BENGALLA Mining Company

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Agricultural Impact Assessment

Bengalla Coal Mine – Continuation of Mining Project
Agricultural Land Use Impact Assessment

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Bengalla Coal Mine – Continuation of Mining Project
Agricultural Impact Assessment

Report prepared for Hansen Bailey Environmental Consultants on behalf of Bengalla Mining Company Pty Ltd

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Executive Summary

Scott Barnett & Associates was commissioned by Hansen Bailey Environmental Consultants on behalf of Bengalla Mining Company Pty Ltd (BMC) to undertake an agricultural land use impact assessment for the Bengalla Coal Mine – Continuation of Mining Project (the Project). This assessment will form part of the Environmental Impact Statement (EIS) supporting an application for Development Consent under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Project is situated in the Upper Hunter region, which has a long history of rural land use for a variety of agricultural and industrial activities. The current dominant land uses within and adjacent to existing Bengalla Mine (Bengalla) include open cut coal mining, dairying, lucerne hay production, thoroughbred horse breeding and cattle grazing.

Major agricultural resources in the proximity to Bengalla include the Hunter Regulated River Water Source (Hunter River) and the Hunter Alluvial soil landscape grouping (DP&I, 2012). The Hunter River is located to the south of the Project Boundary. The Hunter River is a major agricultural asset for the locality and the region in general, serving as a highly reliable water source for industries (mining and power generation), town water, irrigation and stock and domestic supply.

BMC has a long and proud history of maintaining agricultural production on its agricultural lands. Bengalla Agricultural Company was started in 1995 to manage the agricultural land acquired by BMC. With more land coming on-board as part of the Bengalla start up, Bengalla has become one of the largest milk producers in the Hunter Valley, operating three dairies. Milk production peaked at over 5.3 ML in 2002 compared to the 3.3 ML produced in 1992 from the same area. Bengalla Agricultural Company also operated a thoroughbred stud standing three stallions as well as broodmares and weanling and yearling preparation. Dryland beef grazing and irrigated cropping was also carried out. This proud tradition of productive agriculture continued after 2004 when the management of agricultural land owned by Bengalla was transferred to licensees.

Under the management of these licensees the gross production value of BMC owned agricultural is $3.1 M per annum from 2,243 ha and 3,374 ML of irrigation water. This is derived from dairy milk production, Lucerne hay production, a thoroughbred breeding operation and beef cattle grazing. In the summer of 2010/11, BMC owned land was also used for a trial crop of industrial hemp production for the embryonic Hunter Valley industrial hemp industry.

The Study Area comprises the land within the Project Boundary excluding the Approved Bengalla Mine and has total area of 1,356 ha. Not all of the land within the Project Boundary will be removed from agriculture, with only 964 ha proposed to be disturbed (the Disturbance Boundary). The land is currently licensed to four landholders for agricultural purposes, primarily beef production. The Project Boundary contains Biophysical Strategic Agricultural Land and land within the Equine Industry Critical Industry Cluster and the Viticulture Critical Industry Cluster as defined in the Strategic Regional Land Use Plan – Upper Hunter (DP&I, September 2012a).

BMC owns all land within the Project Boundary (with the exception of a small area owned by Coal & Allied) and Disturbance Boundary and additional agricultural land surrounding the Project.

The Disturbance Boundary contains only 1 ha of Biophysical Strategic Agricultural Land which will be affected by the Bengalla Link Road realignment, not active mining.

The Project Boundary contains 35 ha of land mapped as Equine Critical Industry Cluster, however there is no mapped Equine Industry Critical Industry Cluster land within the Disturbance Boundary (DP&I, September 2012a). There are no existing privately owned studs within the Project Boundary or Disturbance Boundary.

The Project will not impact on any the equine industry or on any equine enterprises within the locality or wider Upper Hunter region.

The Project Boundary also contains 494 ha of land mapped as Viticulture Critical Industry Cluster, which has been verified as meeting the relevant criteria in the Appendix of the SLRUP (DP&I, September 2012a). Of this, land within the Disturbance Boundary that also meets these criteria totals 369 ha. There are no vineyards within the Project Boundary including the Disturbance Boundary.

The Project lies on the north east extremity of the Viticulture Critical Industry Cluster with the nearest vineyards being 6 and 12 km to the south and 14.5 km to the west of the Project Boundary. The visual and dust impacts of the Project over the Viticulture Critical Industry Cluster within the locality of the Project is predicted to be minimal. The Project will not impact the Upper Hunter viticulture industry or any viticulture enterprises.

The agricultural industry in the Upper Hunter region, which includes the Singleton, Muswellbrook, Upper Hunter, Dungog, Gloucester and the Great Lakes LGA, is suggested to have a total regional export output of approximately $403 M and employs approximately 5,039 people (Buchan Consulting, 2011).

The current gross value of beef production from Study Area is estimated to be $186,048 per annum turning off 334 head of cattle per year. With further development of the property this could rise to $259,678 per annum turning off 459 head of cattle per year. However, not all of the Study Area will be removed from agriculture. Of the 1,356 ha of land within the Project Area, approximately 964 ha will be temporarily removed from agriculture (Disturbance Boundary). When compared to surrounding BMC land, the land within the Disturbance Boundary has a relatively low productivity. The gross value of production from the beef enterprises within the Disturbance Boundary is estimated to be $129,313 per annum from the sale of 237 head of cattle.

The Project will require the use of up to 2,200 ML of water from The Hunter River Regulated Water Source with an additional 220 ML from the Hunter River alluvium. The gross value of agricultural production foregone from diverting this water for irrigation of Lucerne and maize grain crops compared to utilizing the equivalent area for dryland production of Lucerne hay and grain sorghum crops is $1,003,597 per annum from the sale of 3,114 tonnes of Lucerne hay and 489 tonnes of grain per annum.

Bengalla Mining Company already has a Water Access Licence (WAL) for 1,449 shares (1,449 ML) for use by the Approved Mine. The additional 971 ML required to meet the Project maximum water demand has a gross value of production foregone of $402,683 per annum from the production 1,249 tonnes of lucerne hay and 196 tonnes of hay.

The value of agricultural production from the combined loss of agricultural resources and irrigation water units (associated with the disturbance footprint and mine water usage) is predicted to be $1.1 M per annum. This represents 0.363% of the annual gross value of agricultural production in the Hunter region, 0.014% of NSW's agricultural production and 0.003% of the national production.

As the overall agricultural contribution of the Disturbance Boundary within the Project Boundary and the water resource is small when compared to the total agricultural production on a regional, state and national scale, the reduced availability and productivity of this land and water will have a minimal impact to the industry. In addition, the Project will not reduce the availability of land for agricultural purposes or affect the productivity of existing agricultural land outside the Project Boundary within the locality.

Other potential impacts on agricultural resources and enterprises in the locality, including air quality, noise, water usage from the Hunter River, traffic and transport, and labour supply have been assessed as having minimal effect.

To maintain, and where possible enhance, the agricultural productivity of BMC land outside the Disturbance Boundary it is recommended that BMC:

- Continue, where possible, with the existing Licensee arrangements for BMC agricultural land;
- Utilise the existing Landscape Management Plan as the strategy to control the distribution of invasive species and feral animals on Bengalla owned land;
- Continue with arrangements for sustainable farming practices and management of land situated outside the Disturbance Boundary;
- Ensure Licensees continue to manage their licensed areas according to the conditions;
- Develop a final landform that is consistent with the Project mine plan; and
- Reinstate agricultural production on rehabilitated land (including the Approved Bengalla Mine) as soon as practicable having consideration of safety and legislative requirements relating to mine operations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1 INTRODUCTION

1.1 Introduction

Scott Barnett & Associates (SBA) was commissioned by Hansen Bailey, on behalf of Bengalla Mining Company (BMC), to undertake an Agricultural Impact Statement (AIS) for the Continuation of Bengalla Mine Project (the Project). This assessment will form part of the Environmental Impact Statement (EIS) supporting an application for Development Consent under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to facilitate the continuation of at a rate of up to 15 Million tonnes per annum (Mtpa) run of mine (ROM) coal for up to 24 years to a total of 316 Million tonnes.

1.2 Assessment Objectives

The scope of work completed by SBA for this Agricultural Impact Statement (AIS) included:

- Addressing the Director-General's Environmental Assessment Requirements (DGRs) relating to agriculture, issued on 13 March 2012 (see **Section 2.1**);
- Addressing the Supplementary Director-General's Requirements for Continuation of Bengalla Mine (SSD-5170), issued on 12 July 2012 (see **Section 2.1**);
- Addressing relevant policies and plans relating to agriculture (see **Sections 2.1, 2.2 2.3** and **2.4**);
- Describing the agricultural resources and enterprises in the general locality, including identifying any State significant agricultural resources (see **Section** 3 and **Section** 4);
- Identifying the agricultural potential domains of the land within the Study Area (see **Section 5.2**);
- Assessing the current and maximum agricultural potential for each domain in terms of quantum, gross and net value of agricultural production (see **Section 5.3**);
- Assessing the loss of agricultural production from within the Study Area during the life of the Project in terms of value of agricultural production and downstream activities within the value chain and support activities (see **Sections 5.3** and **Section 8.1**);
- Assessing the use of the regulated water supply for the Project in comparison to it being used for agricultural purposes within the regulated system (see **Sections 5.4** and **8.1.3**);
- Assessing the potential impacts on the agricultural resources and enterprises within the locality (see Sections **8.1.3** and **8.1.5**); and
- Providing appropriate mitigation and management measures (see **Section** 9).

This report also considers the SRLUP – Upper Hunter in particular the draft gateway criteria in Chapter 11 in relation to mapped Biophysical Strategic Agricultural Land (BSAL), Viticulture Critical Industry Cluster (CIC) and the Equine CIC in the 'Upper Hunter Strategic Regional Land Use Plan' (SRLUP) (NSW DP&I, September 2012a).

1.3 Project Description

Bengalla is located in the Upper Hunter Valley of NSW, approximately 130 km north-west of Newcastle and 4km west of Muswellbrook (see **Figure 1**).

Bengalla is an open cut, strip-mining operation where mining advances generally to the west based on dragline strips approximately 60 m in width. Pre-stripped overburden generally is removed by loader and/or excavator and trucks, in advance of the dragline operation and subsequent coaling. Mining is conducted by equipment fleet consisting of a dragline, loading units, trucks and various other ancillary equipment.

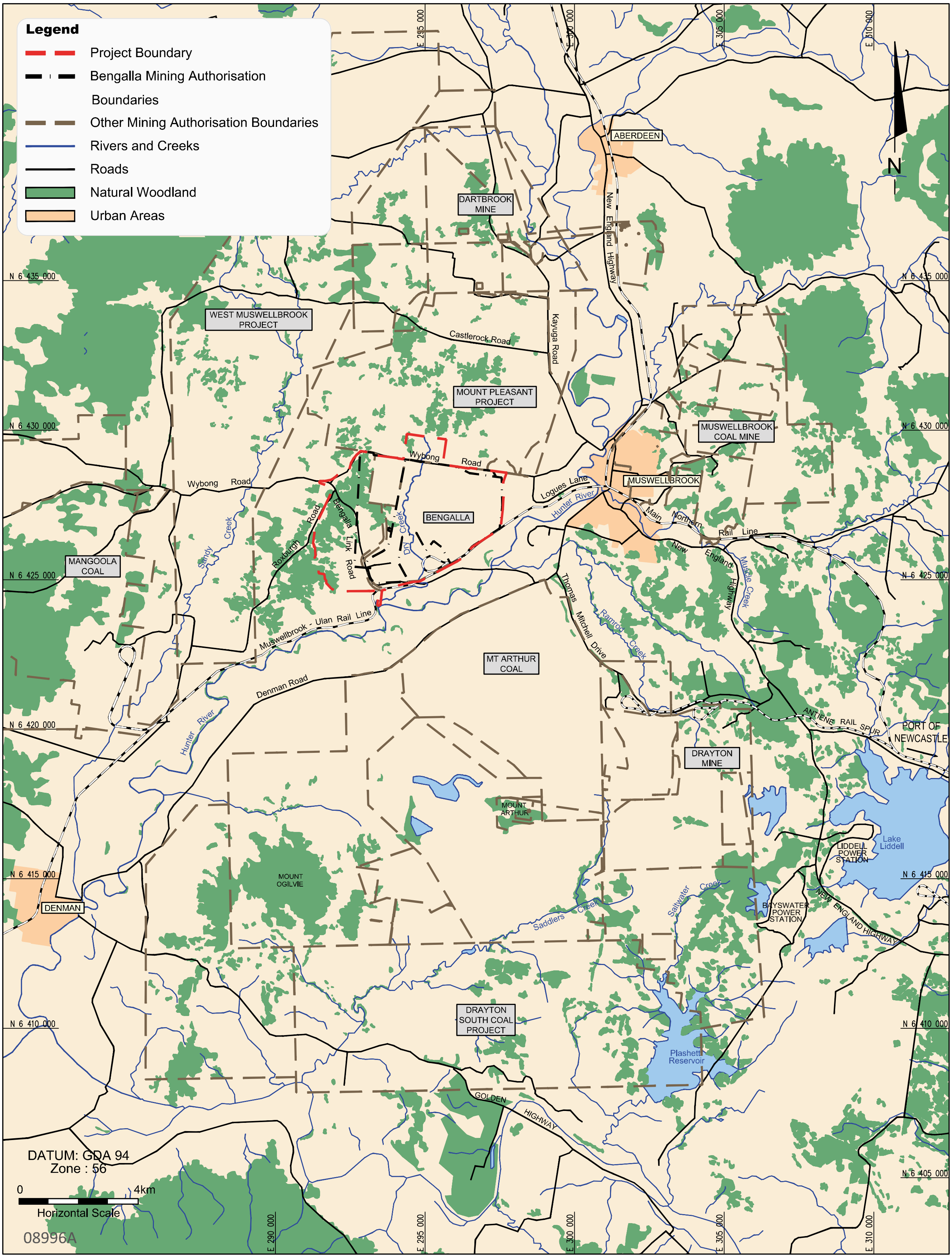
BMC was granted DA 211/93 for Bengalla under the EPA&A Act for the '*Construction and operation of a surface coal mine, coal preparation plant, rail loop, loading facilities and associated facilities'* on 7 August 1995.

BMC has been granted four modifications to DA 211/93 and is approved to operate for a 21 year period from 1996 (i.e. until 2017) and to produce up to 10.7 Mtpa of ROM coal.

The Project generally consists of the following characteristics:

- Open cut mining at a rate of up to 15 Mtpa ROM coal to 316 Million tonnes for up to 24 years continuing to utilise a dragline and truck and excavator fleet;
- Extending mining to the west of current operations;
- An out of pit Overburden Emplacement Area (OEA) to the west of Dry Creek which may be utilised for excess spoil material until it is intercepted by mining;
- Processing, handling and transportation of coal via the Coal Handling and Preparation Plant (CHPP) to be upgraded, and rail loop for export and domestic sale;
- An additional CHPP stockpile and ROM coal stockpile;
- Continued use, extension and upgrades to existing infrastructure;
- The construction of a radio tower;
- Relocation of the Explosives Magazine and Reload Facility;
- Relocation of a section of Bengalla Link Road near the existing mine access road to enable coal extraction;
- The diversion of Dry Creek via dams and pipe work with a later permanent re-alignment of Dry Creek through rehabilitation areas when emplacement areas are suitably advanced;
- Relocation of water storage infrastructure as mining progresses through existing dams (including the Staged Discharge Dam);
- The construction of raw water dams and a clean water dam;
- A workforce of approximately 900 full time equivalent personnel at peak production; and
- Supporting power and water reticulation infrastructure, other ancillary facilities, infrastructure including roads, co-disposal and temporary in pit coal reject emplacement along with earth handling facilities which enable construction activities.

The conceptual Project layout is shown in **Figure 2.**



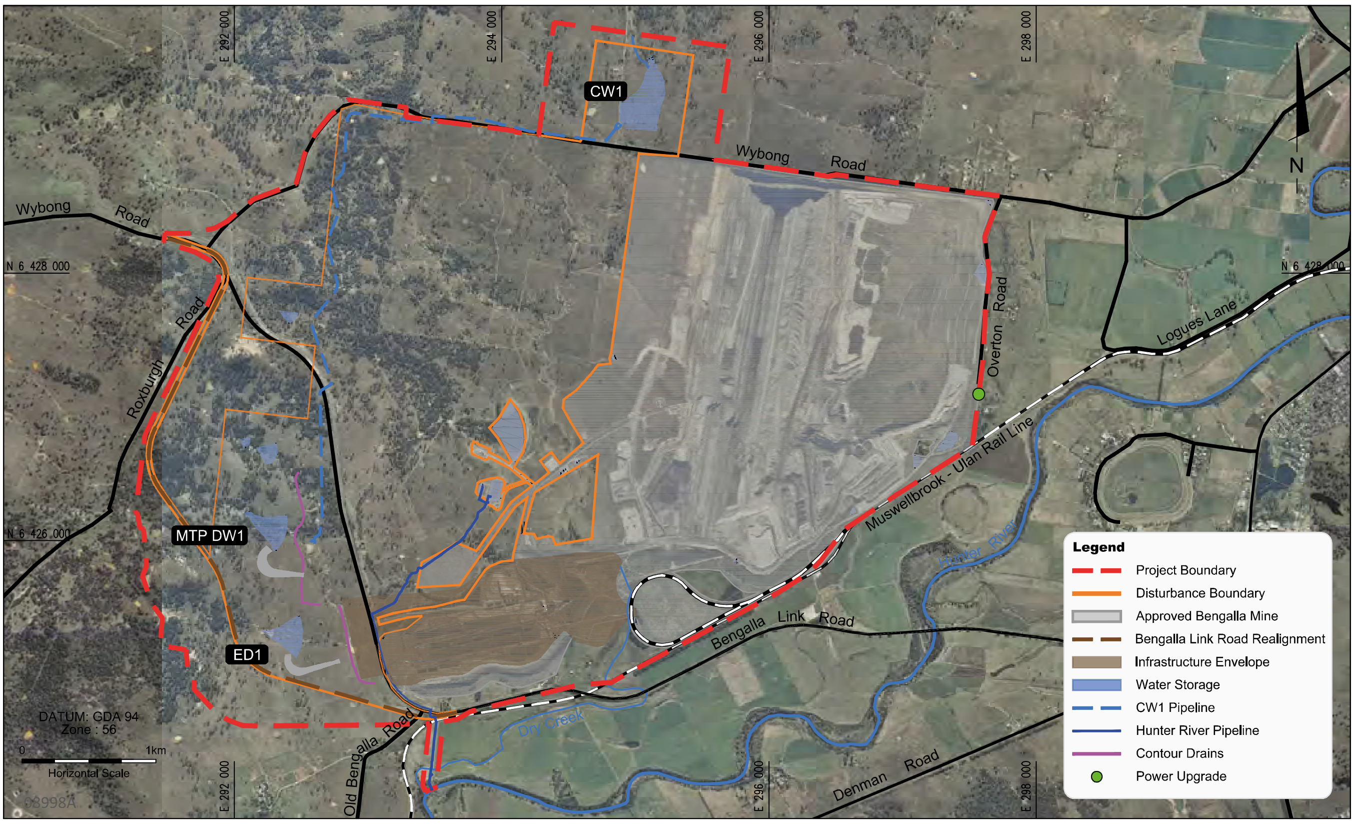
BENGALLA MINE

Regional Locality

FIGURE 1

BENGALLA

Hansen Bailey
ENVIRONMENTAL CONSULTANTS



BENGALLA MINE

Conceptual Project Layout

FIGURE 2

1.4 Study Area

The Study Area for the AIS comprises the following components:

- An overall area of 1,356 ha being the land within the Project Boundary but excluding the Approved Bengalla Mine (974 ha) as shown in **Figure 2**;
- Agriculture in the general locality, which is defined as the land within a 2 km radius of the Project Boundary (see **Figure 2**). A 2 km radius was selected for the Study Area as this provides a representative selection of the primary land uses including various agricultural enterprises associated with the Hunter River floodplain.

1.5 Related Studies

The studies which are to be read in conjunction with this assessment include the following:

- The EIS Soil and Land Capability Impact Assessment (GSS Environmental, 2013);
- The EIS Ecology Impact Assessment (Cumberland Ecology, 2013);
- The EIS Surface Water Impact Assessment (WRM Water and Environment, 2013);
- The EIS Groundwater Impact Assessment (AGE Consultants, 2013);
- The EIS Air Quality and Greenhouse Gas Impact Assessment (Todoroski Air Sciences, 2013);
- The EIS Acoustic Impact Assessment (Bridges Acoustics, 2013);
- The EIS Visual Impact Assessment (JVP Integral Design, 2013);
- The EIS Traffic and Transport Impact Assessment (DC Traffic Engineering, 2013);
- The EIS Social Impact Assessment (Martin & Associates, 2013); and
- The EIS Economic Impact Assessment (Gillespie Economics, 2013).

2 REGULATORY FRAMEWORK

This chapter describes the regulatory framework relevant to the Project and this AIS.

2.1 Environmental Planning and Assessment Act 1979

The EP&A Act is the overarching planning legislation in NSW. This act provides for the creation of planning instruments that guide land use.

Upon the repeal of Part 3A of the EP&A Act on 1 October 2011, *the Environmental Planning and Assessment Amendment* (Part 3A Repeal) Act 2011 inserted a new Division 4.1 in Part 4 of the EP&A Act. The Project will require planning assessment and determination under the new Division 4.1, regime for a State Significant Development (SSD).

Section 78(8A) states that a development application for SSD must be accompanied by an EIS prepared in accordance with *the Environmental Planning & Assessment Regulation*. The EIS is to be prepared in accordance with the Director-General's DGRs.

The application for this development is the preparation of an EIS, which must be in accordance with the DGRs. This assessment, which forms part of the EIS, addresses the DGRs relating to agriculture. **Table 1** lists the DGRs that were issued on 13 March 2012 and supplementary DGRs (12 July 2012) that are relevant to this assessment and the sections in this report where these DGRs are addressed.

Table 1 Director-General's Environmental Assessment Requirements

Key Issue	Requirement	Report Section Where Addressed
Land Resources	Include an Agricultural Impact Statement and a detailed assessment of the Potential impacts on:	**Sections 3, 4, 5, 6, 7, 8** and **9**.
	• soils and land capability (including salinisation and contamination);	Soil and Land Capability Impact Assessment (GSSE, 2013)
	• landforms and topography, including steep slopes;	**Section 3.2** and Soil and Land Capability Impact Assessment (GSSE, 2013)
	• land use, including agricultural, forestry, conservation and recreational use, with particular attention on viticulture and equine industries;	**Sections 3** and **4**
	• A specific focused assessment of the impacts of the proposal on strategic agricultural land, having regard to the draft gateway criteria in the Upper Hunter Strategic Land Use Plan,	**Section 2.3**

Further, the letter from Howard Reed of the NSW Department of Planning and Infrastructure which accompanied the DGRs dated 13 March 2012 states that:

> *"The Department's preliminary assessment of your project under the draft Upper Hunter Strategic Regional Land Use Plan shows the proposed mine extension is located within 2 kilometres of mapped Biophysical Strategic Agricultural Land and the Equine Critical Industry Cluster. The Department strongly recommends that you consider the draft Plan and in particular the draft gateway criteria in Chapter 11 of the Plan during preparation of your mine plan and EIS".*

Since this time, the final SRLUP – Upper Hunter has been released and is addressed in **Section 8.2** of this report.

This AIS has been prepared in consideration of the relevant DGRs input from Department of Primary Industries – Office of Agricultural Sustainability & Food Security (DPI). **Table 2** details the key issues raised by DPI to be addressed by the AIS.

