On this basis, the proposed mine plan has a combination of 160 m, 180 m and 200 m wide longwall panels.

Furthermore, four locations within the Study Area were considered by Centennial Mandalong for the proposed Mandalong South Surface Site. In short, the proposed location was identified and selected as the optimal option in consideration of surrounding residences, the existing surface environment, including vegetation communities and watercourses, and engineering design requirements.

5.2 Proposed Mitigation Measures and Management Strategies

This section describes the proposed mitigation measures and management strategies recommended to be implemented to minimise potential agricultural impacts as a result of the Project. It is proposed that the recommendations made in the specialist assessments (as relevant) undertaken for the Project be adopted and incorporated into the Project's Environmental Management System (EMS) (including issue-specific environmental management plans and monitoring programs).

Whilst the majority of impacts on agricultural enterprises and resources have been assessed as negligible, as a matter of best practice Centennial Mandalong has adopted a number of mitigation measures to further minimise these impacts. A summary of key measures specifically in relation to potential agricultural impact is provided below.

5.2.1 Land Resources

5.2.1.1 *Minimisation of Disturbance to Agricultural Lands*

The area of agricultural land disturbed by the Project at any one time will be minimised so that agricultural uses can continue. Mine planning will minimise land clearance in advance of operations and will include prompt progressive rehabilitation of disturbed areas. This will reduce potential impacts on agricultural land.

Any areas subject to mine-induced subsidence will be inspected. Where there is any evidence of cracking, or other related surface expressions related to subsidence, all remedial works will be undertaken in accordance with the requirements of the approved site Extraction Plan.

5.2.1.2 *Soil Resources*

The *Decommissioning and Rehabilitation Strategy* (GSSE, 2013b) provides general soil management practices to minimise the impact of the Project on soil resources. These practices include the:

- identification and quantification of potential soil resources for rehabilitation;
- optimisation and recovery of useable topsoil and subsoil during stripping operations;
- management of soil reserves in stockpiles so as not to degrade the resource; and

- establishment of effective soil amelioration procedures to maximise the availability of soil reserve for future rehabilitation works.

5.2.1.3 Farm Fencing

The development of an Extraction Plan is recommended in the *Subsidence Predictions and General Impact Assessment for the Mandalong Southern Extension Project* (DGS, 2013) and will include mitigation measures for possible subsidence damage to fencing and farm gates.

5.2.1.4 Dust

The *Air Quality Impact Assessment* (SLR, 2013a) recommends procedures to minimise the impact of dust generated in association with construction and during the life of the Project, including:

- sealing of roads where possible, unsealed road to be kept sufficiently watered (minimum two L/hour/m²) to minimise windblown and traffic generated dust; and
- truck movement should be controlled on site and restricted to designated roadways. All loaded trucks should be covered to minimise transport of dust offsite.

5.2.2 Water Resources

The Project will have negligible anticipated impact on water resources (surface and groundwater) associated with agricultural resources and associated enterprises (Umwelt, 2013, GHD, 2013a). A Water Management Plan will be developed and will include monitoring of surface and groundwater.

The Water Management Plan will include aspects that will control run-off generated from the surface development area. This will minimise off-site water quality impacts and the volume of surface water run-off that is contained on-site and therefore unavailable for agricultural uses.

5.2.2.1 Ponding

A ponding management strategy has been recommended in the *Subsidence Predictions and General Impact Assessment for the Mandalong Southern Extension Project* (DGS, 2013), and includes the following impact management strategies:

- the development of a suitable monitoring and mitigation response plan as a component of the Extraction Plan, based on consultation with the regulatory government authorities to ensure ponding impacts on existing vegetation do not result in long-term environmental degradation; and
- engineered channel earthworks may be necessary to re-establish surface flows between sections of creek that become 'disjointed'. Local experience to-date suggests that if increased in-channel ponding occurs it can either remain as an 'additional' pond along the creek or be remediated in consultation with the relevant government agency.

