APPENDIX 13: Agricultural Impact Statement prepared by GSS Environmental

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

SLR

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21st November 2012

Mr Ralph Northey
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Dear Ralph,

ADDENDUM TO AGRICULTURAL IMPACT STATEMENT (AUGUST 2012): BLAKEFIELD NORTH UNDERGROUND MINE PROJECT

Location: Bulga Underground Mine, Bulga, NSW
Proponent: Bulga Coal Management Pty Ltd

1. PURPOSE OF ADDENDUM

This is an addendum to the Agricultural Impact Statement (AIS) prepared by GSS Environmental (GSSE) dated August 2012.

The AIS was prepared to accompany a proposed modification to the approved Blakefield North Underground Mine (the Project). The proposed modification seeks to modify Development Consent DA 376-8-2003 pursuant to Section 75W of the *Environmental Planning and Assessment Act, 1979* (EP&A Act). The proposed modification provides for a revised longwall underground mine layout and associated infrastructure including, installation of new pre and post-mining gas drainage above the longwall panels and a small-scale power generation plant.

The AIS was prepared in August 2012 having regard to the draft gateway criteria in the draft *Upper Hunter Strategic Regional Land Use Plan* (March 2012). Since this time, the final *Upper Hunter Strategic Regional Land Use Plan* was released in September 2012.

The purpose of this addendum is to address the changes between the draft and the final *Upper Hunter Strategic Regional Land Use Plan* (SRLUP), as they are relevant to the AIS

2. BACKGROUND

In March 2012 the *Guideline for Agricultural Impact Statements* (AIS Guidelines) was released in conjunction with the draft NSW Strategic Regional Land Use Plans for the Upper Hunter and New England North West. The AIS Guidelines stated the following:

> *The requirement for an agricultural impact statement (AIS) applies immediately to all state significant development (SSD) applications for mining and petroleum (including coal seam gas) and will form part of the environmental impact statement (EIS) prepared for the proposal.*
>
> *Source: Strategic Regional Land Use Policy Delivery Guideline March 2012*

Following release of the AIS Guidelines in March 2012, the NSW Department of Planning & Infrastructure (DP&I) issued supplementary Director General's Requirements (DGR's) on 30 April 2012 under section 75F(3) of the EP&A Act for the Project, requiring the preparation of an AIS, as follows:

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

The AIS prepared by GSSE (August 2012) was prepared in accordance with the *Draft Upper Hunter Strategic Regional Land Use Plan* and the *AIS Guidelines*.

3. GATEWAY PROCESS

The proposed "Gateway" will be an independent assessment process that investigates the impacts of major resource projects on Strategic Agricultural Land (SAL) and determines the matters to be addressed at the development application stage. The Gateway has not yet commenced, however, will apply to, inter alia, state significant mining projects that are on land mapped or verified as SAL (unless the development would be wholly located within an existing Mining Lease area).

There are two categories of SAL (as mapped and defined in the SRLUP):

- Biophysical strategic agricultural land; and
- Critical industry clusters – concentrations of highly productive industries within a region which are related to each other, contribute to the identity of the region and provide significant employment opportunities.

The AIS identified that there is land within the Project Area that is mapped as SAL - both Biophysical SAL and Critical Industry Cluster (Viticulture) SAL. As required by the DGRs, **Section 7.0** of the AIS contained a specific focussed assessment of the impacts of the proposal on SAL having regard to the draft Gateway criteria in the SRLUP (March 2012).

Although the SRLUP has now been finalised, the Gateway assessment criteria are still in a draft form as detailed in a *Draft Amendment to State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* and Draft Amendment to the EPA&A Regulation (on public exhibition from 15 November 2012 to 14 December 2012). However, there is no significant difference between the March 2012 and the current draft Gateway criteria. As a result, the Gateway criteria assessment in **Section 7.0** of the AIS remains valid.

*[**Note**: The SRLUP and the proposed Gateway process (once legislated) would only apply to new State Significant Development (or modifications) for mining projects on land mapped as SAL that is located outside an existing mining lease area. Furthermore, savings and transitional provisions proposed in the draft Gateway process provide that the Gateway process would not apply where DGRs have been issued prior to 10 September 2012. On this basis the SRLUP and Gateway process would not apply to the Project]*

4. SOIL SAMPLING PROGRAM

As detailed in Section 3 above, the AIS identified that there is land within the Project Area that is mapped as SAL - both Biophysical SAL and Critical Industry Cluster (Viticulture) SAL. Due to concerns about the

accuracy of the Biophysical SAL, a soil sampling program was undertaken to 'ground truth' the eastern side of the mapped Biophysical SAL. As it was considered that the SAL Viticulture Cluster land does meet the criteria for SAL mapping, the soil sampling program did not address this industry cluster.

The soil sampling program was provided as Appendix 1 to the AIS. It was undertaken to ground-truth the SAL – Biophysical and included a detailed assessment of Rural Land Capability Classification and topsoil fertility attributes. It did not include a detailed assessment of the soil characteristics or attempt to revise the soil mapping present within the Project Area.

This sampling program revealed that the Project Area did not contain soil the land capability classification and soil fertility characteristics that warranted designation as SAL – Biophysical. In other words, the soil sampling identified that no land should be mapped as SAL - Biophysical within the Project Area and that any disturbance in this area would not be impacting SAL - Biophysical.

However, since this soil sampling program was undertaken in June and July 2012, the NSW DP&I has developed an interim site verification protocol which establishes new site verification criteria for identifying SAL – Biophysical (November 2012). As a result, the findings of the soil sampling program in Appendix 1 of the AIS are no longer current and it cannot be concluded that no land should be mapped as SAL – Biophysical within the Project Area.

5. STRATEGIC AGRICULTURAL LAND ASSESSMENT

Mapped SAL

Section 2.5.3 of the AIS included a Strategic Agricultural Land Assessment. This SAL assessment was based on the draft SRLUP maps (as they existed in draft form in March 2012). Pursuant to the March 2012 draft SRLUP maps, the AIS found that the Project Area overlays an area that the draft SRLUP has mapped as "SAL - Biophysical" and an area mapped as a "Viticulture Critical Industry Cluster".

The assessment concluded that approximately 421ha of the mapped SAL in the draft SRLUP would be impacted within the Project Area. This comprised 253ha of the SAL – Biophysical and 421ha of the SAL – Viticulture Cluster (Note: These areas overlap within the Project Area). This represented about 38% of the mapped SAL – Biophysical and 1.9% of the mapped SAL – Viticulture Cluster within the mapped SAL categories in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

The AIS therefore concluded that the Project would result in the disturbance (temporary removal from agriculture) of a relatively small area of 30.3ha (4.3% of Project Area) and 11.8ha of mapped SAL in the draft SRLUP. This in turn represented 2.8% of the mapped SAL in the Project Area or 0.05% of mapped SAL in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

The above assessment in **Section 2.5** regarding Mapped SAL remains current as there have been no changes to the mapped SAL between the draft (March 2012) and the final SRLUP (September 2012), as they apply to the Project Area.

Ground-Truthing Biophysical SAL

As detailed in Section 4 above, the soil sampling program to 'ground-truth' the Biophysical SAL concluded that no land should be mapped as SAL - Biophysical within the Project Area (refer Appendix 1 of the AIS). As a result, the Strategic Agricultural Assessment in **Section 2.5.3** of the AIS reached the conclusion (following soil sampling) that the disturbance within the Project Area would not be impacting SAL - Biophysical.

However, as detailed in Section 4 above, a new interim site verification protocol for identifying SAL – Biophysical was released in November 2012. As a result, the findings of the soil sampling program in

Appendix 1 of the AIS are no longer current and it cannot be concluded that no land should be mapped as SAL – Biophysical within the Project Area.

Notwithstanding the above, it is considered that undertaking a further soil sampling program pursuant to the new interim site verification protocol (to "ground truth" the Biophysical SAL) is not required. This is because the assessment in **Section 2.5** of the AIS regarding Mapped SAL remains current. There have been no changes to the mapped SAL between the draft (March 2012) and the final SRLUP (September 2012), as they apply to the Project Area.

6. CONCLUSION

Notwithstanding, the changes between the draft and the final SRLUP, the findings of the AIS as they relate to the draft Gateway assessment criteria remain unchanged. Only a very small portion of agricultural resource (land and water) in the Broke-Fordwich locality would be affected by the proposed Project. The land affected by the Project Area equals 710ha. Of this 30.3 ha (4.3%) of the Project Area will be temporarily removed from agriculture for access roads and gas drainage. This land will be returned to agricultural production upon completion of mining and rehabilitation as agricultural land capability Class VI.

We trust that this Addendum to the AIS satisfactorily addresses the changes between the draft and the final *Upper Hunter Strategic Regional Land Use Plan*.

Should you have any questions or require any further information, please do not hesitate to contact the undersigned.



Yours sincerely,

David Humphris
Associate – Environmental Planner



Agricultural Impact Statement

Bulga Underground Operations:

Blakefield North Underground Mine Project

Bulga Coal Management Pty Ltd

August 2012

XCN06-043

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Prepared on behalf of Bulga Coal Management Pty Ltd

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Bulga Underground Operations

Blakefield North Underground Mine Project

Agricultural Impact Assessment

Date: August 2012

Prepared for **Bulga Coal Management**

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APPENDICES

APPENDIX 1: STRATEGIC AGRICULTURAL LAND – BIOPHYSICAL ASSESSMENT

ABBREVIATIONS

AEMR	Annual Environmental Monitoring Report
AIS	Agricultural Impact Statement
AIS Guideline	*Agricultural Impact Statement Guideline*
BCC	Bulga Coal Complex
BCM	Bulga Coal Management P/L
BFN	Blakefield North Underground Mine
BFS	Blakefield South Underground Mine
BJV	Bulga Joint Venture
BSO	Bulga Surface Operations
BUO	Bulga Underground Operations
CHPP	coal handling and preparation plant
DGR	Director General's environmental assessment requirement
DP&I	Department of Planning and Infrastructure
EA	Environmental Assessment Proposed Modification Blakefield North Underground Mine
EC	electrical conductivity
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPL	Environmental Pollution Licence
GSS, GSSE	GSS Environmental
ha	hectares
LGA	local government area
LOM	Life of Mine
M	million
Mtpa	million tonnes per annum
NA	not applicable
NOW	NSW Office of Water
NSW	New South Wales
OEH	Office of Environment and Heritage
PEA	Preliminary Environmental Assessment
PPSMP	Private Property Subsidence Management Plans
Project, the	Blakefield North Underground Mine
ROM	run-of-mine
SAL	strategic agricultural land
SRLUP	draft NSW Strategic Regional Land Use Plans for the Upper Hunter
SWMP	Site Water Management Plan
t	tonnes
TSS	Total Suspended Solids
uS/cm	micro Siemens per centimetre

EXECUTIVE SUMMARY

Bulga Coal Management Pty Ltd (BCM) is seeking to modify an existing development consent to allow for a revised longwall underground mine layout and associated infrastructure including, installation of new pre and post-mining gas drainage above the longwall panels and a small-scale power generation plant (up to 32MW).

The proposed modification of the approved Blakefield North Underground Mine represents a minor variation from the mine approved pursuant to Development Consent DA 376-8-2003. The area of difference is approximately 208ha, representing an increase in land subject to underground mining South – West of the existing open-cut operations.

The Director General of the Department of Planning and Infrastructure (DP&I) has requested the preparation of an Agricultural Impact Statement (AIS) to accompany the proposed modification. The AIS is to consider the impacts of the proposed mining operations upon the agricultural resources of the locality and region. This is part of the process under the draft Strategic Regional Land Use Plan (SRLUP) for the Upper Hunter.

The AIS has identified that there is land within the Project Area that is mapped as Strategic Agricultural Land (SAL), both Biophysical SAL and Critical Industry Cluster (Viticulture) SAL. However, due to concerns about the accuracy of the Biophysical SAL, a soil sampling program was undertaken to 'ground truth' the eastern side of the mapped Biophysical SAL. This sampling program revealed that the Project Area does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical.

Notwithstanding, in total, approximately 421ha of the mapped SAL in the draft SRLUP would be impacted within the Project Area. This comprises 253ha of the mapped SAL – Biophysical and 421ha of the mapped SAL – Viticulture Cluster (Note: These areas overlap within the Project Area). This represents about 38% of the mapped SAL – Biophysical and 1.9% of the mapped SAL – Viticulture Cluster within the mapped SAL categories in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

The Project Area will result in the disturbance (temporary removal from agriculture) of a relatively small area of 30.3ha (4.3% of Project Area) and 11.8ha of mapped SAL in the SRLUP. This in turn represents 2.8% of the SAL in the Project Area or 0.05% of mapped SAL in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

It is considered that the SAL Viticulture Cluster land does meet the criteria for SAL mapping, though it is unlikely that additional viticultural operations shall establish to the east side of the SAL Viticulture (towards Charlton Rd) due to poorer quality soil and that the land is in mine ownership.

Notwithstanding, irrespective of whether mapped or 'ground-truthed', Biophysical Sal or Viticulture Cluster SAL, the AIS assessment has identified that a very small portion of agricultural resource (land and water) in the Broke-Fordwich locality will be affected by the proposed Project.

The land affected by the Project Area equals 710ha. Of this 30.3 ha (4.3%) of the Project Area will be temporarily removed from agriculture for access roads and gas drainage. This land will be returned to agricultural production upon completion of mining and rehabilitation as agricultural land capability Class VI.

The agricultural land within the Project Area is estimated to have a potential agricultural production value of up to approximately $234 000 per year, with approximately $62 650 per year potentially available from private land, the remainder in mine ownership. However not all land in the Project Area is actively used for agriculture. The number of persons employed by these operations is difficult to quantify. However, as the Project will not impact upon the agricultural production of any private property there is no change expected to the production value or employment in agriculture.

In terms of the direct impacts from the Project, potential impacts may arise from visual/landscape impacts and subsidence. Management and mitigation strategies are proposed which should ensure these potential

impacts will not have a long term impact upon the agricultural or tourist related operations in the locality. No impacts are expected to groundwater systems and minor impacts to ephemeral drainage lines in the Project Area may occur due to subsidence. Mitigation and management strategies are proposed if this occurs.

It is considered that the proposed modification of the Blakefield North Underground Mine shall not have a significant detrimental impact upon the agricultural resources or Strategic Agricultural Land (SAL) of the locality or region.

1.0 INTRODUCTION

1.1 Background

The Bulga Underground Operations (BUO) is an underground coal mine located approximately 12 kilometres (km) south-west of Singleton, in the Upper Hunter Valley of New South Wales (NSW). The BUO form part of the Bulga Coal Complex (BCC), which is managed by Bulga Coal Management Pty Ltd (BCM) on behalf of Bulga Joint Venture (BJV). The BCC is composed of the BUO and the Bulga Surface Operations (BSO). Each operation is managed by a separate business unit but serviced by a common coal handling and preparation plant (CHPP) and rail loading facility.

The BUO comprises the Blakefield South (BFS) Underground Mine (Blakefield seam) and the Blakefield North (BFN) Underground Mine (Blakefield Seam). The BFN Underground Mine has been approved but is yet to commence operations.

1.2 Project Description

BCM is seeking to modify Development Consent DA 376-8-2003 pursuant to Section 75W of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) to allow for the following:

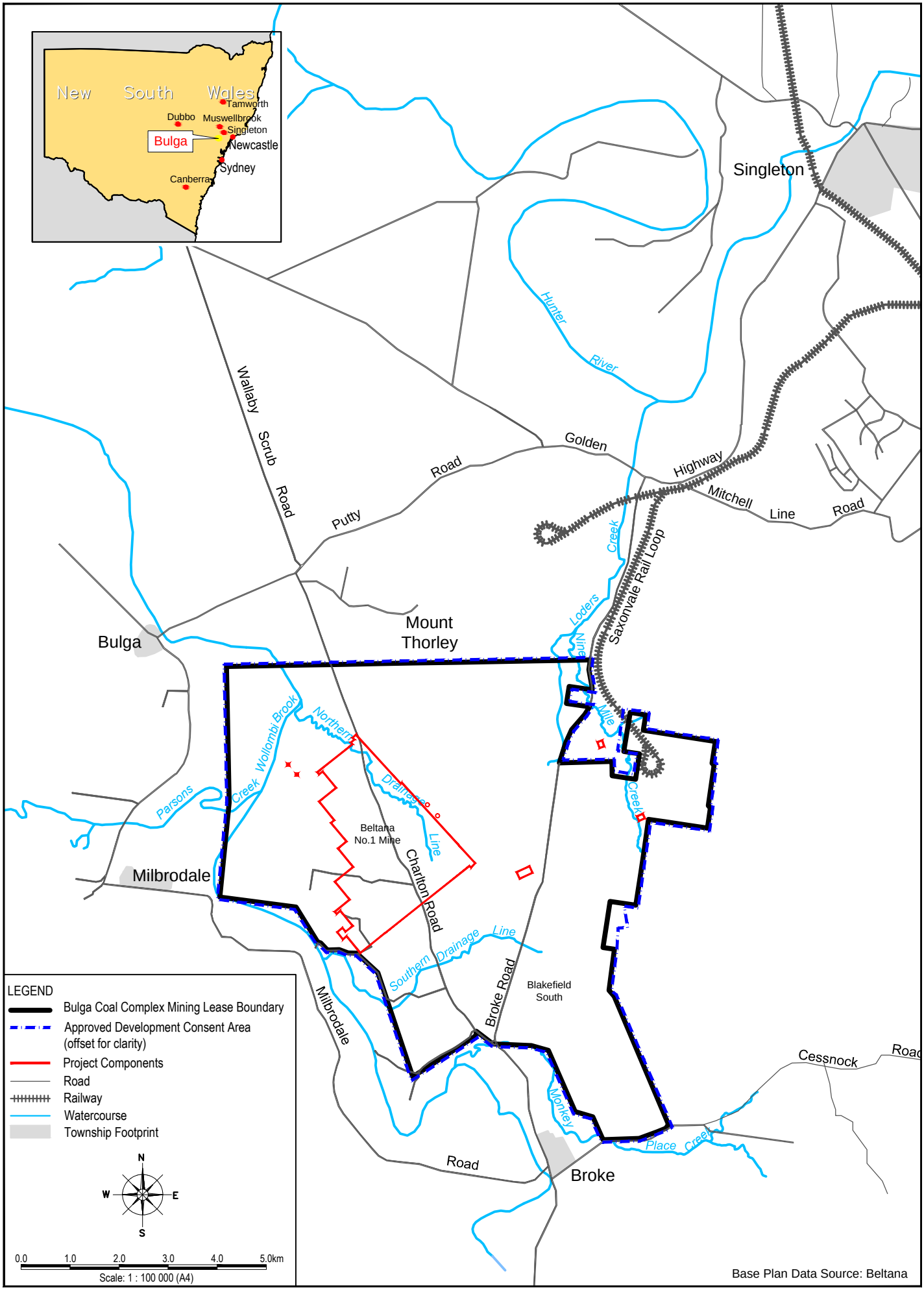
- Realigned longwall layout, including expansion of the longwall extraction width up to the previously approved 400 metres;
- Increased pre and post-mining gas drainage infrastructure above the longwall panels (similar to that employed in the BFS Underground Mine) including electricity lines;
- Construction of a gas drainage plant at the top of the Whybrow highwall, including goaf plant, gas compressors, workshop, offices, hardstand areas, buried pipelines and associated infrastructure. Five goaf extraction unit flares and 5 pre-mining gas drainage flares (already approved for the BFS Underground Mine) are to be relocated to this proposed gas drainage plant;
- Modified mine ventilation, including the relocation of the two approved ventilation fans to the base of the open cut highwall within a new access slot.
- Changed coal clearance infrastructure for the clearance of development coal only, through the trucking of coal to the existing BFS ROM stockpile;
- The construction of a small-scale power generation plant (up to 32MW), and associated underground pipeline and infrastructure, to manage the increased methane production from gas drainage; and
- Ongoing exploration activities during the life of the BFN Underground Mine.

The location of the development is shown on **Figure 1** and **Figure 2**.

The timing of the Project is to be in accordance with Life of Mine (LOM) planning which extends to 2031. The proposal will use the same longwall mining methods, type of equipment and infrastructure already in use by BUO. No changes are proposed to the pit top workshop areas, the Coal Handling Preparation Plant (CHPP), coal handling techniques (other than for development coal), approved operating hours, or mining methods currently in use at the mine. No extension or reduction to the life of the current development consent is proposed, and the Project would not require any additional tailings or coarse rejects storage.

1.3 Project Area

The Project overlays an area that the *Draft Strategic Regional Land Use Plan: Upper Hunter* (SRLUP) DP&I, 2012) has mapped as “Strategic Agricultural Land - Biophysical” and an area mapped as a “Strategic Agricultural Land - Viticulture” (see **Figure 3**) with the Broke-Fordwich Geographical Indicator sub-region also specifically nominated in the SRLUP.