Table 2 Relevant Agency Comments to the DGRs

Agency	Comment	Report Section Where Addressed
DPI	The proposed extension of open cut coal mining at Bengalla for a further 24 years will involve the further disturbance of agricultural lands due to mining.	**Section 8**
DPI	Additional agricultural lands and businesses may be affected by the impacts on water resources and various socio-economic impacts including on-going competition for labour.	**Section 8** and Groundwater Impact Assessment, Surface Water Impact Assessment and Social Impact Assessment
DPI	Effective consideration of cumulative impacts over time and from interactions with other mines will also be important.	**Section 8**

2.2 Strategic Regional Land Use Plan – Upper Hunter

The Strategic Regional Land Use Plan – Upper Hunter (DP&I, September 2012a) (SRLUP) is a component of the broader Strategic Regional Land Use Policy, which consists of various initiatives to manage land use conflicts in regional areas, in relation to agriculture, coal mining and coal seam gas. The plan defines strategic agricultural land as:

> *"…highly productive land that has both unique natural resource characteristics (such as soil and water resources) as well as socio-economic value (such as high productivity, infrastructure availability and access to markets)."* (NSW DP&I 2012a).

The plan defines areas of both Biophysical Strategic Agricultural Land (BSAL) and CICs, including clusters for the equine and viticulture industries. A description of the interactions between mapped strategic agricultural land and the Project is provided below.

The Project is moving in a general westerly direction away from the Hunter River alluvial floodplain and mapped BSAL.

Biophysical Strategic Agricultural Land

Under the SRLUP, BSAL is defined as:

- Land that falls under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH), and
- Land capability classes I, II or III under the Land and Soil Capability Mapping of NSW (OEH), and
- Reliable water of suitable quality, characterised by having rainfall of 350mm or more per annum (9 out of 10 years); or properties within 150m of 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 5L/s and total dissolved solids of less than 1,500mg/L.

OR

- Land that falls under soil fertility classes 'moderate' under the Draft Inherent General Fertility of NSW (OEH), and
- Land capability classes I or II under the Land and Soil Capability Mapping of NSW (OEH),

AND

- Reliable water of suitable quality, characterised by having rainfall of 350mm or more per annum (9 out of 10 years); or properties within 150m of 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 5L/s and total dissolved solids of less than 1,500mg/L.

The Project is located adjacent to the Hunter River alluvial floodplain which is mapped under the criteria for BSAL, as illustrated on **Figure 3**. **Figure 3** has been developed based on Map 6 of the SRLUP and indicates that an area of approximately 28 ha of BSAL falls within the Project Boundary.

This area of mapped BSAL within the Project Boundary is largely associated with the Approved Bengalla Mine or is currently used for grazing associated with dairying. A small area of approximately 1 ha of BSAL mapped land is located within the Disturbance Boundary and is associated with the realignment of Bengalla Road.

Critical Industry Cluster (Equine & Viticulture)

Under the SRLUP a CIC is defined as one which meets the following criteria:

- There is a concentration of enterprises that provides clear development and marketing advantages and is based on an agricultural product;
- The productive industries are interrelated;

- It consists of a unique combination of factors such as location, infrastructure, heritage and natural resources;
- It is of national and/or international importance;
- It is an iconic industry that contributes to the region's identity; and
- It is potentially substantially impacted by coal seam gas or mining proposals.

As such the Equine industry within the Upper Hunter has been classified as a CIC.

The Project Boundary, based on Map 6 of the SRLUP (**Figure 3**), also contains a small area (35 ha) of land which falls within the Equine CIC as defined as having a slope of less than 18% and being within the 2km of the Muswellbrook Denman Road (NSW DP&I 2012a).

There is no land within the Disturbance Boundary which falls into the Equine CIC.

The Appendix of the SRLUP provides a definition for the Viticulture CIC as presented on Map 6 of the SRLUP (DP&I, September 2012) and reproduced on **Figure 3**. This definition and how it has been used to verify the Viticulture CIC within this report is provided in **Table 3**.

In order to verify the mapping associated with the Viticulture CIC as outlined in the SRLUP Appendix, the relevant criteria were investigated and are identified in **Table 4**. The Soils and Landscape Impact Assessment (GSSE, 2013) (to determine soil fertility and land capability) and the Groundwater Impact Assessment (AGE, 2013) (to determine the extent of any alluvial aquifer) were investigated to determine if land within the Project Boundary conformed to the requirements presented in **Table 4**. These verification criteria in relation to determining the extent of Viticulture CIC are presented in **Table 4** and **Figure 4**.

Following the verification process, the Project Boundary contains 494ha of Viticulture CIC that meets all the criteria presented in **Table 4**. The area of verified Viticulture CIC within the Disturbance Boundary is 369 ha. The area of verified Viticulture CIC is presented on **Figure 5**.

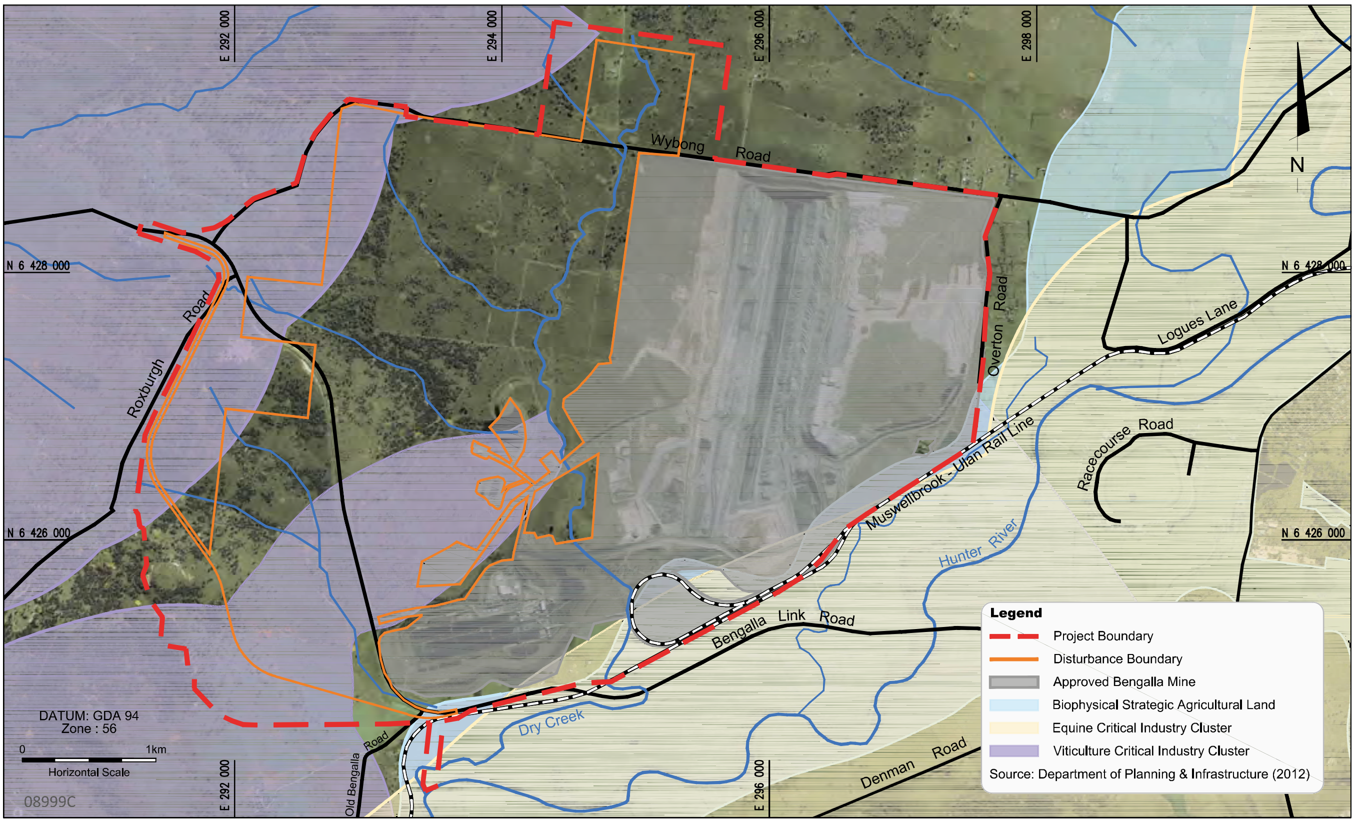
Table 3 Viticulture Critical Industry Cluster

Definition	Where addressed
The Viticulture CIC is spatially defined as the following land (excluding State Forests and National Park):	
• The Broke-Fordwich and Pokolbin Geographical Indicators (GI) sub-regions;	Not Applicable
• The parish of Belford and the suburbs of Lovedale, Nulkaba, Mount View and Rothbury;	Not Applicable
• Properties proximate to the Hunter Wine Country Private Irrigation District pipeline to the east of Lovedale Road as well as those properties bounded by Mears Lane, Majors Lane and the Suburb of Lovedale; and	Not Applicable

Definition	Where addressed
• Land (excluding National Park and State Forests) within 20 km of Denman; and that falls under soil fertility classes 'high', moderately high, moderate or moderately low under the Draft Inherent General Fertility of NSW (OEH), and land capability classes I, II, III, IV or V under the Land and Soil Capability Mapping of NSW (OEH) and is within 2 km of a mapped alluvial water source.	See **Table 4**

Table 4 Viticulture Critical Industry Cluster Verification

Definition	Within Project Boundary
• Land (excluding National Park and State Forests) within 20 km of Denman; and	Yes – See **Figure 4**
• Falls under soil fertility classes 'high', moderately high, moderate or moderately low under the Draft Inherent General Fertility of NSW (OEH); and	Yes – See **Figure 4**
• Land capability classes I, II, III, IV or V under the Land and Soil Capability Mapping of NSW (OEH); and	Yes – See **Figure 4**
• Is within 2 km of a mapped alluvial water source.	Yes – See **Figure 4**



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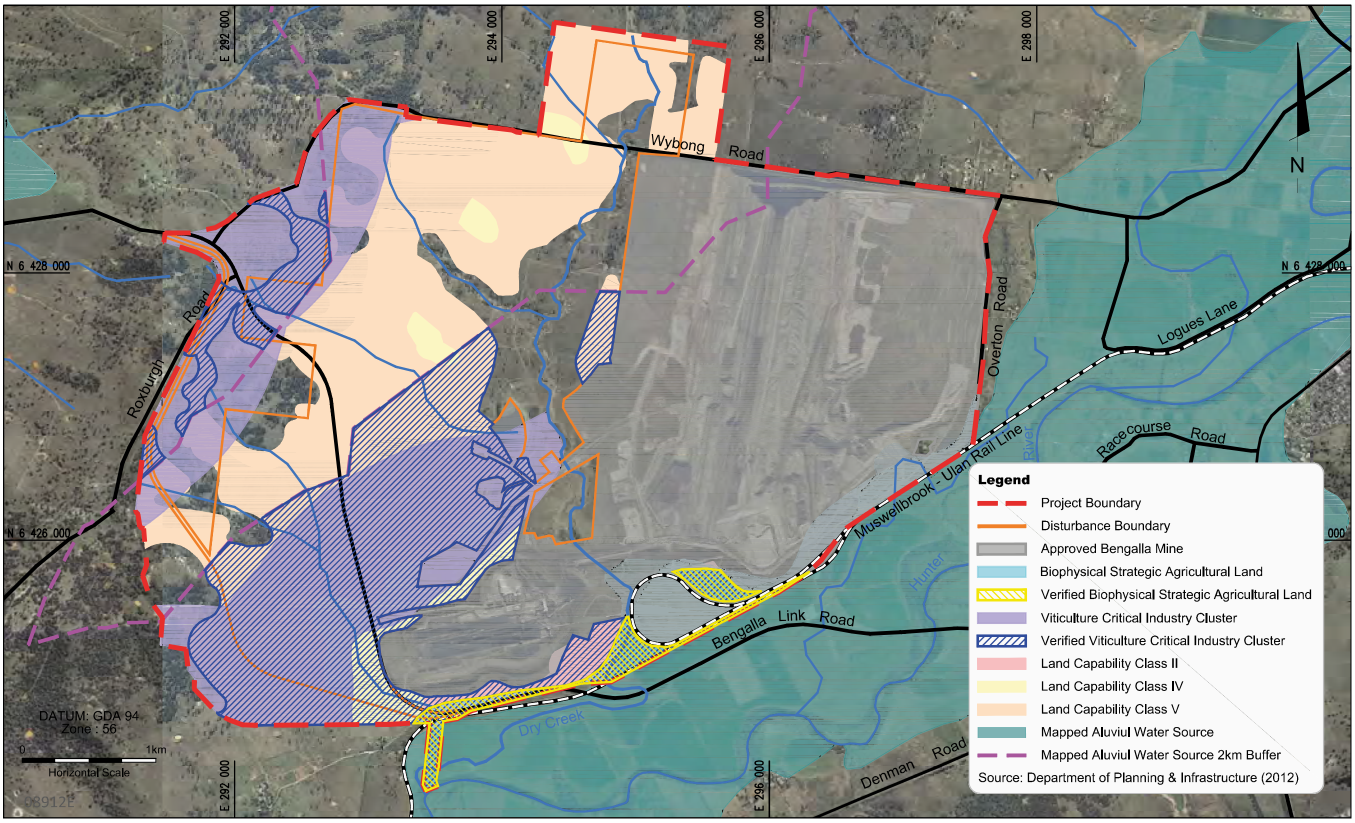
Strategic Agricultural Land (SRLUP Mapping)

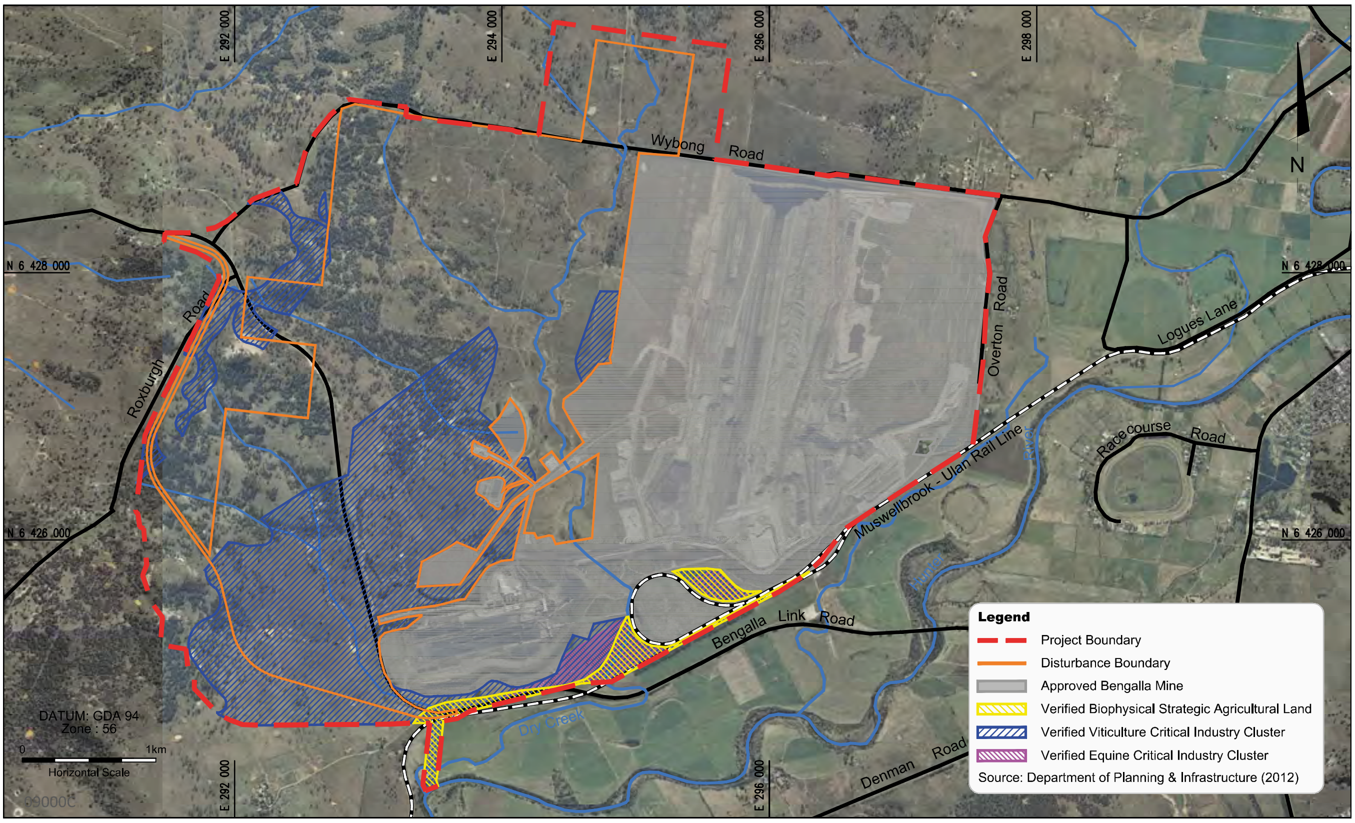
FIGURE 3



BENGALLA MINE

Strategic Agricultural Land Verification Process

FIGURE 4



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Verified Strategic Agricultural Land

FIGURE 5

2.3 Gateway Criteria Assessment

As the Project Boundary lies within the Equine CIC, the Viticulture CIC and mapped BSAL, an assessment has been conducted against the gateway criteria for BSAL and the Equine and Viticulture CICs as provided in the SRLUP. The assessment aims to determine any potential significant impacts on the BSAL and / or the CICs as a result of the Project.

Table 5 lists the assessment criteria in Table 2 of Chapter 11 of the SRLUP against the reference to the relevant section of this report, in which the potential issue is addressed.

Table 5 Gateway Criteria Assessment

Gateway Criteria	Report Section Where Addressed
BSAL: Potential significant impacts as a result of the Project:	
Impacts on the land through surface area disturbance and subsidence	**Section 8.2** and Soil and Land Capability Impact Assessment (GSSE, 2013)
Soil fertility, rooting depth and soil profile materials and thickness	**Section 8.2** and Soil and Land Capability Impact Assessment (GSSE, 2013)
Increase in land surface micro relief or soil salinity, or significant changes to soil pH	**Section 8.2** and Soil and Land Capability Impact Assessment (GSSE, 2013)
Impacts on Highly Productive Groundwater, including provisions of the Aquifer Interference Policy and the advice of the Minister for Primary Industries.	**Sections 8.3.1** and **8.3.2**
Critical Industry Cluster: Potential significant impacts as a result of the Project:	
Surface area disturbance	**Section 8.2**
Subsidence	Not Applicable
Reduced access to agricultural resources	**Sections 8.1.1** and **8.1.5**
Reduced access to support services and infrastructure	**Sections 8.5 8.8**
Reduced access to transport routes	**Section 8.7**
Loss of scenic and landscape value	**Section 8.6**

2.4 Guidelines for Agricultural Impact Statements

The Guidelines for Agricultural Impact Statements released by DP&I in March 2012 outlines the requirements for the assessment of agricultural impacts associated with all SSD applications, particularly coal mining and petroleum proposals (See **Table 6**). It is a supplementary document to the Strategic Regional Land Use Plan – Upper Hunter (DP&I, September 2012a). This report has been prepared in accordance with the Guidelines for Agricultural Impact Statements.

Table 6 Guidelines for Agricultural Impact Statements Requirements

Guideline Requirement	Report Section Where Addressed
Detailed assessment of the agricultural resources and agricultural production of the project area	**Section 5**
Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the project area	**Sections 3.1, 3.2, 3.4,** and Soil and Land Capability Impact Assessment (GSSE, 2013)
Identification and assessment of the impacts of the project on agricultural resources or industries	**Section 8**
Account for the physical movement of water away from agriculture	**Sections 8.1.2** and **8.3**
Assessment of socio-economic impacts	**Sections 8.1.4** and **8.8** and Social Impact Assessment (Doug Martin & Associates, 2013)
Identification of options for minimising adverse impacts on agricultural resources, including agricultural lands, enterprises and infrastructure at the local and regional level	**Section 9**
Document consultation with adjoining users and government departments	**Section 6**

2.5 Water Management Act 2000

The objective of the *Water Management Act 2000* (WM Act) is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources.

The Hunter Regulated River Water Sharing Plan (NSW Department of Infrastructure, Planning and Natural Resources 2004), commenced on 1st July 2004 and applies for a period of 10 years to 30 June 2014. It is a legal document made under the WM Act. The Hunter Regulated River Water Sharing Plan contains rules governing how water is shared between the environment and water users and different categories of licences.

The Hunter Regulated River Water Source extends from Glenbawn Dam downstream to the estuary of the Hunter River (below Greta) and includes Glennies Creek, from Glennies Creek Dam to the junction of Glennies Creek with the Hunter River and is fed by several tributaries. Two regulated storages, Glenbawn Dam on the Hunter River and Glennies Creek Dam on Glennies Creek, are used to store and regulate flows for irrigation, power generation, industrial and urban usage as well as flood mitigation purposes.

The Project is situated in an area where a potential source of water is from the Hunter River which is covered by the Hunter Regulated River Water Sharing Plan and is therefore subject to the provisions of the WM Act.

2.6 Standards

The following documents were referred to in preparation of this assessment:

- AS/NZS 4360:2004 Risk Management (Standards Australia);
- Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources (2009);
- Water Sharing Plan for the Hunter River Regulated Water Source ((2004);
- Agricultural Impact Statement Guidelines 2012(DP&I);
- Agfact AC25: Agricultural Land classification (NSW Agriculture); and
- Rural Land Capability Mapping, 1998 (Soil Conservation Service of NSW).

3 EXISTING ENVIRONMENT

This chapter describes the existing environment of the study area for the agricultural land use impact assessment.

3.1 Climate

Long-term climatic data from the Bureau of Meteorology weather stations at Jerrys Plains Post Office (Site No. 061086) and Scone SCS (Site No. 061089) are used to characterise the local climate in the proximity of the Project. The Jerrys Plains Post Office station is located approximately 25km southeast of the Project and the Scone SCS station is located approximately 25km north-northeast of the Project.

The data indicates that January is the hottest month with mean maximum temperatures of 31.7ºC and 31.1ºC respectively at the Jerrys Plains and Scone stations. July is the coldest month with mean minimum temperatures of 3.8ºC and 4.7ºC.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 59% in October to 80% in June at Jerrys Plains and 59% in October to 78% in June at Scone. Mean 3pm humidity levels vary from 42% in the months of October, November and December to 54% in June at Jerrys Plains. Mean 3pm humidity levels at Scone vary from 39% in December to 58% in June.

Rainfall peaks during the summer months and declines during winter at both stations. The data indicates that January is the wettest month with an average rainfall of 76.8mm over 6.5 days at Jerrys Plains and 81.3mm over 6.5 days at Scone. August is the driest month at Jerrys Plains with an average rainfall of 36.5mm over 5.2 days and July is the direst month at Scone with an average rainfall of 36.1mm over 5.1 days.

As expected, wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. At Jerrys Plains, mean 9am wind speeds range from 8.6km/h in May to 11.7km/h in September and mean 3pm wind speeds range from 11.0km/h in May to 14.7km/h in September. At Scone, mean 9am wind speeds range from 6.7km/h in May to 10.0km/h in November and mean 3pm wind speeds range from 10.0km/h in May to 15.0km/h in November.

Kovac and Lawrie (1991) report that plant growth is not limited by soil moisture for the period May to October, but low temperature does limit growth for June, July and August. Improvements in introduced temperate pasture species have the potential to increase feed availability during this period. The locality is suited to both temperate crops and annual pastures and summer crops and tropical (and sub-tropical) pasture species.