5.2.2.2 Farm Dams

The recommended Extraction Plan in the *Subsidence Predictions and General Impact Assessment for the Mandalong Southern Extension Project* (DGS, 2013) includes the following mitigation measures for farm dams:

- inspection of each dam conducted by the Mine Subsidence Board for current water level and dam condition prior to and after mining,
- should monitoring indicate potential for dam wall failure due to subsidence cracking, water will be transferred from the dam to a height that reduces the risk of dam wall failure. An alternate water supply will be provided to the owner until the dam can be reinstated; and

- in the event of subsidence damage to any farm dams Centennial Mandalong will remediate the damage and reinstate the dam in conjunction with the Mine Subsidence Board.

5.3 Rehabilitation of Disturbed Lands: Demonstrated Capacity

The successful restoration of agricultural land to target Land and Soil Capability Classification is an important component of mining operations to negate any long-term impacts on agricultural resources. Centennial Mandalong has previously demonstrated successful rehabilitation of disturbed lands at the Mandalong Mine site to achieve nominated final land use and restoration of natural resources. The majority of the Mandalong Mine site has been progressively rehabilitated following the completion of construction activities in 2005. Rehabilitated areas of Mandalong Mine's surface area have well established vegetative cover, effectively minimising the potential for erosion.

Examples of successful rehabilitation are taken directly from the *2011 Centennial Mandalong Annual Environmental Management Report (AEMR)* (Centennial, 2012) and the *2012 Centennial Mandalong AEMR* (Centennial, 2013) and are briefly described below:

- rehabilitated sections of the Mandalong Mine surface area are well established and have provided vegetation cover to effectively minimise the potential for erosion;
- the drainage lines constructed to alleviate ponding above longwall panels two and three were inspected and found to be rehabilitated;
- the area disturbed during the construction of subsurface drainage, installed to alleviate remnant ponding above longwall panel six was rehabilitated in October 2009. The area was inspected in 2011 following rainfall events and it was confirmed that the drains take up to seven days to remove ponded water from the paddock. This drying period is consistent with other areas of the flood plain, which drains or dries out over a similar period;
- drainage lines constructed to alleviate ponding on Centennial owned property above longwall panels two and three inspected and found to have up to 90% groundcover;
- the remnant ponding on properties above longwall panels five and six are now free-draining following works to reinstate and extend existing surface drainage. Use by the tenants for cattle grazing and other activities are now occurring as they did prior to mining; and
- water drainage for the car park and demountable buildings was connected into existing surface water drains. The surface water structures at Mandalong Mine have been previously rehabilitated to prevent erosion and are stable.

Mandalong Mine has shown an ongoing commitment to the rehabilitation of mine disturbance areas.

5.4 Demonstrated Planning for Progressive Rehabilitation

Planning for progressive rehabilitation is detailed in the Project's *Decommissioning and Rehabilitation Strategy* (GSSE, 2013b) and will be undertaken on areas that cease to be used for mining or mine related activities as soon as reasonably practicable. Principal rehabilitation objectives for the Project include:

- achieving an acceptable post-disturbance land use;
- creating a stable post-disturbance landform;
- preserving downstream water quality; and
- preserving the integrity of public utilities.

In addition to the above key rehabilitation objectives the Centennial Coal Environment and Community Policy also takes into account mine closure issues, with specific reference to:

- making appropriate decisions which comply with or exceed approvals, licences and agreements;
- working constructively with local authorities, stakeholders and communities;
- contributing to the conservation of biodiversity;
- planning, designing and closing operations in a manner that enhances sustainable development; and
- engaging and communicating openly with communities, with due regard and respect for local interests, cultures and customs.

Centennial Mandalong has committed to a policy of post-mining land use being consistent with the pre-mining land use.

6.0 STAKEHOLDER CONSULTATION

Centennial Mandalong has undertaken consultation with government agencies, local Aboriginal groups, the Mandalong Mine Community Consultative Committee (CCC), surrounding residents and the wider community and service providers during pre-feasibility, feasibility and planning stages of the Mandalong Southern Extension Project. Prior to the commencement of the Project, a *Stakeholder Engagement Strategy* was developed to provide a consistent management framework for the identification and consultation with stakeholders that have an interest in the Project. The objectives of the *Stakeholder Engagement Strategy* are to:

- Establish a process for engagement with stakeholders, with clear outcomes for Centennial Mandalong and the various stakeholders;
- Openly communicate with stakeholders about the Project; and
- Provide a means of community access to the Centennial Mandalong Project Team via a dedicated information phone line.