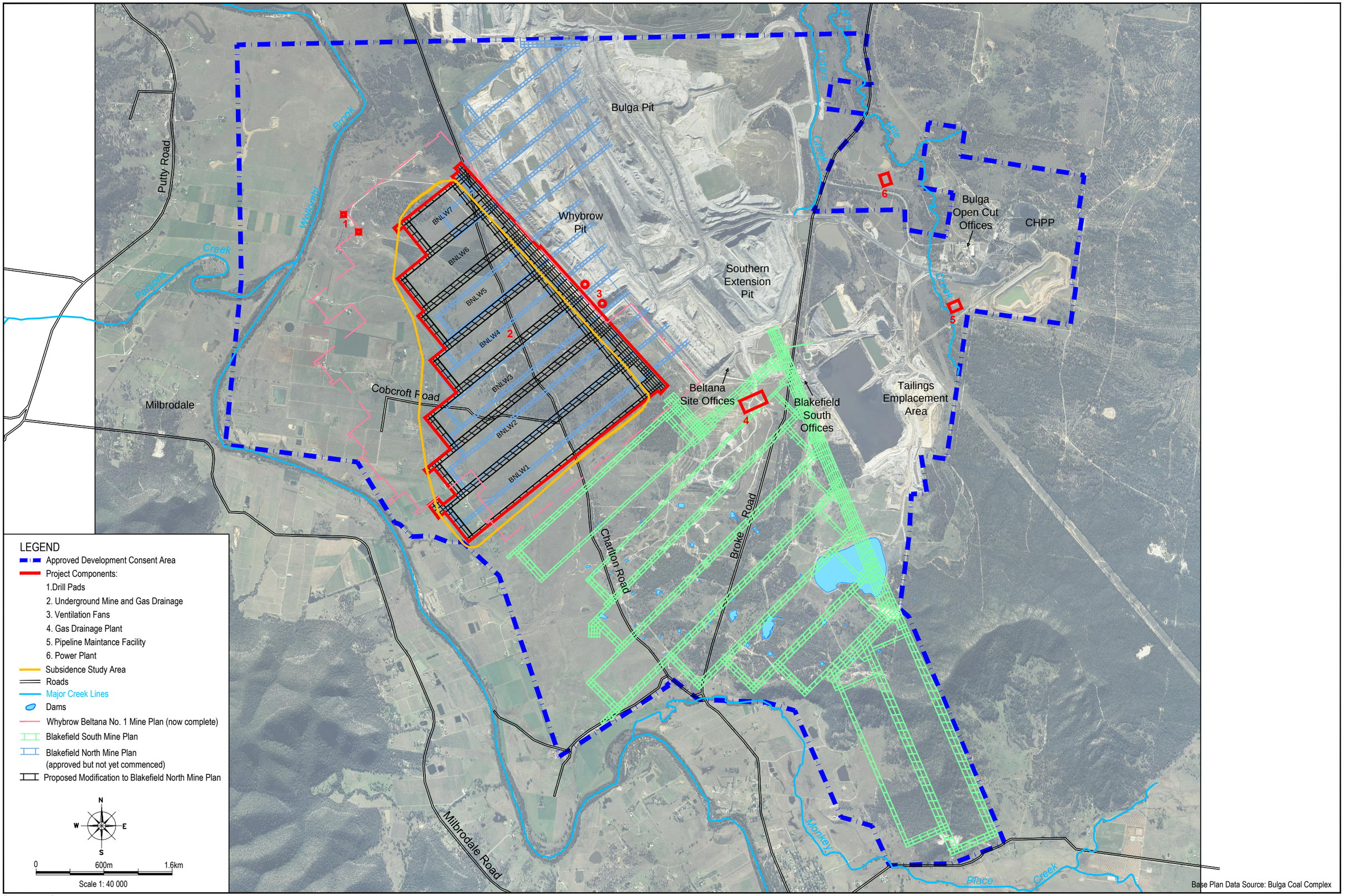


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Bulga AIS
Location Plan
FIGURE 1

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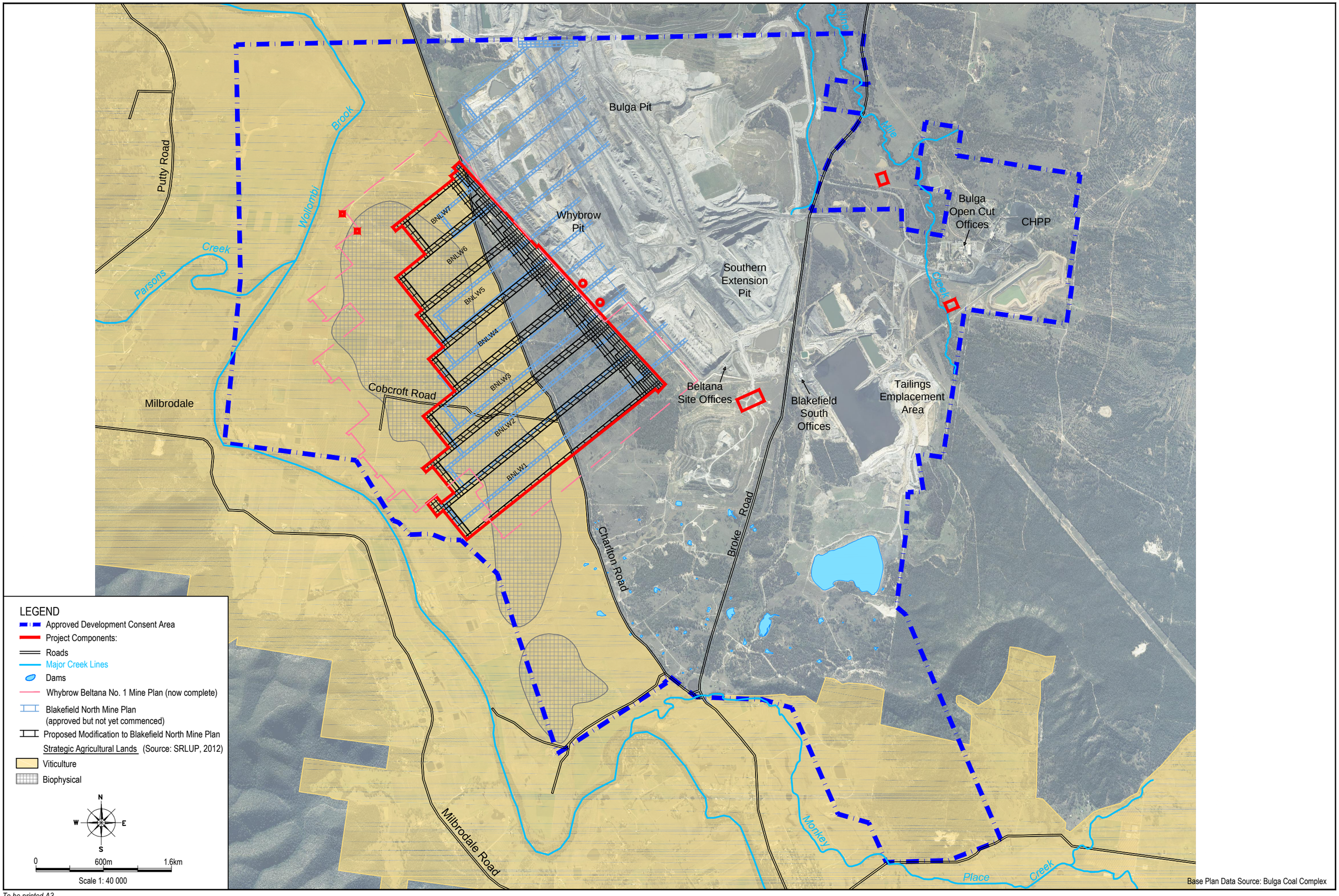
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Bulga AIS
Site Layout

FIGURE 2



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Bulga AIS
Strategic Agricultural Lands Mapping

FIGURE 3

There is also grazing land within 2 km of the mapped Strategic Agricultural Land (SAL). (See **Figure 3)**.

(Note: The previously mined Wybrow and Blakefield South Seams also extend below the mapped SAL.)

Figures 4-9 illustrates the difference between the current, approved Blakefield North Mine Plan and the area proposed for modification.

The Project represents a modification of the existing approval for underground mining. The area of difference between the currently approved underground mine area and existing land uses is shown in **Figure 4b**.

The original approved Blakefield North underground mine had an area of approximately 837ha. The modification (Project Area) is approximately 710ha, however, as the original Blakefield North underground mine had a significant proportion of land subject to open-cut mining since the original approval, the proposed modified layout has a focus to the south-west (SW) of the open-cut. There is now approximately 208ha of difference (increase) on land to the SW of the open-cut (ie. will be subject to underground mining).

The proposed modification area contains about 253ha and 421ha of mapped Bio-physical and Viticulture Cluster Strategic Agricultural Land (SAL) respectively. (Note these areas overlap).

The Project Area for the purposes of this AIS, has been defined after ascertaining the location of the various Project components and relationship to the SAL and 'agricultural resources'. An analysis of the proposed development against the SAL is shown in **Table 1**.

Table 1 – Analysis of Project Modification Against SAL

Development Modification	Affects SAL	Area (Approx)	Included in AIS
Realigned longwall layout underground mine	**Yes**	**710ha**	**Yes**
Pre and post mining gas drainage above longwalls	**Yes**	**30.3ha**	**Yes**
Gas well drill pads (beyond longwalls)	Yes	1 x (80 x 80m) 1 x (40 x 40m) = 0.8ha	No[#]
Gas drainage plant	No - > 2km from SAL, located on existing Whybrow highwall (disturbed mining ground)	Approx. 2.5ha	No
Pipeline Maintenance Facility	No- > 2km from SAL, located adjacent to Nine Mile Ck near CHPP.	50 x 50m = 0.25ha	No
Power generation plant	No - > 2km from SAL on cleared grazing land.	100 x 125m = 1.25ha	No
Pipelines supplying power generation from Gas Drainage Plant	No	Nil surface disturbance – underground (directionally drilled).	No
Trucking of development coal	No - via existing haulage roads and disturbed mining ground.	-	No
Exploration activities	To be considered at relevant time.	-	No
Mine ventilation	No - located at base of open cut highwall	-	No

[#] - the minimal area of 0.8ha and fact that land will be rehabilitated once mining has been completed does not warrant detailed assessment as part of the AIS.

It is relevant to note that the area subject to subsidence is of a similar area (approximately 710ha) to that of the proposed underground longwalls, but has a slightly different footprint. The subsidence study area is shown in **Figure 2** and identified in the MSEC report as

- A 26.5 degree angle of draw line from the extents of the proposed longwalls, and
- The predicted level of vertical subsidence, taken as 20mm subsidence contour resulting from the extraction of the proposed longwalls.

Therefore the Project Area for this AIS is illustrated in **Figure 2** and comprises the footprint of the realigned longwalls and pre and post mining gas drainage surface infrastructure located above the longwalls.

Subsidence impacts are assessed in **Section 3.0**.

1.4 AIS Objectives and Relevant Guidelines

In March 2012 the *Guideline for Agricultural Impact Statements* (AIS Guidelines) were released in conjunction with the *draft NSW Strategic Regional Land Use Plans for the Upper Hunter and New England North West*. The AIS Guidelines state the following:

> *The requirement for an agricultural impact statement (AIS) applies immediately to all state significant development (SSD) applications for mining and petroleum (including coal seam gas) and will form part of the environmental impact statement (EIS) prepared for the proposal.*
>
> *Source: Strategic Regional Land Use Policy Delivery Guideline March 2012*

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.

The AIS has been prepared in accordance with the *Strategic Regional Land Use Policy Delivery Guideline* and the *AIS Guidelines*.

The objectives of this AIS include:

- Description of the current agricultural resources and enterprises within the locality surrounding the Project;
- Identification and assessment of the potential impacts of the Project on agricultural resources and industries, including agricultural support services, processing industries and value-adding industries;
- Assessment of the socio-economic impacts associated with anticipated impacts to agricultural resources and industries, including agricultural support services, processing industries and value-adding industries; and
- Identification of options to minimise adverse impacts from the Project on agricultural resources, agricultural lands, enterprises and infrastructure at a local and regional level.

1.4.1 Director General's Environmental Assessment Requirements

A briefing letter and a *Preliminary Environmental Assessment* (PEA) were provided to the Department of Planning and Infrastructure (DP&I) on 26 September 2011 outlining the Project. DP&I responded in a letter dated 7 October 2011 stating that Director General's Requirements (DGR's) would not be required as the PEA adequately identifies the likely environmental impacts associated with the Project.

However, following release of the AIS Guidelines in March 2012, the DP&I issued supplementary DGR's on 30 April 2012 under section 75F(3) of the EP&A Act for the Project, requiring the preparation of an AIS, as follows:

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

1.4.2 The Gateway Process

As stated in the DGRs, the AIS must contain a specific focussed assessment of the impacts of the proposal on Strategic Agricultural Land (SAL) and have regard to the draft Gateway criteria in the SRLUP.

There are two categories of SAL:

- Biophysical strategic agricultural land – 'moderately high' to 'high' soil fertility, Class 2 and 3 land and soil capability and reliable access to suitable water quality with an area of more than 20 hectares (ha); and
- Critical industry clusters – concentrations of highly productive industries within a region which are related to each other, contribute to the identity of the region and provide significant employment opportunities.

The proposed Gateway will be an independent assessment process that investigates the impacts of major resource projects on SAL and determines whether that project should proceed to lodgement of a development application. The Gateway will apply to state significant mining or coal seam gas projects that are on or within 2 kilometres (km) of SAL.

Where the proposal is on land identified as Biophysical SAL the Gateway Panel will consider whether the proposal would significantly reduce agricultural productivity of the land due to:

- Surface area disturbance and subsidence;
- Impact on soil fertility, rooting depth or soil profile materials and thickness;
- Increases in land surface micro-relief or soil salinity, or significant changes to soil acidity; and
- Impacts upon highly productive groundwater, in accordance with the provision of the draft Aquifer Interference Policy.

Where the proposal is on land identified as belonging to a Critical Industry Cluster, the Gateway Panel will consider whether the proposal would lead to significant impacts on the critical industry cluster through:

- Surface area disturbance;
- Subsidence;
- Reduced access to agricultural resources;
- Reduced access to support services and infrastructure;
- Reduced access to transport routes; or
- Loss of scenic and landscape values.

A key principle of the Gateway process is that the proposal must satisfy a public benefit test based on a triple bottom line cost benefit analysis.

Although the Gateway Panel has not yet commenced an assessment of draft criteria has been undertaken at **Section 7.0**.

2.0 EXISTING ENVIRONMENT

2.1 Locality

The BCC is located in the Upper Hunter Coalfields, approximately 12 km southwest of Singleton, 1 km north of Broke and 1.5 km east of Bulga, in the Upper Hunter Valley of New South Wales. (**See Figure 1)**.

The BCC is located within the Singleton local government (LGA) area which is located in the Hunter Region of NSW. Singleton LGA had an estimated residential population (ERP) of 24 331 in 2011 (ABS 2012).

The BCC approved development consent area occupies a total site area of approximately 6 027ha.

The Project Area is zoned 1(a) Rural zone under the *Singleton Local Environmental Plan (LEP) 1996*.

The Project Area has an area of approximately 710ha. The nearest privately owned residences are located within the Project Area (south-west corner) and land ownership is shown at **Figure 4a**.

The area available for agricultural production across the entire BCC (consent area) is approximately 4397ha and predominantly comprises potential grazing land (approximately 4156ha), viticulture (approximately 219ha) and an olive grove (approximately 22ha).

2.2 Land Ownership

The majority of surface holdings over the land covered by this Project Area are owned by the BJV, with the exception of some private land above the re-aligned longwall panels (refer to **Figure 4a**). In addition, Charlton, Cobcroft, Broke and Fordwich Roads, which traverse the mining area, are Crown roads under the jurisdiction of Singleton Council.

There are four private properties and 1 privately owned residential dwelling within the Project Area.

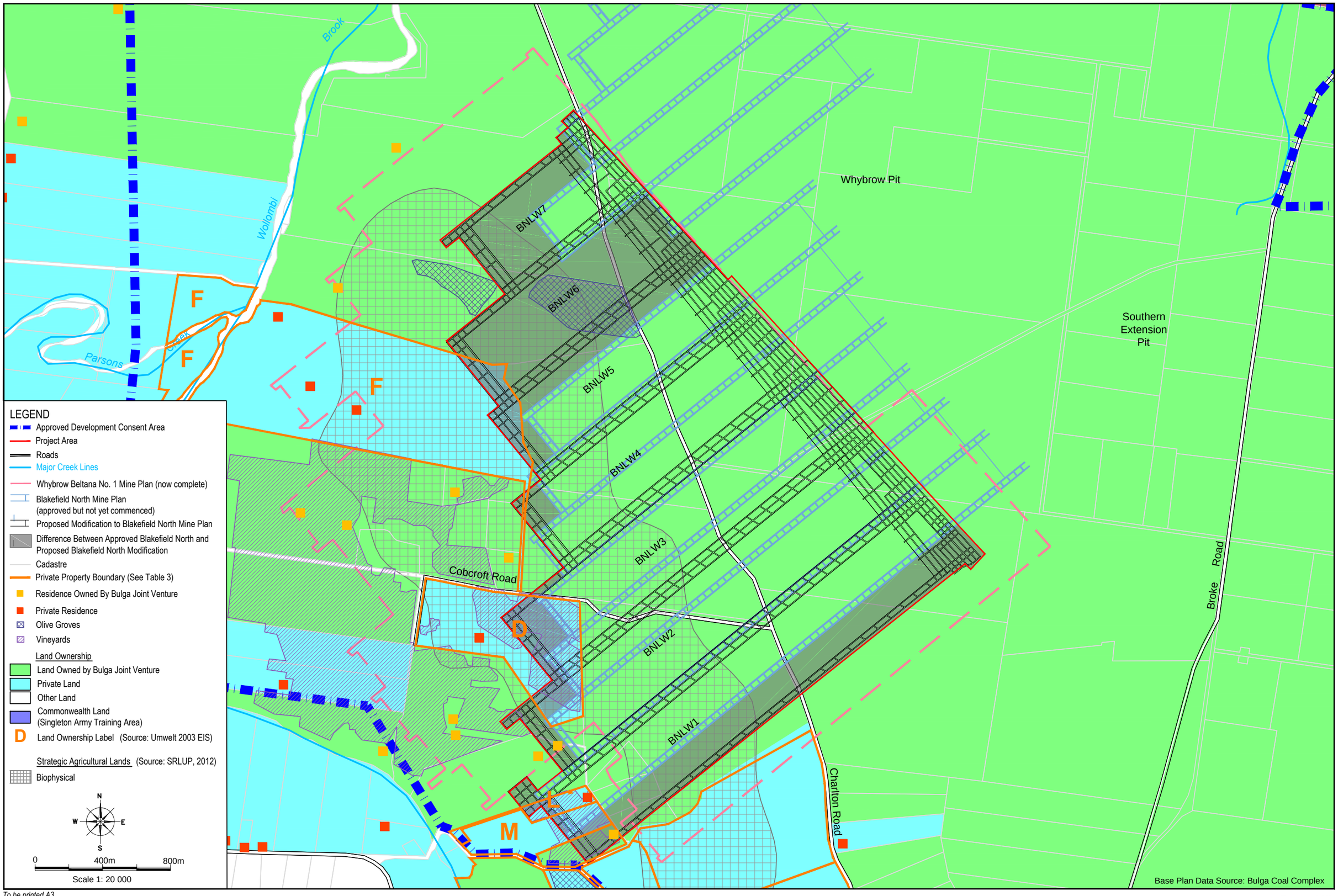
2.3 Existing Agricultural Conditions

2.3.1 History

Region

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

In recent decades there has been marked change in agricultural activities in the Upper Hunter. Deregulation of the dairy industry in 2000 has seen many dairy operators leave the industry and a 57% decrease in employment in dairying between 1996 and 2006. Forestry has also declined, while beef and sheep grazing, cereal cropping, viticulture and thoroughbred horse breeding have all been growth industries in the past decade (HVRF 2009).



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All indicative locations - will be finalised pending constraints

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Bulga AIS
Property Ownership and Agricultural Enterprises

FIGURE 4a

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Locality

The Project Area is located within the Broke Fordwich Wine Region which accounts for 11% of the vineyard area planted in the Hunter Valley and can be found between the Lower Hunter and the Upper Hunter Valley.

At the end of WW l the Fordwich Soldier Settlement Purchase Area was created with many planting grapes on their 10-acre allotments. These allotments were from land owned by the Blaxland family as part of the original land grant to John Blaxland Snr in the late 1820's. The Tulloch family had acquired most of the allotments by the 1930's due to depression and severe hail storms which devastated the vines.

Grapes from the area have been processed in Pokolbin from early times with the Tulloch family being the most prominent. The Elliott family, original owners of the present Oakvale Vineyard also had smallholdings in the area. (Source: www.brokefordwich.com.au, accessed 29/5/2012)

The locality surrounding the Project has an identified "viticulture cluster", being a "highly integrated concentration of vineyards and associated wineries and tourism infrastructure in a rural landscape" in the Broke – Fordwich Geographic Indication Sub-Regions. This area is further discussed in **Section 2.5.3.**

2.3.2 Agricultural Enterprises

The **Upper Hunter** Region:

- Comprises just 2% of the area used for grazing and cropping in NSW but provides a much greater contribution to the NSW production of many agricultural commodities, particularly equine, viticulture, milk and beef cattle;
- Has an established international reputation for thoroughbred breeding and wine making and provides 80% of the total value of stud horses exported by Australia;
- Produces 15% of milk, 6% of cattle for slaughter, 5% of wine grapes, 8% of herbs and garlic and 6% of olives in the state. It also grows approximately 90% of the state's industrial hemp. Other emerging specialist agribusinesses in the region include mushrooms, cut flowers, turf and nurseries, stud cattle, land-based aquaculture, goats and essential oils;
- Is located in the Hunter Statistical Division which had a total agricultural value of $333.2 million with 4 690 people (of 219 787 or 2.13% of all employment) in agriculture (2005-06);
- Grapes (wine and table) value in the Hunter Statistical Division for 2005-06 was $10.9 million, down from $18.8 million in 2000-01. Grapes were produced on 4 161ha, yielding 24 100 tonnes. This equates to approximately $2619/ha, 5.5t/ha or $459/t;
- Has the most productive and highest value cropping lands located on the alluvial floodplains along the major rivers and the black soil plains;
- Has land suitable for grazing industries, orchard or viticultural developments and farm forestry. These typically occur on the adjoining lower slopes where there is access to reliable water sources;
- Has reliable water supplies and capacity for year round pasture production;
- Has grazing as the region's dominant agribusiness sector in terms of employment, area involved and the overall economic returns. Beef cattle are the most widespread sector, followed by dairying and horses. Sheep and wool production are also significant in the Upper Hunter LGA;

The Upper Hunter Region includes the **Singleton LGA** which has:

  - substantial alluvial areas with high levels of agricultural productivity, with 2% of the LGA (over 8,500 ha) identified as Class 1 agricultural suitability. This land is significant at a regional and state level;
  - An agricultural economic value of $34 million from 600 producers (2001 ABS). In 2006 this value rose to $37.1 million;
  - An average farm size (in 2001) of approximately 356 ha and has been declining, and the total number of farms has been increasing. This does not take into account small holdings on which there is limited agricultural production;

- In 2006 there was a total of 156 484ha of land under agricultural production, with 4.5% of the agricultural land irrigated (7000ha). Animal numbers (principally related to meat and milk cattle production) had a combined total of 59 556 animals. (ABS 2011);
- Grapes (wine and table) value in 2005-06 of $2.05 million and represented approximately 5.5% of total agricultural value in the LGA, down from 9.5% in 2000-01. Grapes were produced on 855ha, yielding 4 500 tonnes. This equates to approximately $2397/ha, 5.2t/ha or $455/t;
- 510 (out of 12 368) employees in agriculture (excluding forestry and fishing (2005-06) which represented about 4.12% of the LGA workforce. In comparison, about 20% of the workforce in 2006 (2 055 employees) were employed in mining;
- A significant proportion of the LGA is used for coal mining or part of mining company land holdings, predominantly in the Rural West Planning Area; and
- An increasingly significant rural tourism industry, particularly in vineyard areas (e.g. Hermitage Road and Broke-Fordwich).

Sources: Draft Strategic Land Use Plan - Upper Hunter, Singleton Land Use Strategy (2008), ABS 2001 and 2006, and former NSW Industry and Investment, Value of Ag. Production Data.

The Project Area

The area of difference between the previously approved BFN underground mine and the proposed modification is 208ha larger on the land to the SW of the existing open-cut operations. Within the Project Area, an additional (approximate) 15ha of olive groves, 15ha of vineyards and 178ha of grazing land are now subject to under-ground mining compared to that originally approved. See **Figure 4b**.

The value of agriculture (potentially available) from the Project Area is estimated to be up to $234 000 per year from **Table 2**.