3.2 Topography within the Study Area

Kovac and Lawrie (1991) include the Project Boundary and general locality in Central Lowlands topographic zone within the Singleton soil landscape survey. The general topography consists of undulating hills which slope southward towards the Hunter River. Within the eastern and southern margins of the Project Boundary are the Hunter River Alluvial Flats. Land within the Project Boundary is dominated by slopes of greater than 7.5% and often greater than 10% (see **Figure 6**). Ephemeral streams, such as Dry Creek drain to the Hunter River flats but may not drain directly into the Hunter River except in exceptional high flows.

Figure 6 presents the topography (at a 10 m contour interval) within the locality of the Project Boundary.

The Overton Ridge is located in the eastern part of the Project Boundary and reaches 188 m AHD. South of the Overton Ridge are lower hillslopes of the Hunter Valley which rise from 134 m AHD at the Hunter River to 250 m AHD (Envirosciences 1993).

South of the Project Boundary is the Hunter River Alluvial floodplain, which generally slopes at no more than 1 degree. It is transacted by gullies of ephemeral streams which may or may not drain into the Hunter River. The approximate height of the river bank to the south of the Project Boundary is RL 130 m.

To the west of the Project Boundary the topography, as described by Kovac and Lawrie (1991) is undulating low hills and some undulating hills. Elevation varies between 300 m ADH and 160 m ADH.

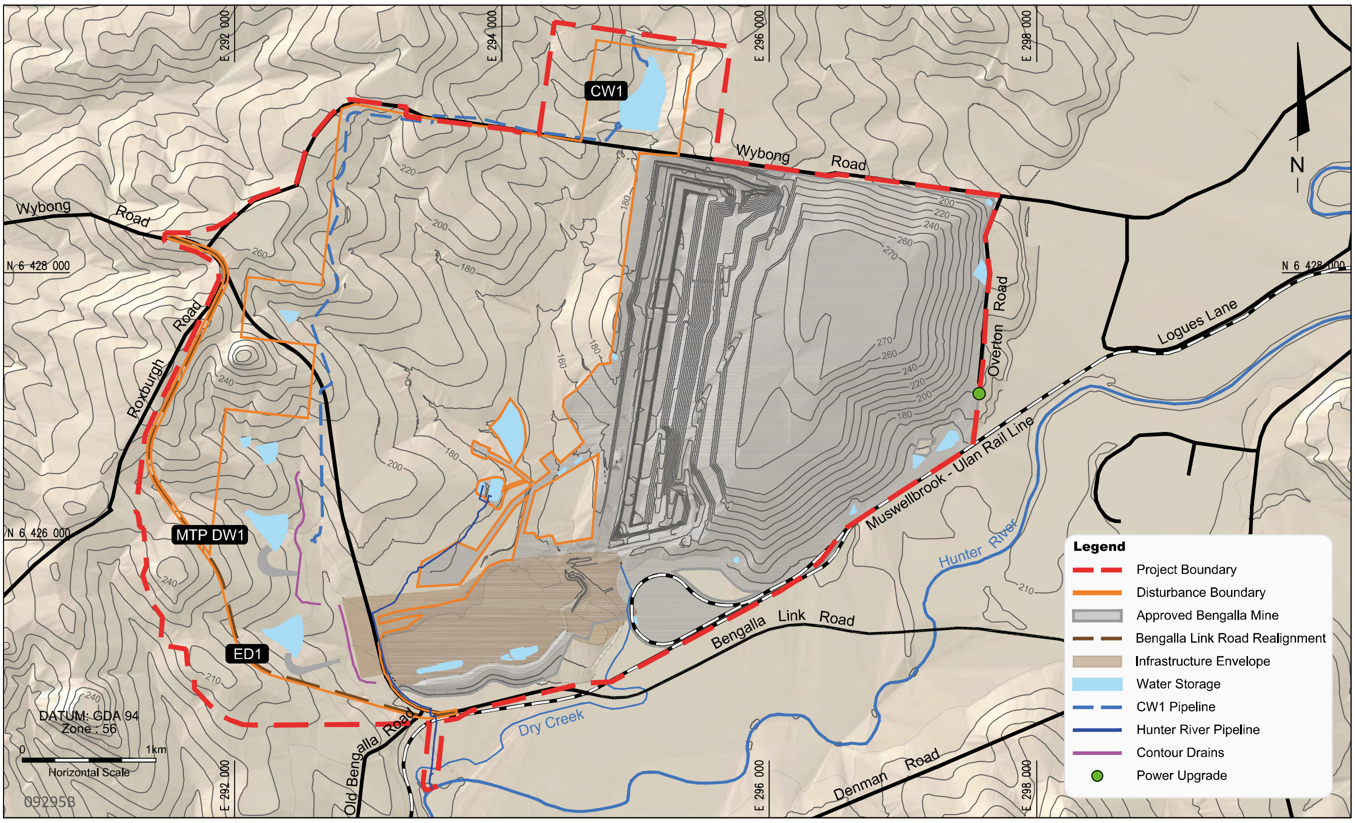
The land west of the Project Boundary is typical of the extensive grazing country to the west of Muswellbrook. Agricultural capability and land use is restricted by the slope and the potential for sheet and rill erosion if the soil was cultivated. Many areas of the locality west of the Project Boundary show signs of lack of topsoil from previous cropping land use patterns.

West of Roxburgh Road, the topography slopes downwards towards Sandy Creek.

3.3 Soils

GSS Environmental (GSSE) (2013) prepared a soil and land capability impact assessment. The impact assessment indicates that the soils within the Project Boundary are characterised by the Roxburgh and Bayswater soil landscapes as delineated by the Soil Landscapes of the Singleton 1:250,000 Sheet (Kovac & Lawrie, 1991). The main soil landscapes associated with the surrounding locality include:

- Bayswater soil landscape;
- Roxburgh soil landscape; and
- Hunter Alluvial soil landscape.



BENGALLA MINE

Conceptual Project Layout - Topographical Base

FIGURE 6

The Bayswater soil landscape describes soils that have formed from the underlying Permian Singleton Coal Measures on landscapes with between 40-60 m RL (Reduced Level) with an elevation of RL 140 to 220 m. These measures are composed of sandstone shale, mudstone, conglomerate and coal parent material and have been derived from ancient marine sediments. Due to the sediments' origin, salt levels are usually high and soils are often dispersive and highly erodible with sheet and gully erosion common landscape features (GSSE, 2013).

The Roxburgh soil landscape also describes soils that have formed from Permian Singleton Coal Measures on slightly higher and steeper landscapes with between 60-120 m local relief. These measures also comprise sandstone, shale, mudstone, conglomerate and coal which has in situ weathered parent rock material derived from colluvium. The Roxburgh unit covers undulating low hills and undulating hills with an elevation of 80 - 370 m ASL (Above Sea Level) and minor to moderate sheet erosion. Soils are primarily yellow podzolic soils (Yellow Chromosols) on upper to midslopes with red solodic soils (Red Sodosols) and brown podzolic soils (Brown Chromosols) on upper concave slopes, and Lithosols (Rudosols/Tenosols) on steeper slopes (GSSE, 2013).

The Project Boundary covers land that has a moderate K-factor and soil erosion hazard ratings. This hazard is predominately present due to the sodicity and fine texture (high clay content) of many soils in the B horizon.

The key Soil types identified included:

- Brown Chromosol (41.8 %);
- Red Chromosol (13.0%);
- Brown Vertosol (11.7%);
- Red Sodosol (5.0%);
- Brown Kurosol (1.4 %);
- Deep Brown Sodosol (4.4 %);
- Brown Sodosol (6.5%); and
- Rudosol (16.1%).

Further detail of the soil types is described in the soil and land capability impact assessment (**Appendix V** of the EIS).

The Hunter Alluvial soil landscape grouping underlies the floodplains of the Hunter River and its tributaries. This soil landscape is associated with the terraces and the floodplain of the Hunter River, does not overlap the Project Area but is located immediately to the south of the southern boundary. This grouping is characterised by brown clays and black earths along watercourses and drainage lines typically adjacent to the Dartbrook and Brays Hill soil landscapes groupings. Red podzolic soils and lateritic soils are known to occur on terraces, with the presence of non-calcic brown soils and yellow solodic soils in some drainage lines (Kovac *et al.*, 1991).

The Hunter Alluvials are considered the most agriculturally significant soils in the locality. These moderately to highly fertile soils are generally well drained with low to moderate water holding capacity and are suited to irrigation. These soils are listed as BSAL in the SRLUP and are situated outside of the Disturbance Boundary. These soils in relation to the SRLUP are discussed further in **Section 8**.

3.4 Agricultural history of the locality

The history of the Bengalla estate generally reflects the agricultural history of the wider Muswellbrook area. This section has included consideration following sources:

- Anom, (Unknown), *Bengalla Station – Unlocking Regional Memory Pastoral Station*, www.nswera.net.au
- Anom. (Unknown) *A Brief History of Muswellbrook*, www.muswellbrook.nsw.gov.au
- BMC (2008), *European Heritage Management Plan,* Bengalla Mining Company, www.riotintocoalaustralia.com.au)

The first major land parcels in the Muswellbrook district were surveyed in 1824 by Henry Dangar along the banks of the Hunter River. This was followed by the first land grants being made Including Captain Samuel Wright who was granted 2,560 acres west of Muswellbrook which he called Bengalla. Over the next decade Wright accumulated more land around Bengalla, increasing his holding to 14,000 acres. Under Wright's ownership Bengalla ran sheep and cattle as well as growing wheat and establishing a vineyard.

Wheat growing in the district grew to a level that enabled the establishment of a flourmill in Muswellbrook in 1841. At this stage the local economy was based on wheat and wool production.

After Wright's death in 1852, Bengalla Estate was sold first to Henry Osborne before being bought by the Keys family in 1854. Under various generations of the Keys family, Bengalla expanded to 20,000 acres.

The Keys family were innovative farmers leading the district in many agricultural pursuits. The third generation of Keys was responsible for recognising the fertile flats of the Hunter River were too valuable for sheep raising and cattle breeding and as such began fattening cattle from northern NSW and Queensland for the Sydney market. Keys was also responsible for the first shipment of live fattened cattle to Britain in 1895 which lead the claim by Keys that "*the pioneer shipments have been well backed up and the trade wonderfully developed".*

Keys was also instrumental in the development of dairying in the region. In 1897 he had developed dairying on Bengalla under share farming arrangements. In 1902, Keys established one of the earliest pumping stations to irrigate Lucerne crops for his dairy herds.

Under government direction (NSW Closer Settlement Acts) in 1911, 12,000 acres was offered for sale as 42 lots from 100 to 700 acres, being marketed to dairy farmers, fruit growers, wheat farmers and market gardeners.

The keys family retained 8,000 acres for dairying, Lucerne growing and the fattening of cattle and pigs. In the 1930's there were seven (7) dairy farms, each milking around 75 cows. The milk and/or cream was supplied to the Muswellbrook Co-operative Dairy Company to which John Keys was a Director.

In 1953 further subdivision of the estate took place for the purposes of soldier settlement with the Keys family retaining only 1,300 acres by 1978. The property at this time was used for dairying, Lucerne production, irrigated crops (maize and soya beans) wheat farming and a Hereford beef cattle stud.

Over time, BMC has acquired much of the Bengalla Estate of previous years and have continued the operation of farming enterprises on much of the Bengalla land. This is discussed further in **Section 4.1** of this assessment.

BMC has owned agricultural land at Bengalla since 1995. This land has been acquired as part of the process of establishing and operating Bengalla. Between 1995 and 2004 the Bengalla Agricultural Company (BAC), managed the vast majority of BMC's non-mine land assets which were used for agriculture.

Over time, BAC managed over 2,500 ha including the operation of:

- 3 dairy farms; Thornbro, Wantana and Lumeah;
- Bengalla Thoroughbred Stud;
- Dryland beef grazing; and
- Irrigated cropping of Lucerne and opportunity cash crops.

The three dairy farms were the amalgamation of six dairy farms that operated on the Hunter Alluvial flats. The first dairy was acquired in 1995. The other dairies were progressively acquired in line with Bengalla's acquisition policy. The last dairy came online in 1998 after extensive capital investment in an upgrade to the milking facility and purchase of the final dairy herd. BAC was the largest market milk quota holder in the Hunter Valley at the time of dairy deregulation in 2000.

The management of Bengalla's agricultural land during this period is discussed more fully in **Section 5.3.3**.

As well as the farming land, BMC owns four establishments at Muswellbrook Racecourse. These are currently used as racehorse training lodges at the racecourse and help maintain the Muswellbrook racetrack as one of NSW's premier racing establishments.

In 2004, BMC decided to change the management structure of their agricultural land and licensed their farming land to third parties. This saw over the transition the management of Bengalla's agricultural land to seven different parties, however the agricultural usage continued.

3.4.1 Success of land management under BMC ownership

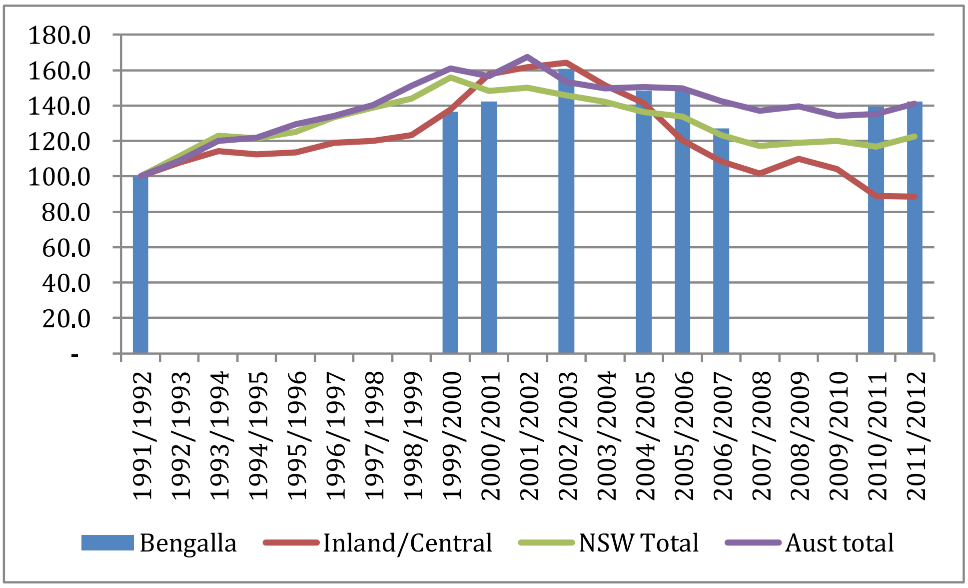
BMC has been managing agricultural land since 1995. Most of this land was identified in the report prepared for Enviroscience by NSW Agriculture (1992) (now Agriculture NSW within the NSW DPI) as part of the Bengalla EIS. The Authorisation area covered approximately 1,950 ha and the 2 km radius covered a further 4,950 ha.

As an example of how BMC has maintained and improved the production of its agricultural land examination of milk production from BMC owned land over time was carried out.

In 1992 NSW Agriculture reported that there were five dairy farms that where within the Authorisation Area while a further five had a significant area within the 2 km buffer. The five dairies within the Authorisation area produced 2.6 million litres and the dairies on the adjoining land produced another 3.0 million litres. This represented 12.3% of the total Muswellbrook factory intake of 45.8 million litres from 105 suppliers. These suppliers would have been predominantly from the Muswellbrook and the now Upper Hunter Shires. The five dairies within the initial Bengalla Authorisation Area and one of the dairies from the adjoining land are the six dairies that Bengalla amalgamated into three under its management. Prorating the production from the adjoining land the estimated production from these six dairies was 3.1 Million litres.

Figure 4 shows how Bengalla dairies have increased and maintained production over the period since 1991/92 relative to the Central/Inland regions of NSW, NSW as a whole and Australia. Muswellbrook is classified the Central/Inland region of NSW.

Figure 7 Milk production from Bengalla (available years) compared to Central/Inland region of NSW, NSW and Australia



Base year 1991/92 =100

Source: Dairy Australia (2012)

It is noted that milk production information for the Bengalla owned land is not available for all years. As stated, from 1995 to 1998 Bengalla progressively acquired the land and milking facilities that became the BAC dairy operations.

Using 1991/92 as a base year it can be seen that all areas increased production till just after dairy deregulation in 2000. Since then drought and volatile milk markets have seen milk production decline across Australia to where now the Central/Inland (which includes the Hunter Valley) is producing 88.5% of the volume of 1991/92 from a peak of 162%. The NSW comparison is current 122% from a peak of 150% and Australia 141% from a peak of 161%.

Bengalla's milk production peaked at 161% in 2004/05 and is currently 142% of the base level of 1991/92.

During its tenure BAC also successful operated the Bengalla Stud. As well as standing up to three stallions on behalf of clients, Bengalla Stud foaled down up to 40 mares per season and ran dry mares. Each year Bengalla Stud prepared weanlings and yearlings for the major thoroughbred sales in NSW and Queensland, gaining a reputation for the quality of preparation carried out. Bengalla Stud achieved notoriety when a mare bred at Bengalla won a Group 2 race in Adelaide. Other enterprises Bengalla participated in were beef cattle grazing, Lucerne hay production and irrigated (winter cereals) cropping. These enterprises were driven by seasonal conditions.

3.5 Hunter Regulated River Water Source

The Hunter River is situated to the south of the Project and is a source of highly reliable irrigation water, which is utilised on adjacent river flats and also used for industrial purposes (coal mining and power generation), basic landholder rights (stock and domestic) and urban water use.

The Hunter Regulated River Water Source extends from Glenbawn Dam downstream to the estuary of the Hunter River (below Greta) and includes Glennies Creek, from Glennies Creek Dam to the junction of Glennies Creek with the Hunter River and is fed by several tributaries. Two regulated storages, Glenbawn Dam on the Hunter River and Glennies Creek Dam on Glennies Creek, are used to store and regulate flows for irrigation, power generation, industrial and urban usage as well as flood mitigation purposes. Inflows into Glenbawn Dam can be supplemented by the Barnard Scheme.

The Barnard Scheme allows for water to be pumped from the upper catchment of the Manning River into the Hunter River. Its purpose is to allow Bayswater and Liddell Power Stations to utilise water from the Manning catchment to ensure adequate water supply for power generation in times of severe drought.

The Hunter Regulated River Water Sharing Plan, which was developed under the WM Act provides for 22,159 unit shares of high security water and 128,163 unit shares of general security water. At 100% allocation, one unit share is equivalent to 1.0ML of water. (NSW DIPNR, 2004). Since the implementation of the Hunter Regulated River Water Sharing Plan in 2004, the general security final allocation has been 100% except in the 2006/07 water year when the final allocation was 35% (high security allocation was 92%). This is the only time since Glenbawn Dam was enlarged in 1987 that the general security final allocation has been less than 100%. In seven of the years since enlargement of the dam the final allocation has been 120%.

The Project is located in zone 1 under the Hunter Regulated River Water Sharing Plan. Zone 1 covers the Hunter River upstream of the Glennies Creek junction. Access licence rules provide for restrictions to dealings which would over commit the reliability of allocations within zone 1 (assignment of allocations from downstream of Glennies Creek junction into zone 1).

Appendix 1 shows the water access licences (WALs) held by Bengalla for mining and agricultural purposes. This shows that Bengalla holds WALs from the Hunter River Regulated Water Source for:

- 5,996 shares of general security water;
- 6 shares of high security water;
- 134 units of stock and domestic water, and
- 629 shares of supplementary flow water.

4 EXISTING AGRICULTURAL ENTERPRISES AND RESOURCES

This section identifies and describes the existing agricultural resources and enterprises within Bengalla owned land and the surrounding locality. These agricultural resources and enterprises are shown on **Figure 8**. In general, agricultural activities in locality include:

- Dairying;
- Equine activities (thoroughbred breeding, Australian Stock Horse and pleasure and performance horses),
- Irrigated Lucerne growing,
- Irrigated cash crops;
- Intensive and extensive cattle grazing; and
- Sheep production.

Further afield in the general Muswellbrook district wine grape production and olives production is also carried out.

4.1 Agricultural Enterprises

4.1.1 Bengalla owned land

As at May 2012, BMC owned 3,203 ha of land with 974 ha consisting of the Approved Bengalla Mine. The balance of 2,229 ha is leased out by BMC for agricultural, rural residential or thoroughbred horse training (associated with Muswellbrook Race Club) (see **Figure 8**). The breakup of this area is approximately:

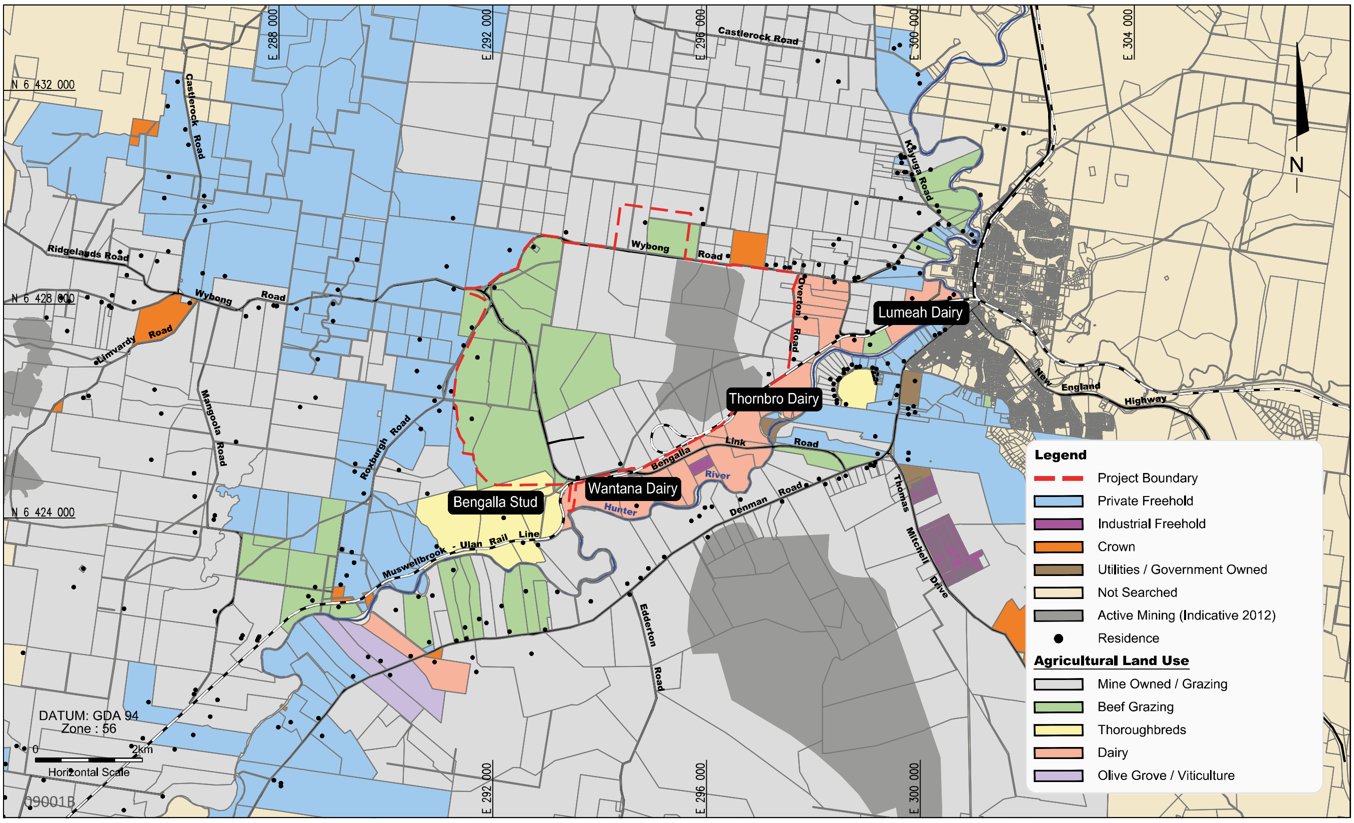
- Agriculture (2,196 ha);
- Race course: training with residences (23 ha); and
- Rural residential (10 ha).