A number of different strategies for communicating with the community throughout the Project were identified and undertaken, including:

- the Mandalong Mine Community Consultative Committee (CCC);
- meetings with individual landowners and stakeholders;
- community newsletters;
- publications in the local newspaper, the *Lakes Mail*;
- community open days and information sessions; and
- community survey.

Full details of consultation undertaken by Centennial Mandalong are contained in the EIS prepared for the Project. No issues regarding impacts to agricultural resources, enterprises or stakeholders were raised during the extensive consultation process.

Centennial Mandalong is committed to on-going community consultation and will continue to engage with the community for the purposes of providing information relating to the Project and on-going operations of Mandalong Mine.

7.0 KEY FINDINGS

This AIS has been prepared for the Mandalong Southern Extension Project in accordance with the *Strategic Regional Land Use Policy* (DP&I, 2012a) and *Guideline for Agricultural Impact Statement* (DP&I, 2012b). The purpose of this AIS is to assess and report on the potential impacts of the Project on agricultural resources and/or industries within and surrounding the Study Area.

The key findings are listed below.

- The Study Area contains no areas of potential BSAL, based on an assessment undertaken by GSSE (2013a) using the *Upper Hunter Strategic Agricultural Land Use Plan* (DP&I, 2012c) and the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH, 2012b).
- The majority of agricultural land use within the Study Area is for hobby farms and small cattle grazing areas, which are not major contributors to income generation. Grazing is mostly carried out as a land and vegetation management tool.
- Any impacted agricultural land will be returned to its pre-mining state following mining, in accordance with the *Decommissioning and Rehabilitation Strategy* (GSSE, 2013b) prepared for the Project.
- Post-mining agricultural economic activity in the Study Area is expected to be similar to pre-mining activity as there is no change predicted between the pre- and post-mining LSC classifications (GSSE, 2013a).
- The Project will have negligible impact on surface and groundwater resources relied upon by agriculture (Umwelt, 2013 and GHD, 2013a, respectively). GHD (2013a) advises that groundwater resources are expected to be less than the Level 1 minimal impact considerations as per the *NSW Aquifer Interference Policy* (NOW, 2012).
- Any impacts resulting from the Project are expected to be temporary and can be managed through application of appropriate mitigation measures and management strategies.
- The Project will provide considerable positive economic benefits to the local and broader communities (Aigis Group, 2013). These benefits are much greater than the potential income lost by existing or potential agricultural enterprises, calculated as a precautionary assessment on impacted agricultural resources, of \$2,098 per annum.
- In summary, the Project will provide economic benefits to the region whilst having negligible impact on agricultural resources, enterprises or related industries.

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Gross Margin Sensitivity Analysis





SURFACE IRRIGATED LUCERNE - Established stand

Farm Enterprise Budget Series - Northern Zone

Summer 2011-2012

1. GROSS MARGIN BUDGET:

INCOME:

7 cuts per season @ 1.90 t/ha per cut

Total Yield = **13.30** tonnes per hectare

@ 40 bales per tonne (25 kg bales)

60% AFIA Grade A1	320 bales/ha at	\$8.80 / bale
20% AFIA Grade B2	106 bales/ha at	\$5.00 / bale
20% AFIA Grade C3	106 bales/ha at	\$3.00 / bale

See http://www.afia.org.au/quality/national_grades/ for more details on hay grades used.

A. TOTAL INCOME \$/ha:

Sample Budget	Your Budget
\$/ha	\$/ha
\$2,816.00	
\$530.00	
\$318.00	
\$3,664.00	

VARIABLE COSTS:

see following page(s) for details

Depreciation of establishment cost.....
Fertiliser.....
Herbicide.....
Insecticide.....
Irrigation.....
Mow, rake & bale (contract).....
Twine @ \$0.113/bale.....
Cart and stack 100% of hay (\$10.68/t).....