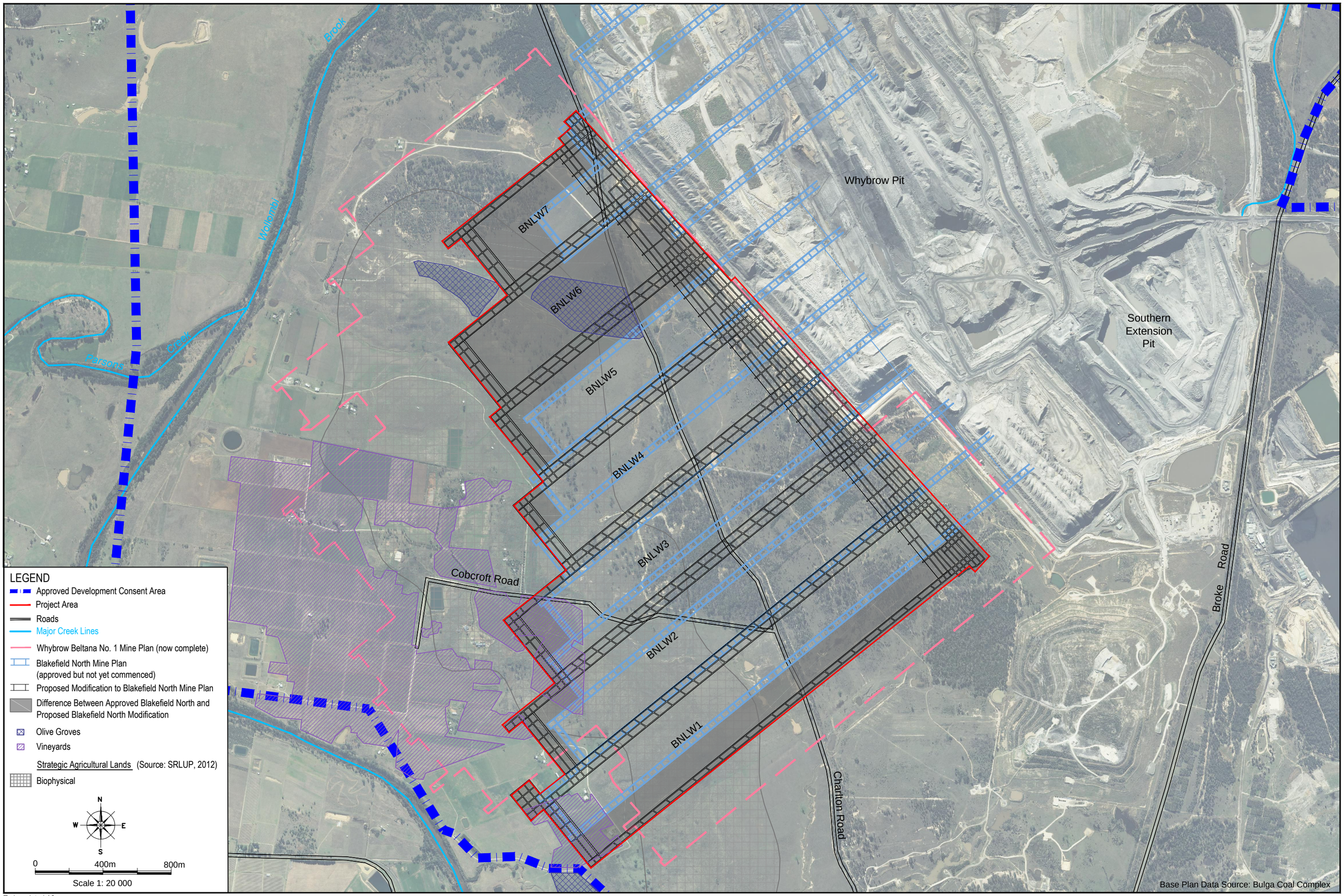
Table 2 – Estimated Agricultural Value within the Bulga Coal Complex and Project Area

Agricultural Activity BCC		Area (ha)	Gross Margins Value/ha ($)	Total BCC Site ($/yr)	Total Project Area[1] ($/yr)
Grazing	Total	4156	$175[2]	727 300	-
	Project	665		-	116 375
Viticulture	Total	219	$2 397[3]	524 943	-
	Project	29.4			70 472
Olive Production	Total	22.4	$3 020[4]	67 648	-
	Project	15.6		-	47 112
	Total Area	**4397.4 ha**		**1 319 891**	**233 959**

[1] = Project Area is from Table 1.
[2] = NSW DPI Beef Gross Margins 2011 (Assumed yearling production).
[3] = NSW DPI, Value of Agricultural Production Data 05/06 and ABS Agricultural Commodities: Small Area Data, Australia, 2005-06 (Reissue).
[4] = NSW DPI Gross Margins 2005 (Assumed Oil Olives – Non-Organic)

It is estimated that the agricultural potential of the entire BCC site is approximately $1.32M per year and from Project Area estimated up to $234 000 per year. Therefore, the Project Area represents about 17.7% of the potential agricultural value and approximately 16% of the land area of the BCC site.

Note: These estimates assume that 100% of land within the BCC and/or Project Area is used for agriculture. The actual production value is likely to be less than the potential value as not all land is actively used for agriculture.



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All indicative locations - will be finalised pending constraints

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Bulga AIS
Mine Plans (Approved and Proposed Modification) and Existing Land Uses

FIGURE 4b

The privately owned agricultural enterprises within the Project Area are described in **Table 3** and shown on **Figure 4a**.

Table 3 – Estimated Private Property Agricultural Production Values

Label[5]	Total Site Area (ha)	Agricultural Use	Total Production Value (Est)[6] $/yr	Area Affected By Project	Value of Private Ag Subject to Project[6] $/yr
D	86[1]	38ha - vines	91 086	17.8ha - vines	42 667
		Grazing – 48ha	8 400	Negligible grazing	-
F	153.6[2]	Grazing (Biodynamic) + 10% crops	26 880 (grazing)	8.7ha – grazing	1 522
L	6.4[3]	3.9 - vines	9 348	3.3ha vines	7 910
			Negligible grazing	Negligible grazing	Negligible
M	18.8[4]	5.2ha - vines	12 464	4.4ha vines	10 547
		15.6ha grazing	2 730	Negligible grazing	Negligible
		Totals	**$150 908**		**$62 646**

[1] = PPSMP: (Umwelt 2004)
[2] = PPSMP: (Umwelt 2004)
[3] - [4] = GIS measurement
[5] = 2003 EIS Table 4.1/Fig 4.1 & AIS Figure 4a
[6] = Value/ha from Table 2.

There are four privately owned properties within the Project Area. From **Table 3** it is estimated that the potential agricultural production value from private land within the Project Area is approximately $62 650 per year with the majority of that value stemming from wine grape production.

The number of persons employed by these operations is difficult to quantify. However, as the Project will not impact upon the agricultural production of any private property there is no change expected to the employment in agriculture from the Project.

2.3.3 Agricultural Support Infrastructure

In terms of agricultural support infrastructure the Region includes the following infrastructure:

- Livestock saleyards are located at Singleton;
- An abattoir is located at Whittingham, close to Singleton;
- There are grain delivery silos at Merriwa.
- There are wineries (processing) at Broke and Pokolbin.
- Singleton provides agri-business support industries and suppliers; and
- The Project locality is serviced with public roads, electricity and telecommunication infrastructure and private irrigation infrastructure.

Within the Project Area there is no agricultural support infrastructure (other than roads and utilities) of any significance.

2.4 Soil Resources

2.4.1 Inherent Soil Fertility

The Draft Inherent Soil Fertility Map – Upper Hunter and New England (OEH April 2012) (**Figure 5)** shows the 'inherent fertility' of land in proximity to the Project Area.

Regionally, the soils are of 'low' to 'moderately low' fertility, except for soil along the alluvial floodplain of the Hunter River which is generally of 'moderately high' fertility and there are areas of 'moderately high' and 'high' fertility in the Merriwa locality.

The land within the Project Area has a mapped 'Inherent Soil Fertility' of

- 'moderately low' - the majority of the Project Area; and
- 'moderately high' - coinciding with the 'bio-physical' mapped SAL.

(Note: See **Section 2.5.3** regarding the findings of soil sampling programme to ground-truth the presence of SAL Biophysical within the Project Area.)

2.4.2 Land and Soil Capability

The Draft Land and Soil Capability Mapping – Upper Hunter and New England (OEH April 2012) shows the 'land and soil capability' of land in proximity to the Project Area. The PDF is available from the OEH website - http://www.oeh.nsw.gov.au/resources/soils/SRLUP1_5_LSC_v2_4_120411_A3.pdf

The Land and Soil Capability Map has not been reproduced as part of this AIS. The mapping data supplied by DP&I only identifies 'Class 3 - Land and Soil Capability' where it coincides with Inherent Soil Fertility of 'moderately high'. It does not show any other Class 3 or other land Classes in the vicinity of the Project Area and therefore does not show any additional information. Therefore, **Figure 5** (Inherent Soil Fertility) 'moderately high' indicates the location of Land and Soil Capability Class 3.

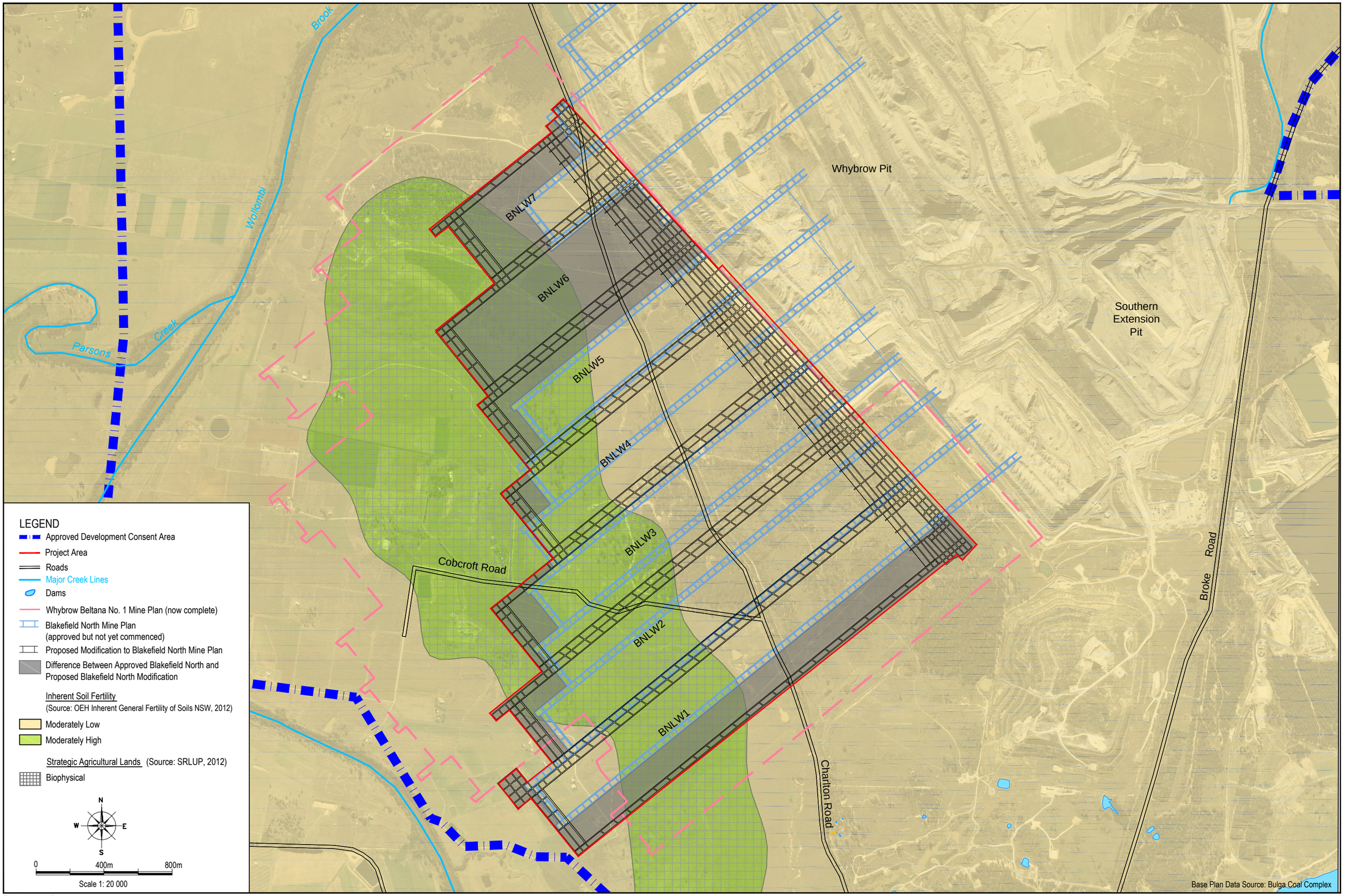
Note: See **Section 2.5.3** regarding the findings of soil sampling programme to ground-truth the presence of SAL Biophysical within the Project Area.

2.4.3 Soils

The 2003 EIS prepared for the BCC identified two landscapes covering the Project Area: Branxton Soil Landscape and Saxonvale Soil Landscape. The Branxton Soil Landscape covers the undulating low hills and rises, and small creek flats developed on the coal measures, which covers the majority of the Project Area. The main soils are Yellow Podzolic Soils on midslopes with Red Podzolic Soils on crests. Yellow Soloths occur on lower slopes and in drainage lines (see **Figure 6**). The Saxonvale Soil Landscape covers the Fordwich Sill ridge area located in the western portion of the Project Area. The main soils in this landscape are Chocolate Soils with minor Brown Soloths on some upper slopes. Contrary to the area shown in **Figure 5**, the Saxonvale Soil Landscape does not really extend beyond the eastern limit of the associated ridge but does extend west of the ridge.

A description of the soil landscapes present in the Project Area are shown in **Table 4**.

Note: The soil sampling program (**Appendix 1**) that was undertaken to ground-truth the SAL – Biophysical, did not include a detailed assessment of the soil characteristics or attempt to revise the soil mapping present within the Project Area. The sampling program was limited to identifying the land capability and soil fertility. See **Section 2.5.3**.



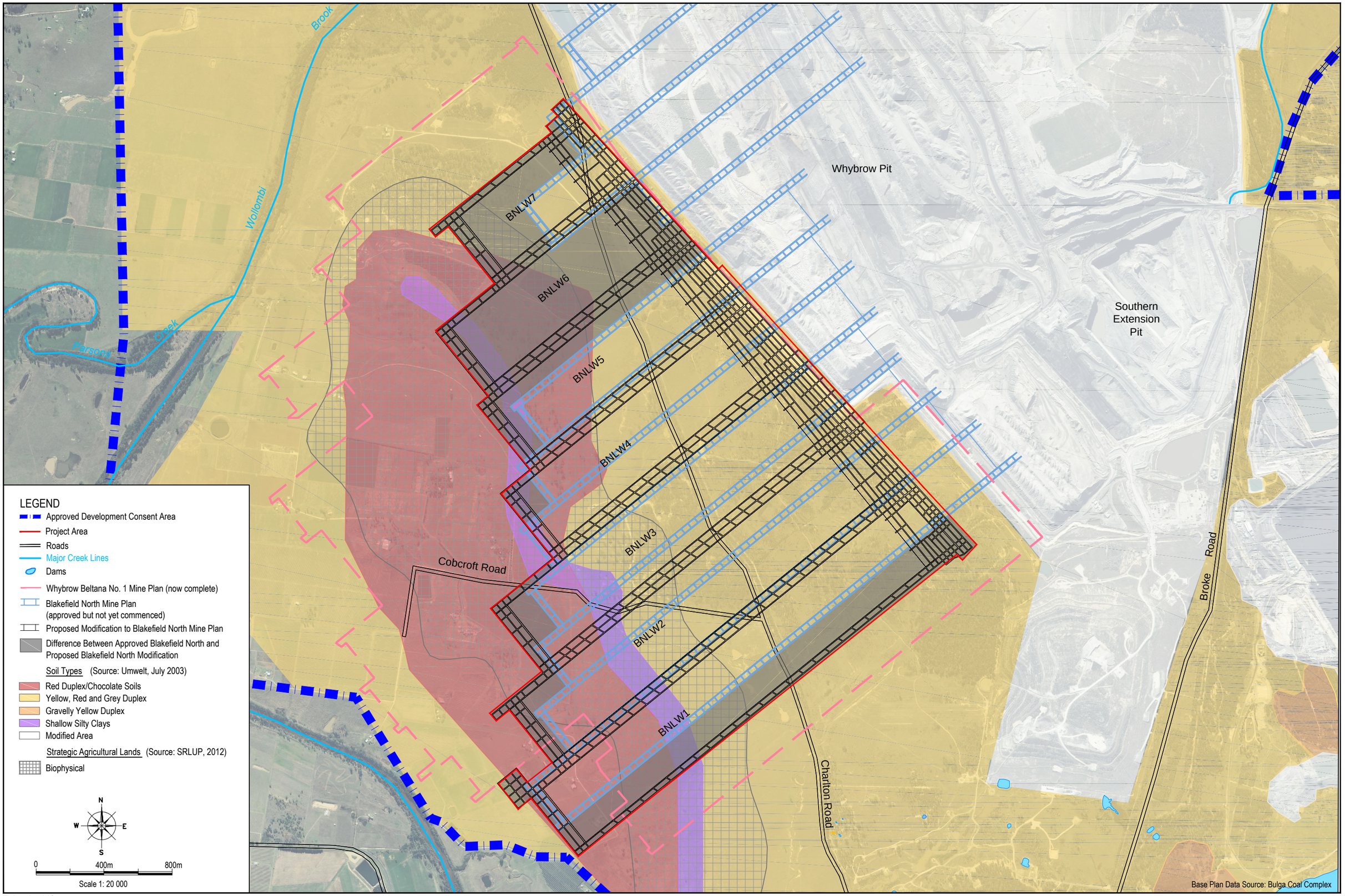
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Bulga AIS
Inherent Soil Fertility

FIGURE 5



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Bulga AIS
Soil Types

FIGURE 6

Table 4 – Soils present in the Project Area

Soil Landscapes within Project Area	Landform	General Soil Description	Area (ha) (Approx.)	%
Branxton Soil Landscape	Undulating low hills and rises, and small creek flats developed on the coal measures.	**Yellow, Red and Grey Duplex Soils** Hard Pedal Yellow Duplex Soils: relatively shallow, highly dispersive duplex soils, which overlie sandstone and siltstone on low rises and undulating hills. Hardsetting topsoil which overlies a pedal, clayey subsoil. The pH ranges from 5.0 to 7.5 for the topsoil, with depth ranges from 8 to 25cm. Subsoils are yellowish brown to dull brown, while in areas of impeded drainage, subsoils are typically greyish yellow brown with bright brown mottles. The pH ranges from 7.0 to 9.0 and depth ranges from 48 to 230cm. Hard Pedal Red Duplex Soils: occur on the slopes adjacent to the Fordwich Sill and in the vicinity of the majority of the proposed surface infrastructure. The parent material is sandstone and siltstone. The soil is weakly pedal to massive, hardsetting, brownish black to greyish brown topsoil and dull reddish brown to bright reddish brown, whole coloured subsoil. Topsoil is loam to silty loam with pH ranges from 6.0 to 6.5 and depths from 8 to 10cm. Subsoil it strongly structured medium to heavy clay with a field pH of 5.5 and depth greater than 35cm. Hard Pedal Grey Yellow Duplex Soils: hardsetting brownish black to very dark reddish brown loam topsoil horizon, underlain by a greyish brown sandy loam horizon. Topsoil pH is 5.5 to 6.0 with depth around 20cm. Subsoil is brown to yellowish brown medium-heavy clay to sandy clay with common grey, pale and dark mottles. Subsoil pH is 7.0 to 9.0 with lower depth ranges from 160-310cm.	492	69%
Saxonvale Soil Landscape	Covers the Fordwich Sill ridge area to the west of Charlton Road.	**Red Duplex/Chocolate Soils** Derived from in-situ weathered dolerite and basalt parent material. Topsoil (20-30cm) consists of brownish black silty clay loam to clay loam texture which is highly pedal. Topsoil pH ranges between 5.8 and 7.1. Salinity levels are low and fertility is generally high. Surface condition is friable, horizon is moderately well drained and erosion potential is low. Light to medium clay subsoil is dark reddish brown and exhibits moderate to strong structural grade, with an alkaline trend. Erodibility is relatively low. **Shallow Silty Clays** Occur in a narrow band associated with the Chocolate Soils on the Fordwich Sill. These clays contain rock fragments and have similar properties to the topsoil of the Chocolate Soils, except for lighter texture and shallower depth.	177.4 40.6	25% 6%
Total			**710**	**100%**

Note :

1. A significant proportion of land to the north - north east of the Project Area is land disturbed by open cut mining, in which there is no significant soil development.
2. As the mining process shall be underground by longwall technique, the soil profile shall be relatively unaffected by mining.

2.5 Rural Land Classification

2.5.1 Land Capability Classification System

This is a guideline approved by the *NSW Office of Environment and Heritage* (OEH) (former Soil Conservation Service) and classifies the land on its potential for sustainable agricultural use if developed. This classification includes three broad types of land use, being:

- suitable for cultivation (cropping land; classes I–III);
- suitable for grazing (classes IV–VI); and
- not suitable for rural production (classes VII–VIII).

The area surrounding the Project Area has a range of land capabilities – Class I and II are present between the ridge (geomorphological expression of the Fordwich Sill) and the Wollombi Brook . The remainder of the land is predominantly Class IV, V and VI. Some Class VIII land is present in the south east of the mining lease area and within the Wollombi Brook watercourse.

Land capability of the Project Area was assessed at a scale of 1:100 000 using aerial photo interpretation by the former NSW Soil Conservation Service. Three land capability classes occur within the Project Area (**Figure 7**) and are summarised in **Table 5**.