The agricultural land within BMC's landholders is managed for agricultural purposes by licensees who occupy the land. The licensees may also operate other land holdings.

The land uses on BMC owned land is shown on **Figure 8.** There are a number of enterprises currently being undertaken including:

- Dairying;
- Thoroughbred breeding;
- Beef cattle breeding;
- Lucerne hay production; and
- Industrial hemp production.

BMC also leases out 4,114 units of its WALs from the Hunter River Water Source. This is in addition to the WALs Bengalla owns for mining purposes. **Table 7** shows the categories and shares licensed of the land managers of Bengalla owned agricultural land as part of their licence arrangements.



BENGALLA MINE

Indicative Land Use

FIGURE 8

Table 7 Bengalla Hunter River Regulated Water Source Entitlements Licensed to Land Managers

Licensee Category	General Security (shares)	High Security (shares)	Stock & Domestic (ML)	Supplementary Flow (shares)
Agricultural Licensees	3,369.2	5.1	20.4	596.9
Racecourse Licensees	45.0	0	0	0
Rural Residential Licensees	0	0	108.0	0
Total	**3,414.2**	**5.1**	**128.4**	**596.9**

The value and quantum of agricultural production from Bengalla owned agricultural land and irrigation water is documented in **Section 5.3.**

4.1.2 Current agricultural production on Bengalla Owned Land

A series of land managers and business owners currently operate Bengalla owned agricultural land under a "Licence to Occupy". These licences set out the terms and conditions under which the various licensees operate. These licences include amongst over things:

- Extended licence periods with some operating under 5 year initial term with 2 further five year options;
- Requirement to supply a farm plan every 12 months;
- Requirement to maintain soil fertility (as per agreed farm plan);
- Requirement for pest and weed control plans;
- Restrictions on removal of trees and other vegetation; and
- Twice yearly farm inspections by third party agent of BMC including verification of licence conditions (e.g. maintenance of soil fertility levels).

The success of these arrangements for BMC and the Licensees is seen in that most of the Licensees covering the vast majority of the land are operating on the initial licences negotiated.

Current (2012) agricultural operations leased to private holders include:

- Dairying, calving approximately 900 cows per annum on the Hunter River Alluvials producing 4.7 million litres of milk;
- Operate a thoroughbred stud and brood mare farm, standing 3 stallions and agisting 38 mares and 26 young horses permanently, increasing in the season;
- Over 1,500 tonnes of hay (mainly Lucerne) for sale as well as producing hay for on farm use;

- Harvest 100 tonnes of industrial hemp as an experimental crop for the embryonic Hunter Valley hemp fibre industry; and
- Run over beef breeding cows selling over 900 fat and store stock per annum.

This varied production base is based on 2,196 ha, of which 823 ha are outside the approved Bengalla Mine and the Project Boundary.

The Licenses also have access to WALs totalling 3,392 of General Security shares from the Hunter Regulated River Water Sources well as 5.1 High Security shares, 596.9 Supplementary Flow shares 20.4 and 20.4 ML of Stock and Domestic water.

Based on interviews with Licensees and gross margin budgets (NSW DTIRIS 2011) the gross value of this production from Bengalla owned agricultural land is estimated at $3,087,584 per annum with a net value of $1,390,881 per annum. This is detailed in **Table 8.**

Table 8 Quantum and value of agricultural production from Bengalla agricultural land

Enterprise	Quantum of Production
Dairying	4.7 million litres
Thoroughbred Stud	3 stallions, dry mares, foals, yearlings
Cattle sales	910 head
Hay sales	1,597 tonnes
Hemp Sales	100 tonnes
Total Gross Value	**$3,087,584**
Total Net Value	**$1,320,381**

4.1.3 Surrounding Locality

Some of the major landholders in the locality are coal mining operations, including:

- BHP's Mount Arthur Coal Mine;
- Coal & Allied's Mount Pleasant Project; and
- Xstrata's Mangoola Coal Mine.

These operations also have agricultural enterprises occurring on their non-operational land. Mount Arthur licensees its agricultural land out to land managers in a similar manner too Bengalla. Mangoola's agricultural land is managed by Colinta Holding, a wholly owned subsidiary of Xstrata (Mangoola Coal, 2010)

One of the major agricultural land uses within the locality of the Project is beef cattle grazing. Common beef cattle enterprises include:

- Weaner production;
- Vealer production;
- Yearling production;
- Feeder steer production;
- Japanese Ox production; and
- EU cattle production.

Beef production occurs across all soil types and topography within the locality, including the Hunter River flats (BSAL), improved and unimproved dryland pasture and irrigated land. The thoroughbred breeding enterprises also tend to have an associated beef operation to utilise excess grass growth and lower quality land not assigned for horses.

As well as intensive and extensive beef cattle grazing, other agricultural land uses of the alluvial flats within the locality of Bengalla are:

- Dairying;
- Lucerne hay production;
- Thoroughbred brood mare farms including Edinglassie (owned by Mount Arthur Coal Mine) and Balmoral Stud,
- Horticulture including an olive grove and a small vineyard; and
- Sheep farming for wool and fat lamb production (on dryland grazing country within the Study area).

There are no forestry enterprises, designated conservation areas, designated recreation areas or privately owned wineries within 10 km of the Project Boundary.

Associated with the olive grove is an olive oil processing plant and retail outlet. It should be noted that the olive grove is owned by Hunter Valley Energy Coal.

Land use in the locality is shown in **Figure 8**.

4.1.4 Supporting Infrastructure and Services

Agricultural enterprises in the locality of Bengalla are supported by a range of general and specialist services and infrastructure.

The thoroughbred breeding operations of the Hunter Valley are supported by a sophisticated network of support services, including the Muswellbrook Veterinary Hospital (recently acquired by Scone Equine Hospital) and the Barn Veterinary Service, feeder farms (such as specialist Lucerne producers), farriers and specialised horse transport companies.

Cattle production in the locality relies on the livestock sale yards at Scone and Singleton. These sale yards hold weekly fat sales and monthly store sales, which are serviced by livestock agents in the area. To a lesser extent, the Denman sale yard is utilised to hold a monthly store sale.

Various agricultural producers supplying hay, silage and green crop, support select dairy operations in the area. Other agricultural industries in the locality rely on a range of services provided in the Singleton and Muswellbrook Local Government Areas (LGAs), including veterinary practices, input suppliers (fertiliser, seed, chemicals, and agricultural hardware), irrigation suppliers and technicians, and heavy and light engineering works.

Key routes utilised by most agricultural enterprises to access supporting services within the local area and further abroad are typically via the Golden Highway, the New England Highway and Denman Road.

4.2 Agricultural Resources

The significant agricultural resources in the locality of the Project include:

- Hunter Regulated River Water Source (Hunter River); and
- Hunter Alluvial soil landscape grouping.

The Hunter River Regulated River Water Source and associated aquifers together with the Hunter Alluvial soil landscape grouping contribute to the BSAL identified in the SRLUP (DP&I, September 2012a). This is discussed further in **Section 8**.

4.3 Agricultural Value

The agricultural industry for the Upper Hunter region, which includes the Singleton, Muswellbrook, Upper Hunter, Dungog, Gloucester and the Great Lakes LGAs is estimated to have a total regional export output of approximately $403 M (Buchan Consulting, 2011). The contribution of each agricultural enterprise is listed in **Table 9**.

Table 9 Upper Hunter Agricultural Industry Export Values

Enterprise	Output Value
Beef, dairy and some crops	$248M
Equine	$100M
Wine and grapes	$55 M

Source: Buchan Consulting, 2011

The Project is entirely situated within in the Muswellbrook LGA. From the census data of 2006, the total gross value of agriculture production for the Muswellbrook LGA was $34 M, excluding equine and wine (ABS, 2006).

4.4 Employment

The agricultural industry in the Upper Hunter region employs approximately 5,039 people (Buchan Consulting, 2011). Employment for each agricultural enterprise is listed in **Table 10.**

Table 10 **Upper Hunter Agricultural Industry Employment**

Enterprise	Employment
Beef, dairy and some crops	886 (direct)
Equine	3,753 (direct and support)
Wine and grapes	400 (direct)

Source: Buchan Consulting, 2011

A shown in **Table 11**, in the Muswellbrook LGA, the highest proportion of employment associated with agriculture lies with the beef, equine and wine enterprises (ABS, 2006).

Table 11 **Muswellbrook LGA Agricultural Industry Employment**

Enterprise	Muswellbrook LGA	
	No. Persons	%
Beef	166	17.7
Sheep	11	1.2
Dairy	81	8.6
Other Livestock	6	0.6
Equine	274	29.2
Poultry	23	2.4
Wine	171	18.2
Fruit and Vegetables	6	0.6
Grains	22	2.3
Flowers	10	1.1
Forestry and Timber	3	0.3
Fishing and Aquaculture	0	0.0
Other Agriculture	31	3.3
Agriculture Support	90	9.6
Food Processing	45	4.8
Total	**939**	**100**

Source: ABS, 2006

5 AGRICULTURAL ASSESSMENT

This chapter discusses the agricultural assessment of the land that will be occupied by and the water to be used by the Project. It also provides alternative land uses for land within the Project Boundary and discusses the suitability of those enterprises.

5.1 Methodology

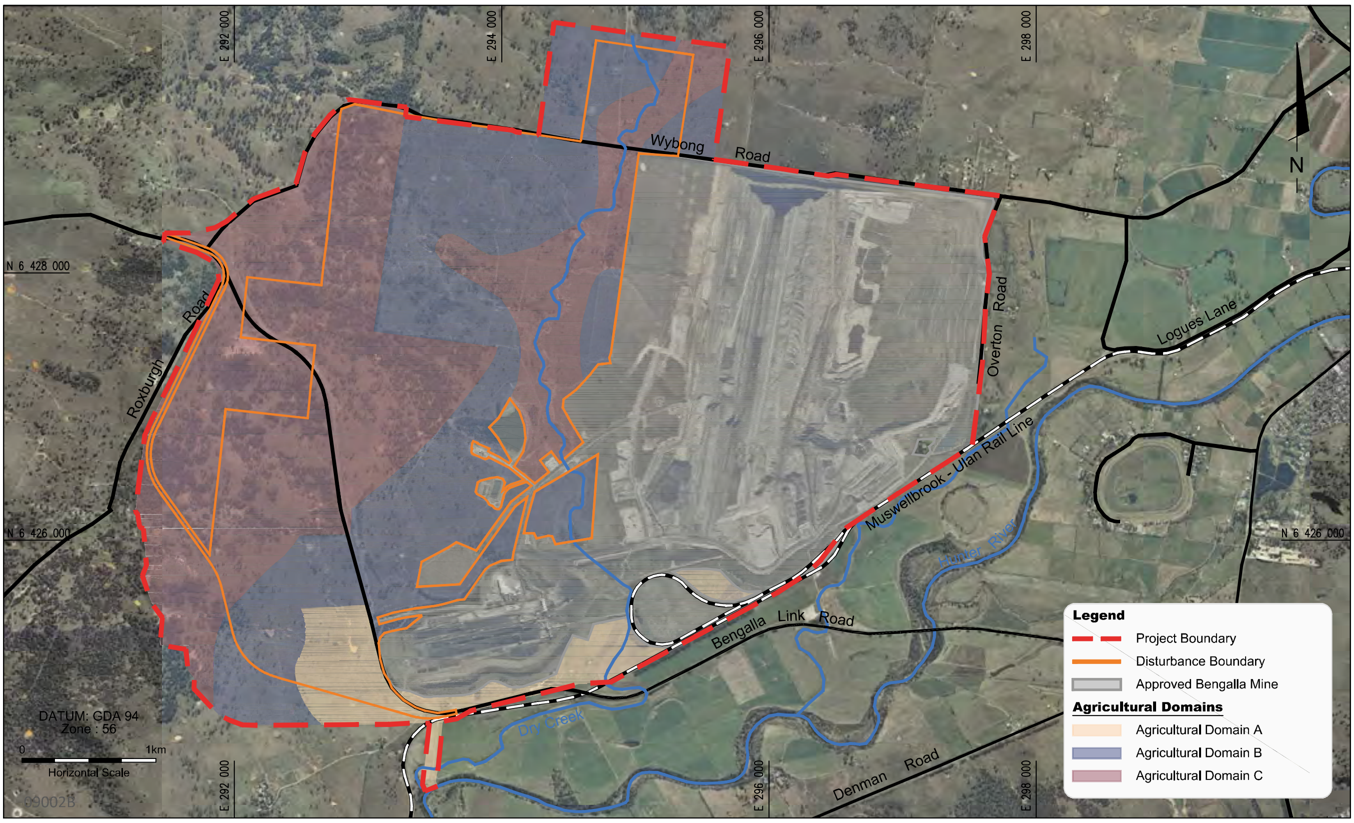
The assessment methodology comprised:

- A review of the EIS soil and land capability impact assessment prepared by GSSE (2013);
- A review of the EIS surface water impact assessment by WRM Water and Environment (WRM)(2013);
- A review of the EIS ecology impact assessment by Cumberland Ecology (2013);
- A site visit to Bengalla and SBA's previous knowledge of the BMC agricultural land uses to assist in reviewing GSSE's soil and land capability impact assessment and to inspect the current agricultural production within the Study Area;
- Interviews with available BMC's agricultural land licensees to confirm current agricultural enterprises currently being undertaken;
- Desktop analysis of the quantum and value of agricultural production from BMC agricultural land and enterprises in the locality;
- Desktop analysis of the potential quantum and value of agricultural production of the water from the Hunter River Water Source to be used by the Project;
- Desktop analysis of the agricultural production's contribution to the local, regional, State and national agricultural output; and
- Consideration of the potential impacts of the Project on BSAL and identified CICs as defined by the SRLUP.

5.2 Agricultural Domains

5.2.1 Project Boundary

The Project Boundary was dissected into agricultural domains based on the soil and land capability impact assessment (GSSE, 2013) and SBA's own field observations of agricultural characteristics. The domains are shown in **Figure 9**.



BENGALLA MINE

Agricultural Domains

FIGURE 9

BENGALLA

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Table 12 provides an overview of each of the agricultural domains and their quantitative distribution within the Project Boundary and excluding the area occupied by the approved Bengalla Mine.

Table 12 The Project Boundary Agricultural Domains

Agricultural Domain	Description	Area (ha)	Area %
A	Area adjacent to the Hunter River alluvials to the south of Project Boundary - lower slopes of dryland country suited to grazing and pasture improvement.	113	8.3
B	Area associated with lower to mid slopes, requires soil conservation works/minimum tillage techniques to establish improved pastures or grazed as unimproved pasture.	527	38.9
C	Area associated with steeper slopes, not suited to any cultivation due to erosion risk, restricted to native pasture, occasional rotational grazing required to avoid soil erosion issues.	716	52.8
Total		**1,356**	**100.0**

Table 12 shows Agricultural Domain A is the highest quality agricultural land and least abundant within the Project Boundary, comprising an area of approximately 113 ha (8.3%). This land is suited to the establishment of improved pasture utilising minimal tillage techniques or occasional tillage and is capable of supporting reasonable levels of pasture production. This land primarily coincides with the following from the EIS soil and land capability impact assessment (GSSE, 2013):

- Brown Vertosol soils;
- Land capability classes IV (Cunningham *et. al.* 1988); and
- Agricultural land suitability class 3 (Hulme *et. al 202).*

Agricultural Domain B covers an area of 527 ha (38.9% of land within the Project Boundary) and is suited to limited pasture improvement by minimal tillage techniques. This land is capable of supporting reasonable levels of pasture production and such can be used for beef cattle grazing for weaner production. This land primarily coincides with the following from the EIS soil and land capability impact assessment (GSSE, 2013):

- Brown Chromosol soils;
- Land capability classes V and VI; and
- Agricultural land suitability class 3 and class 5.

The majority (716 ha or 52.8%) of the land within the Project Boundary is composed of land classed as Agricultural Domain C. This land is suited to grazing by beef cows for weaner production at low stocking pressure. It is not suited to pasture improvement due to soil type and or slope. This land primarily coincides with the following from the EIS soil and land capability impact assessment (GSSE, 2013):

- Brown Vertosol soils and Rudosol soils;
- Land capability classes V, VI and VII; and
- Agricultural land suitability Class 4.

5.3 Agricultural Production and Value

5.3.1 Project Boundary

To examine the quantum and value of the agricultural production from the Project Boundary, information as to the current agricultural practices and the number of livestock the Licensees to Occupy carried, interviews were held with licensees. It is noted that the current operators' may operate land outside the Project Boundary but on Bengalla owned land and/or non-Bengalla owned land. This information was used in association with the NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) (Primary Industries) (2011) gross margin budgets to calculate the quantum and value of agricultural production from Bengalla. The assumptions are summarised in **Appendix 2**.

The enterprises used for each agricultural domain is shown in **Table 13**.

Table 13 Current Enterprises per Agricultural Domain within Project Boundary

Agricultural Domain	Carrying Capacity (DSE/ha)*	Area (ha)	Description of Agricultural Enterprise	Stocking Rate (ha/Breeding Cow)
A	8.0	113	Cattle breeding enterprise producing yearlings for domestic trade	2.1
B	5.1	527	Cattle breeding enterprise producing inland store weaners	2.9
C	3.5	716	Cattle breeding enterprise producing inland store weaners	4.3

** DSE – Dry Sheep Equivalent. The equivalent daily energy requirement of a 50 kg wether not losing or gaining weight.*

The production value of the three agricultural domains per hectare and total value is summarised in **Table 14**. The assumptions are summarised in **Appendix 2**.

Table 14 Value of Current Agricultural Production within Study Area

Agricultural Domain	Enterprise	Number Animals Sold*	Gross Value of Production	Net Value of Production
A	Yearlings	45	$32,275	$26,549
B	Inland weaners	150	$79,750	$60,056
C	Inland weaners	139	$74,022	$55,742
Total		**334**	**$186,048**	**$142,347**

** Includes culled breeding stock.*

Table 14 shows that the gross value of agriculture (beef cattle) production from the Project Boundary, based on the current land use, is $186,048 per annum. The net value of agricultural production is $142,347. This is from the sale of 334 head of cattle per annum (weaner and fattened weaners, cull cows and bulls). It is noted that only the Disturbance Boundary will be removed from agricultural production. This is discussed in **Section** 8.

The two closest regional sale yards with weekly prime sales are at Scone and Singleton. Both sale yards also hold monthly store cattle sales. The National Livestock Reporting Service NSW Cattle Saleyard Survey for the financial year ended 30 June 2011 (MLA, 2011) shows that the Scone and Singleton sale yard had throughputs of 76,402 and 56,903 head, respectively. During this period, the Scone sale yard was ranked 8th and the Singleton sale yard was ranked 11th in NSW for cattle sold by auction through the saleyard system. The National Livestock Reporting Service NSW Cattle Saleyard Survey (MLA, 2011a) reports a total of 1,847,555 cattle sold through NSW saleyards in 2011.

There is a small sale yard located at Denman, which holds monthly store sales. Meat and Livestock Australia (MLA) did not report the number of cattle sold through the Denman sale yard in 2011 nor was it ranked amongst NSW sale yards. The 2010 NSW Cattle Saleyard Survey did report Denman sale yards, which was ranked 53 out of 54 yards listed.

If it is assumed that all cattle from the Project Boundary are sold through the Scone and Singleton sale yards, the expected number to be turned off represents 0.44% of Scone's throughput or 0.59 % of Singleton's throughput. The number of cattle turned off the Project Boundary represents 0.25% of the combined cattle throughput (prime and store) of the Scone and Singleton saleyards.

Based on the Upper Hunter Shire Council's yard charges of $8.18 per head (financial year 2011/12), the 334 head sold from Project Boundary would contribute $2,732 of income to the Scone sale yards (if all were sold through Scone). Yard charges for Singleton are not available; however, a similar figure to Scone would be expected. It should be noted that cattle do not necessarily have to be sold through these saleyards but could be sold direct to slaughter works (prime stock) or "*out of the paddock*" to be grown out and/or fattened by other producers. These options are also popular management choices.

There are local cattle abattoirs at Scone and Singleton, however, cattle from the Upper Hunter are often processed outside the region at abattoirs such as at Wingham, Casino and Dinmore in Queensland. **Table 15** shows the value of the regional, State and National beef slaughtering. It illustrates the relatively small magnitude the agricultural output of Project Boundary compared to regional, State and National production.

Table 15 Value of Beef Slaughtering

Enterprise	Bengalla Project Boundary	Hunter Region	NSW	Australia
Beef Slaughtering	$ 0.2 M	$ 95.5 M	$ 1,487.6 M	$ 6,550.5 M
Total Agricultural Production	$ 0.2 M	$ 311.7M	$ 8,359.2 M	$ 39,645.1 M

Source: ABS, 2008; ABS, 2011

5.3.2 Quantum and Value of Agricultural Water

BMC currently holds WAL 001106 from the Hunter River Regulated Water Source which entitles BMC to 1,449 shares from the water source. Based on 100% allocation this equates to 1,449 ML. This water allocation will be required to supplement existing site water for use in the CHPP and for dust suppression. This water is also used for the existing operations of the Approved Bengalla Mine. If this water was not used for mining related activities it could be used for agriculture.

In addition to the 1,449 shares under WAL 001106, BMC licences a further 4,070 shares of general security water and 5.1 shares of high security water to its agricultural licensees and further 45 shares to its racecourse licensees.

Irrigated agriculture, associated with the Hunter River flats, is not undertaken within the Project Boundary. On BMC owned land, irrigation is used for growing pasture and fodder crops (Lucerne, maize silage) for dairying and hay for sale. This allocation of irrigation is a management decision of the licensee and depends on their own enterprise. The majority of BMC's irrigation water licenses are not used for cash crops but used for the production of fodder (pasture and crops) which are valued added to on farm in terms of dairying or fed to horses.

To conservatively quantify the potential agricultural production (quantum and value) of the water, it was assumed that the water would be used for the production of cash crops, namely Lucerne hay and maize grain. Production was based on a seven year rotation (5 years Lucerne, 2 years maize production). A 100% water allocation was also assumed, that is 1,449 ML used per year. Agriculture NSW gross margin budgets where used (NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) (Primary Industries) (2011)).

The 1,449 ML of water potentially produces a gross value production of $797,488 and a net value of $211,413 from the production of 2,397 tonnes of Lucerne hay and 533 tonnes of maize grain. The gross value of production per ML of water was $550 and the net value $146. This is detailed in **Table 16**.

Table 16 Potential Production from BMC Water Licence WAL 001106 per annum*

Crops grown	Lucerne	Maize	Total	Value/ML
Years grown	5	2	7	
ML/ha	8.0	7.2		
Weight average ML/ha	5.7	2.1	7.8	
Ha grown	132.5	54.0	186.5	
Yield (t)	2,397	533		
Gross value	**$654,719**	**$142,769**	**$797,488**	**$550/ML**
Net value	**$151,570**	**$59,843**	**$211,413**	**$146/ML**

**Assumes 1 share equals 1 ML of water (100% allocation).*

The land that is potentially irrigated by the 1,449 ML is still able to be used for productive agriculture. If it is assumed that the same area (186.5 ha) is used for the production of cash crops in the form of dryland lucerne hay production and grain sorghum (less sensitive to water stress at flowering than maize) the area would produce 533 tonnes of lucerne hay and 240 tonnes of grain sorghum, representing a gross value of production per annum of $196,574 and net value per annum of $65,113.