\$101.91	
\$241.85	
\$60.15	
\$6.33	
\$443.90	
\$1,773.80	
\$60.29	
\$142.04	
\$2,830.28	

B. TOTAL VARIABLE COSTS \$/ha:

C. GROSS MARGIN (A-B) \$/ha:

D. GROSS MARGIN \$/ML:

\$833.72	
\$83.37	

SENSITIVITY TABLES

2. EFFECT OF YIELD AND PRICE ON GROSS MARGIN PER HECTARE:

Yield Cuts	tonnes/ha	Grade A1 \$6.80	Grade A1 \$7.80	Grade A1 \$8.80	Grade A1 \$10.80	Grade A1 \$12.80
		Grade B2 \$3.00	Grade B2 \$4.00	Grade B2 \$5.00	Grade B2 \$7.00	Grade B2 \$9.00
		Grade C3 \$1.00	Grade C3 \$2.00	Grade C3 \$3.00	Grade C3 \$4.00	Grade C3 \$5.00
		\$195 /tonne	\$235 /tonne	\$275 /tonne	\$347 /tonne	\$419 /tonne
4 cuts	5.8	-\$820	-\$588	-\$356	\$62	\$480
5 cuts	8.3	-\$623	-\$291	\$41	\$639	\$1,237
6 cuts	10.8	-\$427	\$5	\$437	\$1,215	\$1,993
7 cuts	13.3	-\$230	\$302	\$834	\$1,792	\$2,750
8 cuts	15.8	-\$34	\$598	\$1,230	\$2,368	\$3,506
9 cuts	18.3	\$163	\$895	\$1,627	\$2,945	\$4,263
10 cuts	20.8	\$359	\$1,191	\$2,023	\$3,521	\$5,019

3. EFFECT OF YIELD AND PRICE ON GROSS MARGIN PER MEGALITRE:

Yield Cuts	tonnes/ha	Grade A1 \$6.80	Grade A1 \$7.80	Grade A1 \$8.80	Grade A1 \$10.80	Grade A1 \$12.80
		Grade B2 \$3.00	Grade B2 \$4.00	Grade B2 \$5.00	Grade B2 \$7.00	Grade B2 \$9.00
		Grade C3 \$1.00	Grade C3 \$2.00	Grade C3 \$3.00	Grade C3 \$4.00	Grade C3 \$5.00
		\$195 /tonne	\$235 /tonne	\$275 /tonne	\$347 /tonne	\$419 /tonne
4 cuts	5.8	-\$82	-\$59	-\$36	\$6	\$48
5 cuts	8.3	-\$62	-\$29	\$4	\$64	\$124
6 cuts	10.8	-\$43	\$1	\$44	\$122	\$199
7 cuts	13.3	-\$23	\$30	\$83	\$179	\$275
8 cuts	15.8	-\$3	\$60	\$123	\$237	\$351
9 cuts	18.3	\$16	\$89	\$163	\$294	\$426
10 cuts	20.8	\$36	\$119	\$202	\$352	\$502

SURFACE IRRIGATED LUCERNE - Established stand

Farm Enterprise Budget Series - Northern Zone

(diesel pump from river-regulated)

Summer 2011-2012

CALENDAR OF OPERATIONS:								
Operation	Month	Machinery			Inputs			Total Cost \$/ha
		hrs/ha	Cost \$/hr	Total \$/ha	Rate/ha	Cost \$	Total \$/ha	
Spray - paraquat + diquat	Jul	0.10	24.51	2.45	2.5 L	10.28	25.70	28.15
Spray - diuron	Jul	with above			2.50 L	7.70	19.25	19.25
Apply Single Super	Aug	0.42	21.55	9.05	125kg	0.35	43.75	52.80
Spray aphids -dimethoate	Aug	0.10	24.51	2.45	0.37 L	10.49	3.88	6.33
Fertiliser- #Muriate of Potash	Aug	0.42	21.55	9.05	250kg	0.72	180.00	189.05
Irrigate	Oct				1.25 ML	44.39	55.49	55.49
Irrigate	Nov				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	Nov	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Nov	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Irrigate	Nov				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	Dec	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Dec	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Irrigate	Dec				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	Dec	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Dec	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Herbicide (haloxyfop-R)	Dec	0.10	24.51	2.45	0.1 L	103.00	10.30	12.75
Irrigate	Feb				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	Feb	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Feb	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Irrigate	Mar				1.25 ML	44.39	55.49	55.49
Mow, rake & bale + accumulator	Mar	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Mar	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Irrigate	Apr				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	Apr	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	Apr	contract	0.27	per bale @ 76 bales/ha per cut				20.29
Irrigate	May				1.25 ML	44.39	55.49	55.49
Mow, rake, bale & accumulator	May	contract		253.40				253.40
Cart & stack in shed (tractor + FEL)	May	contract	0.27	per bale @ 76 bales/ha per cut				20.29

AGRONOMIC NOTES:

Herbicides: paraquat + diquat and diuron applied to established stands to clean up weeds.