Table 5 – Pre-Mining Land Capability Project Area and Disturbance Footprint

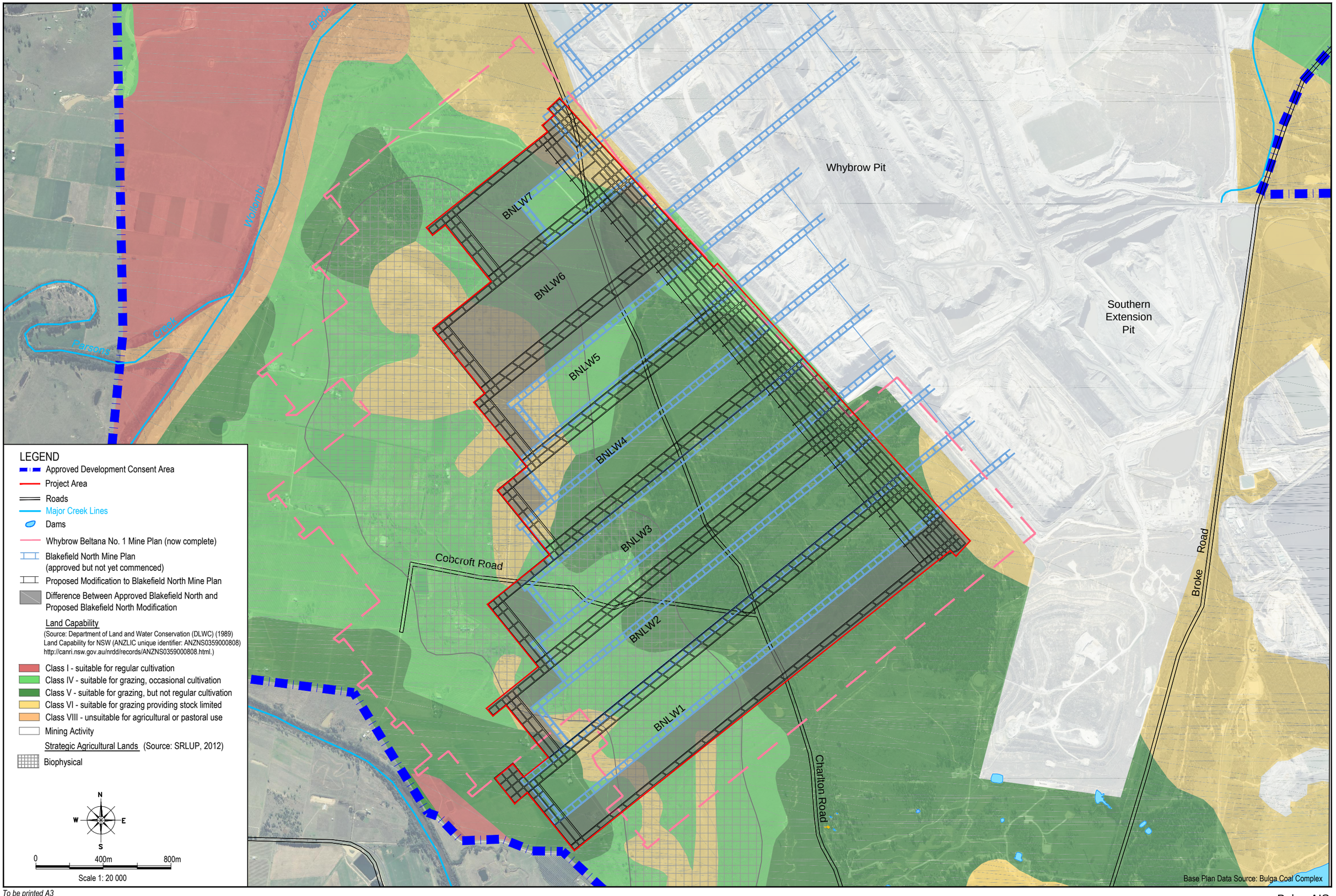
Land Capability	Land Use	Management	Project Area (Approx.)		Disturbance Footprint (Approx.)	
Class			ha	%	ha	%
IV	Grazing, occasional cultivation	Simple practices such as stock control and fertiliser application.	248.1	35	30.3	4.3
V	Grazing, occasional cultivation	Intensive soil conservation measures required, such as contour ripping and banks.	372.1	52		
VI	Grazing only	Managed to ensure ground cover is maintained.	89.8	13		
Total			**710**	**100**	**30.3**	**4.3**

The land capability classification system identifies the majority (87%) of the Project Area as land not capable of being regularly cultivated, but suitable for grazing with occasional cultivation (Class IV & V), and 13% as suitable for grazing only (Class VI). The majority of land likely to be subject to surface works as a result of underground mining is Class V and VI. The major constraints to sustainable land use involving cultivation are soils and topography.

Note: See **Section 2.5.3** regarding the findings of GSSE soil sampling programme to ground-truth the presence of SAL Biophysical within the Project Area.

2.5.2 Agricultural Land Suitability

The relevant guideline used to classify the agricultural suitability of land in NSW is the Agricultural Suitability Maps. The system consists of five classes that provide a ranking of rural lands according to their productivity for a wide range of agricultural activities. The overall suitability classification for each specific soil type is determined by the most severe limitation, or a combination of the varying limitations.



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Bulga AIS
Land Capability

FIGURE 7

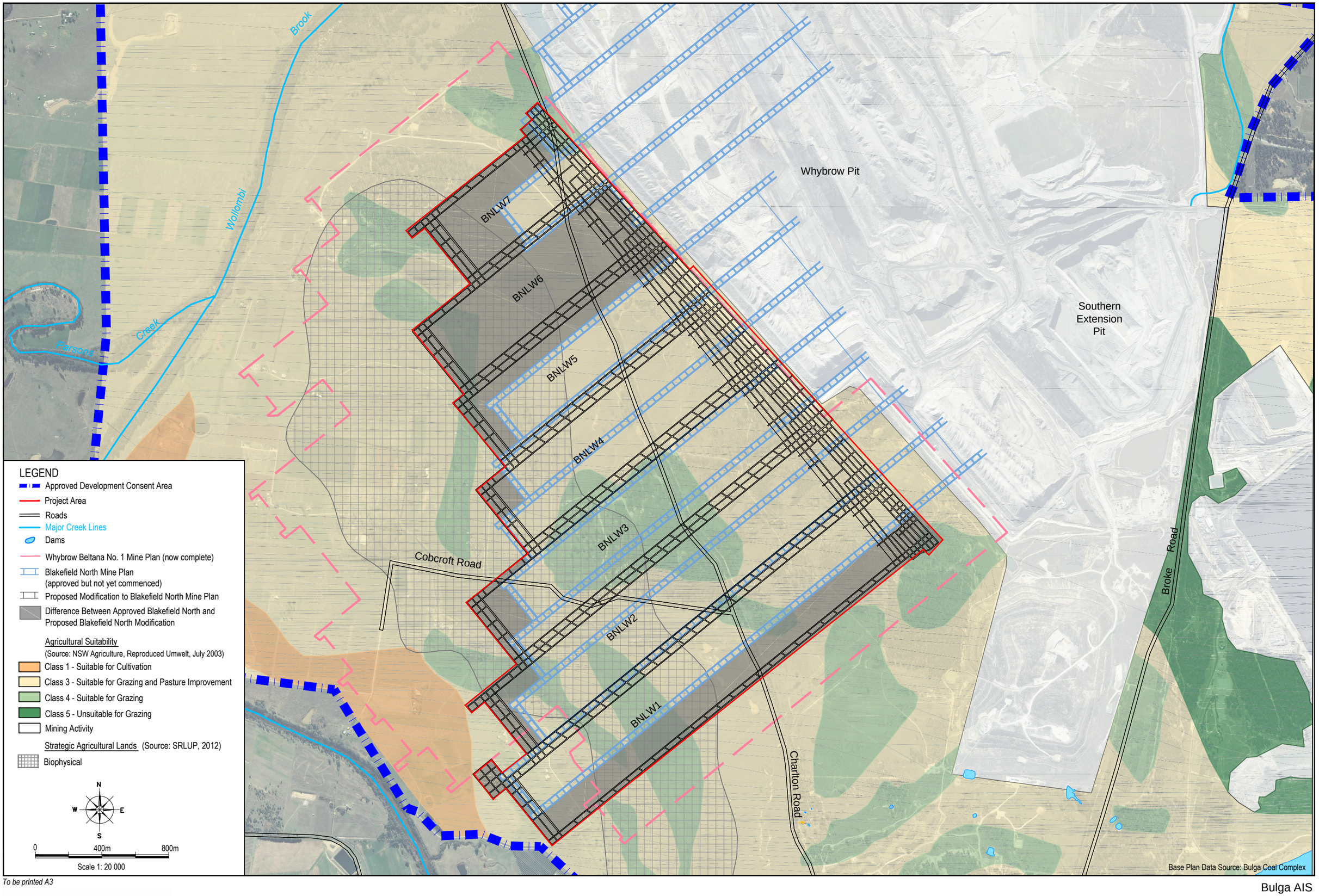
Class 1 ranks the land as most suitable for agricultural activities and Class 5 the least suitable. Classes 1 to 3 are generally considered suitable for a wide variety of agricultural production whereas Classes 4 and 5 are unsuitable for cropping, however, are suitable for some grazing activities.

Agricultural suitability of the Project Area was mapped by NSW Agriculture at a scale of 1:100,000. Two agricultural suitability classes occur within the Project Area (**Figure 8**). Definitions of these classes are provided in **Table 6**.

Table 6 – Pre-Mining Agricultural Suitability Classes

Agricultural Suitability Class	Land Use	Management Options	Project Site (Approx.)		Disturbance Footprint (Approx.)	
Class			**ha**	**%**	**ha**	**%**
3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture.	The overall production level is moderate because of edaphic factors or environmental constraints. Erosion hazard, soil structural breakdown or other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required	574.8	81	30.3	4.3
4	Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high, but the overall production level is low as a result of major environmental constraints.	The inability for the preparation of a cultivated seedbed on these lands typifies their limitations.	135.2	19		
Total			**710**	**100**	**30.3**	**4.3**

The agricultural suitability classification system identifies approximately 80% of the Project Area as moderately productive land suited to improved pasture and to cropping with pasture rotation (Class 3) (**Figure 8**). Approximately 20% is suitable for grazing based on native pastures (Class 4). There is no Class 1 or 2 land within the Project Area.



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Bulga AIS
Agricultural Suitability Mapping

FIGURE 8

2.5.3 Strategic Agricultural Land Assessment

Mapped SAL

The Project Area overlays an area that the draft SRLUP has mapped as "Strategic Agricultural Land - Biophysical" and an area mapped as a "Viticulture Critical Industry Cluster" with the Broke-Fordwich Geographical Indicator sub-region also specifically nominated. (See **Figure 3)**. There is also grazing land within 2 km of the mapped Strategic Agricultural Land (SAL).

The Project Area relative to the mapped SAL is summarised in **Table 7**.

Ground-Truthing Biophysical SAL

Due to concerns over the accuracy of SAL Biophysical mapping in the SRLUP, Bulga Coal requested GSSE to undertake a soil sampling program to 'ground-truth' the Biophysical SAL. This soil sampling and analysis program was undertaken on the eastern side of the Biophysical SAL within the Project Area. The sampling program consisted of:

- Literature review,
- Aerial photos, satellite imagery and topographic maps,
- Physical inspection of the soil and vegetation, including soil sampling, and
- Laboratory analysis

A copy of the soil sampling program report is in **Appendix 1**.

The soil sampling program (ground truthing) identified that the Project Area does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical.

Table 7 – Strategic Agricultural Land And Project Area

	Mapped SAL (SRLUP)						
SAL	**Total Mapped SAL (Broke – Fordwich Locality)**	**Project Area (of mapped SAL) (Approx.)**		**Disturbance Footprint (of Project Area mapped SAL) (Approx.)**		**Disturbance Footprint (of mapped SAL Broke–Fordwich locality (Approx.)**	
	ha	**ha**	**%**	**ha**	**%**	**ha**	**%**
Biophysical[#]	662	253	38	11.8	2.8	11.8	0.05
Viticulture Cluster[#]	22 569	421	1.9				
Sub-Total	22 569	421	1.9				
Project Area Outside of SAL	-	289	-	18.5	-	18.5	-
Total	**22 569**	**710**	**-**	**30.3**	**-**	**30.3**	**-**

[#] Biophysical SAL and Viticulture Cluster overlap

Impacts Upon SAL: Mapped vs Ground-Truthed

In total, approximately 421ha of the mapped SAL in the draft SRLUP would be impacted within the Project Area. This comprises 253ha of the mapped SAL – Biophysical and 421ha of the mapped SAL – Viticulture Cluster (Note: These areas overlap within the Project Area). This represents about 38% of the mapped SAL – Biophysical and 1.9% of the mapped SAL – Viticulture Cluster within the mapped SAL categories in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

The Project Area will result in the disturbance (temporary removal from agriculture) of a relatively small area of 30.3ha (4.3% of Project Area) and 11.8ha of mapped SAL in the SRLUP. This in turn represents 2.8% of the mapped SAL in the Project Area or 0.05% of mapped SAL in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

In comparison, the soil sampling program to ground-truth SAL - Bio-physical, has identified that no land should be mapped as SAL - Biophysical within the Project Area. Therefore, any disturbance in this area would not be impacting SAL - Biophysical.

It is considered that the SAL Viticulture Cluster land does meet the criteria for SAL mapping.

Notwithstanding, irrespective of whether mapped SAL or 'ground-truthed', the AIS assessment has identified that a very small portion of agricultural resource (land and water) in the Broke-Fordwich locality will be affected by the proposed Project.

SAL Values and Criteria

The draft SRLUP – Upper Hunter identifies 'strategic agricultural land' (SAL) based on values and criteria as shown in **Table 8**. The values and criteria combine to identify land that has significant value for agriculture or for 'industry clusters' present in the relevant area. The draft Gateway criteria (**Section 7.0**) for strategic agricultural land requires verification as to whether the mapped land meets the relevant criteria for bio-physical SAL or critical industry cluster SAL.

An assessment of the criteria for the mapped SAL relative to the Project Area is shown in **Table 8**.

Table 8 – Strategic Agricultural Land Criteria

Criteria	Locality	Disturbance Footprint
Biophysical Strategic Agricultural Land		
Land that falls under soil fertility classes "high" or "moderately high" under the Draft Inherent General Fertility of NSW (OEH, 2011a); and	The *Draft Inherent Soil Fertility Map – Upper Hunter and New England* (OEH April 2012) shows the land within the Project Area as having Inherent Soil Fertility as :- **(Figure 5)** • 'moderately low' - the majority of the Project Area, • 'moderately high' - coinciding with the 'bio-physical' mapped SAL. Ground-truthing has identified that the land within the Project Area does not meet this criteria.	11.8ha (2.8%) of mapped Biophysical and Viticulture Cluster SAL in the Broke-Fordwich locality (which contains approximately 22 569ha of SAL) is within the Project Area and will be disturbed.
Land capability classes II or III under the Land and Soil Capability (LSC) Mapping of NSW (OEH); and (Note: This is different 'land and soil capability mapping' to that shown in Figure 7.)	Land of capability LSC Class 3 is present in the Project Area and coincides with the mapped Bio-physical SAL. Ground-truthing has identified that the land within the Project Area does not meet this criteria.	Land of capability LSC Class 3 present in the Project Area
Reliable water of suitable quality, characterised by: o land having rainfall of greater than 350 mm per annum (9 out of 10 years); or	Average rainfall is approximately 645mm at Jerry's Plains (BOM 2012) - being the nearest weather station. NA	

Criteria	Locality	Disturbance Footprint
o land within 150 m of the following surface or groundwater resource:	The Project Area or Biophysical SAL is not within 150m of the Wollombi Brook, which is not regulated.	
- a regulated river; or		
- unregulated rivers where there are flows for at least 95% of the time (i.e. 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.	Groundwater suitable for irrigation is also present in the alluvial land adjoining Wollombi Brook. The extent of the alluvial aquifer is shown on **Figure 9.** The Project Area does not extend over the alluvial groundwater aquifer.	
Minimum 20 hectares in area (based on minimum area required for commercial food production).	Within the Project Area the land mapped as 'biophysical SAL' and the revised area as 'ground-truthed' are both greater than 20ha. The area of Biophysical SAL within the Project Area is approx. 253ha, being 38% of the total mapped Biophysical SAL in the locality. Ground-truthing has identified that the land within the Project Area does not meet this criteria.	
Critical Industry Cluster (Viticulture) **Including Broke – Fordwich Geo-Graphic Indicator Sub-Region**		
Industry clusters that meet the following criteria:		
- there is a concentration of enterprises that provides clear development and marketing advantages and is based on an agricultural product.	There is an aggregation of interrelated viticulture and tourist industries in the Broke-Fordwich locality. The factors contributing to this are a combination of heritage, landscape/natural setting, proximity to major population centres and tourist related infrastructure. It is considered that the SAL Viticulture Cluster land does meet the criteria for SAL mapping, though it is unlikely that additional viticultural operations shall establish to the east side of the SAL Viticulture (towards Charlton Rd) due to poorer quality soil and the fact that land is entirely in mine ownership.	
- the productive industries are interrelated.		
- it consists of a unique combination of factors such as location, infrastructure, heritage and natural resources.		
- it is of state, national and/or international importance.	Viticulture in the Hunter and in the Broke – Fordwich area is of local, regional, state and national importance and contributes to the identity of the region and locality.	
- it contributes to the region's identity.		
- it is potentially substantially impacted by coal seam gas or mining proposals.	The underground mine proposal has the potential to impact upon the viticulture cluster in terms of short-term subsidence impacts. Note: 1. Whybrow Beltana No. 1 has already mined beneath the majority of the vineyards in the Project Area. This activity had a total footprint of 1141ha. 22ha of olives and 113ha of vineyards were undermined by Whybrow Beltana No. 1 mining between 2005 and 2008. There has not been any long term impact on the	

Criteria	Locality	Disturbance Footprint
	subsided vineyards from this activity. 2. It is predicted that the impacts from mining of BFN will only have short-term manageable impacts on the overlying vineyards. No surface disturbance is proposed to the vineyards. . *(Note: The Project is for a modification of the existing development consent in an area that has previously been mined.)*	

Source: Table 1 - Draft Strategic Regional Land Use Plan (DP&I, 2012)

The assessment of the SRLUP mapped SAL (Biophysical) and SAL (Critical Industry Cluster (Viticulture) has identified that

- the Biophysical SAL mapped land meets the criteria for SAL mapping due to land capability Class 3 and Inherent Soil Fertility of 'moderately high' being present in the Project Area.
- the locality does meet the criteria for Critical Industry Cluster (Viticulture), though future extension of viticulture to the east are a low possibility.

However, the soil sampling program (ground truthing) identified that the Project Area does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical.

Only a small portion of the SRLUP mapped SAL in the locality will be affected by the proposed Project. In total, approximately 253ha of the SAL – Biophysical and 421ha of the SAL – Viticulture Cluster shall be located above the underground mining operation (Project Area). (Note: These areas overlap). This represents about 38% and 1.9% of land within the mapped SAL categories in the wider Broke-Fordwich locality (which contains approximately 22 569ha of SAL) respectively. Only approximately 11.8ha of the SAL affected will be disturbed, representing about 2.8% of the mapped SAL locally and 0.05% of the mapped SAL in the wider Broke-Fordwich locality.

The Draft SRLUP Gateway Criteria has been assessed in **Section 7.0**.

As discussed at **Section 2.3.2** and shown on **Figure 4b**, the difference between the previously approved BFN underground mine and the current modification proposal is approximately 208ha, located SW of the existing open-cut operations.

Note: The majority of the Project Area has been previously undermined by the Whybrow Beltana No 1 mine and this includes the land now mapped as SAL – Biophysical and Critical Industry Cluster (Viticulture) under the SRLUP.

2.6 Topography

BCC is located adjacent to the Great Dividing Range in the Hunter Valley. The foothills of the Wollemi National Park are located approximately 2.5 km to the west and form the dominant feature of the land surrounding the complex. Steep timbered slopes and rocky outcrops occur on land within the BCC from the south east through to the north-west.

The topography within the Project Area consists of a moderately steep ridge to the west that slopes to level ground that characterises the remainder of this area. The western ridge, which at its highest is over 165m above sea level, separates the alluvial flats surrounding Wollombi Brook from the rest of the Project Area that has an average elevation of around 80m above sea level. Land to the immediate west of the BCC, slopes down to the Wollombi Brook and associated alluvial floodplain. Land to the east of Bulga is gently undulating and is largely cleared for agricultural use, while land to the north has been generally disturbed for other mining operations.

2.7 Vegetation

An analysis of the vegetation present and impacts from mining is not a consideration for the AIS, and a full analysis of the existing 'vegetation' and impacts is detailed in of the Environmental Assessment for the Project.

From an agricultural perspective, the Project Area contains vegetation communities and agricultural commodities as shown in **Table 9**. (Source: Umwelt 2012)

Table 9 – Vegetation Communities Identified Within the Project Area

Vegetation Community	Subsidence Study Area (ha)
Central Hunter Box - Ironbark Woodland	103
Central Hunter Box - Ironbark Grassland	465
Central Hunter Bulloak Forest Regeneration	13
Central Hunter Swamp Oak Forest	2.1
Hunter Valley Weeping Myall Woodland	0.15
Riparian Grassland	3.5
Disturbed	14
Exotic Grassland	31
Olive Grove	21
Landscaping/Screening Areas	16
Rehabilitation	0
Vineyard	38
Waterbodies	2.5
Total	**709.25**

Note: Table 9 includes around 4.3ha of surface disturbance outside of the Project Area as detailed in Table 1.

The major agricultural use of the Project Area is grazing, with small areas of viticulture and olives.

2.8 Water Resources

2.8.1 Surface Water

The relationship of the Project components to local surface water resources is shown in **Figure 9**. The proposed longwall mining area is located within the Wollombi Brook catchment and its tributary Monkey Place Creek. Wollombi Brook catchment has an area of over 2,000 km^2 and drains to the Hunter River approximately 10.5 km west (upstream) of Singleton. These surface water features are generally relied upon by agricultural industries and water licence holders downstream. A number of unnamed ephemeral tributaries of Wollombi Brook and Monkey Place Creek drain the surface area proposed to be undermined. Water quality in Wollombi Brook is generally good with low salinity and neutral pH (Umwelt 2003).

Loders Creek, Nine Mile Creek, (see **Figure 2**) and the minor ephemeral drainages in the Project Area typically have poor quality water, which is alkaline and highly saline, except during high rainfall events (Umwelt 2003). There are a number of licensed surface water extraction points located on Wollombi Brook in the vicinity of the Project Area. These are predominantly used for irrigation, although a large proportion of the allocation is under-utilised.

There are a number of ephemeral drainage lines located above the proposed longwalls, the largest being Drainage Line 1 which is located above the north-eastern ends of the proposed longwalls. Drainage Line 1 flows in a north-westerly direction to where it drains into Wollombi Brook approximately 1.6 km north of the proposed longwalls. The natural gradient of Drainage Line 1 within the Project Area is around 10 mm/m (i.e. 1 %, or 1 in 100).

There are also a number of smaller drainage lines located directly above the proposed longwalls. The drainage lines in the central and north-western parts of the longwall area flow in north-easterly directions to where they drain into Drainage Line 1. The drainage lines in the south-eastern part of the longwall area flow in southerly directions to where they drain into Drainage Line 10. These ephemeral drainage lines have alluvial beds with average natural gradients around 10 mm/m (i.e. 1 %, or 1 in 100).

There are a number of farm dams above the longwalls which have been constructed along the alignments of the drainage lines. The farm dams are typically of earthen construction and have been established by localised cut and fill operations. Nine Mile Creek is the closest watercourse to the proposed power plant and pipeline maintenance facility. However, this surface infrastructure would be setback beyond the 40 m buffer zone.

Surface water impacts are discussed at **Section 3.3.1**. It is not proposed to remove any surface water from agricultural production as part of the modified longwall underground mine

A Private Irrigation Distribution (PID) pipeline provides water to rural properties along Cobcroft Rd, within the Project Area. The pipeline comprises butt welded polyethylene pipes with diameters varying between 50 mm and 160 mm. The PID rising main crosses directly above the south-western ends of the proposed BNLW4 to BNLW6 and a distribution line also crosses directly above the south-western end of BNLW3.

2.8.2 Groundwater

Introduction

Comprehensive groundwater assessment of mining in the Blakefield seam for the approved BFN Underground Mine was undertaken by Mackie Environmental Research (2003) for the 2003 EIS. A key aspect of this assessment was the identification of the extent of important alluvial areas that required consideration in designing the mine layout and the extent of the buffer zone from underground mining required to protect these alluvial areas. The Project does not substantially change the extent of proposed longwall mining layout and does not seek any change to the approved maximum production rate. Mackie Environmental Research remodelled the combined impact of the BUO and BSO SWMP in 2009 and 2012 with the results being consistent with the 2003 groundwater modelling. The BCC includes a rigorous process of monitoring and review of groundwater inflows and water level against 2003 EIS predictions. Additionally, as per the BCC SWMP, a hydrogeological review is conducted by a qualified Hydrogeologist for each successive longwall including the comparison of groundwater inflows and water levels against the EIS predictions.