The impact of removing this water from agriculture is a loss of production of 1,865 tonnes of lucerne hay and 293 tonnes of grain, resulting in a loss of gross value of production per annum of $501,295 and a net value of production of $102,096.

Assumptions used for calculations of the value of irrigation water are shown in **Appendix 3**.

The impacts of the additional water required for the Project are discussed in **Section 8.1.2** of this report.

5.4 Potential Agricultural Production

5.4.1 Project Boundary

The potential agricultural production from the Project Boundary area was examined assuming changes to management to represent superior management and or capital investment. The changes identified were pasture improvement and paddock subdivision to allow for more intense grazing management.

The following assumptions were made:

- Agricultural Domain A: $350 per hectare invested in pasture improvement and repeated every seven years; one off $125 per hectare for paddock subdivision and stock water reticulation; additional annual pasture maintenance cost of $50 per hectare per annum; carrying capacity improves to 15 DSE/hectare;

- Agricultural Domain B: $150 per hectare invested in pasture improvement and repeated every seven years; one off $125 per hectare for paddock subdivision and stock water reticulation; additional annual pasture maintenance cost of $50 per hectare; carrying capacity improves to 10 DSE per hectare; and
- Agricultural Domain C: No change to management due to poor soil type.

No allowance has been made for increased risk of seasonal climatic variations and greater sensitivity to timeliness of management decisions and actions. Under the above scenarios the management systems would be operating further along the marginal risk reward portion of the production curve.

Table 17 shows that the gross value of agricultural production could be increased to $264,901 per annum and the net value to $204,054. The assumptions are summarised in **Appendix 4**.

Table 17 Maximum Potential of Agricultural Production within Project Boundary

Domain	Enterprise	Number Animals Sold*	Gross Value of Production	Net Value of Production
A	Yearlings	85	$60,963	$50,147
B	Inland weaners	235	$124,693	$93,899
C	Inland weaners	139	$74,022	$55,742
Total		**459**	**$259,678**	**$199,789**

**Cattle would need to be withheld from grazing for first 12 months of pasture improvement.*

This change in management would result in an increase gross value of production from the Project Boundary of $73,630 from the sale of an extra 125 head of cattle. The increase in net value of production would be $57,442.

5.5 Alternate Agricultural Land Use Suitability

The south-western corner of the Project Boundary where Bengalla Road turns north is potentially the most productive agricultural land within the Project Boundary.

The area is well suited to grazing animals. As such an alternative land use may include beef enterprises or the land may be utilised for dry mares or young thoroughbred stock. This would require development of the pasture base and further enhancement of the fencing and stock water reticulation system.

Further capital expenditure for the development of an irrigation system would further enhance the pasture production. The capital cost to install the irrigation system would be approximately $10,000 per ha ($100,000 for 10 ha travelling high pressure gun irrigation system). This includes the cost of supply and installation of pumps, irrigation mains and irrigator. The cost of WAL from the Hunter River Water Source is not included in this cost.

The cost of general security water from the Hunter Regulated River Source has traded in the range of $643 to $4,089 per ML as shown in **Table 18** below.

Table 18 Analysis General Security Water Trading Hunter River 2005/06 to 2010/11

Water Year	Number of trades	Total volume traded (Shares)	Weighted average price
2011/12	2	308	$2,881
2010/11	2	201	$2,614
2009/10	2	70	$643
2008/09	4	257	$3,109
2007/08	9	2,510	$4,089
2006/07	9	844	$3,398
2005/06	5	1,018	$1,842
TOTAL	**31**	**4,900**	**$3,315**

** General Security Record of trading as of 2 November 2012*
Only trades with record value or non "peppercorn" value
Source: http://registers.water.nsw.gov.au/wma/WaterShareIntraWSLocSearch.jsp?selectedRegister=WaterShare

Excluding years 2006/07 and 2007/08 (drought year and drought recovery year) the weighted average price is $2,229/ML. Based on pasture use of 8 ML/ha per annum (adequate for 4 years in 5 years), this represents a further capital cost of $17,832 per ha.

The total capital cost to establish the irrigation system for a 10 ha site is estimated to cost $278,320.

The potential land uses for these irrigated sites are:

- Wine grape vineyard; or
- Intensive irrigated pasture production for beef grazing or dairying.

Both these enterprises also require capital expenditure for irrigation infrastructure and WAL purchase which would be of the same magnitude.

It is noted that the area under wine grapes in the Upper Hunter has decreased over the past five years including Vineyards in the Muswellbrook, Denman and Scone areas operated by large family owned (Tyrrells) and corporate (Rothbury Estate, Treasury Wine Estates) vineyards as well as smaller vineyards.

If it is assume that the dairy operation at Bengalla can access this land with the milking herd, the 10 ha of irrigated land could grow enough feed for 35 milking cows (3.5 milking cows per ha). These extra 35 cows would be expected to produce a further 245,000 litres of milk gross (including livestock sales) $122,500 (50 cpl). The cost of production of 245,000 litres would be approximately 38 cpl leaving a net profit of 12 cpl or $29,400 profit.

The capital investment for this $29,400 profit is:

Irrigation water:	$178,320
Irrigation infrastructure	$100,000
Cattle Purchase (@ $1,800/hd)	$ 63,000
Total Capital Investment	$341,320

Based on a capital investment of $341,320 the marginal return on assets projected is 8.6% and over 11 years payback period.

6 STAKEHOLDER CONSULTATION

The stakeholder engagement program for the Project and this assessment included consultation with local, state and federal government agencies, neighbouring landowners and industries, and the wider local community. Full details of the stakeholder engagement program for the Project are discussed in the main volume of the EIS.

Specific to this AIS, regulatory stakeholders consulted were:

- Department of Primary Industries – Agriculture NSW.

Table 19 outlines the regulatory stakeholder issues specific to this assessment and the section of the report which corresponds to each issue.

Table 19 Regulatory Issues specific to AIS

Ref.	Issue Raised	Section
1	Final landform and agricultural use	**Sections 8.1.1** and **9.1** and Soil and Land Capability Impact Assessment (GSSE, 2013)
2	Topsoil to maintain a suggested land use	Soil and Land Capability Impact Assessment (GSSE, 2013)
3	Leasing arrangements and length of lease to demonstrate long term	**Section 4.1.2**
4	Soil testing on BMC agricultural land	**Section 4.1.2**
5	Final landform of Dry Creek and water access	Soil and Land Capability Impact Assessment (GSSE, 2013)
6	Timing for introduce grazing onto rehabilitated land	**Section 8.1.1** and **9.1**

7 RISK ASSESSMENT

The Guideline for agricultural impact statements requires a risk-based assessment (guided by the DGRs) in consideration of:

- The effects of the project on agricultural resources;
- Consequential productivity effects of this on agricultural enterprises, including productivity impacts of any water moved away from agriculture and any water quality issues as they affect agriculture;
- Uncertainty associated with the predicted impacts and mitigation measures, as well as consequences and the likely hood that these uncertainties will be realise; and
- Further risks such as weed management, biosecurity, subsidence, dust, noise, vibration and traffic.

To assist in identifying the key environmental impacts to agricultural resources and enterprises within the locality of the Project, a risk assessment was completed utilising the risk assessment tool, The Risk Matrix (Standards Australia, 2004). This risk assessment is presented in **Appendix 5**.

Each of the potential environmental issues was ranked in accordance with the Risk Matrix as either being of low, medium, significant or high risk (see **Table 20**).

Table 20 Risk Assessment of Impacts on Agriculture

Category	Issues
High	N/A
Significant	Availability and Productivity of Agricultural Land
Medium	Surface and ground water, water Usage
Low	Air Quality, Noise, Visual, Labour, Traffic and Transport, Impact on agricultural businesses, Weeds and pests

Following the assessment of potential impacts, risks will be reduced, where reasonable and feasible, or controlled through the implementation of appropriate mitigation and management measures.

The specific impacts are discussed in **Section 8** and mitigation measures in **Section 9** of this agricultural impact statement.

8 IMPACT ASSESSMENT

This chapter assesses the potential impacts on agricultural land within the study area and locality. As part of the AIS, Gillespie Economics was engaged to undertake an economic review of the potential agricultural impacts of the Project. A summary of the findings of this review are presented throughout this section and in full in **Appendix 6**.

8.1 Availability and Productivity of Agricultural Land and Water

8.1.1 Land Within the Disturbance Boundary

964 ha of agricultural land within the Disturbance Boundary will be removed from production as a result of the Project. Sustainable farming practices will, however, continue during the life of the Project in available areas outside the Disturbance Boundary. Prior to an area being disturbed it shall remain in agricultural production as long as practical having regard for relevant safety and mine operational considerations. This is the same practice adopted by BMC during its period of operation of the Approved Bengalla Mine.

Rehabilitation of the Approved Bengalla Mine is currently underway and will continue as mining progresses. The landform proposed for the Project will be consistent with the landform being established as part of the Approved Bengalla Mine rehabilitation.

Post mining, agricultural land within the Disturbance Boundary shall be rehabilitated in line with the conceptual rehabilitation plans of the Project. These plans shall improve upon the rehabilitation plan of the Approved Bengalla Mine.

BMC plans to reintroduce agriculture to the appropriate areas of rehabilitated land (including the Approved Bengalla Mine) as soon as practicable having consideration of safety and legislative requirements relating to mine operations.

Affected land will be rehabilitated to establish a post-mining landforms with a Land Capability Classes II to VI and Agricultural suitability classes 3 and 4 GSSE (2013). It is difficult to predict the most appropriate land use 24 years in advance as markets and technology change. The conceptual post mining landforms allow for agricultural land use options to remain open.

It is currently predicted that the major proportion of land within the Disturbance Boundary shall be reinstalled as Land Capability Class IV and Agricultural suitability classes 3 and 4. Based on current land use practices in the locality and community expectations, this land would be suited to beef grazing at varying levels of stocking pressure reflective of landform and re-instated soil type. Landforms near the final void shall have steep slopes which shall render them unsuitable for agriculture.

It is estimated that the following areas of the identified agricultural domains will be affected:

- Domain A 43 ha;
- Domain B 448 ha; and
- Domain C: 473 ha.

Table 21 shows the total value of agricultural production impacted by the Project on the agricultural land within the Disturbance Boundary. The assumptions are shown in **Appendix 7**.

Table 21 Quantum and Value of Agricultural Production Affected within Disturbance Boundary

Enterprise	Impact of Project
Beef cattle sold per annum	237
Gross value of production per annum	$ 129,313
Net value of production per annum	$ 98,251

Conservatively assuming that agricultural production from the Disturbance Boundary ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is $1.7M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is $1.3M (using a 7% discount rate) (Gillespie Economics, 2013) (see **Appendix 6**).

8.1.2 Water diverted from agriculture

As stated in section 5.3.2, BMC currently holds WAL 001106 from the Hunter River Regulated Water Source which entitles BMC to 1,449 shares from the water source. Based on 100% allocation this equates to 1,449 ML. This water allocation will be required to supplement existing site water for use in the CHPP and for dust suppression. If this water was not used for mining related activities it could be used for agriculture.

In addition to the 1,449 shares, BMC licences a further 4,070 shares of general security water and 5.1 shares of high security water to its agricultural licensees and further 45 shares to its racecourse licensees.

WRM have completed a Surface Water Impact Assessment for the Project (WRM, 2013) which indicates water is required from the Hunter River Intake for all years of the Project life. The maximum (99th percentile) external water requirement is approximately 2,200 ML/annum between Years 5 to 24. The median (50th percentile) external water requirement is approximately 1,500 ML/annum. The 10th percentile external water requirement is approximately 1,000 ML/annum.

The maximum quantum is 751 ML greater than the 1,449 ML BMC holds under WAL 001106 (assuming 100% allocation). This maximum (2,200 ML) is that required to meet the maximum mine production of 15Mt per annum.

Based on a lucerne hay and maize grain cropping rotation 751 ML could be expected to produce 1,242 tonnes of lucerne hay and 276 tonnes of maize grain from 96.9 ha. The gross value of production from this 96.9 ha would be $413,329 per annum and a net value of production of $109,573.per annum.

To compare the loss of agricultural production if this water is removed water from agriculture it is assumed the 96.6 ha is used for dryland lucerne production and sorghum grain production rotation. Grain sorghum production is used as it is less sensitive to water stress at flowering than maize. The 96.6 ha would be expected to produce 276 tonnes of lucerne hay and 124 tonnes of sorghum for a gross value of production of $101,882 and a net value of production of $33,748. Assumptions are shown in **Appendix 3**.

Based on a lucerne hay and maize grain cropping rotation, the maximum surface water requirement (2,200 ML) could be expected to irrigate 283.1 ha to produce 3,639 tonne of lucerne hay and 809 tonne of maize grain combining to produce a gross value of production of $1,210,817 and Net Value of Production of $320,986. Assumptions are shown in **Appendix 3**. . The same land used for dryland lucerne and sorghum grain production could be expected to produce 809 tonnes of lucerne hay and 364 tonnes of sorghum grain for a combined gross value of production of $298,456 and net value of $98,861. Based on these assumptions the quantum and value of agricultural production lost by utilising this water for mining is 2,831 tonnes of lucerne hay and 445 tonnes of grain with a gross value of production of $912,361 and net value of $222,125. Assuming that this water is not available to agriculture for the total life of the Project, the present value of the gross value of production foregone is $9.8M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is $2.4M (using a 7% discount rate) (Gillespie Economics, 2013) (see **Appendix 5**).

BMC will use a stage approach to acquiring the additional surface water requirements as production levels dictate so as to minimise the impact on agriculture.

In order to assess the potential impacts of the Project on the existing groundwater regime, a groundwater impact assessment was completed by Australasian Groundwater & Environment Consultants (AGE, 2013) (Appendix N of the EIS). This assessment showed that predicted maximum annual take by the Project from alluvial sources.

Based on the same assumptions used for assessing the impact of surface water the quantum and value of production from 220 ML of irrigation water over 28.3 ha is 364 tonnes of lucerne hay and 81 tonnes of maize grain for a gross value of production $99,405 and net value of $23,100. The dryland quantum and value of production of the same area is 81 tonnes of lucerne hay production and 36 tonnes of grain sorghum with a gross value of $29,846 and a net value of $9,886. The quantum and value of agriculture production lost by utilising this water for mining is 283 tonnes of Lucerne hay and 44 tonnes of grain with a gross value of $91,236 and a net value of $22,212. Assuming that this water is not available to agriculture for the total life of the Project, the present value of the gross value of production foregone is $1.0M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is $0.2M (using a 7% discount rate) (Gillespie Economics, 2013) (see **Appendix 5**).

The combined quantum and value of agricultural production lost by utilising both water sources (2,420 ML) for mining is 3,114 tonnes of lucerne hay and 489 tonnes of grain with a gross value of production of $1,003,597 and a net value of $244,337.

At the end of the Project this water will be available for agricultural use. Assuming that this water is not available to agriculture for the total life of the Project, the present value of the gross value of production foregone is $10.8M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is $2.6M (using a 7% discount rate) (Gillespie Economics, 2013) (see **Appendix 5**).

8.1.3 Combined Value

The combined gross value of agricultural production from the Disturbance Boundary and maximum water resource to be used by the Project is impacted properties is $1.1 M per annum. As shown in **Table 22** this value is 0.363% of the total agricultural production of the Hunter Region, 0.014% of NSW and 0.003% of Australia.

Table 22 Comparison of Annual Value of Agricultural Production Affected by Project

Resource	Disturbance Boundary	Hunter Region	NSW	Australia
Land	$ 0.1 M			
Water	$ 1.0 M			
Total agricultural production	$ 1.1 M	$ 311.7M	$ 8,359.2 M	$ 39,645.1 M

Source: ABS, 2008; ABS 2011

In total, foregone net agricultural production from agricultural land resources required for the Project is estimated at $12.5M present value (using 7% discount rate) (Gillespie Economics, 2013).

As the overall agricultural contribution of the land within the Disturbance Boundary and the water resource earmarked for use by the Project is small when compared to the total agricultural production on a regional, state and national scale, the reduced availability and productivity of this land will have a minimal impact to the industry.

8.1.4 Regional Impacts of Agriculture Foregone as a Result of the Project

The regional impacts of the level of annual agricultural production foregone as a result of the Project were estimated from the sectors in the Upper Hunter regional input-output table by Gillespie Economics (see **Appendix 5**).

Table 23 compares the annual regional production and economic impacts associated with the Project with the level of annual agricultural production that would be foregone as a result of the Project. Further details are provided within **Appendix 5**.

Table 23 Annual Regional Production / Economic Impacts of the Foregone Agriculture and the Project

	Agriculture Land	Agricultural Water Requirements	Agricultural Impacts Total	Project
Area (ha)	964[1]	-	-	964
Production Type	Beef cattle production	Lucerne hay and summer cereal grains	-	Coal
Direct Output Value	$0.1 M	$1.0 M	$1.1 M	$1,174.1 M
Direct Income	$0.1 M	$0.2 M	$0.3 M	$92.1
Direct Employment (FTE)	1	5	6	738
Direct and Indirect Output Value	$0.2 M	$1.4 M	$1.6 M	$1,478.8 M
Direct and Indirect Income	$0.1 M	$0.4 M	$0.4	$185.5 M
Direct and Indirect Employment (FTE)	1	7	8	1,822

1 *This is the area of agricultural land that would be impacted in perpetuity by the Project assuming all Disturbance Boundary remains removed from agriculture.*

The direct annual output of the Project is estimated at $1,174 M per annum. In contrast, the direct annual output of future use of agricultural lands that would be utilised by the Project is estimated at $12.5 M per annum. Gillespie Economics concluded that based on these comparative values, the Project is considered to be significantly more efficient than continued agricultural production.

8.1.5 Surrounding Locality

The Project will not significantly reduce the availability of land for agricultural purposes or affect the productivity of existing agricultural land outside the Disturbance Boundary, including land utilised by the viticulture or the equine industry cluster within the locality. As such, this has not been discussed further in the assessment.

8.2 Strategic Agricultural Land

8.2.1 Biophysical Strategic Agricultural Land

GSSE (2013) identified that there is 1 ha of land currently in the 964ha of the Disturbance Boundary been mapped as BSAL (**Figure 3**). This 1 ha is currently as part of a beef grazing enterprise.

Except for this area of 1 ha which shall be impacted by the realignment of the Bengalla Road, there is no other BSAL land located within the Disturbance Boundary. The impact of loss of this land is included in the discussion of loss of agricultural production within the Disturbance Boundary (**Section 8.1**).

Table 24 shows how the Project relates to the Gateway Criteria Assessment for BSAL.

Table 24 Gateway Criteria Assessment BSAL

Draft Gateway Criteria	Response
Biophysical Strategic Agricultural Land: Project likely to lead to a significant impact through:	
Impacts on the land through surface area disturbance and subsidence:	Minimal impact with loss of 1 ha from realignment of Bengalla Road.
Soil fertility, rooting depth and soil profile materials and thickness	No impact as outside disturbance area
Increase in land surface micro relief or soil salinity, or significant changes to soil pH	No impact as outside disturbance area and soils not affected
Impacts on Highly Productive Groundwater, including provisions of the Aquifer Interference Policy and the advice of the Minister for Primary Industries.	1 to 2 m draw down of the Hunter River aquifer during years 1to 4 of Project recovering over the life of the Project

Therefore it was concluded that the Project will have only a very minor impact on BSAL.

8.2.2 Equine Critical Industry Cluster

Mapping has identified 35 ha of the of the Project Boundary is within the 2km radius of the Muswellbrook Denman road (as defined in the Appendix of the SRLUP) and thus this area falls within the Equine CIC.

There is no CIC within the Disturbance Boundary. Further to this, it is noted that Disturbance Boundary of the Project is moving west and is moving further away from the Equine CIC.

Table 25 shows how the Project relates to the Gateway Criteria Assessment for Equine Industry CIC.

Table 25 Gateway Criteria Assessment Equine Critical Industry Cluster

Gateway Criteria	Response
Equine Industry Critical Industry Cluster: Project likely to lead to a significant impact through:	
Surface area disturbance	No impacts, refer **Section 2**
Subsidence	No impacts
Reduced access to agricultural resources	Potential minor impact, refer **Sections 8.1.2, 8.1.5 and 8.3**
Reduced access to support services and infrastructure	No impact, refer **Sections 8.5 and 8.8**
Reduced access to transport routes	No impact, refer **Section 8.7**
Loss of scenic and landscape value	No impact, refer **Section 8.6**

It can be seen that the Project will not impact on Equine CIC nor any component of the equine industry in the Hunter Valley. The operation of the Approved Bengalla Mine simultaneously as Bengalla Stud, Edinglassie and Balmoral Studs and the Muswellbrook Racetrack precinct have continued to operate is a guide that the Project will operate in harmony with the local equine industry.

8.2.3 Viticulture Critical Industry Cluster

Verification of the Map 6 of the SRLUP was undertaken to determine the extent that the Project Boundary corresponds with the Viticulture CIC as outlined in the SRLUP (DP&I, September 2012a).

Figure 3 shows the area mapped as Viticulture CIC in the SRLUP – Upper Hunter which falls within the Project Boundary. Closer verification of the identified area shows that some of this area fails to meet the criteria of the Viticulture CIC as identified in **Table 4**.

Figure 5 shows the area of viticulture CIC that has been verified and meets the relevant classification criteria.

GSSE soil and land capability impact study (GSSE, 2013) classified the soils of the Project Boundary according to Australian Soil Classifications (Isbell, 1996). Appendix 5 of Australian Soil Classifications (Isbell 2002) references Australian Classifications against Great Soil Groups (Stace et. al. 1968) as used by Office of Environment and Heritage (OEH) to estimate soil fertility as per the SLURP (OEH, 2012).

Table 26 shows the soil types identified within the project Boundary (GSSE, 2013) which meet the Viticulture CIC criteria identified in **Figure 5**.

Table 26 Verification of Viticulture CIC Mapping

Soil Type as per soil and landscape impact assessment	Corresponding Great Soil Group	Estimated Fertility	Land capability Classes	Within 2km of mapped alluvial water source	Meet viticulture CIC criteria
Brown Chromosol	Non-calcic brown soils, Some red-brown earths,	Moderate Moderate	V	Partially	Limited area
Red Chromosol	Non-calcic brown soils, Some red-brown earths,	Moderate Moderate	V	Partially	Limited area
Brown Vertosol	Black earths, Grey, red and brown clays	Moderate Moderate	IV	Partially	Limited area
Red Sodosol	Solidized solenetx and solidic soils, Some solths and red-brown earths	Moderately low Moderately low and moderate	V	Partially	Limited area
Brown Kurosol	Many podzolic soils and soloths	Low and moderate	VI	No	No
Deep Brown Sodosol	Solidized solenetx and solidic soils, Some soloths and red-brown earths	Moderately low Moderately low and moderate	VI	No	No
Brown Sodosol	Solidized solenetx and solidic soils, Some solths and red-brown earths	Moderately low Moderately low and moderate	VI	Partially	No
Rudosol	Lithosols, calcareous and siliceous sands, some solonchaks	Low	VII	Partially	No

It is noted that the verification process not only identified areas mapped as Viticulture CIC that did not meet the criteria but also identified an area that was not mapped Viticulture CIC but did meet the criteria set out in the SRLUP. The verification process identified 494 ha within the Project Boundary as part of Viticulture CIC and 369 ha within the Disturbance Boundary.