To reduce the likelihood of herbicide resistance, rotate herbicide groups and weed management techniques.

Fertilisers: # In areas of long term irrigated hay production, there is a possibility that higher rates of potash may be required to correct chronic potassium deficiency.

Hay storage: The assumption is made that all of the hay is stored on farm prior to selling.

Hay Grades: The Australian Fodder Industry Association (AFIA) has developed a national grading system for legume and cereal hays. It is based on digestible dry matter, crude protein content and metabolisable energy.

AFIA (Incorporated in 1996) is the peak body for the hay and silage industries. Further information and a fodder vendor declaration form is available from AFIA. Phone: 03 9890 6855 Website: www.afia.org.au

Use of a particular brand name does NOT imply recommendation of that brand by NSW DPI.

Always read chemical labels and follow directions, as it is your legal responsibility to do so.

LABOUR REQUIREMENTS: Labour to apply fertiliser or spray is not costed. If we assume a labour cost of \$21/hr the total labour cost would be \$29.93/hectare, reducing the gross margin to \$804/ha.

This does not include labour required to irrigate since this is more likely to be an overhead cost.

MACHINERY ASSUMPTIONS:

Tractor: pto power: 57 KW (76 HP) FEL = front end loader

Machinery costs refer to variable costs of: fuel, oil, filters, tyres, batteries and repairs.

Mow, Rake, Bale costs: Assumes raking is done twice. Use your own costs if you use your own machinery.

Irrigation Costs: Estimated water usage charge of \$31.75 per ML assumed, your charges may be different.

Estimated water pumping cost of \$12.64 per ML assumed, your costs may be different.

Water use assumed: 10.0 ML/Ha

Costs calculated using a flood/furrow system with diesel powered pumping from surface supply.

This budget should be used as a GUIDE ONLY and should be changed by the grower to take account of movements in crop and input prices, changes in seasonal conditions and individual farm characteristics. Estimated prices are GST exclusive.

BEEF CATTLE GROSS MARGIN BUDGET

Farm enterprise Budget Series: June 2012

Enterprise: Yearling (Southern/Central NSW)

Enterprise Unit: 100 cows

Pasture: Improved

			Standard Budget	Your Budget
INCOME:				
42	steers 12-15 months @	\$687 /hd	\$28,844	
22	heifers 12-15 months @	\$611 /hd	\$13,431	
1	CFA Bull @	\$1,253 /hd	\$1,253	
7	CFA cows @	\$701 /hd	\$4,909	
11	Other culls @	\$701 /hd	\$7,714	
83				
A. Total Income:			\$56,150	
VARIABLE COSTS:				
Replacements	1 Bull @	\$5,000 /hd	\$5,000	
Livestock and vet costs: see section titled beef health costs for details.			\$1,203	
Ear tags @	\$2.00		\$40	
Fodder crops			\$0	
Hay & Grain			\$0	
Droughts can increase feed costs. For example costs see main menu.			\$0	
Pasture maintenance (211 ha improved pasture per 100 cows)			\$10,550	
Livestock selling cost (see assumptions on next page)			\$4,437	
B. Total Variable Costs:			\$21,230	
			GM including pasture cost	GM excluding pasture cost
GROSS MARGIN (A-B)			\$34,920	\$45,470
GROSS MARGIN/COW			\$349.20	\$454.70
GROSS MARGIN/DSE*			\$20.67	\$26.92
GROSS MARGIN/HA			\$165.50	\$215.50

Change in gross margin (\$/cow) for change in price &/or the weight of sale stock

(Note: Table assumes that the price and weight of other stock changes in the same proportion as steers. As an example if steer sale price falls to 325c/kg and steer weight to 195 kg, gross margin would fall to \$281 per cow. This assumes that price and weight of all other sale stock falls by the same percentage.