Given the compliance with the 2003 EIS predictions and the SWMP since 2004 and the lack of a material difference between the approved and proposed mine layout, a supplementary groundwater modelling exercise has not been undertaken.

The following section outlines the existing groundwater regime, potential impacts, and management measures for the Project.

Existing Environment

Two types of groundwater are found within the vicinity of the Project Area: the alluvial aquifer of Wollombi Brook (and to a lesser degree Monkey Place Creek) and the hard rock aquifer associated with the Wittingham and Wollombi Coal Measures. The alluvial aquifer is of variable quality, with poor quality groundwater observed in deeper zones, whilst shallower groundwater is generally fresh to brackish. The alluvial aquifer is of sufficient yield to provide an important water supply for irrigation, stock and domestic purposes. The water held in the coal measures, however, is of poor quality and low yield.

The extent of the alluvial aquifer system in the vicinity of the Project Area has been mapped (refer to **Figure 9**) through analysis of topography, air photo interpretation, geomorphological observations, existing borehole data and targeted exploratory drilling to define the perimeter in areas close to the underground mining area. The mine plan has been developed to maintain a buffer of at least 40 metres from the edge of the alluvium to the 20mm subsidence limit. The limit of alluvium is located 290 metres south-west of BNLW1, at its closest point. The predicted 20mm subsidence contour after extraction of the proposed BNLW1 – BNLW2 is still located around 145m to the alluvium at its closest point.

There are a number of water or monitoring bores within and surrounding the Project Area (refer to **Figure 9**).

The modified BFN Underground Mine would not include mining beneath the alluvial aquifer associated with either of the creek systems.

2.8.3 User Extraction Points

There are a number of water or monitoring bores within the Project Area. There are also a number of private water supply bores and wells located within the vicinity of the Project Area. These are predominantly located within the alluvial aquifer of Wollombi Brook.

2.9 Climate

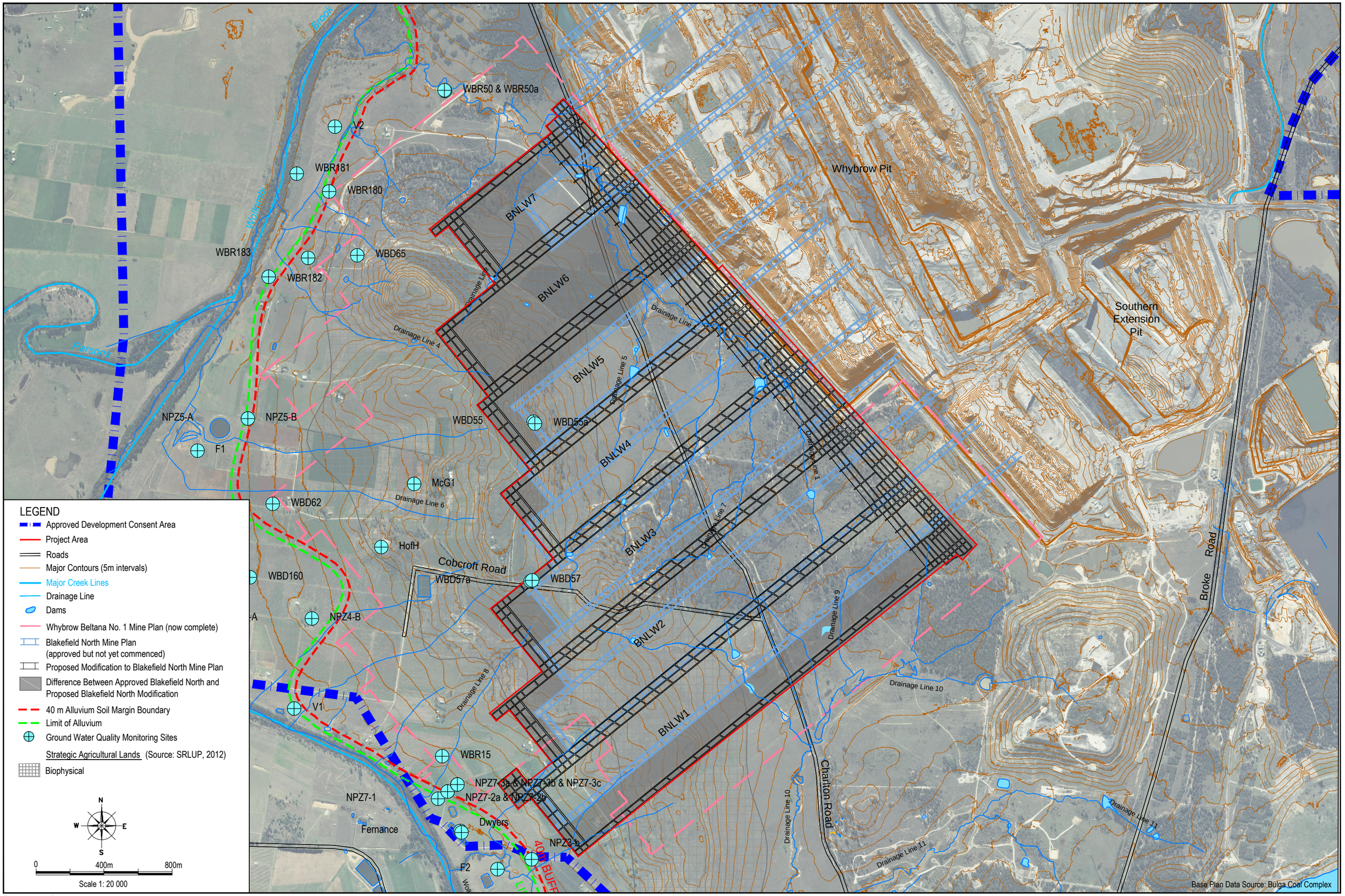
Long-term (125 year) climatic data from the closest Bureau of Meteorology weather station at Jerrys Plains Post Office was sourced (BOM 2012) and this identified that:-

- January is the hottest month with a mean maximum temperature of 31.7ºC;
- July is the coldest month with a mean minimum temperature of 3.8ºC;
- January is the wettest month with an average rainfall of 77.0 mm over 6.4 days;
- August is the driest month with an average rainfall of 36.5 mm over 5.2 days; and
- The average rainfall is 645.4 mm.

Analysis of the windroses, from the Bulga Complex Weather Station, (annual and seasonal from data collected between 15 September 2010 and 14 September 2011) showed

- The most common winds on an annual basis were from the south and northwest with few winds originating from the northeast quadrant;
- Summer winds from the east-southeast dominate with a lesser portion of winds from the south;
- Autumn winds from the south were most common;
- Winter months, winds predominately occur from the northwest with a spread of winds from the southwest quadrant; and
- Spring windrose had a wind distribution similar to the annual windrose with winds originating from the south, northwest and southeast.

The climate in the Region is considered to be favourable to the existing agricultural industries present.



LEGEND

- Approved Development Consent Area
- Project Area
- Roads
- Major Contours (5m intervals)
- Major Creek Lines
- Drainage Line
- Dams
- Whybrow Beltana No. 1 Mine Plan (now complete)
- Blakefield North Mine Plan (approved but not yet commenced)
- Proposed Modification to Blakefield North Mine Plan
- Difference Between Approved Blakefield North and Proposed Blakefield North Modification
- 40 m Alluvium Soil Margin Boundary
- Limit of Alluvium
- Ground Water Quality Monitoring Sites
- Strategic Agricultural Lands (Source: SRLUP, 2012)
- Biophysical

N W E S

0 400m 800m

Scale 1: 20 000

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Bulga AIS
Surface Water Locations and Ground Water Monitoring Sites

FIGURE 9

3.0 ASSESSMENT OF IMPACTS – AGRICULTURAL RESOURCES

Agricultural resources are defined as land upon which agriculture is dependent and the associated water resources which are linked to that land.

3.1 Land Temporarily Removed From Agriculture

The Project consists of approximately 35ha of land to be cleared or disturbed as shown in **Table 10**.

3.1.1 Clearing/Disturbance

Table 10 – Vegetation Communities Within Modification Area (Umwelt 2012)

Vegetation Community	Surface Infrastructure Disturbance Area (ha)[1] (Approx.)	Type Disturbance	Total Vegetation Community Within Subsidence Study Area (ha) (Approx.)
Central Hunter Box - Ironbark Woodland	5.0	pre and post-mining gas wells and access tracks	103
Central Hunter Box - Ironbark Grassland	22	pre and post-mining gas wells, the proposed pipeline maintenance facility, proposed gas drainage plant, proposed power generation plant and access tracks	465
Central Hunter Bulloak Forest Regeneration	0.54	pre and post-mining gas wells and access tracks	13
Central Hunter Swamp Oak Forest	0.38	pre and post-mining gas wells and access tracks	2.1
Hunter Valley Weeping Myall Woodland	0	-	0.15
Riparian Grassland	0.71	pre and post-mining gas wells and associated access tracks	3.5
Disturbed	2.3	gas drainage plant, ventilation fans, SIS drill pads, pre and post-mining gas wells and associated access tracks	14
Exotic Grassland	0.34	pre and post-mining gas wells and associated access tracks	31
Olive Grove	0.42	pre and post-mining gas wells and access tracks	21
Landscaping/Screening	0.5	pre and post-mining gas wells and access tracks	16
Rehabilitation	1.9	Rehabilitation land for the proposed gas drainage plant	0
Vineyard	0.0	pre and post-mining gas wells and access tracks	38
Waterbodies	0	-	2.5
Total	**34.09[2]**		**709.25[2]**

[1] = The final area of woodland communities to be disturbed will likely be lower than that shown as trees and woodland areas will be avoided where possible.

[2] = Table 10 includes around 4.3ha of surface disturbance outside of the Project Area as detailed in Table 1.

The gas drainage systems will involve the clearing or disturbance of approximately 30.3 ha of land that will be temporarily removed from agriculture, as this relates to pre and post mining gas wells, access tracks and electricity infrastructure.

This land will be temporarily removed from potential agricultural use for a period of up to 19 years (2031). Upon completion of post mining activities, this land would be returned to pre-mining land capability Class VI in accordance with the *Bulga Coal Landscape Management Plan*.

It is noted that clearing of vegetation is not necessarily detrimental to agriculture. Clearing of vegetation can contribute to increased agricultural production opportunities due to additional area available for grazing or plantings.

Of the vegetation types listed in **Table 10** only approximately 11.8ha will be disturbed for the Project Area as it relates to mapped SAL. The bulk of this disturbance relates to the construction of pre and post-mining gas wells and access tracks to provide gas drainage above the longwalls.

Table 11 shows the temporary removal of 30.3 ha of vegetation and this is not considered significant to agriculture as this represents 4.3% of the Project Area (710ha). Of the 30.3 ha, up to 0.42 ha will be removed from an existing olive grove owned by BJV, the remainder would predominantly remain available for grazing opportunities. No direct impacts or disturbance to vineyards is proposed.

Table 11 – Surface Disturbance in Project Area

	Area (ha) (Approx.)	**% Project Area**
Project Area	710	100
Total Area to be cleared (Gas wells and access)	29.9	4.2
Olive Grove	0.42	0.06

There are three privately owned vineyards (25.5ha of total 29.4ha within Project Area) which will overlay the proposed longwall mining and in this respect the modification is predominantly the same between the previously approved BFN underground mine and the proposed modification – the areas of difference are shown on **Figures 4 – 9**. These private vineyards will not be directly impacted by mining and viticultural activities may continue. These areas may however, be subject to subsidence from longwall mining. See **Section 3.1.2** and **3.3.1** for discussion on the potential impacts of subsidence. Some private land may require provision of electricity infrastructure to service gas drainage systems. Any such infrastructure would be subject negotiation and agreement with the affected landholders and agricultural activities could continue above/beneath such infrastructure.

Rehabilitation will be undertaken in accordance with the *Bulga Coal Complex Landscape Management Plan*. Rehabilitation consists of repairing shallow depth of cover subsidence impacts with the land being returned to land capability of Class VI.

The Project will impact on vegetation communities and endangered ecological communities habitat. Some of these impacts cannot be minimised or avoided by the Project and offsets will be used to address these remaining or residual impacts. Due to removal of up to 5 hectares of Central Hunter Box – Ironbark Woodland (EEC), a biodiversity offset strategy would be developed in consultation with the NSW OEH to offset this impact. The 5 ha (maximum) of Central Hunter Box – Ironbark Woodland for pre and post-mining gas wells and access tracks that may be removed shall be 'offset' at another location that will be subject to further approval.

Details of the land proposed to comprise part of the offset package are not yet available. At this stage, no assessment of potential impacts on agricultural land contained within the offset package can be undertaken. This assessment will be undertaken when the offset strategy has been finalised. Noting, that

- The area that is to be set aside for biodiversity conservation is likely to have high conservation value and corresponding low agricultural value,
- The SRLUP states (p61) "land set aside for biodiversity offsets should not result in the significant loss or destruction of agricultural resources or industries", and
- A small area of the mine site being disturbed (5ha) is to be offset.

It therefore is considered that the potential nett loss to agriculture from any offset strategy would be relatively minor.

3.1.2 Subsidence Impacts - Land and Soil Capability

The existing land capability and agricultural suitability are described in **Section 2**. The proposed modification will not change the inherent characteristics or capability of the land over the Project Area. (Umwelt 2003 EIS).

The main potential impact underground mining will have on land capability and agricultural suitability is the effect of subsidence following mining. The area subject to subsidence has a similar area (approximately 710ha) to the Project Area, but a slightly different footprint. The subsidence study area (Source: MSEC479 Aug 2012) is shown in **Figure 2.** The Project could result in the subsidence of additional land based on an increased underground mining footprint of approximately 208ha of land compared to the original development consent. However, the majority of subsidence will occur within the footprint of the underground mining longwalls (ie. the Project Area). Noting that the majority of land within the Project Area has already been subject to underground mining within the Beltana No. 1 Underground Mine (Whybrow Seam).

Potential impacts resulting from subsidence include surface cracking (potentially cracks up to 450 mm in width) and increased ponding along otherwise ephemeral drainage lines. Except for a small area of BNLW1 and BNLW2 the surface area has been previously undermined as part of the Beltana No. 1 Underground Mine (Whybrow Seam). Although surface cracking was observed across the Project Area as part of the previous mining operations, there were no observable surface water flow diversions in the drainage lines resulting from the extraction of the longwalls, once remediation of the larger surface cracks had been completed.

A *Subsidence Prediction and Impact Assessment Report – Blakefield North Underground Mine: Longwalls 1 to 7* (MSEC479 Aug 2012) has been prepared as part of the assessment of the impacts of the proposed change to the underground mining operations. The predicted subsidence contours for the proposed Modification of Blakefield North Mining Area are provided in the MSEC479 Aug 2012 report.

This report states:

- Whilst the maximum predicted additional tilts and curvatures, based on the modified layout, are greater than those provided in the Bulga 2003 EIS, the predicted parameters are similar to those previously observed as the result of the extraction of the overlying longwalls in the Whybrow Seam at South Bulga and the Beltana No. 1 Underground Mine;
- The potential impacts resulting from the extraction of the proposed BNLW1 to BNLW7, therefore, are expected to be similar to those previously observed resulting from the Whybrow Seam longwalls;
- That the levels of impact on the natural features and items of surface infrastructure can be managed by the implementation of suitable management strategies;
- BCM has developed management strategies for the natural features and surface infrastructure which have been directly mined beneath by previously extracted Whybrow Seam longwalls at South Bulga and the Beltana No. 1 Underground Mine and by BSLW1 at Blakefield South;
- With the implementation of these management strategies, it is expected that there would be no long term adverse impacts on the natural features and surface infrastructure resulting from the extraction of the proposed longwalls.

Therefore, provided the drainage lines are maintained to minimise the potential for erosion and any adverse changes in slope or surface cracking are remediated by earthworks, the land capability and agricultural suitability should be relatively unaffected by underground mining.

3.1.3 Subsidence Impacts – Vineyards

The land within the Subsidence Area has been generally cleared and has been used for light grazing and viticulture. Three privately-owned vineyards would be undermined by BNLW1, 2 and 3. General grazing land and a very minor portion of a private olive grove would be affected by minor subsidence associated with mining the longwalls.

As part of the 2003 EIS which supported the current DA 376-8-2003 consent, a detailed Viticulture Assessment was undertaken by viticulture expert, Dr Richard Smart, in consultation with affected vignerons. This assessment looked at the potential impacts of subsidence on the vineyards and associated infrastructure (irrigation network, trellises, fencing, etc.). A monitoring program of vineyards proposed to be undermined was also commenced at this time, which continues today. The initial program included an assessment of yield and quality (e.g. pruning weight, bud retention, yield, berry weight, sugar, acidity, pH). The monitoring program was assisted by the analysis of satellite imagery of the vineyards to identify vine vigour across all vineyards and compared against the monitoring results.

The only observable impacts on the vineyards undermined by the Beltana No.1 Underground Mine were a few broken trellis posts and wires. There was no observable impact on vine health as a result of subsidence or any indication in the extensive monitoring data that the subsidence had any impact on vine yield or fruit quality. It should however be noted that there have been three separate claims for compensation from private vineyard owners for reduced tonnages as the result of subsidence. These claims have been settled and the vineyard which was subject to the most substantial claim achieved record yields in the year following the claim. There has never been any claim regarding subsidence impacts on fruit quality.

It is anticipated that the maximum predicted subsidence parameters resulting from the extraction of the proposed BNLW1 to BNLW7, based on the modified layout, would be similar to those previously observed during the previous extraction of the overlying longwalls in the Whybrow Seam at Beltana No. 1 Underground Mine.

BCC already has monitoring and management strategies for the privately owned vineyards which have been directly mined beneath by previously extracted Whybrow Seam longwalls at Beltana No. 1 Underground Mine. Following approval of the Project, the relevant Private Property Management Plans and monitoring programs would be developed in consultation with the property owners. This would include a continuation of the existing monitoring program for vineyards that has been established by the BCC in consultation with vignerons.

3.2 Land Permanently Removed from Agriculture

No land is proposed to be permanently removed from agriculture as a result of the Project.

The proposed modifications to the BUO will result in a small area of permanent plantings being removed from agricultural production, being approximately 0.9 ha:-

- 0.42 ha of Olive Grove for pre and post-mining gas wells and access tracks;
- 0.5 ha of Landscaping/Screening for pre and post-mining gas wells and access tracks.

The loss of this area from permanent plantings is considered negligible at local or regional scale, and the land would still be available for agriculture post-mining.

3.3 Water Use

3.3.1 Surface Water

Existing surface water is discussed at **Section 2.8.** It is not proposed to remove any surface water from agricultural production as part of the Project.

There are no major creeks or streams above the modified longwall panels. The largest watercourse in the vicinity of the proposed longwalls is the Wollombi Brook, which is located approximately 700 metres south-west of BNLW1, at its closest point to the proposed longwalls. The brook is a perennial stream associated with a shallow aquifer, which is incised into the alluvial deposits in the bottom of a valley. The bed of the brook is approximately 5 m below the banks on each side of the brook. The limit of alluvium for the Wollombi Brook and the 40 m buffer zone to the limit of alluvium are shown in **Figure 9**. The limit of alluvium is located 290 m south-west of BNLW1, at its closest point. The 20mm subsidence limit is also located well outside the buffer zone (MSEC479 Aug 2012).

No surface water is captured from the proposed Project Area other than the subsidence ponding or temporary erosion and sediment control associated with rehabilitation or construction activities.

Subsidence Impacts

The ephemeral drainage lines are located across the longwall area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls is provided in Appendix C & D of the Subsidence Assessment (MSEC479 Aug 2012). The drainage lines (**Figure 9**) have shallow incisions into the surface soils and therefore it is unlikely that the drainage lines would experience any significant valley related movements resulting from the extraction of the proposed longwalls. However, the drainage lines would experience ground strains resulting from the extraction.

A comparison of the maximum predicted additional subsidence parameters for the drainage lines resulting from the extraction of BNLW1 to BNLW7, based on the modified layout (with those provided in the 2003 EIS) is provided in the Subsidence Report (MSEC479 Aug 2012). This report indicates that the maximum predicted additional tilt and curvatures, based on the modified layout, would be greater than the maxima predicted based on the EIS Layout. The reason for this is that the predictions provided in the 2003 EIS were based on the longwalls in the Blakefield Seam being offset from those in the Whybrow Seam (i.e. staggered case), which provides flatter subsidence profiles (i.e. smaller tilts and curvatures) than the modified case, which includes some locations where the Blakefield Seam chain pillars are beneath the Whybrow Seam chain pillars (i.e. stacked case). Whilst the maximum predicted additional tilt and curvatures, based on the modified layout, are greater than those predicted based on the 2003 EIS layout, the predicted parameters are based on those previously observed as the result of the previous extraction of the longwalls in the overlying Whybrow Seam at the BFS and Beltana No. 1 underground mines. Furthermore, the predicted total 20 mm subsidence contour, after the extraction of the proposed BNLW1 to BNLW7, is located well outside the buffer zone to the limit of alluvium.

The predicted subsidence and tilts are likely to be of sufficient magnitude to result in minor changes in the surface water flows along the drainage lines. The initial surface levels and predicted final surface levels, after the extraction of the longwalls in the Whybrow and Blakefield Seams, along the alignments of Drainage Line 1 and Drainage Line 5 are shown in Figures 5.1 and 5.2, respectively of the Subsidence Assessment (MSEC479 Aug 2012). These figures indicate that increased likelihood of ponding is predicted to increase directly above the proposed BNLW1 to BNLW7. Increased ponding is likely to have already developed along the drainage lines, resulting from the previous extraction of the longwalls in the overlying Whybrow Seam, and the proposed longwalls are expected to increase the depths and lengths of the existing ponding.

The maximum observed subsidence along the ground monitoring lines, due to the extraction of the overlying Whybrow longwalls, varied between 1600mm and 1900mm. The maximum increased ponding along the drainage lines due to the previous mining in the Whybrow Seam, based on the maximum

observed subsidence and based on the natural grades along the alignments of the drainage lines, is estimated to be in the order of 1.0m to 1.5m.

The additional subsidence along the alignments of the drainage lines, resulting from the extraction of the proposed longwalls in the Blakefield Seam, is estimated to be between 80% and 100% of the extraction height, based on the observations at Blakefield South Mine. The maximum additional ponding along the drainage lines, resulting from the proposed mining in the Blakefield Seam only, therefore, is estimated to be between 1.5m and 2.5m.

It is noted, that the total ponding depth is not the addition of the maxima for the Whybrow and Blakefield Seams, as these occur in differing locations. It is also noted, that the estimated ponding depths are based on a basic assessment of the changes in grade along the alignments of the drainage lines, which does not consider the changes in grade across the alignments of the drainage lines. For example, drainage lines which are oriented at small angles to the longwall sides will have smaller changes in grade along their alignments (i.e. less ponding), but will have greater changes in grade across their alignments.

In this regard a few points should be noted

- Drainage Line 1 and 5 are entirely on mine owned land, not private land.
- Increased subsidence is likely to only occur at three locations along Drainage Line 1 and one location along Drainage Line 5.
- Drainage Line 5 is grazing land and has recently been purchased by the mine.
- Therefore, no ponding along these drainage lines will occur on private 'farming' land.
- The estimates for ponding are based along the centre-line of a drainage line. The depth of ponding does not account for cross-falls or local features.
- The potential surface water ponding behind the longwalls for the proposed mine layout may vary slightly to that of the approval mine layout but the overall impact is predicted to be effectively the same.