Referencing Map 6 of the SLURP it can be seen that the area verified as Viticultural Industry Critical Cluster within the Project Boundary is at the northeast extent of the mapped Viticultural Industry Cluster.

The mapped Viticulture CIC in the SRLUP includes the Pokoblin and Broke-Fordwich Geographic Indication (GI) sub –regions and industry proposed GI subregions covering the Parish of Belford and the localities of Lovedale and Mount View and part of the Upper Hunter Wine GI around Denman. This area covers an area of approximately 107,135 ha.

The Draft SRULP (DP&I, March 2012c) Viticulture CIC covered the above area excluding the part of the Upper Hunter Wine GI around Denman. Tis initial mapped area covered approximately 53,292 ha. By difference this indicates that the area in the Viticulture CIC that is in the Upper Hunter Wine GI around Denman is 53,843 ha.

The area verified as Viticulture Industry Cluster within the Project Boundary is 0.46% of the total Upper Hunter Viticulture CIC and 0.92% of the Viticulture CIC around Denman.

The area verified as Viticulture Industry Cluster within the Disturbance Boundary is 0.34% of the total Upper Hunter Viticulture CIC and 0.69% of the Viticulture CIC around Denman.

No existing vineyards occur within the Project Boundary or Disturbance Boundary (see **Figure 7**). The nearest operating vineyards are located approximately 6 km and 12 km south of the south east corner of the Project Boundary and 14.5 km west of the western Project Boundary.

Table 27 shows how the Project relates to the Gateway Criteria Assessment for Viticulture Industry CIC.

Table 27 Gateway Criteria Assessment Viticulture Critical Industry Cluster

Gateway Criteria	Response
Viticulture Critical Industry Cluster: Project likely to lead to a significant impact through:	
Surface area disturbance	No impacts, refer **Section 8.2.3**
Subsidence	No impacts
Reduced access to agricultural resources	Potential minor impact, refer **Sections 8.1.2, 8.1.5 and 8.3**
Reduced access to support services and infrastructure	No impact, refer **Sections 8.5 and 8.8**
Reduced access to transport routes	No impact, refer **Section 8.7**
Loss of scenic and landscape value	No impact, refer **Section 8.6**

The potential dust and visual impacts on the Viticulture CIC of the locality are covered in **Sections 8.5 and 8.6.** It can be seen that the Project will not impact significantly on Viticulture CIC nor any component of the viticulture industry in the Hunter Valley.

8.3 Water

8.3.1 Surface water

As stated previously in **Section 4.2**, one of the significant agricultural resources of the local area is irrigation water from the Hunter Regulated River Water Source. This system is a highly reliable source of industrial, town and irrigation water for the regulated users who are licensed to extract water.

WRM have completed a Surface Water Impact Assessment for the Project (WRM, 2013) which indicates water is required from the Hunter River Intake for all years of the Project life. The maximum (99th percentile) external water requirement is approximately 2,200 ML/a between Years 5 to 24. The median (50th percentile) external water requirement is approximately 1,500 ML/a. The 10th percentile external water requirement is approximately 1,000 ML/a.

BMC holds approximately 1,449 high security units of Hunter River water shares. Water will continue to be extracted from existing licences, and there will therefore be no cumulative impact on water supplies in the Hunter River catchments caused by the changes for the Project. BMC will seek the relevant licences to account for the additional Hunter River water demands progressively consistent with production levels to minimise the impacts to the Hunter River flow regime.

The EIS surface water impact assessment provides further details regarding the Project's water balance (see Appendix J of the EIS).

The surface water model for the Project has also determined that over the life of the Project, and that under certain circumstances, the Project will need to discharge excess water into the Hunter River in accordance with the Hunter River Salinity Trading Scheme (HRSTS). The HRSTS was implemented by the NSW government to reduce salinity levels in the Hunter River and allows controlled water discharges into the Hunter River during periods of high flow.

A review of the Surface Water Assessment results shows that:

- No discharges are required under the HRSTS for the 50th percentile results;
- The 90th percentile results show that approximately 350 ML/a are discharged under the HRSTS;
- The 99th percentile results show that approximately 1,000 ML/a are discharged under the HRSTS;
- There are no simulated uncontrolled discharges from the Mine Water system for the 99th percentile in any year of the Project life; and
- The impacts of HRSTS controlled discharges from the Project on the Hunter River flow duration relationship are negligible.

The predicted flow rate of the controlled discharge will be maintained at less than 200 ML/d (2,300 L/s), as required by the existing Environmental Protection Licence (EPL) 6538.

Overall the surface water impact assessment for the Project has determined that the Project will not impact significantly on receiving waters (WRM, 2013) (Appendix J of the EIS).

8.3.2 Groundwater

In order to assess the potential impacts of the Project on the existing groundwater regime, a groundwater impact assessment was completed by Australasian Groundwater & Environment Consultants (AGE, 2013) (Appendix K of the EIS). As part of this assessment a predictive numerical model was developed to assess the potential impacts of the Project on the groundwater regime. This model was used to estimate the inflows of groundwater into the open cut void over the life of the Project, predict the zone of influence of dewatering and the potential for impacts on other registered users and predict the magnitude of any drainage from the alluvial aquifers associated with the Hunter River.

The modelling indicated groundwater seepage into the open cut mine will peak early in the Project life at about 1.2 ML/day, and then slowly reduce over the Project life as the mine moves further away from the alluvial aquifer, and up into more elevated land where the unsaturated zone thickens.

Evaporation of groundwater that seeps from the coal seams at the pit face will be significant, and is likely to mean that there will be no notable seepage into the pit in the latter years of the Project life, (i.e. the pit will be dry). The rate of seepage to the mine is slightly higher than predicted by earlier models due to the changes to the aquifer properties adopted during the recalibration.

The model predicts mining will continue to depressurise and lower groundwater levels in the Permian sequence, but this will not result in drawdown extending a significant distance into the alluvial aquifer with drawdown being less than 1m. The depressurisation of the Permian sequence will reduce the groundwater discharge rates into the Hunter River alluvium by about 0.65 ML/day (220 ML/year) at the beginning of the Project, reducing to 0.25 ML/day as the Project moves away from the floodplain. The groundwater flow to the alluvium reduces over the Project life by an average 112 ML/year.

BMC will transfer additional share component to its existing water access licence for the Hunter River alluvium which authorises projected take of water from the Hunter River Alluvial Water Source due to mining to increase total share component to 220 units. The additional share component will be transferred from other water access licences which are already held by BMC. These licences will ensure the Project holds sufficient share component and water allocation to account for the take of water from the adjacent water sources at all times, and complies with the requirements of the Aquifer Interference Policy.

A sensitivity analysis indicated the river and alluvial aquifer acted as a controlling boundary condition, with the 1m drawdown contour remaining along the edge of the alluvium when model parameters were varied. The limited drawdown predicted means there are no known private groundwater bores where the groundwater drawdown is predicted to exceed 1m. Stygofauna and groundwater dependent vegetation are also not expected to be impacted by the limited drawdown.

The Hunter River alluvial aquifer is more likely to constitute 'highly productive groundwater'. However, the Project will not have any significant impact on the Hunter River alluvial aquifer. Therefore, the Project will not reduce the agricultural productivity of BSAL through impacts to highly productive groundwater.

There are not anticipated to be any significant impacts on groundwater availability for any agricultural enterprises within the locality.

The EIS groundwater impact assessment provides further details regarding the Project's potential impacts on the existing groundwater regime (see Appendix K of the EA).

8.4 Dust

In most cases the impacts of dust on agricultural resources and enterprises in the locality can be assessed as minimal as the Project will meet legislative criteria governed for air quality. The implementation of real time monitoring systems within the vicinity of the Project, use of appropriate mobile equipment and infrastructure, and implementation of blast management techniques will also ensure that dust emission targets are not exceeded. This will be accompanied by the establishment of progressive rehabilitation as each mining area advances, thereby, minimising the extent of dust emissions.

Air Quality modelling completed for the Project (Air Quality and Greenhouse Gas Impact Assessment Todoroski Air Sciences(2013)) (Appendix G of the EIS) predicts that the cumulative annual average dust deposition concentration predicted for privately owned properties is below 4g/m^2/month in all modelled years except Year 24 (when only one property is affected). When considering the Project's emissions alone the dust deposition concentration predicted for privately owned properties are less than 2g/m^2/month in all modelled years except Year 24 (when only one property is affected).

The Air Quality and Greenhouse Gas Impact Assessment (Todoroski Air Sciences June 2013) indicates that depositional dust levels will generally range from 2g/m^2/month - 4g/m^2/month (Worst case all years) is predicted to fall across the active grazing land within the Project Boundary and the Hunter Valley alluvial flats currently used for dairying on Bengalla owned land. It is noted that the land used by the Bengalla Stud lies outside the 2g/m^2/month (Worst case all years) contour. As discussed in **Section 3.4** BMC has maintained extremely productive dairy and grazing enterprises on land adjacent to Bengalla since operations commenced, even through a review of the 2005 – 2012 Bengalla Annual Environmental Management Reports indicate that depositional dust levels exceeding 2g/m^2/month have previously been recorded on Bengalla's owned agricultural land.

8.4.1 Impact dust on grazing animals

Kannegieter (2006) stated that most reports would indicate that feed, bedding, manure or urine contamination of dust is responsible for the majority of respiratory problems seen in production and racing animals. Kannegieter then concluded that: " Given the absence of these additional contamination (feed, manure and urine) in coal dust, it would seem unlikely that an increase in dust deposition would adversely affect grazing horses and dairy cattle".

Kannegieter also concluded that the ingestion of dust-contaminated pasture "would be considered unlikely to create problems".

Andrews and Skriskandarajah (1992) were engaged by the NSW Coal Association and Australian Co-operative Foods (a dairy farmer owned processing cooperative) to investigate the effects of coal mine generated dust on dairy cattle production. The study found that levels of dust on forage at a level of 4,000 mg/m^2/day did not impact on feed palatability or dry matter intake, a primary driver of animal performance. A level of 4,000 mg/m^2/day equates to dust deposition concentration of 120g/m^2/month assuming that no dust is removed due to wind, precipitation and that no new leaves appear during the 30 day period.

As such the dust deposition concentration of 120g/m²/month is conservative figure. This level of dust concentration is significantly higher than the 2g/m²/month predicted due to the Project, by a factor of 60.A literature review carried out by Kannegieter (2012) sensitivity of horses to dust concluded that it is not inhalation per se that impacts on horses respiratory tract and function but the endotoxins, bacteria and fungi etc that are attached to particulate matter. It was noted in the review the primary sources of dust are bedding, hay and feed. Further, Kannegieter reported that dust that does not have high levels of endotoxin dust associated with it (e.g. nuisance or crustal dust) does not appear to increase the incidence of Inflammatory Airway Diseases in horses.

Based on the studies of Andrews and Skriskandarajah (1992) and Kannegieter (2006) and results from the Air Quality and Greenhouse Gas Impact Assessment (Todoroski Air Sciences June 2013) it is predicted that the dust levels generated by the Project will not impact on the animal performance of any grazing enterprise (dairy, beef or equine) within the locality.

This is supported by the author's own experience managing dairy, beef and grazing enterprises adjacent to operating coal mines and the performance of the Bengalla owned agricultural land since the mine's commencement in 1998.

The implementation of real time monitoring systems within the vicinity of the Project will also ensure that dust emission targets are not exceeded at privately owned properties. This will be accompanied by the establishment of progressive rehabilitation as each mining area advances, thereby, minimising the extent of dust emissions.

8.4.2 Dust impacts on plant growth

A dust deposition rate of 2g/m²/month equates to an average daily deposition rate of 0.067g/m²/day.

Doley and Rossato (2010) report that "*Deposition of mining, quarry and road dust on vegetation canopies has been observed to inhibit plant growth when dust burdens exceed 7 g/m²*". They also reported that there is a linear relationship of increase plant dry matter (production) and net dust deposition up to 1g/m²/day while in cotton (which matures in hot sunny weather) estimated net rates of dust deposition of 0.5g/m²/day reduced canopy photosynthesis by 11% and cotton yield by 3%. A dust deposition rate on a leaf of 0.5g/m²/day is equivalent to a monthly deposition rate of 15g/m²/month, greatly above the levels predicted for all privately owned land surrounding the Project Boundary.

As well as dust deposition rates other factors affect the net amount of dust deposited on a leaf. Dooley and Rossato (2010) report the following factors.

- Leaf characteristics with smooth leaves and pendant leaves accumulating less dust;
- Period leaf has been exposed to dust including factors of leaf appearance rate, leaf life span and age of leaf; and
- Environmental events that remove dust such as rainfall and wind.

Based on the findings of the Air Quality and Greenhouse Gas Impact Assessment (Todoroski Air Sciences (2013)) (Appendix G of the EIS) and work conducted by Dooley and Rossato (2010), the predicted dust deposition rates will have nil to minimal impact on the productivity of privately owned land surrounding the Project Boundary due to the Project individually or as part of a cumulative effect with other dust sources.

The EIS air quality and greenhouse gas impact assessment addresses the extent of dust emissions in further detail (see Appendix G of the EA).

8.5 Noise and Vibration

An Acoustics Impact Assessment undertaken for the Project (Bridges Acoustics, 2013) (see Appendix H of the EIS) confirmed that operational noise levels would be audible over areas of grazing land currently owned by BMC and some neighbouring private landowners.

Cattle and horses run on the Bengalla owned properties and impacted private lands will be subject noise levels of approximately 40dBA under worst case meteorological and operating conditions. This is an increase of up to 10 dBA above rating background levels, but consistent with impacts from existing operations since 1998.

Heffner and Heffner (1983) documented that cattle showed a gradual increase in sensitivity as frequency increased to the point of best hearing at 8 kHz. This was followed by a rapid decrease in sensitivity until reaching an upper limit of audibility, which at an intensity of 60 dBA extends from 23 Hz to 35 Hz.

At an intensity of 40 dBA, audiograms (Heffner and Heffner, 1983) correlate with a frequency of approximately 0.062 kHz and 32 kHz, which is within the range of hearing of cattle. However, given that these frequencies are not close to the best point of hearing in cattle the Project is not anticipated to have any significant impact on the health or productivity of cattle within the impacted area.

Heffner and Heffner (1983) found that horse's hearing ranged from 33.5 kHz to 55 kHz with a region of best sensitivity from 1 kHz to 16 kHz, with a lowest threshold of 7 dBA. At an intensity of 60 dBA, the horses hearing ranges from 33.5 kHz to 55 Hz.

In summary, horses and cattle (and sheep) are more sensitive to low frequencies and less sensitive to high frequencies than most mammals. However cattle and sheep have more defined frequencies of best sensitivity that are 13-18 dBA more sensitive than horses.

As discussed in **Section 3.4,** current mining operations at Bengalla have used BMC owned land within close proximity to open cut mining to raise beef cattle, operate dairy farms and thoroughbred breeding enterprises since mining commenced in 1998. This suggests that livestock are not sensitive to environmental noise. As such, it is unlikely that livestock on privately owned grazing properties within the locality of the Project will be affected by noise. Similarly, livestock quickly become accustomed to vibration from blast events, which would limit the potential for impacts on livestock health.

Predicted noise levels experienced by livestock will vary depending on the location of the livestock within each grazing property. In general, livestock located in an area of a property closest to the Project will experience slightly higher noise levels while livestock in more remote areas of a property will experience lower noise levels. The impacts of noise on agricultural resources and enterprises in the locality are assessed as minimal as the Project will satisfy the legislative criteria governing industrial noise.

There is little scientific data regarding the effect of ground vibration on animal performance. Kannegieter (2012) reviewed the literature for the impact on horses and found that animal models evaluating the effects of whole body vibration (WBV) suggest that WBV can be used as a performance–enhancing tool on traits related to athletic performance and bone strength.

Kannegieter cited one study which indicated that WBV may have an anabolic effect on bone and muscle.

Kannegieter postulated that the intermitted blasting experienced by animals (horses) close to a coal project such as Bengalla would be less than which may be experienced by animals during transport. Kannegieter stated *"Given that horses (and cattle) are regularly transported long distances in both motor vehicles and planes without ill effects or concern, it is likely that vibration from blasting will cause no concern to horses (and cattle) in the area."*

This author's own observations of grazing dairy cows during blasting events from the current Bengalla mine is that grazing and/or ruminating behaviour is not interrupted by blasting events that are easily felt by humans. Based on the findings of the Acoustic Impact Assessment (Bridges Acoustics, 2013), noise and blasting impacts on agricultural resources and enterprises in the locality is assessed as minimal.

The implementation of real time monitoring systems within the vicinity of the Project, installation of noise reduction technology on mobile equipment and infrastructure, implementation of blast management techniques will further assist in reducing noise and blasting impacts. Given the measures in place to control noise, agricultural resources and enterprises are not anticipated to be impacted by the Project from this aspect.

The EIS Acoustic Impact Assessment addresses the extent of noise in further detail (see Appendix H of the EIS).

8.6 Visual

A visual impact assessment was undertaken by JVP Visual Planning and Design (JVP) and is provided in Appendix I of the EIS. The purpose of the assessment was to define the character of the surrounding landscape, assess the visual impacts of the Project and recommend measures to mitigate and manage these impacts.

A Visual Impact Assessment undertaken for the Project (JVP, 2013) addresses the extent of changes to the landscape and visual amenity in further detail (see Appendix I of the EIS).

The Project will increase screening from sensitive locations to the north, east (particularly Muswellbrook township and Racecourse Road) and to the south. The Main OEA will continue to be rehabilitated throughout the life of the Project. The Main OEA will continue to reduce views of the mine extraction area from most sensitive receivers to the north east, east and south east.

As part of the visual impact assessment due consideration was given to the Gateway criteria as prescribed under the SRLUP (as outlined in **Section 8.2**). It is recognised that scenic and landscape diversity is a key resource base for tourism and associated agricultural pursuits such as viticulture and thoroughbred horse breeding. No sensitive receptors will experience significant impacts as a result of the Project.

The EIS visual impact assessment describes the Project's impact on the visual aesthetics of the surrounding environment at sensitive receptors in further detail (see Appendix I of the EIS).

8.7 Traffic and Support Infrastructure and Services

All access to the Project will be via the Bengalla Link Road and no permanent road closures are proposed for the Project. Modelling undertaken in the Traffic Impact Assessment (DC Traffic Engineering, 2013) indicates that the traffic generated by the construction and operational phases of the Project will be absorbed into the existing traffic stream. This is largely due to the substantial spare capacity available in the road network even with an assumed conservative 2.5% per annum growth in background traffic.

Despite the minimal disruption during the construction phase, the Bengalla Link Road realignment will result in an improved support infrastructure route to services in the north. The Bengalla Link Road realignment will result in a net increase of 900m of additional road length. For through traffic travelling along this road, this would result in a worst-case additional 36 seconds of travel time under normal operating conditions of the road. This was not considered significant and as such, no further mitigation measures are recommended.

Increase traffic use Bengalla Road will not impact the dairy farm on Bengalla owned lane as cattle use road (and rail) underpasses to access pasture on either side of Bengalla Road.

Agricultural enterprises in the locality utilise the road network to transport products to domestic markets or to intermediate delivery locations. Based on the Traffic and Transport Impact Assessment it is anticipated that any growth in traffic demands from the local agricultural industry will be accounted for in the assumed growth in background traffic. In addition, support services directly employed by agricultural enterprises, including those by the equine and viticulture CIC, will not be shared by the Project and therefore will not be impacted.

The EIS traffic and transport impact assessment discusses the traffic regime in further detail (see Appendix Q of the EIS).

Increase traffic use Bengalla Road will not impact the dairy farm on Bengalla owned lane as cattle use road (and rail) underpasses to access pasture on either side of Bengalla Road. Farm vehicles entering, leaving or crossing Bengalla Road do so at points which have good visibility along and from Bengalla Road.

8.8 Labour Supply

A Social Impact Assessment was undertaken for the Project (Doug Martin & Associates, 2013) (See Appendix R of EIS). The Social Impact Assessment focused on three key areas including the:

- Primary Study Area – consisting of the Muswellbrook LGA;
- Secondary Study Area – consisting of the Singleton and Upper Hunter LGA's; and
- Hunter Region (Hunter Statistical Division 110 in 2011 Census).

The Social Impact Assessment indicates that the Primary and Secondary Study Areas have relatively low unemployment in regard to NSW levels see **Table 28**. This indicates that the local economy is very close to fully employed with the remainder probably representing long term unemployed or structural unemployment.

These unemployment numbers suggest there are some unemployed persons available however they may be unskilled. Consequently the Project will result in employees to be sourced from a number of areas including:

- Reliance on additional employees to be sourced from areas outside the Primary and Secondary Study Area personal;
- Rely more heavily on commuting from outside the Study Area;
- Recruitment from other mines; and
- Seek employees from other sectors.

Table 28 Unemployment levels in Primary and the Secondary Study Area (2011 -2012)

LGA/ Region State	Unemployment					Unemployment Rate (%)				
	Jun	Sep	Dec	Mar	Jun	Jun	Sep	Dec	Mar	Jun
	2011			2012		2011			2012	
Maitland (C)	1,620	1,544	1,521	1,495	1,511	4.4	4.2	4.1	4.0	4.1
Cessnock (C)	1,692	1,606	1,566	1,511	1,507	6.8	6.4	6.3	6.0	6.0
Muswellbrook (A)	186	190	195	170	233	2.1	2.2	2.3	2.1	2.8
Singleton (A)	149	151	155	135	196	1.1	1.1	1.2	1.1	1.6
Upper Hunter Shire (A)	95	95	100	91	126	1.2	1.2	1.3	1.2	1.7
Secondary Study Area	430	436	450	396	555	1.5	1.5	1.6	1.5	2.0
Balance of NSW	72,100	72,800	71,400	70,500	70,600	5.4	5.5	5.4	5.3	5.4
NSW	191,200	193,900	196,900	197,400	197,000	5.1	5.1	5.2	5.2	5.2

Source: DEEWR, Small Area Labour Markets, June Quarter 2012

8.8.1 Impact on Agricultural Industries

Review of the employment trends in both the agricultural and mining industries over the past 15 years suggest that any employment recruited from the agriculture sector will be of very marginal significance.

The employment trends of both agriculture and the mining industry during the period 1996 - 2011 for the Secondary Study Area indicated that over the 15 year period, even though it the relative share of employment in agriculture has declined at a rate of 1.3% per year, it represents a net long term loss of jobs of 31 per year.

In the most recent census period 2006-2011 the declining trend in agriculture has increased slightly but still represents only 36 jobs per year whereas mining has increased by 301 jobs per year.

Consequently the impact of mining on the loss of agricultural jobs is considered to be a factor but only a marginal issue as the loss of jobs in agriculture remained at around 10% of the total increase in mining jobs. In the latter period the proportion has dropped further to around 8%. Also there are other factors affecting slow declines in agriculture. Losses in agricultural employment could be entirely explained by productivity and efficiency gains over the 15 year period through technology and the increase in scale of agricultural enterprises. It should also be noted that agricultural sector employment also includes forestry and fisheries which also further reduces the degree of losses from agriculture itself.

There is also anecdotal evidence that any movement of employment from agriculture to mining is in primary employment only with a high proportion of farmers moving to mining continuing to operate there agricultural enterprises while being in full time employment within the mining industry. This trend of off farm wage and salary income supporting agricultural enterprises and farm families is reflective of a trend across Australian agriculture as a whole (Laguna and Ronan, 2009).