Dresses wt kgs		Steer sale price cents/kg dw				
Stock sold		315	325	335	345	355
Steer dw						
-40 kgs	185	217	230	243	256	269
-20 kgs	195	267	281	296	311	325
0	205	317	333	349	365	382
+20 kgs	215	366	384	402	420	438
+40 kgs	225	416	436	455	475	495

GM \$ per Cow

An increase of 5% in weaning percentage increases gross margin per cow by \$29.59

Assumptions Yearling (Southern/Central NSW)

Enterprise unit is 100 cows weighing on average 500 kg

Weaning rate: 86%, conception 92%

Sales

100% steers sold at 12-15 months	205 kg	@335c/kg dressed weight
100% sale heifers sold at 12-15 months	185 kg	@330c/kg dressed weight
20 heifers retained for replacement.		
Cull cows cast for age at 10 years	255 kg	@275c/kg dressed weight
100% of preg tested empty cows culled	"	" "
4% cows culled for other reasons	"	" "
Bulls run at 3% & sold after 4 years use	432 kg	@290c/kg dressed weight

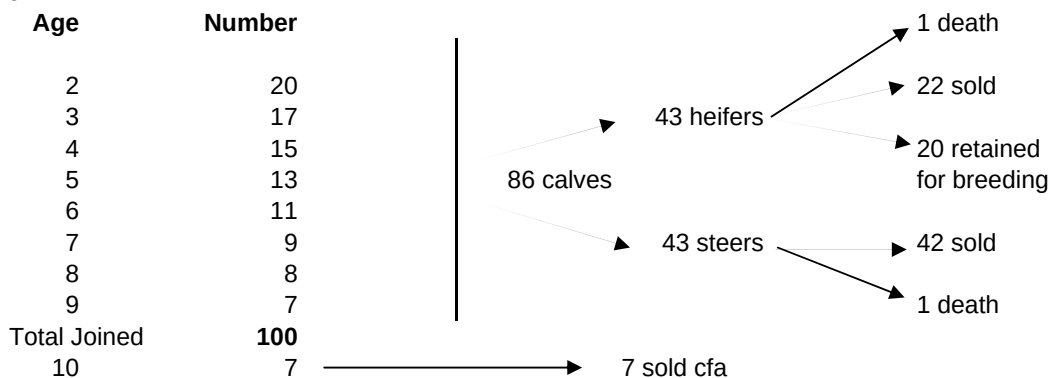
Selling costs include: Commission 5%, MLA levy \$5/hd, average freight cost to abattoirs 5.5c/kg dw, NLIS tags @ \$2.90 for all sale cattle.

Cows: age at first calf : 24 months

Mortality rate of adult stock: 2%

The average feed requirement of a cow + followers is rated at 16.89 dse's*. This is an average figure and will vary during the year.

Age structure



Marketing Information:

Suited to the domestic supermarket trade and could access MSA grading with careful preparation. Note that for MSA grading producers need to be licensed. Good frame, well muscled, later maturing steers can be suited to the Japanese grain fed markets at heavier turn off weights than above. Steer portion may also be suited for live export to the Japanese feeder steer market (Angus and Murray Grey and Shorthorn breeds preferred) as a lighter weight option.

Production Information:

A common production system in the south west slopes; and the southern and central tablelands areas.

DRYLAND LUCERNE HAY

Northern Zone

Summer 2010-11

1. GROSS MARGIN BUDGET:

INCOME: Assumes most bales are prime hay quality.

2 cuts per season @ 2.00 t/ha per cut

Total Yield = **4.00** tonnes per hectare

@ 40 bales per tonne (25 kg bales)

60% AFIA Grade A1	96 bales/ha@	\$8.50 / bale	\$816	
20% AFIA Grade B2	32 bales/ha@	\$6.50 / bale	\$208	
20% AFIA Grade C3	32 bales/ha@	\$4.00 / bale	\$128	

See http://www.afia.org.au/quality/national_grades/ for more details on hay grades used.