The drainage lines have shallow incisions into the natural surface soils and, in some locations, have farm dams constructed within their alignments. It is expected, at the magnitudes of predicted curvatures and strains, that significant fracturing and buckling would occur in the uppermost bedrock beneath the natural surface soils along the drainage lines. Surface cracking in the beds of the drainage lines would be visible at the surface where the depths of the surface soils are relatively shallow. The drainage lines are ephemeral and so water typically flows during, and for periods of time after, rain events. The drainage lines overlying the South Bulga, Beltana No. 1 and BFS underground mines have been undermined where the depths of cover has varied between 40 m and 200 m. Although surface cracking was observed across the mining area, there were no observable surface water flow diversions in the drainage lines, resulting from the extraction of these longwalls, after the remediation of the surface cracks had been completed. Accordingly, it is not anticipated that any significant surface water diversions would result from the extraction of the proposed BNLW1 to BNLW7, after the completion of any necessary remediation of surface cracking. With the implementation of the necessary management strategies, it is expected that there would be no long term adverse impacts on the drainage lines within the Project Area other than localised ponding behind the topographical highs caused by coincident subsidence over some chain pillars.

The farm dams in the Subsidence Area which have been constructed along the alignments of the drainage lines are expected to be impacted by subsidence movements. The maximum predicted subsidence parameters resulting from the extraction of BNLW1-7 based on the modified layout are based on those previously observed during the previous extraction of the overlying longwalls in the Whybrow seam at the Beltana No. 1 and BFS underground mines. There were no adverse impacts observed on the farm dams along drainage lines resulting from the mining of these longwalls.

A Private Irrigation Distribution (PID) pipeline provides water to rural properties along Cobcroft Rd, within the Project Area. The pipeline comprises butt welded polyethylene pipes with diameters varying between 50 mm and 160 mm within the Study Area. The PID rising main crosses directly above the south-western ends of the proposed BNLW4 to BNLW6 and a distribution line also crosses directly above the south-western end of BNLW3.

- The PID pipeline was designed to accommodate mine subsidence movements and was approved by the Mine Subsidence Board in August 2000.
- It has been indicated that butt welded polyethylene sections of the pipeline, such as the rising main and distribution line within the Study Area, could accommodate ground strains greater than 70 mm/m and ground curvatures of 9 metres.
- Based on this, it would be expected that the PID Pipeline would be able to accommodate the predicted additional movements resulting from the extraction of BNLW1 to BNLW7, based on the Modified Layout, without adverse impacts. *(Section 5.6 MSEC479 Aug 2012)*

3.3.2 Groundwater

Groundwater is discussed at **Section 2.8.2.** No additional investigations were deemed necessary due to the comprehensive groundwater modelling conducted for the 2003 EIS and that subsequent monitoring has confirmed the 2003 EIS predictions. In this regard it is relevant to note that the Project:

- Does not substantially change the extent of proposed longwall mining layout;
- Does not seek any change to the approved maximum production rate;
- The longwall modification continues to be physically separated from the alluvial groundwater system;
- No change is proposed to the existing underground mine de-watering program from that already approved. It is not proposed to remove any groundwater from agricultural production as part of the modified longwall underground mine.

Groundwater Quality

Groundwater quality within the hard rock aquifer is typically poor, with electrical conductivity ranging from approximately 2 000 µS/cm to over 10,000 µS/cm (Umwelt 2003). Consistent with currently approved operations, it is unlikely that any measurable improvement in groundwater quality would be observed in the coal measures as a result of the Project. Mackie Environmental Research (2003) identified that a minor improvement in the water quality of the deeper alluvial aquifer may occur due to the reduced input of saline water from the hard rock aquifer. This trend is also relevant for the proposed modified mine layout and is likely to revert back to the current groundwater flow regime as the hard rock aquifer recovers from the cessation of mining. Generally the alluvial groundwater quality is predicted to remain unaffected.

Groundwater Supply

The modified longwall layout for the BFN Underground Mine has been designed to ensure that there is an adequate buffer to protect the Wollombi Brook alluvials (**Figure 9**), consistent with the approved longwall layout. The 40 m buffer zone for the limit of the alluvials lies outside the 20 mm predicted subsidence contour. The limit of alluvium is located approximately 145m south-west of the subsidence study area, at its closest point.

There are groundwater monitoring bores within the Project Area (**Figure 9**) and a number of registered bores within the vicinity. These are generally located within the Wollombi alluvium and are located outside of the predicted 20mm subsidence line. As these bores are located within the alluvial aquifer it is considered very unlikely that they will exhibit any loss of yield due to the lack of any measurable impact on the alluvial aquifer.

3.3.3 Reallocated Water Resources

As discussed in **Section 3.3.1** and **Section 3.3.2**, there is no intention to permanently remove surface or groundwater from agricultural production as part of the proposed modification of the underground longwall mining Project.

3.3.4 Post Mining Water Use

Surface

Subsidence impacts are discussed in **Section 3.3.1**. Accordingly, it is not anticipated that any significant surface water diversions would result from the extraction of the proposed BNLW1 to BNLW7, after the completion of any necessary remediation of surface cracking. With the implementation of the necessary management strategies (which will be included in future Subsidence Management Plans prepared prior to the commencement of mining), it is expected that there would be no long term adverse impacts on the drainage lines within the Project Area. (MSEC479 Aug 2012)

As longwall mining has already been considered and approved as part of the original development consent, it is considered that the proposed modification will not substantially alter the findings of the original surface water investigations.

Groundwater

The likely impacts of the continued underground operations at BUO upon groundwater are –

- Groundwater pressures/water levels within coal measures will re-establish post mining.
- However it is unlikely that pressures will fully recover since cracking within the failure/subsidence zone will generate enhanced bulk permeabilities and connectivities between otherwise isolated strata.
- Loss of pressure (within the coal measures) in the long term will result in a reduced pressure differential between coal measures and the lower lying alluvial resulting in a reduced flux and reduced upward leakage of saline waters to the alluvial lands. Impacts arising from this loss of leakage are judged to be small and generally acceptable.
- On cessation of mining, groundwater levels/pressures within the coal measures will slowly rebound. The period for repressurisation is predicted to exceed 100 years. During this time, areas where downward leakage may have occurred within the alluvial system through pressure reversals, may again reverse and an upward leakage of saline water could be re-established. The salinity of upward leaking water will be similar to current leakage.

(Appendix 7 2003 EIS (Mackie - Hydrological Studies)

As longwall mining has already been considered and approved as part of the original development consent, it is considered that the proposed modification will not substantially alter the findings of the original groundwater investigations.

In the meantime, BUO monitors and mitigates any impacts to groundwater as required.

3.4 Other Risks

3.4.1 Weed management

A minor risk from weeds is possible during disturbance of land for construction, roads and the like. Management of this risk is proposed to be undertaken in accordance with the continued implementation of the BCC *Weed and Pest Management Plan* as part of normal mine management operations.

3.4.2 Biosecurity

No change to operations and underground activities are proposed and therefore the Project is unlikely to represent any greater risk to biosecurity of agricultural resources than currently approved.

3.4.3 Noise and Vibration

No noise impacts from underground operations are predicted to impact upon agricultural enterprises. Some impact is anticipated from construction, particularly drilling for the vertical gas well holes. Mitigation measures are proposed (equipment selection, time of use, acoustic barriers etc) to minimise noise, minimal

impacts upon sensitive receivers is anticipated. Ongoing monitoring and community consultation is also proposed.

3.5 Summary

The Project represents a minor modification of the currently approved (but not commenced) underground mining operation.

A small area of land (30.3ha or 11.8ha mapped SAL) shall be temporarily removed from agriculture comprising 29.9ha for grazing and 0.42ha olives for construction of access roads and gas drainage and the like.

In context, this is a small area and unlikely to have a significant impact upon agricultural production locally or regionally.

The potential impacts to agricultural resources may be from subsidence associated with the modified longwall layout. Impacts of this are unlikely to affect the agricultural capability of the land. Impacts upon drainage lines can be remediated if required/desired in accordance with the relevant Subsidence Management Plan.

4.0 ASSESSMENT OF IMPACTS – SOCIO-ECONOMIC

4.1 Agricultural Enterprises

The Project is expected to have minimal impact upon the existing agricultural enterprises or the agricultural resources of the land within the Project Area as the temporary loss of approximately 30.3ha of agricultural land in total and 11.8ha of land mapped as SAL predominantly affects grazing land.

4.1.1 Land Use Controls

The predominant local planning control is the Singleton LEP 1996 (LEP). The LEP provides for the following development in the 1(a) Rural zone.

> *Development without consent*
>
> *Agriculture, forestry, intensive agriculture, small gravel pits* (i.e. max. 1ha of disturbance for use on Council roads) and *exempt development*.
>
> *Permitted with consent*
>
> Development that is not 'without consent' or 'prohibited'
>
> *Prohibited*
>
> *advertising structures (other than as would be permitted by clause 33 of the Environmental Planning and Assessment Model Provisions 1980 if they applied); boarding-houses; bulk stores; bus depots; business premises; car repair stations; dual occupancy-detached; industries other than offensive or hazardous industries; junk yards; light industries; liquid fuel depots; motor showrooms; residential flat buildings; road transport terminals; shops; warehouses.*

Rural Dwelling/Subdivision Potential: The minimum lot size for a dwelling on 1(a) zoned land is 40ha (Cl. 17 LEP).

The LEP provisions are typical of a rural council environment and provide for a wide range of permissible uses with and without consent in the rural zone. The potential to have a dwelling (subdivision) for each 40 ha may represent a 'viable' holding size for an intensive agricultural activity, but would not be a 'viable' size for dryland or extensive agricultural activities. It is noted that the proposed Singleton Rural Lands Study has recommended an increase in lot size (for a dwelling) to 150 ha in areas predominantly used for grazing.

Therefore the temporary loss/disturbance of 30.3 ha of agricultural land (predominantly grazing) associated with the Project equates to an area less than the minimum prescribed by the Singleton LEP for subdivision of 1(a) Rural land for a dwelling, confirming the minor nature of the impacts upon agricultural land.

4.2 Agricultural Support Services

There are no agricultural support services within the Project Area.

There is however, public and private infrastructure within the Project Area that would contribute to or facilitate agricultural production. The MSEC479 Aug 2012 report identified that

> *A number of natural features and items of surface infrastructure have been identified within or immediately adjacent to the Study Area, including Wollombi Brook and alluvium, drainage lines, natural vegetation, publics roads, the PID* (Private Irrigation Distribution) *pipeline, 11 kV and*

consumer power lines, an optical fibre cable, copper telecommunications cables, fences, farm dams, houses and rural structures, archaeological sites, heritage sites and survey control marks.

Again the dominant risk is from subsidence (See **Section 3**) and will be managed via the relevant Subsidence Management Plan (SMP). No permanent negative impacts are predicted from the underground mining operations.

4.3 Processing and Value Adding Industries

The loss of 0.42 ha of olive grove is not considered significant at local or regional scale and is unlikely to affect any processing industry. Similarly, the loss of 29.9ha grazing land will have a negligible effect on livestock processing through any reduction in stock numbers.

No loss of viticultural plantings is proposed.

4.4 Employment

Due to the very small areas of agricultural land being affected by the Project and that no impact is predicted to the viticulture operations, it is not anticipated that there will be any reduction in employment in agriculture at a local or regional scale.

Any risk to employment in agriculture from the proposed modification, is substantially off-set by providing on-going employment in mining and supporting industries/services.

4.5 Visual Amenity and Landscape Values

As part of the Project, a *Visual Impact Assessment: Blakefield North Undergound Mine Project* was prepared by Terras Landscape Architects (March 2012). This report concluded:

- That the most significant impact would arise from the construction of gas drainage wells and associated roads and services within pastures located west of Charlton Road over a nine year period;
- The use of good siting techniques and the establishment of short-term screen planting along Charlton Road would assist in reducing the visual impact;
- The gas drainage plant and power generation plant would produce only a low visual impact on their surroundings in spite of having the highest visibility arising from their proximity to Broke Road and overall size;
- The night-time glow created by the flares of these elements would have a minor impact and would merely augment the spill lighting emanating from other existing mining structures;
- That tree and shrub planting be provided along the roadside along Broke Road where it may be possible to view components of the gas plant and power plant;
- The SIS well/drill pad (located beyond the longwall panel) and powerlines would have a minor impact during the construction phase due to siting and scale of development.
- The ventilation fans shafts and pipeline maintenance facility would not be seen externally by the community and have been sited in severely degraded visual environments.
- That the proposed gas drainage infrastructure would produce a low to insignificant visual impact on the local visual environment either as individual elements or as a collective group in the long term. These impacts could be readily addressed with appropriate siting and the use of screen planting in selected locations; and
- Some short-term impacts such as the installation of gas drainage wells west of Charlton Road could not be fully mitigated and would have to be accepted for the duration of mining following which the areas would have been returned to their current pre-mining condition.

On that basis, subject to appropriate mitigation strategies being implemented in affected areas there will be minimal negative impact upon agricultural enterprises or associated tourist development reliant on visual or landscape values in the locality and region.

4.6 Tourism Infrastructure

Viticulture is a significant tourism industry in the Hunter Valley. The vineyards of the Hunter Valley are primarily located between Broke and Pokolbin, to the south. This area is a popular tourist destination with accommodation options set amongst vineyards, which overlook the scenic Broken Back Range, west of Wollombi Brook.

The vineyards offer a range of tourist opportunities for visitors, including vineyard tours, dining, wine tasting and sales, overnight accommodation and food and wine festivals.

In the immediate Broke – Fordwich locality, there are

- 15 cellar door premises;
- 34 tourist accommodation options;
- 6 food premises;
- 6 tour and transfer services; and
- 4 tourist related retail outlets.

(Source: http://www.brokefordwich.com.au accessed 17/5/2012)

Public road infrastructure provides access to the tourist services. The Project will not affect public roads to the point where they are not trafficable. Minor short term impacts from subsidence (which would be rehabilitated) may be expected to Charlton and Cobcroft Roads. Charlton Road has been undermined previously on eleven occasions with no detrimental impact to agricultural activities or associated tourism.

There are no tourism operations within the Project Area, but three privately owned vineyards would be undermined by the Project. All cellar door and tourist facilities in the Broke to Bulga area are located either south of Broke, along Milbrodale Rd or Inlet Road in Bulga. Charlton Road is not considered a tourist destination in the local area.

As the Project will not affect existing tourism infrastructure and have minimal impact upon the visual and landscape qualities of the locality and region (subject to mitigation strategies), it is considered that there will be no detrimental impact upon agricultural enterprises reliant on such tourism, resulting from the Project.

4.7 Summary

In summary, the Project is not expected to have any significant negative impact upon the socio-economic fabric of the locality or region, subject to the appropriate mitigation strategies being implemented.

5.0 STAKEHOLDER CONSULTATION

5.1 Consultation Undertaken to Date

Consultation has been undertaken and included in the EA. In summary consultation has occurred with:

- NSW Government authorities;
- Singleton Council;
- Staff and management of Xstrata and Bulga Coal Complex (BCC), and
- Adjoining mines.

In addition to the above, extensive community consultation has occurred with the local community via:

- Community Consultative Committee;
- Newsletters, advertisements and website;
- Direct consultation (face to face) with adjoining landowners and community members;
- Local Aboriginal groups; and
- Awareness/consultation at "Community Barbecue Program" and the "Broke Village Fair".

5.2 Identification of Issues to be Addressed

Government agencies required issues identified in the PEA to be addressed. The DP & I requested the preparation of this AIS as a supplementary requirement of the DGRs.

The main issues raised by the community related to "*surface disturbance and the visual impact of gas drainage infrastructure"*.

These issues have been addressed as part of the EA for the Project and within this AIS.

5.3 Outcomes and Further Consultation Commitments

Additional consultation with government agencies, adjoining landholders and other stakeholder groups is envisaged as part of the formal exhibition of the Project EA. In addition, regular and on-going consultation occurs as part of the mine operations, providing opportunity for the community and landholders affected by the mining operations to provide feedback to mine management.

This would include preparation of Private Property Management Plans (PPMPs) for each private property within the Project Area. These PPMPs would be prepared in consultation with each property owner.

6.0 MITIGATION MEASURES

6.1 Review of Project Design

The current Project represents a modification of the longwall layout for the Blakefield North Underground Mine, from that currently approved.

The area of difference is approximately 208ha, representing an increase in land subject to underground mining SW of the existing open-cut operations.

The Project design has been modified to avoid and mitigate adverse environmental, socio-economic (including agricultural resources) and visual impacts. The resulting proposal has minimised the potential negative impacts upon agriculture and associated tourism dependent industries to a level which is relatively minor.

6.2 Proposed Monitoring of Impacts

The BCC operates a comprehensive environmental management system. This includes a wide range of environmental management plans and procedures which have been developed by BCC in accordance with conditions of DA376-8-2003 (as amended), mining lease conditions, the Environmental Protection Licence (EPL) and the Xstrata Corporate Environmental Management System and Policy.

This system includes water, noise, air quality management, visual mitigation, land rehabilitation, and subsidence remediation. These plans are updated on a regular basis and are backed by an environmental monitoring network including meteorological, air quality, water quality, noise and subsidence monitoring. The existing environmental management plans and systems currently utilised at the BCC will be amended, as required, to incorporate the proposed modifications and the relevant recommendations of the EA and this AIS.

6.3 Water Mitigation Management Plan

No change is proposed to current water management plans as a result of the Project. As discussed in Section 3 the impact from subsidence on the drainage lines present within the Project Area will be managed via the relevant SMP.

6.3.1 Mitigation Measures

In accordance with the current development consent, BCM has a comprehensive *Site Water Management Plan* (*SWMP)*, including a groundwater monitoring program, and groundwater response plan. The measures outlined in this management plan have been determined in consultation with DP&I and NOW and would apply to the BFN operations. Additionally, a *Wollombi Brook Groundwater Contingency Plan* has been approved by the DP&I as part of the BFS Subsidence Management Plan process. This would be reviewed and updated as part of the BFN Subsidence Management Plan process.

The existing BCC groundwater monitoring program would be maintained throughout the life of the Project. BCC currently monitors 46 locations (comprising piezometers and groundwater bores - see **Figure 9**), every two months for depth to water, odour, temperature, pH, EC, turbidity and colour. The effectiveness of this monitoring network is reviewed annually and updated as required. Monitoring results would continue to be reported annually in the AEMR.

Should the above monitoring reveal that there is a reduction in groundwater level or water quality in a bore on neighbouring property as a result of mining, then BCC would undertake the mitigation measures outlined in the *SWMP*. Such measures may include rehabilitation of the bore/well supply by deepening or

replacement of supply, whichever is considered the most appropriate course of action, in consultation with the landowner.

6.3.2 Impacts on Downstream Users

Surface remediation activities would be undertaken periodically during the life of the Project. Such works have the potential to generate short term localised water quality impacts downstream. Water management measures to minimise potential water quality impacts would continue to be undertaken in accordance with the *BCC SWMP* and *Erosion and Sediment Control Plan*.

Construction of the proposed surface infrastructure and associated surface water runoff has the potential to impact on water quality in Wollombi Brook and Nine Mile Creek. However, implementation of the existing water management and sediment/erosion control systems at the BCC would minimise the potential for the Project to contribute to adverse water quality impacts on these creek systems.

6.3.3 Surface Water Management, Monitoring and Reporting

The BCC *SWMP* would be applied to all operations in the Project Area. This management plan includes a surface water monitoring program and surface water response plan. Current development consent conditions require that the site water balance is reviewed each year against the predictions made in the 2003 EIS and reported in the AEMR. A *Sediment and Erosion Control Plan* (Consent Condition 19) is also in place to control all construction activities outside the 'dirty water' management system. The existing BCC surface water monitoring program would be maintained throughout the life of the Project. Nine surface water locations are currently monitored monthly for pH, EC, TSS and depth. Monitoring results would continue to be reported annually in the AEMR.

All drainage lines to be undermined would be monitored as part of the subsidence monitoring program. Remediation of areas subject to ponding, scouring and cracking would be undertaken as required. After the completion of mining, earthworks would be required to establish the natural gradient along the drainage lines. Alternatively, if the additional ponding caused by mining was considered desirable by local farmers, the beds of the drainage lines could be reinforced to prevent scouring, and to provide additional dam walls to those which already exist along the drainage lines.

Construction of the majority of surface infrastructure would predominantly take place on land already disturbed by the BSO and BUO mining activities. Erosion and sediment control in these areas would be managed in accordance with the existing environmental management systems for the BCC. A range of mitigation measures would be implemented throughout the construction period to control surface runoff, erosion and sedimentation from the land disturbance areas. These measures would include:

- Erosion and sediment controls would be incorporated into the final site layout design plans and installed prior to construction commencing;
- All activities with the Project Area would predominantly be contained within existing or previously disturbed areas;
- Ongoing monitoring and maintenance of the erosion and sediment controls would be undertaken; and
- Disturbed areas would be rehabilitated promptly upon completion of construction.

In summary, it is considered that the cumulative impact of surface works associated with the Project would not have significant off site hydrological or water quality effects. During operation of the Project, surface drainage would be adequately managed through implementation and continual improvement of the existing water managements systems.

6.4 Trigger Response and Rehabilitation Planning

Rehabilitation of the BCC is undertaken in accordance with the *Bulga Coal Complex Landscape Management Plan*. Rehabilitation consists of repairing shallow depth of cover subsidence impacts with the land being returned to agricultural land capability of Class VI or better. Due to the underground nature of

the operation, surface disturbance and the need for rehabilitation (particularly revegetation) is relatively minor compared to open cut mines. Areas requiring rehabilitation throughout the life of the mine currently include:

- Subsidence crack remediation;
- Landscaping relevant areas within the infrastructure site and other surface facilities;
- Screening key areas of operations with vegetation and bunding;
- Limiting the number of and screening reject disposal areas; and
- Maintenance of rehabilitated areas.

Whilst the progressive rehabilitation requirements are generally minimal, BCC continues to undertake specific rehabilitation projects as mining progresses. For example, any area subject to mine induced subsidence is surveyed and monitored during coal extraction. Where substantial cracking occurs, or damage to public infrastructure occurs, BCC undertake necessary remedial works in conjunction with the Mine Subsidence Board as applicable.

Visual impacts of the BCC are minimised in accordance with the *Bulga Coal Complex Landscape Management Plan* and the *Bulga Complex Lighting Management Plan*. Visual mitigation is achieved through the use of bunding and tree planting along public roads and the selective placement of facilities and lighting. Personnel and materials infrastructure is placed below ground level wherever possible, to reduce the impact of light on surrounding residences and road users. New buildings and infrastructure are designed to be aesthetically pleasing in colour and to provide minimal visual impact.

7.0 DRAFT GATEWAY CRITERIA

As detailed in **Section 1.3.2** the Draft SRLUP contains criteria for assessment/review with a view to being considered by a Gateway Panel (yet to be established). An assessment of the criteria is shown in **Table 12**.