Further detail in relation to the Social Impact Assessment is presented in Appendix R of EIS.

8.9 Agricultural support services

As detailed in **Section 8.1** and **Section 0**, the Project will result in a relatively small decrease in potential annum agricultural output from the Study Area equivalent to a reduction of:

- 237 less cattle;
- 2,831 less tonnes of hay, and
- 445 less tonnes of grain.

The change agricultural production will result in a decrease of purchased agricultural inputs estimated to be $790,322 per annum (difference between gross value of production and net value of production) (**Appendix 3** and **Appendix 7**).

These input suppliers would include:

- Agricultural input resellers;
- Transport companies;
- Stock and station agents;
- Saleyards;
- Service providers;
- Fuel suppliers; and
- Farm machinery suppliers and servicing businesses.

The gross value of production in the Hunter for hays, field crops excluding hays and livestock slaughterings is $268.25M (ABS, 2008). Based on the same prorata allocation of costs to gross income for each sector, the value of inputs compares to the value of agricultural inputs used for cropping and livestock for the Hunter of $103.3M. The Project is estimated to reduce the value of agricultural inputs by 0.77% of the total value of agricultural production for the Hunter.

As stated in **Section 5.3**, if all cattle turned off from the grazing land impacted by the Project (Disturbance Boundary) were sold through the local saleyards in Scone and Singleton, the combined throughput of the two yards would fall by 0.44% based on 2011 saleyard throughput. This would result in an estimated fall in saleyard income of $2,732 per annum (which is included in the estimate of agricultural purchased inputs).

The Project's impact on transport links as outlined in **Section 0**will not impact on the transport of agricultural inputs or produce to and from the region.

8.10 Agricultural related tourism

As part of the visual impact assessment, due consideration was given to the Gateway criteria as prescribed under the SRLUP (as outlined in **Section 8.2**). It is recognised that scenic and landscape diversity is a key resource base for tourism and associated agricultural pursuits such as viticulture and thoroughbred horse breeding. No sensitive receptors will experience significant impacts as a result of the Project.

The Main OEA will continue to be rehabilitated throughout the life of the Project and will continue to reduce views of the mine extraction area from Racecourse Road.

No other privately owned agricultural tourism enterprises are located within 10 km of the Project Boundary.

9 MITIGATION AND MANAGEMENT MEASURES

Based on the findings outlined in **Section** 8, the Project is not anticipated to have impacts on:

- Productivity or marketability of products from surrounding enterprises by means of changes to the landscape and visual amenity;
- Traffic regimes along support infrastructure routes;
- Agricultural labour supply; and
- Support services directly employed by agricultural enterprises.

As such, no mitigation measures regarding these issues have been proposed in this assessment.

9.1 Availability of Agricultural Land

To compensate for the loss in available agricultural land as a result of the Project, post-mining landform (rehabilitated disturbance footprint) will be shaped and soil redistributed to return it to a Class II to IV Rural Land Capability except for the final void which shall be Class VII Rural Land Capability.

This will be consistent with the landform being established as part of the Approved Bengalla Mine rehabilitation. This area (including the Approved Bengalla Mine) will be dedicated to agricultural purposes as soon as practicable having consideration of safety and legislative requirements relating to mine operations.

9.2 Dust

The impacts of dust on agricultural resources and enterprises in the locality have been assessed as minimal. To ensure that dust targets are not exceeded, real time monitoring systems within the vicinity of the Project, use of appropriate mobile plant and infrastructure, and implementation of blast management techniques will be implemented.

Should real time monitoring detect any potential for exceedances appropriate corrective actions will be implemented to avoid impacts, where possible. This may include relocating equipment and or scaling back operations in certain areas during unfavourable weather conditions. This will be accompanied by the establishment of progressive rehabilitation as each mining area advances, thereby, minimising the extent of dust emissions.

9.3 Noise

The impacts of noise and blasting on agricultural enterprises and livestock in the locality have been assessed as minimal. The implementation of real time monitoring systems within the vicinity of the Project, use of appropriate mobile equipment and infrastructure, implementation of blast management techniques will ensure that targets are not exceeded or assist in reducing noise and blasting impacts.

9.4 Water

The Project will require the extraction of 2,200 ML of water to supply maximum operational demand. In addition it is predicted that the Project will require a maximum annual take of 220ML to alleviate the impact on groundwater sources. Bengalla will hold the necessary WALs under the relevant Water Sharing Plans prior to extraction.

Draw down of the Hunter Aquifer shall be monitored and if impacts differ from predicted levels appropriate corrective actions will be implemented where possible.

9.5 Weed and Pest Management

BMC will continue to develop and implement a weed and pest management plan as part of its existing Landscape Management Plan. This plan will see the commitment of appropriate resources (physical, financial and labour) to ensure it is implemented in an effective manner.

9.6 Sustainable Farming Practices

Within the Project Area sustainable farming practices, including grazing techniques to ensure appropriate residual pasture coverage should be implemented in available areas outside of the Disturbance Boundary.

Elsewhere on BMC owned land, current licensee requirements should continue, including implementation and monitoring of annual farm plans.

10 CONCLUSION

The agricultural land associated with Bengalla is owned by Bengalla Joint Venture Partners and licensed to landholders who use the land for dairying, thoroughbred breeding, hay production and beef cattle grazing. Bengalla has a long history of maintaining the productivity of its agricultural lands.

The current gross value of beef production from Project area is estimated to be $186,048 per annum turning off 334 head of cattle per year. With further development of the property this could rise to $259,678 per annum turning off 459 head of cattle per year. Not all of the Project Area will be removed from agriculture. The area that will be removed (disturbance footprint) is approximately 964 ha and is predominantly the least productive land within the Project Area. The gross value of production from the beef enterprises within this area $129,313 per annum.

The Project will require the use of up to 2,200 ML of water from The Hunter River Regulated Water Source with an additional 220 ML from the Hunter River alluvium. The gross value of agricultural production foregone from diverting this water for irrigation of Lucerne and maize grain crops compared to utilizing the equivalent area for dryland production of Lucerne hay and grain sorghum crops is $1,003,597 per annum from the sale of 3,114 tonnes of Lucerne hay and 489 tonnes of grain per annum.

Bengalla Mining Company already has a WAL for 1,449 shares (1,449 ML) for use by the Approved Mine. The additional 971 ML required to meet the Projects maximum water demand has a gross value of production foregone of $402,683 from the production 1,249 tonnes of lucerne hay and 196 tonnes of hay.

The value of agricultural production from the combined loss of agricultural resources and irrigation water units (associated with the disturbance footprint and mine water usage) is predicted to be $1.1 M per annum. This represents 0.363% of the annual gross value of agricultural production in the Hunter region, 0.014% of NSW's agricultural production and 0.003% of the national production.

The Project Disturbance Boundary corresponds with 1 ha of BSAL. This land is impacted by the realignment of Bengalla Road. The land is currently used as part of a beef grazing enterprise. The adjacent BPSAL will not be impacted by the Project.

The Disturbance Boundary does not overlap with any land within the Equine CIC. The Project will not impact on the equine industry within the Study Area or in the wider Hunter Valley.

The Disturbance Boundary contains 369 ha of verified Viticulture CIC however this is not expected to result in a significant impact to the viticulture industry within the Study Area or in the wider Hunter Valley. In addition, there are no vineyards located within the Project Boundary. As the overall agricultural contribution of the Disturbance Boundary within the Project Boundary and the water resource is small when compared to the total agricultural production on a regional, state and national scale, the reduced availability and productivity of this land and water will have a minimal impact to the industry. In addition, the Project will not reduce the availability of land for agricultural purposes or affect the productivity of existing agricultural land outside the Project Boundary but within the locality.

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APPENDICES

Appendix 1 Water licences owned by Bengalla

Appendix 1 Water Licences owned by Bengalla

Old Licence Number		General Sercurity			High sercurity			Stock & Domestic			Supplemntary		
		WAL	DIPNR Ref	Share Units	WAL	DIPNR Ref	Share Units	WAL	DIPNR Ref	Share Units	WAL	DIPNR Ref	Share Units
Thornbro													
12690	75.00	1129	20AL201644	75.00							1366	20AL203068	0.50
23695	99.00	498	20AL200087	99.00							1384	20AL202873	28.00
28521	247.00	1128	20AL201642	247.00							1365	20AL203067	62.00
32020	231.00	915	20AL201122	231.00							1294	20AL202996	38.70
43355	97.00	914	20AL201120	97.00							1293	20AL202995	3.00
43465	147.00	916	20AL201124	147.00							1295	20AL202997	27.30
Wanata													
28101	258.00	949	20AL201198	258.00									
30436	437.00	909	20AL201113	426.00	908	20AL201112	3.00	910	20AL201114	8.00	1291	20AL202993	74.40
33594	326.00	1131	20AL201648	318.00				1132	20AL201649	8.00	1367	20AL203069	88.40
36201	342.00	906	20AL201106	342.00									
Lumeah													
18891	147.00	1226	20AL201891	147.00							1257	20AL203101	59.00
34733	243.00	907	20AL201108	243.00							1290	20AL202992	101.00
36268	306.00	1104	20AL201587	306.00							1361	20AL203061	50.00
45260	254.00	912	20AL201117	243.00	911	20AL201116	3.00	913	20AL201118	8.00	1292	20AL202994	97.00
Bengalla Stud													
45873	702.00			702.00									
Redcliffe													
24080	207.00			207.00									
Rankin Block													
28730	207.00			207.00									
Chudyk Block													
XX	207.00			207.00								XX	
Race course 1				24.00									
Race course 2				21.00									
Residential										108			
Groundwater extraction Licence			20BL169798										
Wanatana bore licences			20BL172091										
			20BL172092										
			20BL172093										
Monitoring Bore			20BL172488										
BMC		1106	20SL060388	1,449.00									
TOTAL	3,209.00			5,996.00			6.00			132.00			629.30

Appendix 2 Assumptions for carrying capacity of Project Area (As Is)

Appendix 2 Assumptions for carrying capacity of Project Boundary (As Is)

Ag Domain		A	B	C	Total
Bengalla	Ha	113	527	716	1,356
	%	8.3	38.9	52.8	
CURRENT	DSE/ha	8.0	5.1	3.5	
	TDM/ha	2.9	1.9	1.3	
Total DSE		904	2,688	2,506	6,098
Total pasture		330	981	915	2,226
Enterprise		Yearlings	Weaners	Weaners	
DSE Rating	DSE/breding cow	16.68	14.88	14.88	
Total cows		54	181	168	403
Stocking rate	ha/breeder	2.1	2.9	4.3	
Gross Income	$/ha	$ 285.62	$ 151.33	$ 103.38	
Costs	$/ha	$ 50.85	$ 37.37	$ 25.53	
Gross Margin	$/ha	$ 234.94	$ 113.96	$ 77.85	
Animals sold per ha		0.4	0.3	0.2	
Gross Income	$/breeder	$ 597.68	$ 440.61	$ 440.61	
Costs	$/breeder	$ 106.40	$ 108.81	$ 108.81	
Gross Margin	$/breeder	$ 491.64	$ 331.80	$ 331.80	
Animals sold per breeeder		0.83	0.83	0.83	
Gross Income	$	$ 32,275	$ 79,750	$ 74,022	$ 186,048
Costs	$	$ 5,746	$ 19,695	$ 18,280	$ 43,720
Gross Margin	$	$ 26,549	$ 60,056	$ 55,742	$ 142,347
Total Animal Sold		45	150	139	334

Appendix 3 Assumptions for irrigation water removed from agriculture

Appendix 3 Assumptions **Assumptions for water removed from agriculture**

Surface Water Max

Irrigation

ML	1,449	Current surface water		
	0			
	1,449			
Rotation	Years	%	ML/ha	Weight ML/ha
Lucerne	5	71%	8.0	5.7
Maize	2	29%	7.2	2.1
				7.8
Ha in rotation	186.5			
	Lucerne	Maize	Total	$/ML
Yeild (t)	2,397	533		
Gross Value	$ 654,719	$ 142,769	$ 797,488	$ 550
Net value	$ 151,570	$ 59,843	$ 211,413	$ 146

Dryland

ML	0			
Rotation	Years	%		
Lucerne	5	71%		
Sorghum	2	29%		
Ha in rotation	186.5			
	Lucerne	Sorghum	Total	$/ML removed
Yeild (t)	533	240		
Gross Value	$ 153,424	$ 43,150	$ 196,574	$ 415
Net value	$ 49,474	$ 15,640	$ 65,113	$ 101

Surface Water Max

Irrigation

ML	0	Current surface water		
	751	Surface Water to be acquired		
	751			
Rotation	Years	%	ML/ha	Weight ML/ha
Lucerne	5	71%	8.0	5.7
Maize	2	29%	7.2	2.1
				7.8
Ha in rotation	96.6			
	Lucerne	Maize	Total	$/ML
Yeild (t)	1,242	276		
Gross Value	$ 339,333	$ 73,996	$ 413,329	$ 550
Net value	$ 78,557	$ 31,016	$ 109,573	$ 146

Dryland

ML	0			
Rotation	Years	%		
Lucerne	5	71%		
Sorghum	2	29%		
Ha in rotation	96.6			
	Lucerne	Sorghum	Total	$/ML removed
Yeild (t)	276	124		
Gross Value	$ 79,518	$ 22,364	$ 101,882	$ 415
Net value	$ 25,642	$ 8,106	$ 33,748	$ 101

Groundwater Max

Irrigation

ML	0			
	220	Groundwater to be acquired		
	220			
Rotation	Years	%	ML/ha	Weight ML/ha
Lucerne	5	71%	8.0	5.7
Maize	2	29%	7.2	2.1
				7.8
Ha in rotation	28.3			
	Lucerne	Maize	Total	$/ML
Yeild (t)	364	81		
Gross Value	$ 99,405	$ 21,676	$ 121,082	$ 550
Net value	$ 23,013	$ 9,086	$ 32,099	$ 146

Dryland

ML	0			
Rotation	Years	%		
Lucerne	5	71%		
Sorghum	2	29%		
Ha in rotation	28.3			
	Lucerne	Sorghum	Total	$/ML removed
Yeild (t)	81	36		
Gross Value	$ 23,294	$ 6,551	$ 29,846	$ 415
Net value	$ 7,512	$ 2,375	$ 9,886	$ 101

Impact

		Current Surface Water	Additional Surface Water	Groundwater	Total Surface Water	Additional Requirement	Combined
Volume of irrigation water	ML	1,449	751	220	2,200	971	2,420
Area	Ha	186.5	96.6	28.3	283.1		
Loss of Lucerne	T	1,865	966	283	2,831	1,249	3,114
Loss of grain	T	293	152	44	445	196	489
Loss Gross Income	$	$ 600,914	$ 311,447	$ 91,236	$ 912,361	$ 402,683	$1,003,597
Loss Net Income	$	$ 146,299	$ 75,825	$ 22,212	$ 222,125	$ 98,038	$ 244,337

Appendix 4 Assumptions for carrying capacity of Project Area (Potential)

Appendix 4 **Assumptions for carrying capacity of Project Boundary (Potential)**

Ag Domain		A	B	C	Total
Bengalla	Ha	113	527	716	1,356
	%	8.3	38.9	52.8	
CURRENT	DSE/ha	15.0	8.0	3.5	
	TDM/ha	5.475	2.92	1.2775	
Total DSE		1,695	4,216	2,506	8,417
Total pasture		619	1,539	915	3,072
Enterprise		Yearlings	Weaners	Weaners	
DSE Rating	DSE/breding cow	16.68	14.88	14.88	
Total cows		102	283	168	553
Stocking rate	ha/breeder	1.1	1.9	4.3	
Gross Income	$/ha	$ 539.50	$ 236.61	$ 103.38	
Costs	$/ha	$ 96.04	$ 58.43	$ 25.53	
Gross Margin	$/ha	$ 443.78	$ 178.18	$ 77.85	
Animals sold per ha		0.8	0.4	0.2	
Gross Income	$/breeder	$ 597.68	$ 440.61	$ 440.61	
Costs	$/breeder	$ 106.40	$ 108.81	$ 108.81	
Gross Margin	$/breeder	$ 491.64	$ 331.80	$ 331.80	
Animals sold per breeeder		0.83	0.83	0.83	
Gross Income	$	$ 60,963	$ 124,693	$ 74,022	$ 259,678
Costs	$	$ 10,853	$ 30,793	$ 18,280	$ 59,926
Gross Margin	$	$ 50,147	$ 93,899	$ 55,742	$ 199,789
Total Animal Sold		85	235	139	459

Appendix 5 Agricultural Impact Risk Assessment

Appendix 5

Bengalla Coal Mine - Continuation of Mining Agricultural Impact Statement Risk Assessment

Risk Assessment Template

Risk Identification

Identify the types of risk that could arise from the activity, such as:

	Availability and productivity of agricultural land
	Water Usage
	Air Quality
	Noise
	Visual
	Traffic and Transport
	Supporting Infrastructure
	Labour
	Weeds

Risk Quantification

Risks are quantified in terms of likelihood and possible consequences.

Qualitative measures of likelihood

Level	Descriptor	Example detail description
1	Rare	May occur only in exceptional circumstances
2	Unlikely	Could occur at some time
3	Possible	Might occur at some time
4	Likely	Will probably occur in most circumstances
5	Almost certain	Is expected to occur in most circumstances

*Qualitative measures of consequence/ impact**

Level	Descriptor	Example detail description
1	Insignificant	Minimal change in land use or agricultural resources; low financial loss
2	Minor	Low change in land use or agricultural resources within Project Area or minimal change in locality; low financial loss
3	Moderate	Medium change in land use or agricultural resources within Project area or low change in locality; medium financial loss
4	Major	Significant changes in land use or agricultural resources within Project Area or locality; high financial loss
5	Catastrophic	Major change in land use or agricultural resources within Project Area and locality; huge financial loss

*Qualitative risk analysis matrix – level of risk**

Likelihood	*Consequences*				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
1 (Rare)	Low	Low	Medium	Significant	Significant
2 (Unlikely)	Low	Low	Medium	Significant	HIgh
3 (Moderate)	Low	Medium	Significant	HIgh	HIgh
4 (Likely)	Medium	Significant	Significant	HIgh	HIgh
5 (Almost certain)	Significant	Significant	HIgh	HIgh	HIgh

* adapted from "Risk Management" (AS/NZS 4360:2004), Joint Australian / New Zealand Standard, p.34

Risk Assessment Information

- 1 -

Appendix 5

Bengalla Coal Mine - Continuation of Mining Agricultural Impact Statement Risk Assessment

Risk Quantification

Risk type	Description	Likelihood	Consequences	Overall rating (without mitigation measures)
Availability and productivity of agricultural land	Project will result in large areas of productive land being removed from agriculture over 24 years	5	2	Significant
	Project will impact on highly productive alluvial soils	1	3	Medium
Surface and ground water	Project affects downstream surface water quality	2	3	Medium
	Project affects downstream groundwater water quality	2	3	Medium
	Project affects groundwater availability (depth) increasing cost of stock and irrigation water pumping	2	3	Medium
	Increased competition and cost for water resources and licensing	2	3	Medium
	Coarse rejects and tailings emplacement affects the groundwater quality	1	2	Low
	Project will result in new landforms which will affect drainage and cause an aflux in flood events	1	2	Low
Air Quality	Dust from Project will affect plant growth and or quality or impact on animal performance	1	1	Low
Noise	Noise levels have adverse impacts on animal behaviour and production	1	1	Low
Visual	Visual impact on mine affects the marketability of agricultural production or enterprises in locality	1	1	Low
Traffic and Transport	Change in traffic and support infrastructure impacts on efficiency of agricultural operations	2	1	Low
Business & Infrastructure	Project will result in a negative flow-on impact to agricultural infrastructure and businesses in the locality by removing productive land from agriculture	2	2	Low
Labour	Removed labour resources from agriculture	2	1	Low

Appendix 5

Bengalla Coal Mine - Continuation of Mining Agricultural Impact Statement Risk Assessment

Risk type	Description	Likelihood	Consequences	Overall rating (without mitigation measures)
	Increased competition and cost for agricultural labour resources	2	1	Low
Weed Management	Increased vehicle and personnel movements encourage importation of weeds	3	1	Low
Rehabilitation	Productive land will not be reinstated post-mining	2	3	Medium

Appendix 6 Economic Review of Potential Agricultural Impacts

Continuation of Bengalla
Economic Review of Potential Agricultural Impacts

Prepared for

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C/- Hansen Bailey Pty Limited

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November 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Bengalla Mining Company Pty Limited (BMC) operates the Bengalla Mine (Bengalla) in the Upper Hunter Valley of NSW, approximately 130 km north-west of Newcastle and 4 km west of Muswellbrook. BMC is managed by Coal & Allied (CNA) Bengalla Pty Limited. Mining under the current approval will cease in 2016. The Continuation of Bengalla Mine Project (the Project) will enable mining to continue directly west, largely within current Mining Leases (ML), for a 24 year period at a rate of up to 15 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal.

Scott Barnett & Associates Pty Ltd (2012) undertook an Agricultural Impact Assessment for the Project. This report utilises the information provided by Scott Barnett & Associates Pty Ltd to assess the potential economic implications of the impacts of the Project on agricultural (including land and water) resources. In Section 2 some of the underlying issues that have been raised in relation to the perceived conflict between coal mining and the use of agricultural land and water are considered. Section 3 examines agricultural and mining industries in the Upper Hunter region. The economic efficiency and regional economic impact assessment frameworks for consideration of the economic impacts of Projects that impact land and water resources, are identified in Section 4. Section 5 examines the economic efficiency and regional economic impacts of the Project's use of land and water resources.

2 AGRICULTURAL AND MINING INDUSTRIES IN NEW SOUTH WALES

2.1 Land Use

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

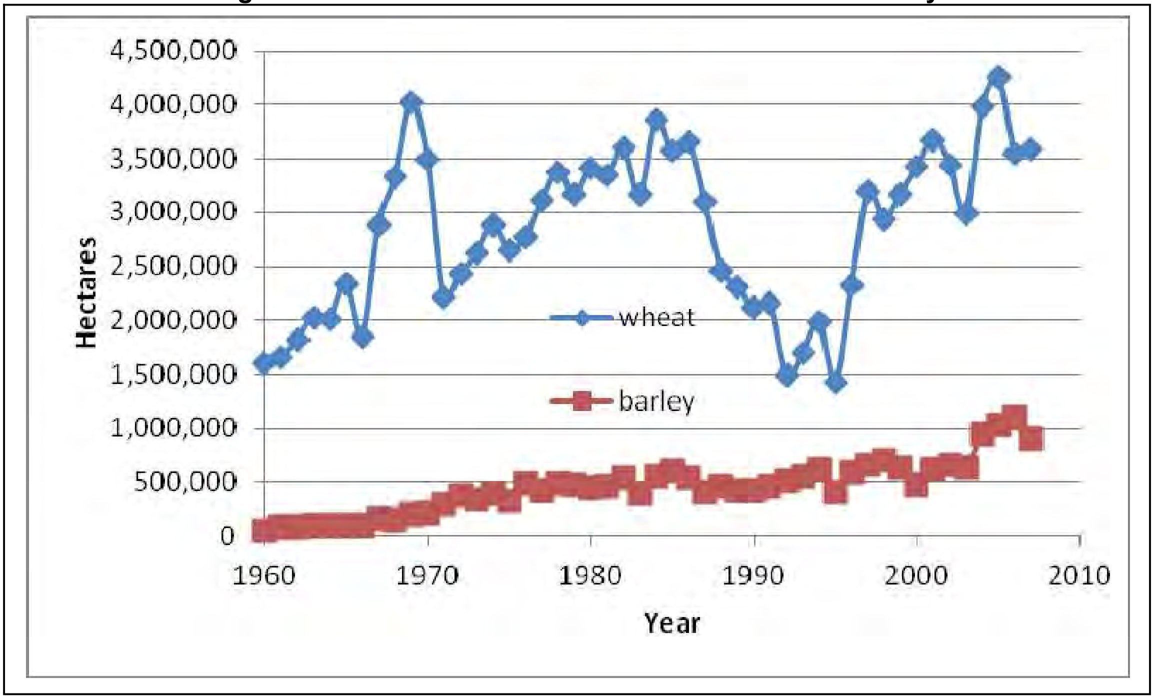
Table 2.1 - NSW Agricultural Land Area

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

Source: ANRA (2009b).