A. TOTAL INCOME \$/ha:

\$1,152

VARIABLE COSTS:

see following pages(s) for details

Depreciation of establishment cost (over 4 years).....	\$52.32	
Fertiliser.....	\$125.00	
Herbicide.....	\$17.96	
Insecticide.....	\$0.00	
Mow, rake & bale (contract).....	\$524.40	
Twine @ \$0.113/bale.....	\$18.13	
Cart and stack 100% of hay (\$10.68/t).....	\$42.72	

B. TOTAL VARIABLE COSTS \$/ha:

\$780.52

C. GROSS MARGIN (A-B) \$/ha:

\$371.48

SENSITIVITY TABLE

EFFECT OF HAY YIELD AND PRICE ON GROSS MARGIN PER HECTARE

Yield Cuts	Total tonnes/ha	Grade A1 \$6.50	Grade A1 \$7.50	Grade A1 \$8.50	Grade A1 \$10.50	Grade A1 \$12.50
		Grade B2 \$4.50	Grade B2 \$5.50	Grade B2 \$6.50	Grade B2 \$8.50	Grade B2 \$10.50
		Grade C3 \$2.00	Grade C3 \$3.00	Grade C3 \$4.00	Grade C3 \$5.00	Grade C3 \$6.00
		\$208 /tonne	\$248 /tonne	\$288 /tonne	\$360 /tonne	\$432 /tonne
1 cuts	2.0	-72	8	88	232	376
2 cuts	3.0	-53	67	187	403	619
2 cuts	3.5	-1	139	279	531	783
2 cuts	4.0	51	211	371	659	947
3 cuts	5.0	70	270	470	830	1,190
3 cuts	6.0	175	415	655	1,087	1,519
4 cuts	8.0	298	618	938	1,514	2,090

DRYLAND LUCERNE HAY

Northern Zone

Summer 2010-11

CALENDAR OF OPERATIONS:		Machinery			Inputs			Total Cost \$/ha
Operation	Month	hrs/ha	Cost \$/hour	Total \$/ha	Rate/ha	Cost \$	Total \$/ha	
Spray - 2,4-DB 500g/L	Jul	0.10	17.05	1.71	1.0 L	16.25/L	16.25	17.96
Apply Single Super	Aug	contract		20.00	250kg	0.42/kg	105.00	125.00
Mow, rake 3 times and bale	Oct	contract		262.20				262.20
Cart and stack hay in shed	Oct	\$0.27	per bale @ 80 bales/ha per cut					21.36
Mow, rake 3 times and bale	Jan	contract		262.20				262.20
Cart and stack hay in shed	Jan	\$0.27	per bale @ 80 bales/ha per cut					21.36

AGRONOMIC NOTES:

Herbicides: 2,4-DB applied to established stands to clean up weeds.

To reduce the likelihood of herbicide resistance, rotate herbicide groups and weed management techniques.
For more information, refer to the I&I NSW Management Guide "Weed Control in Pastures and Lucerne 2010"

Establishment: This budget assumes a stand life of four years, so depreciation of establishment cost is the cost of establishment divided by four.

This budget should be looked at in conjunction with the budget for establishment of a dryland lucerne stand.

Fertilisers: Nutrient requirements should be assessed with soil tests, strip trials and paddock history records.

Hay storage: The assumption is made that all of the hay is stored on farm prior to selling.

Hay Grades: The Australian Fodder Industry Association (AFIA) has developed a national grading system for legume and cereal hays. It is based on digestible dry matter, crude protein percentage and metabolisable energy.

Profitability: Profitability may vary widely depending on dry matter yield and hay prices.
Please refer to the sensitivity table and factor in the seasonal and market risks in your planning activities.

AFIA (Incorporated in 1996) is the peak body for the hay and silage industries. Further information and a fodder vendor declaration form is available from AFIA Phone: 03 9890 6855 Website: www.afia.org.au

Use of a particular brand name does NOT imply recommendation of that brand by I&I NSW.

Always read chemical labels and follow directions, as it is your legal responsibility to do so.

LABOUR REQUIREMENT Labour for carting hay from the paddock to the shed is accounted for in this budget at \$1.50 per bale.

MACHINERY ASSUMPTIONS:

Tractor: PTO power: 57kW (76 HP)

Machinery costs refer to variable costs of: fuel, oil, filters, tyres, batteries and repairs.

Mow, Rake, Bale costs: If you use your own machinery for mowing, raking and baling then substitute this cost in your own budget.