Table 12 – Assessment of Project Against Draft Gateway Criteria

Draft Gateway Criteria		
Value	**Criteria**	**Assessment**
Site Verification	1. Whether the applicant's Gateway Certificate Application demonstrates that the mapped land does not meet the criteria for biophysical strategic agricultural land and/or the critical industry cluster (note: as the maps that identify strategic agricultural land are regional in scale, the applicant would require at the Gateway stage to verify that the project site does meet the criteria of the relevant category/s of strategic agricultural land).	An assessment of the SAL mapping is shown in **Section 2.5.3** and **Table 8**. A soil sampling program (ground-truthing) identified that land within the Project Area, mapped as "Bio-physical SAL" in the SRLUP does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical. It is considered that the land mapped as "Viticulture – Critical Industry Cluster SAL" in the SRLUP does meet the relevant criteria, but the likelihood of additional viticulture within the Project Area is minimal due to low soil fertility and that the land is in mine ownership.
Biophysical Strategic Agricultural Land	2. Whether the proposal would significantly reduce the agricultural productivity of the land based on a consideration of: (a) Impacts on the land through surface area disturbance and subsidence;	The area that is different from the existing approved underground mine is an increase of approximately 208ha, SW of the existing open-cut operations. The mapped SAL area proposed to be disturbed is approximately 11.8ha and will be rehabilitated to a minimum of Class VI land capability. The area subject to subsidence (subsidence study area) is approximately 710ha, but with a slightly different footprint to the Project Area, which includes land that is not SAL. The subsidence report has identified that the impacts can be managed and mitigated if required.
	(b) Impacts on: (i) soil fertility (ii) rooting depth, or (iii) soil profile materials and thicknesses;	Subsidence is not expected to have any impact upon soil fertility, rooting depth or soil profile. The impacts from clearing, roads, drilling pads and gas drainage vents/wells are relatively minor. At the conclusion of mining these areas shall be rehabilitated and made available for agriculture. The vast majority of the Project Area will not involve surface soil disturbance.
	(c) Increases in land surface micro-relief or soil salinity, or significant changes to soil pH, and	The vast majority of the Project Area will not involve surface soil disturbance or changes to the composition of the soil structure. Subsidence is expected to impact upon the finished ground levels above the longwall mining blocks. The subsidence report has identified that subsidence can be managed and mitigated if required.

Draft Gateway Criteria		
Value	**Criteria**	**Assessment**
	(d) Impacts on Highly Productive Groundwater, including the provisions of the Aquifer Interference Policy and the advice of the Minister for Primary Industries (note that the Minister for Primary Industries will be required take into account the advice of the Commonwealth Independent Expert Scientific Committee in providing advice at this stage).	Two types of groundwater are found within the vicinity of the modification area: the alluvial aquifer of Wollombi Brook (and to a lesser degree Monkey Place Creek) and the hard rock aquifer associated with the Wittingham and Wollombi Coal Measures. The alluvial aquifer is of sufficient yield to provide an important water supply for irrigation, stock and domestic purposes. The water held in the coal measures, however, is of poor quality and low yield. The modified BFN Underground Mine would not include mining beneath the alluvial aquifer associated with either of these creek systems. The extent of the alluvial aquifer system in the vicinity of the Project Areas has been mapped (refer to **Figure 9**) through analysis of topography, air photo interpretation, geomorphological observations, existing borehole data and targeted exploratory drilling to define the perimeter in areas close to the underground mining area. The mine plan has been developed to maintain a buffer of at least 40 metres from the edge of the alluvium to the zero subsidence limit. The limit of alluvium is located approximately 145m from the 'subsidence study area' at its closest point. Groundwater impacts are discussed at **Section 3** and no additional investigations were deemed necessary, other than that originally identified in the 2003 EIA. The BCC includes a rigorous process of monitoring and review of groundwater inflows and water level against 2003 EIS predictions. Additionally, as per the BCC SWMP, a hydrogeological review is conducted by a qualified Hydrogeologist for each successive longwall including the comparison of groundwater inflows and water levels against the EIS predictions. Given the compliance with the 2003 EIS predictions and the SWMP since 2004 and the lack of a material difference between the approved and proposed mine layout, a supplementary groundwater modelling exercise has not been undertaken. It is not proposed to remove any groundwater from agricultural production as part of the modified longwall underground mine. There is no proposal to alter mine dewatering from that currently approved for the existing Blakefield Underground Mine.
Critical Industry Clusters	3. Whether the proposal would lead to significant impacts on the critical industry cluster through: (a) surface area disturbance,	The level of surface disturbance for clearing is approximately 11.8ha (across both the mapped biophysical and viticulture SAL) which is 0.05% of the mapped SAL in the Broke-Fordwich locality (which contains approximately 22 569ha of SAL). The existing vineyards within the Project Area will not be disturbed at surface level. The majority of the Project Area is not used for viticulture. The main potential for surface disturbance is via the construction of access roads, pipelines, drill pads and gas drainage infrastructure, which is approximately 30.3ha in total. Land subject to disturbance will be rehabilitated to Class VI land capability. (ie. suitable for grazing)
	(b) subsidence,	The subsidence impact has been assessed at **Section 3**. The subsidence report has identified that impacts from the proposal can be managed and mitigated if required.

Draft Gateway Criteria		
Value	**Criteria**	**Assessment**
	(c) reduced access to agricultural resources,	The proposed modification does not propose any significant reduction in access to agricultural resources. The mine layout/operation has been designed to minimise the impacts upon agriculture, particularly those activities held in private ownership. The level of potential impact is considered minor. The area of surface disturbance is 30.3ha in total and approximately 11.8ha of SAL in the Project Area. Once rehabilitated it is expected that 30.3ha would be returned to agricultural production. No long-term impact to surface or groundwater is proposed with the current proposal.
	(d) reduced access to support services and infrastructure,	The proposed modification does not propose any reduction in access to agricultural support resources or infrastructure.
	(e) reduced access to transport routes, or	The proposed modification will not reduce access to any transport route. Subsidence may impact upon public roads and any impact will be managed/remediated in accordance with the relevant Subsidence Management Plan (SMP).
	(f) loss of scenic and landscape values.	Minimal negative impact upon visual or landscape values in the locality and region is anticipated subject to appropriate mitigation strategies being implemented in affected areas.
Cost Benefit Consideration	4. Whether the proposal would be in the public interest through a cost benefit analysis undertaken in accordance with the Government's published cost benefit methodology.	No 'cost benefit methodology' has been published for application. The estimated potential of agricultural production from within the Project Area is approximately $234 000 per year, with the majority of that income from vineyards which will not be directly impacted by the Project. No land is proposed to be removed from agriculture in the long term. Notwithstanding, the impacts from the proposed modification of the approved BFN are considered to have a positive cost benefit and is in the public interest as:- • Underground mining has already been approved and undertaken in the Project Area (this application for a modification and assessment merely relates to a minor variation to an existing approved (but not developed) longwall mining layout), and • The impacts to agricultural resources, including employment is considered to be very minor, and • The Project Area and surrounds are already developed for mining (surface and underground) and the mining of the known resource at this location will reduce the need to source additional coal resource at an alternate location, make efficient use of existing infrastructure and resources and reduce cumulative impacts, and • Employment and investment security will be provided for the existing operations at BUO.
Consultation	5. The consideration of: a) any submissions received from relevant agencies, council(s) and the community, and	Government agencies required issues identified in the PEA to be addressed. The DP & I requested the preparation of this AIS as a supplementary requirement of the DGRs. The main issues raised by the community have been addressed In the EA and relate to "surface disturbance and the visual impact of gas drainage infrastructure". These issues have been addressed as part of the EA for the Project/Modification and within this AIS.
	b) any advice received from the Commonwealth Independent Expert Scientific Committee.	None received. Additional consultation possible during public exhibition of the EA for the Project.

(Source: SRLUP DP&I 2012)

The Project Area will result in the disturbance (temporary removal from agriculture) of a relatively small area of 30.3ha (4.3% of Project Area) and 11.8ha of mapped SAL in the SRLUP. This in turn represents 2.8% of the SAL in the Project Area or represents 0.05% of mapped SAL in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL). However, the soil sampling program (ground truthing) identified that the Project Area does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical. Notwithstanding, assessment of the Project against the criteria has revealed that subject to the implementation of some management and mitigation strategies, particularly relating to visual/landscaping and subsidence management, there are no anticipated significant impacts upon the agricultural resources of the locality or the region.

8.0 CONCLUSION

The proposed modification of the approved Blakefield North Underground Mine represents a minor variation from the mine approved pursuant to Development Consent DA 376-8-2003. The area of difference is approximately 208ha, representing an increase in land subject to underground mining South – West of the existing open-cut operations.

The AIS has identified that there is land within the Project Area that is mapped as Strategic Agricultural Land (SAL), both Biophysical SAL and Critical Industry Cluster (Viticulture) SAL. However, due to concerns about the accuracy of the Biophysical SAL, a soil sampling program was undertaken to 'ground truth' the eastern side of the mapped Biophysical SAL. This sampling program revealed that the Project Area does not contain soil of land capability or soil fertility that warrants designation as Strategic Agricultural Land – Biophysical.

Notwithstanding, in total, approximately 421ha of the mapped SAL in the draft SRLUP would be impacted within the Project Area. This comprises 253ha of the mapped SAL – Biophysical and 421ha of the mapped SAL – Viticulture Cluster (Note: These areas overlap within the Project Area). This represents about 38% of the mapped SAL – Biophysical and 1.9% of the mapped SAL – Viticulture Cluster within the mapped SAL categories in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

The Project Area will result in the disturbance (temporary removal from agriculture) of a relatively small area of 30.3ha (4.3% of Project Area) and 11.8ha of mapped SAL in the SRLUP. This in turn represents 2.8% of the SAL in the Project Area or 0.05% of mapped SAL in the wider Broke-Fordwich Region (which contains approximately 22 569ha of SAL).

It is considered that the SAL Viticulture Cluster land does meet the criteria for SAL mapping, though it is unlikely that additional viticultural operations shall establish to the east side of the SAL Viticulture (towards Charlton Rd) due to poorer quality soil and that the land is in mine ownership.

Notwithstanding, irrespective of whether mapped SAL or 'ground-truthed', the AIS assessment has identified that a very small portion of agricultural resources or SAL in the Broke-Fordwich locality will be affected by the proposed Project.

The land affected by the Project Area amounts to 710ha. Of this 30.3 ha (4.3%) of the Project Area will be removed from agriculture temporarily for access roads and gas drainage. This land will be returned to agricultural production upon completion of mining and rehabilitation as agricultural land capability Class VI.

The agricultural land within the Project Area is estimated to have a potential agricultural production value of up to approximately $234 000 per year, with approximately $62 650 per year potentially available from private land, the remainder in mine ownership. However not all land in the Project Area is actively used for agriculture. The number of persons employed by these operations is difficult to quantify. However, as the Project will not impact upon the agricultural production of any private property there is no change expected to the production value or employment in agriculture.

In terms of the direct impacts from the Project, potential impacts may arise from visual/landscape impacts and subsidence. Management and mitigation strategies are proposed which should ensure these potential impacts will not have a long term impact upon the agricultural or tourist related operations in the locality. No impacts are expected to groundwater systems and minor impacts to ephemeral drainage lines in the Project Area may occur due to subsidence. Mitigation and management strategies are proposed if this occurs.

It is considered that the proposed modification of the Blakefield North Underground Mine shall not have a significant detrimental impact upon the agricultural resources or mapped Strategic Agricultural Land (SAL) of the locality or region.

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APPENDIX 1

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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Our Ref:- Lt_XCN06-050_SAL Assessment_v1_20120720

20th July 2012

Ralph Northey
Environment and Community Manager
Bulga Coal Complex
PMB 8 (567 Broke Road)
Singleton NSW 2330

Sent Via: Email Transmission

Dear Ralph,

RE: STRATEGIC AGRICULTURAL LAND – BIOPHYSICAL ASSESSMENT: BULGA MODIFICATION

Proponent: Bulga Coal Management Pty Ltd

GSS Environmental (GSSE) was engaged by Bulga Coal Management Pty Ltd (BCM) on behalf of Bulga Joint Venture (BJV) to undertake a Strategic Agricultural Land – Biophysical assessment for the Bulga Underground Operations (BUO) modification Project (the Project).

BACKGROUND

The Project is a modification to the approved Blakefield North Mine located approximately 12 kilometres (km) south-west of Singleton, in the Upper Hunter Valley of New South Wales (NSW). BCM is seeking to modify Development Consent DA 376-8-2003 pursuant to Section 75W of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) to allow for a revised longwall underground mine layout and associated infrastructure. The proposed Project modification area (Project Area) is approximately 710 ha (**Figure 1**).

The draft Strategic Regional Land Use Plan (SRLUP) for the Upper Hunter (DP&I, 2012) has 253 hectares (ha) of land within the Project Area mapped as being "SAL - Biophysical". According to the draft SRLUP, there are four major criteria that are required to be met for land to be designated as "Strategic Agricultural Land - Biophysical". The two criteria relevant to this Assessment are:

- land to fall under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH, 2011a); and
- land to be classified as land capability classes II or III under the Land and Soil Capability Mapping of NSW (OEH).

GSSE was commissioned by BCM to undertake an assessment to 'ground truth' the mapped SAL-Biophysical in the Project Area according to Soil Fertility and Land Capability characteristics. The area under assessment is termed the Study Area and is 253 ha (**Figure 1**).

Ref: **Figure 1**

Title:

Site Plan

Project: Bulga Modification

Client:

Bulga Coal
Management PTY LTD

Legend:

- Sites
- Sites
- Study Area
- Project Area
- SAL Biophysical

Elevation (m)

- 270 - 310
- 230 - 270
- 190 - 230
- 150 - 190
- 110 - 150
- 70 - 110
- 30 - 70
- -10 - 30
- -50 - -10

Source:

This map contains the Bing Maps aerial imagery web mapping service, which provides worldwide orthographic aerial and satellite imagery. Coverage varies by region.
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Drawing No: XCN06-050_Figure1_SitePlan Final

Date: 20/07/2012 Drawing size: A4

Drawn by: NT Reviewed by: AC

Scale: 1:15,000

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ASSESSMENT APPROACH

Background Reference Information

An initial soil map was developed using the resources and techniques listed below.

- Aerial photos, satellite imagery and topographic maps were used to provide detailed analysis of the landscape and mapping of features expected to be related to the distribution of soils.
- Existing literature on the area which included the *Soil Landscapes of the Singleton 1:250 000 Sheet* (Lawrie & Kovac, 1991) and the *Bulga Coal Continued Underground Operations Environmental Impact Statement Volume 1* (Unwelt, 2003).
- Following production of a base soils map, surface soil exposures throughout the survey area were visually assessed to verify soil units, delineate soil unit boundaries and determine preferred locations for targeted subsurface investigations of the proposed Study Area.

Survey Observations

A site inspection of the Study Area was undertaken in June 2012 by GSSE personnel to (a) determine Rural Land Capability classifications, and (b) collect topsoil samples for fertility analysis. Field survey observations comprised of 18 detailed soil profile observations (also referred to as soil cores) and 30 mapping observations. Soil profiles were exposed by hand auguring to a depth of approximately 1 m.

Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* soil classification procedures (NCST, 2009) and *Australian Soil Classification* (Isbell, 1996). Mapping observations used existing surface exposures located on track cuttings, gullies and creek banks as well as small shovel excavated holes to expose the subsoil. This assessment included parameters as detailed in **Table 1**. **Figure 1** shows the observation locations.

Table 1: Detailed Soil Profile Description Parameters

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

Soil Laboratory Assessment

The topsoil samples (0-10 cm) from 18 soil cores and 1 soil mapping observation were sent to the ALS Environmental Division (Brisbane Laboratory) for analysis. All samples were laboratory tested for the parameters in **Table 2**; the accompanying certificates of analysis are provided in **Attachment A**. The guide *Interpreting Soil Test Results* (Hazelton & Murphy, 2007) was used to interpret soil test results.

Table 2: Laboratory Soil Fertility Analysis Parameters

Parameter	
Soil reaction (pH) (1:5, soil: water suspension)	Nitrite plus Nitrate as N (NOx) by Discrete Analyser
Electrical conductivity (EC) (1:5, soil: water suspension)	Total Nitrogen as N (TKN + NOx)
Cation exchange capacity (CEC) and exchangeable cations	Total Sulfur as S by LECO
Total Organic Carbon (TOC)	Fluoride Extractable Phosphorus (Bray)

SAL Assessment

The SAL assessment compares the land capability and fertility results to determine if the SAL-biophysical criteria, as specified below, are met in the Study Area:

- land to fall under soil fertility classes 'high' or 'moderately high' under the *Draft Inherent General Fertility of NSW* (OEH, 2011a); and
- land to be classified as land capability classes II or III under the *Land and Soil Capability Mapping of NSW* (OEH).

Presently, physical and or chemical parameters defining 'high' or 'moderately high' soil fertility is not available. In lieu of this, GSSE received advice from OEH that total CEC can be used to assess soil fertility. Total CEC is interpreted using the guide *Interpreting Soil Test Results* (Hazelton & Murphy, 2007); the relevant interpretation is reproduced in **Table 3**.

Table 3: Laboratory Soil Fertility Analysis Parameters

Total CEC cmol(+)/kg	Fertility Rating
<6	Very low
6 – 12	Low
12 – 25	Moderate
25 – 40	High
>40	Very High

The draft SRLUP for the Upper Hunter describes the land capability system as the 'Land and Soil Capability Mapping of NSW'. Presently, a description that defines each class in this system is not available. In lieu of this, the guideline Rural *Land Capability guideline Systems Used to Classify Rural Lands in New South Wales* (Cunningham et al., 1988) has been used to determine Rural Land Capability Classes within the Study Area. This guideline is approved by the *NSW Office of Environment and Heritage* (OEH) (former Soil Conservation Service) and classifies the land on its potential for sustainable agricultural use if developed. This classification includes three broad types of land use, being:

- suitable for cultivation (cropping land; classes I–III);
- suitable for grazing (classes IV–VI); and
- not suitable for rural production (classes VII–VIII).

ASSESSMENT RESULTS

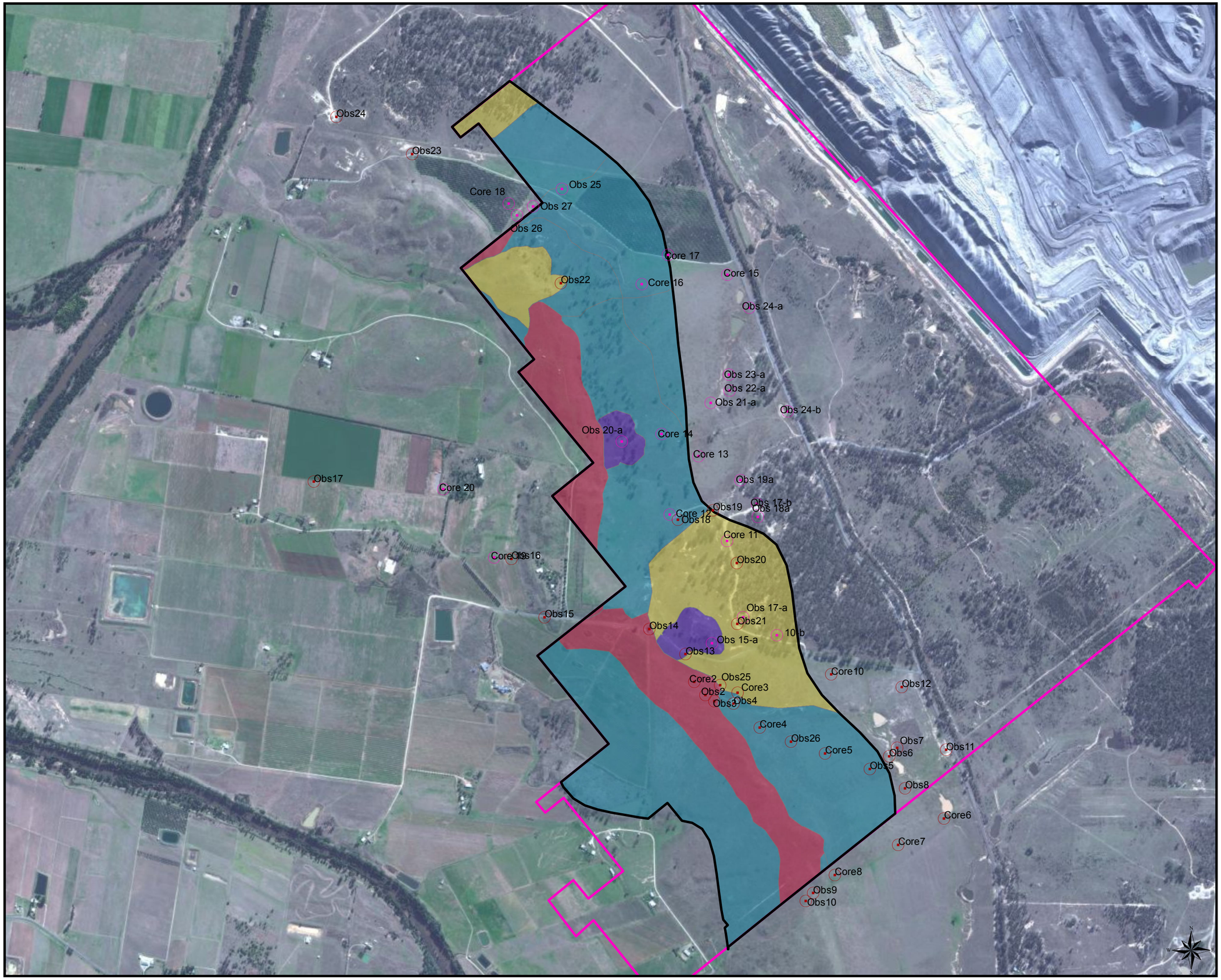
The Study Area contains seven main soil types: (1) Brown Chromosol; (2) Yellow Chromosol/Sodosol; (3) Dark Brown Dermosol; (4) Dark Reddish-Brown Chromosol; (5) Yellowish-Red Chromosol; (6) Dull Reddish Brown Chromosol; and (7) Rudosols. These soil types are listed in **Table 3** and **Table 4** provides a summary of their key fertility attributes. **Attachment B** contains a full summary of the analysed laboratory results. For each of these soil types, **Figure 2** displays their Rural Land Capability Classification.

Table 3: Soil Survey: Summary

Soil Type	Australian Soil Classification: Name	Great Soil Group: Name	Area
#			ha
1-1	Brown Chromosol; shallow	Brown Podzolic Soils	28
1-2	Brown Chromosol; deep		
2-1	Shallow Yellowish-Brown Chromosol/Tenosol	Lithosol	49
2-2	Yellowish-Brown Chromosol	Yellow Podzolic Soils	
2-3	Yellowish-Brown Sodosol	Yellow Soloth/Solodic Soils	
3	Dark Brown Dermosol	Red Podzolic Soils	18
4	Dark Reddish-Brown Chromosol	Red Podzolic Soils	52
5	Yellowish-Red Chromosol	Red Podzolic Soils	10
6	Dull Reddish Brown Chromosol; shallow/ Dull Reddish Brown Chromosol/Dermosol	Chocolate Soil	45
7-1	Rudosol (Dolerite)	Lithosol	44
7-2	Rudosol (Sedimentary)	Lithosol	7
Total			**253**

Table 4: Soil Fertility Assessment: Summary

Soil	Core	pH		EC		Total CEC		Exchangeable Sodium Percentage	
#	#	Value	Rating	Value (1:5 dS/m)	Rating	Value (cmol/kg)	Rating	Value (%)	Rating
1-1	2	6.5	Slightly Acidic	0.15	Low	6.9	Low	1.45	Non-sodic
1-2	5	6.6	Neutral	0.19	Low	14.2	Moderate	0.70	Non-sodic
2-1	3	5.9	Moderately Acidic	0.38	Medium	10.5	Low	0.95	Non-sodic
2-2	10b	6.1	Slightly Acidic	0.23	Medium	8.2	Low	1.22	Non-sodic
2-3	11	6.4	Slightly Acidic	0.35	Medium	7.1	Low	0.83	Non-sodic
3	17	6.9	Neutral	0.39	Medium	22	Moderate	0.46	Non-sodic
4-1	13	6.6	Neutral	0.17	Low	16.2	Moderate	2.47	Non-sodic
5	18	6.6	Neutral	0.23	Medium	13.4	Moderate	0.75	Non-sodic
6	20	7.1	Neutral	0.8	Very High	14	Moderate	0.71	Non-sodic



Ref: **Figure 2**

Title:

Rural Land Capability

Project: Bulga Modification

Client:

Bulga Coal Management PTY LTD

Legend:

- Sites
- Sites
- Study Area
- Project Area

Rural Land Classification

- Class IV
- Class V
- Class VI
- Class VII

Source:

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Soil Type 1: Brown Chromosol

The Brown Chromosol soil type generally consists of moderately structured sandy clay loam overlying strongly structured brown to strong-brown medium-heavy clay subsoil. Topsoil pH ranges from slightly acidic to neutral, is non-sodic and generally non-saline. Cation exchange capacity is low to moderate.

Table 4: Overview of Soil Type 1: Brown Chromosol



Plate 1: Profile (Pit 5)



Plate 2: Landscape (Pit 5)

Representative Site	5	**Sampled Site(s)**	2,5,6,8 and 15
Rural Land Capability Class	IV	**Fertility Class**	Low to Moderate

Soil Type 2: Yellow Chromosol/Sodosol

The Yellow Chromosol/Sodosol soil type generally consists of weakly structured brown sandy loam overlying strongly structured yellowish-brown heavy clay subsoil. A bleached layer can be present and sodic subsoils occur in drainage lines. Topsoil pH generally ranges from slightly to moderately acidic, contains moderate salinity and is non-sodic. Cation exchange capacity is generally low.

Table 5: Overview of Soil Type 2: Yellowish-Brown Chromosol/Sodosol



Plate 4: Profile (Pit 10b)



Plate 5: Landscape (Pit 10b)

Representative Site	10b	**Samples Sites(s)**	3,14,10a,10b,11,9
Rural Land Capability Class	V and VI where soils are very shallow	**Fertility Class**	Low

Soil Type 3: Dark Brown Dermosol

The Dark Brown Dermosol soil type generally consists of moderately structured dark grey light clay grading to a strong brown medium heavy clay. Topsoil generally ranges from neutral to slightly alkaline, contains moderate salinity and is non-sodic. Cation exchange capacity is moderate.

Table 6: Overview of Soil Type 3: Dark Brown Dermosol



Plate 6: Profile (Pit 17)



Plate 7: Landscape (Pit 17)

Representative Site	17	**Sampled Site(s)**	17, O-25
Rural Land Capability Class	IV	**Fertility Class**	Moderate

Soil Type 4: Dark Reddish-Brown Chromosol

The Dark Reddish-Brown Chromosol soil type generally consists of moderately structured dark brown loam overlaying a dark-reddish brown medium heavy clay. Topsoil generally ranges from moderately acidic to neutral, is generally non-saline and non-sodic. Cation exchange capacity is moderate.

Table 7: Overview of Soil Type 4: Dark Brown Dermosol



Plate 8: Profile (Pit 13)



Plate 9: Landscape (Pit 13)

Representative Site	13	**Sampled Site(s)**	12,13,4
Rural Land Capability Class	IV	**Fertility Class**	Moderate

Soil Type 5: Yellowish-Red Chromosol

The Yellowish-Red Chromosol soil type generally consists of moderately structured dark reddish-brown clay loam overlaying a yellowish-red medium heavy clay. Topsoil has a neutral pH, contains moderate salinity and is non-sodic. Cation exchange capacity is moderate.

Table8: Overview of Soil Type 5: Dark Brown Dermosol



Plate 10: Profile (Pit 18)



Plate 11: Landscape (Pit 18)

Representative Site	18	**Sampled Site(s)**	18
Rural Land Capability Class	IV	**Fertility Class**	Moderate

Soil Type 6: Chocolate Soil

The Yellowish-Red Chromosol soil type generally consists of strongly structured brownish-black clay loam overlaying a dull reddish brown light medium clay. Topsoil has a neutral pH, contains moderate to high salinity and is non-sodic. Cation exchange capacity is moderate.

Table 9: Overview of Soil Type 6: Dark Brown Dermosol

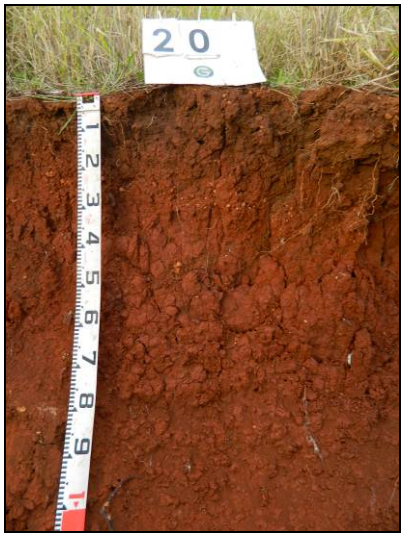


Plate 12: Profile (Pit 20)



Plate 13: Landscape (Pit 20)

Representative Site	19,20	**Sampled Site(s)**	20
Rural Land Capability Class	IV	**Fertility Class**	Moderate

Soil Type 7: Rudosol

Two major types of Rudosols occur in the Study Area. These are associated with (a) crest of the dolerite sill (**Plates 14** and **15**) and (b) sandstone conglomerate outcrops (**Plates 16** and **17**). **Table 10** provides photos and land capability classification.

Table 10: Overview of Soil Type 7: Rudosol

<table>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">Plate 14: Landscape (Dolerite Sill)</td><td colspan="2">Plate 15: Surface Rock (Dolerite Sill)</td></tr>
<tr><td>Rural Land Capability Class</td><td colspan="3">VI</td></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">Plate 16: Profile (Sandstone Outcrops)</td><td colspan="2">Plate 17: Landscape (Obs 15)</td></tr>
<tr><td>Rural Land Capability Class</td><td colspan="3">VII</td></tr>
</table>

SAL ASSESSMENT

The Study Area's Rural Land Capability classifications range from Class IV through to Class VII. It is capable of grazing (Class IV–VI) as well containing some land that is best left undisturbed due to its erosion risk (Class VII). The dominant Rural Land Capability Class in the Study Area is Class IV and the fertility classification ranges from low to moderate.

The Study Area therefore contains no SAL-Biophysical as the criteria for land capability and fertility have not been met. **Table 11** summarises this assessment.

Table 11: SAL Survey: - Summary

Soil Type #	Overall ASC name	Land Capability Class	Fertility*	SAL
1-1	Brown Chromosol; shallow	IV	Low	No
1-2	Brown Chromosol; deep	IV	Low-Moderate	No
2-1	Shallow Yellowish-Brown Chromosol/Tenosol	VI	Low-Moderate	No
2-2	Yellowish-Brown Chromosol	V	Low	No
2-3	Yellowish-Brown Sodosol	V	Low-Moderate	No
3	Dark Brown Dermosol	IV	Moderate	No
4-1	Dark Reddish-Brown Chromosol	IV	Moderate	No
4-2	Yellowish-Red Chromosol	IV	Moderate	No
5	Dull Reddish Brown Chromosol; shallow/ Dull Reddish Brown Chromosol/Dermosol	IV	Moderate	No
6	Brown Chromosol; shallow	IV	Moderate	No
7-1	Rudosol (Dolerite)	VI/VII	Moderate	No
7-2	Rudosol (Sandstone)	VII	Moderate	No

*Based on CEC

^ assumed to be similar to the deeper version.

CONCLUSION

The key findings of this assessment are listed below.

- The two dominant Rural Land Capability Classes in the Study Area are Class IV and Class V. This land is suitable for pastoral grazing activities.
- No SAL-Biophysical land is present in the Study Area.

Please have no hesitation in contacting the undersigned should you have any queries.

Yours Faithfully
GSS Environmental



Adele Calandra
Senior Environmental Scientist

REFERENCES

Hazelton P.A and Murphy B.W. (2007) Interpreting Soil Test Results (CSIRO Publication, Australia).

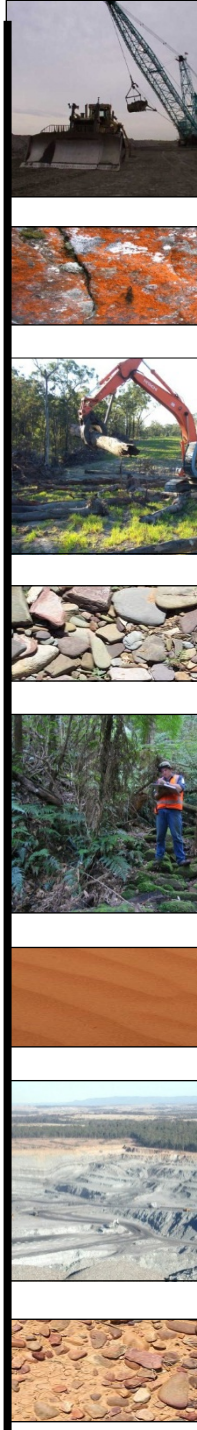
Kovac M. and Lawrie J.L. 1991 Soil landscapes of the Singleton 1:250,000 Sheet Soil Conservation Service of NSW, Sydney.

Isbell, R.F. (1996) Australian Soil Classification. CSIRO Publishing, Australia.

National Committee on Soil and Terrain (NCST) (2009) *Australian Soil and Land Survey Field Handbook: third edition* (CSIRO Publishing, Australia).

CERTIFICATE OF ANALYSIS:

Soil Resources



ATTACHMENT A

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1216794**	Page	: 1 of 6
Client	: **GSS ENVIRONMENTAL**	Laboratory	: Environmental Division Brisbane
Contact	: MS ADELE CALANDRA	Contact	: Customer Services
Address	: LEVEL 1, 241 DENISON ST BROADMEADOW NSW, AUSTRALIA 2292	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: Calandra@gssenvironmental.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 02 4920 3062	Telephone	: +61 7 3243 7222
Facsimile	: +61 02 4961 3360	Facsimile	: +61 7 3243 7218
Project	: XCN06-043	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-JUN-2012
Sampler	: AC & MH	Issue Date	: 11-JUL-2012
Site	: ----		
		No. of samples received	: 19
Quote number	: BN/039/12 V2	No. of samples analysed	: 19

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Metals Production Chemist	Brisbane Inorganics
Andrew Epps	Metals Production Chemist	Stafford Minerals - AY
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics

General Comments

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

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

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

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

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

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

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID	Obs -25 0-10cm	C-02 0-10cm	C-03 0-10cm	C-04 0-10cm	C-05 0-10cm
				Client sampling date / time	14-JUN-2012 15:00	14-JUN-2012 15:00	14-JUN-2012 15:00	14-JUN-2012 15:00	14-JUN-2012 15:00
					EB1216794-001	EB1216794-002	EB1216794-003	EB1216794-004	EB1216794-005
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.6	6.5	5.9	6.0	6.6
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		49	15	38	28	19
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		20.3	16.4	24.8	19.1	19.8
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		12.5	3.7	5.7	10.5	7.7
Exchangeable Magnesium	----	0.1	meq/100g		8.8	2.2	3.6	3.2	5.3
Exchangeable Potassium	----	0.1	meq/100g		1.4	0.9	1.0	0.8	1.1
Exchangeable Sodium	----	0.1	meq/100g		0.1	<0.1	<0.1	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g		22.8	6.9	10.5	14.6	14.2
Exchangeable Sodium Percent	----	0.1	%		0.6	0.7	0.6	0.3	0.9
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	0.01	0.03	0.02	0.02
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.4	0.5	7.4	7.1	0.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1290	1820	3170	4340	1910
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		1290	1820	3180	4350	1910
EK074: Fluoride Extractable Phosphorus (Bray)									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		<1.0	2.6	4.8	6.7	1.0
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		1.46	2.31	2.75	2.37	2.63

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: C-06 0-10cm	C-08 0-10cm	C-09 0-10cm	C-10a 0-10cm	C-10b 0-10cm
				Client sampling date / time: 14-JUN-2012 15:00	14-JUN-2012 15:00	14-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00
				EB1216794-006	EB1216794-007	EB1216794-008	EB1216794-009	EB1216794-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.5	6.1	6.4	6.1	6.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	19	48	22	27	23
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	16.4	17.9	17.2	16.7	11.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.3	7.0	3.2	3.2	4.6
Exchangeable Magnesium	----	0.1	meq/100g	4.2	3.0	3.2	2.3	2.9
Exchangeable Potassium	----	0.1	meq/100g	0.8	1.3	0.6	0.7	0.7
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	10.3	11.4	7.1	6.3	8.2
Exchangeable Sodium Percent	----	0.1	%	0.7	1.0	1.1	0.9	0.9
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	0.02	0.02	0.02
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	15.8	0.6	1.8	3.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1340	3980	1840	1750	2450
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1340	4000	1840	1750	2450
EK074: Fluoride Extractable Phosphorus (Bray)								
Fluoride Extractable P (Bray)	----	1.0	mg/kg	1.1	6.4	1.6	1.4	3.8
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	1.82	2.23	2.80	2.38	2.68

Analytical Results

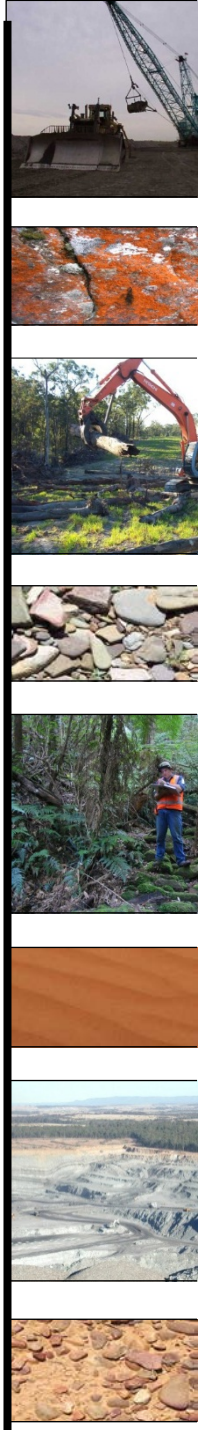
Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	C-11 0-10cm	C-12 0-10cm	C-13 0-10cm	C-14 0-10cm	C-15 0-10cm
				Client sampling date / time	21-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00
					EB1216794-011	EB1216794-012	EB1216794-013	EB1216794-014	EB1216794-015
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**6.4**	**5.6**	**6.6**	**7.9**	**6.8**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**35**	**19**	**17**	**79**	**31**
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		**12.1**	**16.8**	**18.9**	**17.5**	**12.4**
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		**5.9**	**12.1**	**7.6**	**31.3**	**5.5**
Exchangeable Magnesium	----	0.1	meq/100g		**5.3**	**2.4**	**7.2**	**4.7**	**5.6**
Exchangeable Potassium	----	0.1	meq/100g		**0.8**	**0.6**	**1.0**	**0.9**	**0.6**
Exchangeable Sodium	----	0.1	meq/100g		**0.1**	<0.1	**0.4**	<0.1	**0.4**
Cation Exchange Capacity	----	0.1	meq/100g		**12.1**	**15.2**	**16.2**	**37.0**	**12.0**
Exchangeable Sodium Percent	----	0.1	%		**0.9**	**0.4**	**2.2**	**0.2**	**3.0**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	<0.01	**0.01**	**0.01**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.5**	**1.1**	**1.3**	**2.7**	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**1820**	**1320**	**1920**	**2300**	**1400**
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**1820**	**1320**	**1920**	**2300**	**1400**
EK074: Fluoride Extractable Phosphorus (Bray)									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		<1.0	**3.5**	<1.0	<1.0	**1.1**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**2.14**	**1.60**	**2.33**	**1.67**	**1.72**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	C-17 0-10cm	C-18 0-10cm	C-19 0-10cm	C-20 0-10cm	----
			Client sampling date / time	21-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00	21-JUN-2012 15:00	----
Compound	CAS Number	LOR	Unit	EB1216794-016	EB1216794-017	EB1216794-018	EB1216794-019	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.9	6.6	6.7	7.1	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	39	23	41	80	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.4	17.6	14.0	6.6	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	14.9	9.2	11.4	10.1	----
Exchangeable Magnesium	----	0.1	meq/100g	5.9	3.3	1.9	2.5	----
Exchangeable Potassium	----	0.1	meq/100g	1.1	0.9	1.5	1.4	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----
Cation Exchange Capacity	----	0.1	meq/100g	22.0	13.4	14.9	14.0	----
Exchangeable Sodium Percent	----	0.1	%	0.3	0.4	0.3	0.5	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.01	0.01	0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.2	1.0	9.0	11.4	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1590	1960	3880	1510	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1590	1960	3890	1520	----
EK074: Fluoride Extractable Phosphorus (Bray)								
Fluoride Extractable P (Bray)	----	1.0	mg/kg	<1.0	1.5	153	40.4	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	1.56	2.03	1.85	1.68	----

Summary of COA



ATTACHMENT B

Table 3: Laboratory Soil Fertility Results (Part 1)

Soil Type	Core #	Soil Field Texture	pH		EC		Exchangeable Cations		ESP	
#			Value	Rating	Value (1:5 dS/m)	Rating	Value (cmol/kg)	Rating	Value (%)	Rating
1-1	2	Sandy Clay Loam	6.5	Slightly Acidic	0.15	Low	6.9	Low	1.45	Non-sodic
1-2	5	Sandy Clay Loam	6.6	Neutral	0.19	Low	14.2	Moderate	0.70	Non-sodic
	6	Clay Loam	6.5	Slightly Acidic	0.19	Low	10.3	Low	0.97	Non-sodic
	8	Loam	6.1	Slightly Acidic	0.48	High	11.4	Low	0.88	Non-sodic
	15	Sandy Loam	6.8	Neutral	0.31	Medium	12	Low	3.33	Non-sodic
2-1	3	Loam	5.9	Moderately Acidic	0.38	Medium	10.5	Low	0.95	Non-sodic
	14	Loam	7.9	Moderately Alkaline	0.79	Very High	37	High	0.27	Non-sodic
2-2	10a	Sandy Loam	6.1	Slightly Acidic	0.27	Medium	6.3	Low	1.59	Non-sodic
	10b	Sandy Loam	6.1	Slightly Acidic	0.23	Medium	8.2	Low	1.22	Non-sodic
2-3	9	Sandy Loam	6.4	Slightly Acidic	0.22	Medium	12.1	Moderate	1.41	Non-sodic
	11	Loam	6.4	Slightly Acidic	0.35	Medium	7.1	Low	0.83	Non-sodic
3	17	Light Clay	6.9	Neutral	0.39	Medium	22	Moderate	0.46	Non-sodic
	O-25	Light Clay	7.6	Mildly Alkaline	0.49	Medium	22.8	Moderate	0.439	Non-sodic
4	12	Clay Loam	5.6	Moderately Acidic	0.19	Low	15.2	Moderate	0.66	Non-sodic
	13	Loam	6.6	Neutral	0.17	Low	16.2	Moderate	2.47	Non-sodic
	4	Loam	6	Moderately Acidic	0.28	Medium	14.6	Moderate	0.68	Non-sodic
5	18	Clay Loam	6.6	Neutral	0.23	Medium	13.4	Moderate	0.75	Non-sodic
6	19	Sandy Clay Loam	6.7	Neutral	0.41	Medium	14.9	Moderate	0.67	Non-sodic
	20	Clay Loam	7.1	Neutral	0.8	Very High	14	Moderate	0.71	Non-sodic

Table 4: Laboratory Soil Fertility Results continued

Soil Type	Core #	Organic Carbon		Total Nitrogen as N		Carbon / Nitrogen Ratio		Total Sulfur as S		Nitrite + Nitrate as N (Sol.)		Fluoride Extractable P (Bray)	
		Value (%)	Rating	Value (%)	Rating	Value	Rating	Value (%)	Rating	Value (mg/kg)	Rating	Value (%)	Rating
1-1	2	2.31	High	0.18	Medium	12.7	Max. rate of decomposition	0.01	Very Low	0.5	Very Low	2.6	Low
1-2	5	2.63	High	0.19	Medium	13.8	Max. rate of decomposition	0.02	Very Low	0.5	Very Low	1	Low
	6	1.82	High	0.13	Low	13.6	Max. rate of decomposition	0.01	Very Low	0.3	Very Low	1.1	Low
	8	2.23	High	0.4	High	5.6	Max. rate of decomposition	0.02	Very Low	15.8	Adequate	6.4	Low
	15	1.72	Moderate	0.14	Low	12.3	Max. rate of decomposition	0.01	Very Low	0.1	Very Low	1.1	Low
2-1	3	2.75	High	0.32	High	8.6	Max. rate of decomposition	0.03	Very Low	7.4	Low	4.8	Low
	14	1.67	Moderate	0.23	Medium	7.3	Max. rate of decomposition	0.01	Very Low	2.7	Very Low	1.0	Low
2-2	10a	2.38	High	0.18	Medium	13.6	Max. rate of decomposition	0.02	Very Low	1.8	Very Low	1.4	Low
	10b	2.68	High	0.25	Medium	10.9	Max. rate of decomposition	0.02	Very Low	3.5	Very Low	3.8	Low
2-3	11	2.8	High	0.18	Medium	11.8	Max. rate of decomposition	0.02	Very Low	0.5	Very Low	1.0	Low
	9	2.14	High	0.18	Medium	15.2	Max. rate of decomposition	0.02	Very Low	0.6	Very Low	1.6	Low
3	17	1.56	Moderate	0.16	Medium	9.8	Max. rate of decomposition	0.01	Very Low	0.2	Very Low	1.0	Low
	O-25	1.46	Moderate	0.13	Low	11.3	Max. rate of decomposition	0.01	Very Low	0.4	Very Low	1.0	Low
4	12	1.6	Moderate	0.13	Low	12.1	Max. rate of decomposition	0.01	Very Low	1.1	Very Low	3.5	Low
	13	2.33	High	0.19	Medium	12.1	Max. rate of decomposition	0.01	Very Low	1.3	Very Low	1.0	Low
	4	2.37	High	0.44	High	5.4	Max. rate of decomposition	0.02	Very Low	7.1	Low	6.7	Low
5	18	2.03	High	0.20	Medium	10.4	Max. rate of decomposition	0.01	Very Low	1	Very Low	1.5	Low
6	19	1.85	High	0.39	High	4.8	Max. rate of decomposition	0.01	Very Low	9	Marginal	153	High
	20	1.68	Moderate	0.15	Medium	11.1	Max. rate of decomposition	0.01	Very Low	11.4	Adequate	40.4	High