The NSW agricultural industry directly provides employment for 76,261 people or 2.7% of total employment in NSW (Australian Bureau of Statistics [ABS], 2006)[2]. Payment to agriculture, forestry and fishing employees in 20010-11 was $1,539M and value-added was $7,062M. Gross operating surplus and gross mixed income from agriculture, forestry and fishing was $6,908M (ABS, 2011a).

Figure 2.1 - NSW Land Area Allocated to Wheat and Barley



Source: ABS (2009).

Mining land use is a small fraction of the area of NSW (i.e. less than 0.1% of the total NSW land area) (Bureau of Regional Science 2009) and directly employs 19,026 or 0.7% of total employment in NSW (ABS, 2006). Payment to mining employees in 2010-11 was $2,466M and value-added was $10,633M. Gross operating surplus and gross mixed income from mining was $10,035M (ABS, 2011a).

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

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

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

2.2 Economic Growth in Regional Areas

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

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

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

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

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

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

2.3 Prime Agricultural Land and Other Land Uses

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

Table 2.2 - NSW Land Uses

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

Source: Bureau of Rural Sciences (2009)

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

2.4 Food Security

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

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

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

As identified by ABARES (2011, p. 2), "There is no foreseeable risk to Australia's food security. Australia produces twice as much food as it consumes, produces almost all its fresh food, and can easily afford the food it imports". Furthermore, "the global food security challenge is not about the capability of world agricultural producers to produce enough food to feed the world, but rather is about ensuring that the poorest people in the world have the economic and physical access to the food they require to meet their nutritional needs" (ABARES 2011, p. 16).

2.5 Water Supplies and Mining

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

Table 2.3 – NSW Water Consumption 2009-2010

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

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

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

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

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

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

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

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

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

3 AGRICULTURAL AND MINING INDUSTRIES IN THE UPPER HUNTER REGION

3.1 Agriculture

The Upper Hunter region (i.e. the Singleton, Muswellbrook and Upper Hunter Shire local government areas [LGAs]) have a combined land area of 1.6M ha, of which 56% is agricultural land (Table 2). Of this agricultural land, 2.8% is irrigated with annual irrigation volumes of approximately 89,513 million litres (ML) (Table 3.1). The total value of agricultural production in this region in 2006 is estimated at $143M (Table 3.1).

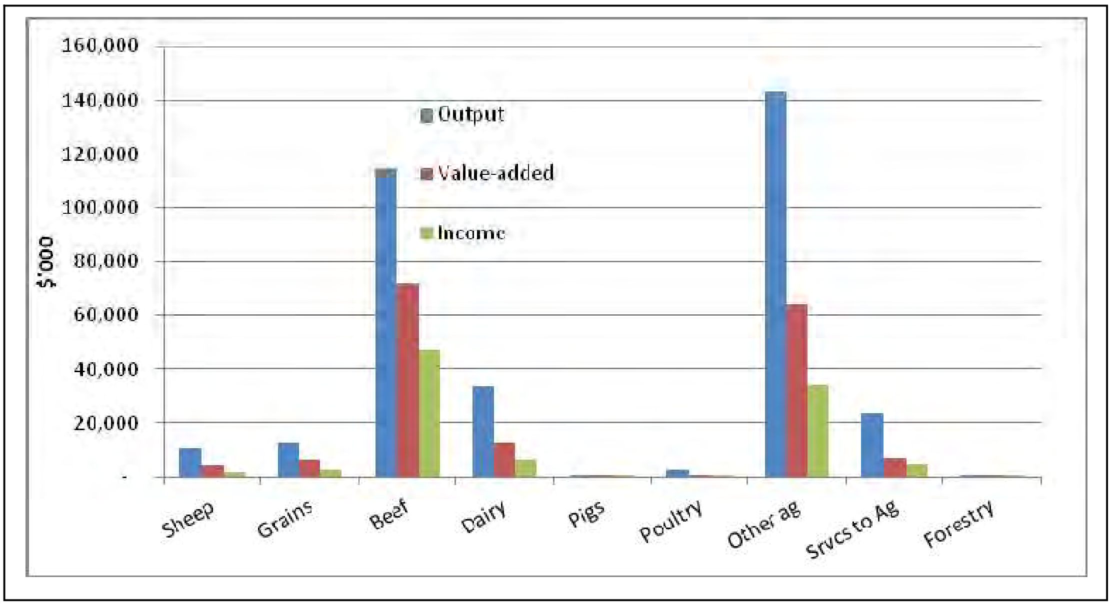
Table 3.1 - Existing Agricultural Land Use and Value of Production in Upper Hunter Region 2006

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

Source: ABS (2011b, 2011c, 2011d).
Note: Totals may have minor discrepancies due to rounding.

The input-output table developed for the Upper Hunter region (Gillespie Economics, 2012) provides an indication of the direct relative significance of the different agricultural sectors, affirming beef cattle and other agriculture (which includes grapes and horse breeding) as the main agricultural sectors (Figure 3.1).

Figure 3.1 - Agricultural Sectors in Upper Hunter Region



Source: Gillespie Economics (2012).

Total employment in the agricultural industry in the Upper Hunter region in 2006 was 2,288 (ABS, 2010e). Table 3.2 provides a more detailed employment by industry breakdown which indicates that the main agricultural employment is in beef cattle farming, horse breeding, dairy cattle farming and grape growing.

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

Sector	No.
0100 Agriculture, not further defined (nfd)	57
0112 Nursery Production (Outdoors)	4
0113 Turf Growing	3
0115 Floriculture Production (Outdoors)	3
0121 Mushroom Growing	37
0123 Vegetable Growing (Outdoors)	22
0130 Fruit and Tree Nut Growing, nfd	6
0131 Grape Growing	122
0136 Citrus Fruit Growing	4
0137 Olive Growing	8
0139 Other Fruit and Tree Nut Growing	3
0141 Sheep Farming (Specialised)	38
0142 Beef Cattle Farming (Specialised)	791
0143 Beef Cattle Feedlots (Specialised)	3
0144 Sheep-Beef Cattle Farming	154
0145 Grain-Sheep or Grain-Beef Cattle Farming	51
0149 Other Grain Growing	25
0159 Other Crop Growing, not elsewhere classified (nec)	40
0160 Dairy Cattle Farming	217
0170 Poultry Farming, nfd	4
0171 Poultry Farming (Meat)	4
0172 Poultry Farming (Eggs)	4
0191 Horse Farming	580
0192 Pig Farming	4
0199 Other Livestock Farming, nec	3
0301 Forestry	3
0420 Hunting and Trapping	3
0520 Agriculture and Fishing Support Services, nfd	7
0522 Shearing Services	8
0529 Other Agriculture and Fishing Support Services	67
A000 Agriculture, Forestry and Fishing, nfd	13
Total	**2,288**

Source: ABS (2010e)

3.2 Coal Mining

NSW DPI (2009) identifies 18 coal mines in the Hunter Coalfield producing 80.44 Mt of saleable coal in 2007/08. Conservatively assuming all of this production is steaming coal with a value of AUD$63.47 per tonne, this level of saleable coal production is estimated to have a value of around $8 billion (B) (Table 3.3) which is significantly greater than the value of all agricultural production in the Upper Hunter region (reported as $143M in Table 3.1). Direct employment in mining in the Hunter Coalfield as reported by NSW DPI (2009) is 8,384 which is also significantly greater than total employment in the agricultural industry in the Upper Hunter region in 2006 which was 2,288 (Table 3.2).

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

Coal Mining	Units	Total
Coal Saleable Production (2007/2008)	Mt	80.44*
Gross Value of Coal Production (2007/8)	$M	5,106**
Direct Mining Employment (2008)	No.	8,384*

Source: * NSW Department of Primary Industries (DPI) (2009)
** Conservatively assuming only steaming coal production and a value of AUD$63.47/t which was the median price for NSW Steaming coal exports
Free on Board (FOB) in December 2007 (DPI, 2009)

Note: Mt = million tonnes.

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

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

From this data it is evident that coal mining is by far the most significant provider of employment in the region and has strong backward linkages to, among other sectors, the mining and construction machinery manufacturing sector and explosives manufacturing sector. The mining sector provides 44 times the direct employment of the grape growing sector, nine times the direct employment of the horse farming sector and four times the direct employment of the entire accommodation, cafes and restaurants sectors. The most significant agriculture sector in terms of direct employment is beef grazing. Beef grazing also has strong linkages to the meat processing sector, which combined provide greater levels of direct employment than the grape growing and wine manufacturing sectors.

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

Agriculture		Mining		Manufacturing		Accommodation	
0131 Grape Growing	122	0600 Coal Mining	4,643	1111 Meat Processing	153	4400 Accommodation	276
0142 Beef Cattle Farming (Specialised)	791	1090 Other Mining Support Services	319	1214 Wine and Other Alcoholic Beverage Manufacturing	235	4500 Food and Beverage Services, nfd	24
0191 Horse Farming	580			1892 Explosive Manufacturing	118	4510 Cafes, Restaurants and Takeaway Food Services, nfd	3
0144 Sheep-Beef Cattle Farming	154		-	2462 Mining and Construction Machinery Manufacturing	178	4511 Cafes and Restaurants	275
0145 Grain-Sheep or Grain-Beef Cattle Farming	51			2461Agricultural Machinery and Equipment Manufacturing	11	4512 Takeaway Food Services	370
0160 Dairy Cattle Farming	217					4513 Catering Services	58
						4520 Pubs, Taverns and Bars	235
						4530 Clubs (Hospitality)	160
						H000 Accommodation and Food Services, nfd	3
Total Agriculture	**2,288**	**Total Mining**	**5,368**	**Total Manufacturing**	**1,819**	**Total Accommodation, Cafes and Restaurants**	**1,404**

Source: ABS 2006 Census of Population and Housing, Customised Data Report, Place of Work by Industry ANZSIC 4 digit.

Figures 3.2 to 3.4 are generated from a 2006 input-output table of the regional economy (Muswellbrook LGA, Singleton LGA and Upper Hunter Shire LGA) and provide a sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the economy.

What is clear from these figures is that in terms of gross regional output, value-added, income, employment, imports and exports, coal mining is the most significant sector of the regional economy. For comparison, the horse breeding and grape growing sectors are located in the other agriculture sector in Figures 3.2 to 3.4, while wine manufacturing is located in the food manufacturing sector. Accommodation, cafes and restaurants are located in the Accom/restaurants sector.

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

Gross Regional Output **Gross Value-Added**

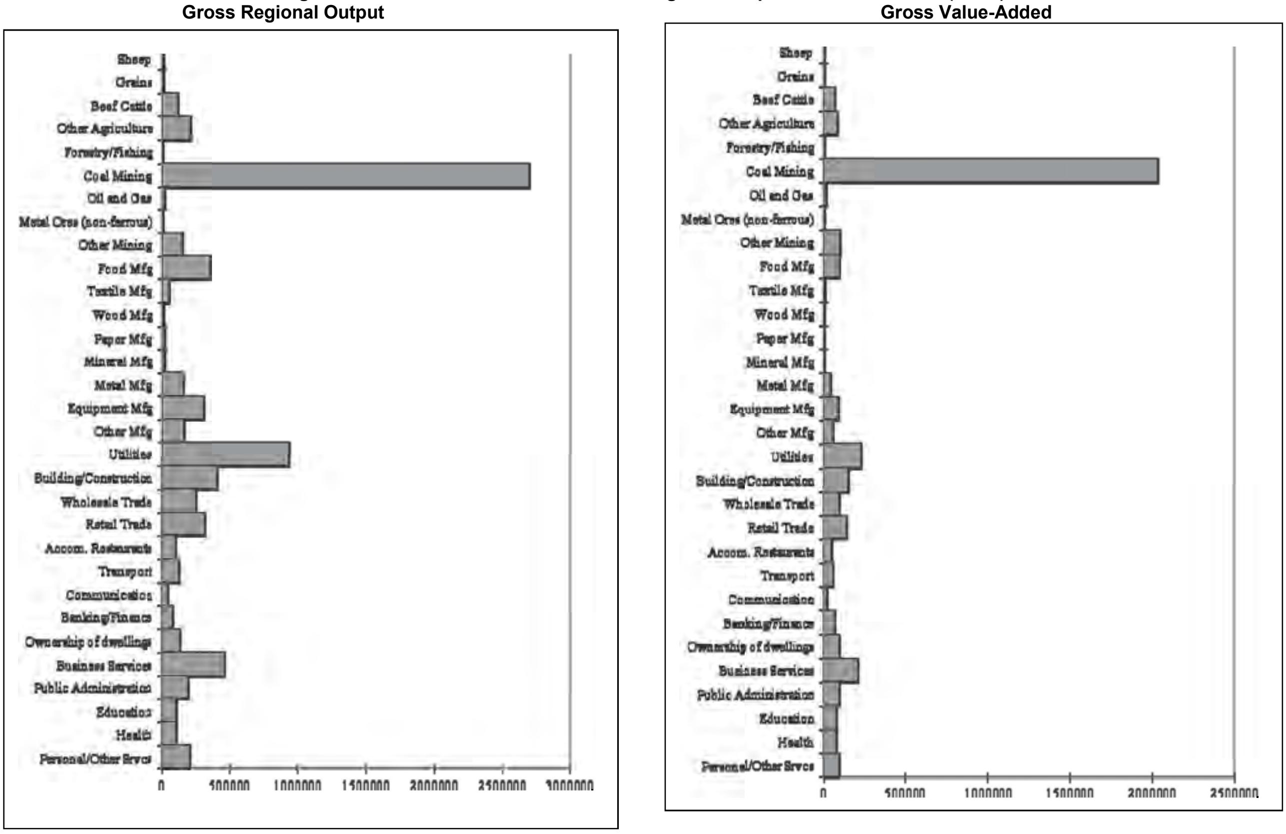
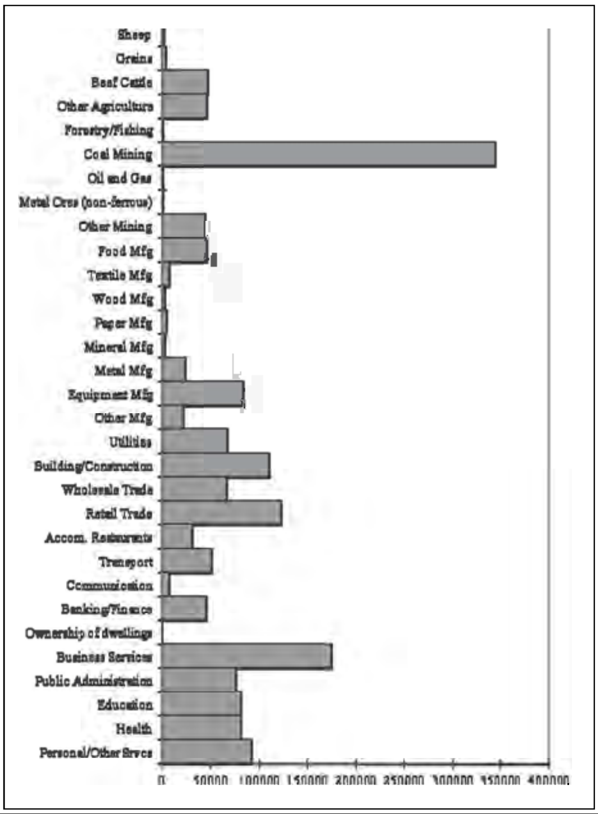


Figure 3.3 Sectoral Distribution of Regional Income ($'000) and Employment (No.)

Income



Regional Employment

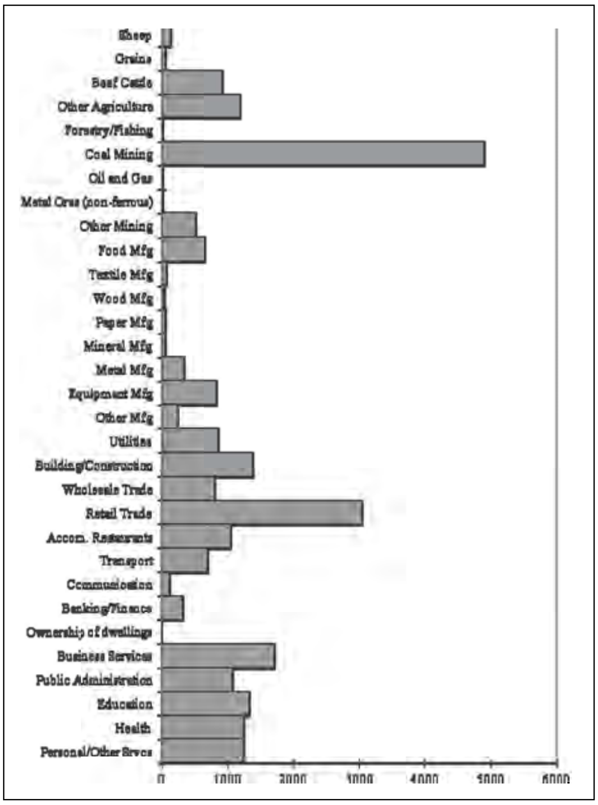
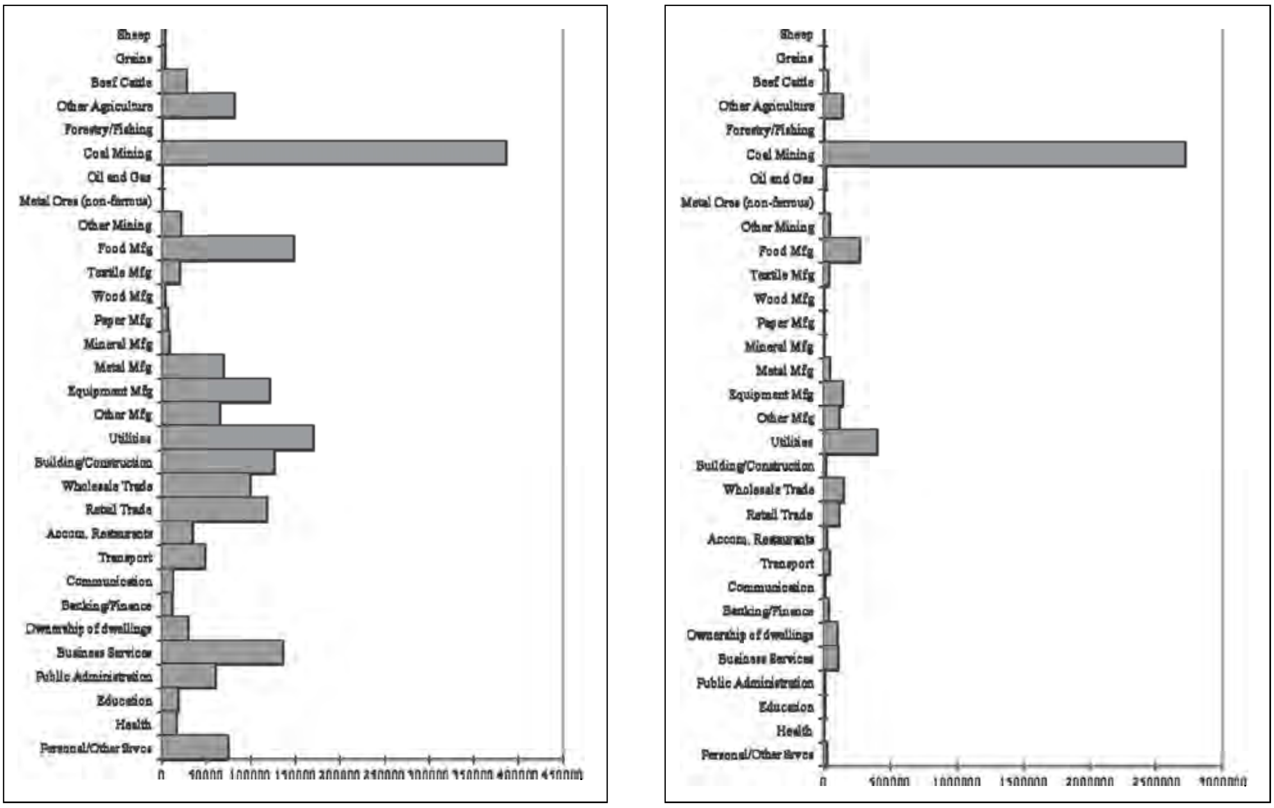


Figure 3.4 Sectoral Distribution of Imports and Exports ($'000)

Regional Imports | **Regional Exports**



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

4.1 Economic Efficiency

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

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

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

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

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

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

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

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

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

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

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

The market value of the land reflects, among other things, the discounted future net income that can be earned from the property and income reflects how much the community values the outputs from the land. Where agriculture production becomes increasingly scarce, this will be reflected in the value of agricultural products and the value of agricultural land. However, the long term trend for agricultural commodity prices has been a decline in real value rather than an increase in value, reflecting that with growth in productivity, supply has strengthened more rapidly than demand (ABARES 2011). Between 1961 and 2008, world population grew by 117 per cent while food production grew by 179 per cent (ABARES 2011). While commodity price increases have risen over the last few years this is partly a response to government subsidies and mandates regarding the production of biofuels (ABARES 2011). In the future, growth in global food consumption is expected to slow. Strong productivity growth and the utilisation of hitherto unused cropping should ensure the continuing adequacy of food supplies (ABARES 2011). Consequently, substantial real increases in food prices are not anticipated.

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

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

4.2 Regional Economic Impact Assessment

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

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

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

5 PROJECT IMPACTS ON AGRICULTURAL RESOURCES

5.1 Opportunity Cost of Agriculture and Water Resources

5.1.1 Land Resources

The Project will primarily impact agricultural land resources through the mine disturbance footprint. While there may also be some impacts through the provision of ecological offsets in the region, information about the location and agricultural suitabililty of offset land is not available.

<u>*Mine Disturbance Footprint*</u>

964ha of agricultural land within the Disturbance Boundary will be removed from production as a result of the Project. Post-mining the land will be rehabilitated to establish landforms with Agricultural suitability classes 3 and 4. However, it is difficult to predict the most the most appropriate land use in 24 years time and so for the purpose of this analysis, agricultural impacts from the mine disturbance footprint are in perpetuity.

Scott Barnett & Associates (2012) identify that impacted land within the Disturbance Boundary could otherwise be used for beef grazing with a gross value of production per annum of $129,313 and a net value of production per annum of $98,251.

The present value of foregone gross value of production is estimated at $1.7M (at 7% discount rate) and the present value of foregone net value of agricultural production is estimated at $1.3M at 7% discount rate).

5.1.2 Water Resources

The Surface Water Impact Assessment for the Project (WRM, 2012) indicates the maximum external water requirement for the Project is approximately 2,200ML/annum.

Scott Barnett & Associates (2012) identify this water resource could otherwise be used to produce lucerne hay and maize grain cropping rotation on 283.1 ha to produce 3,639 tonne of lucerne hay and 809 tonne of maize grain with a gross value of production of $1,210,817 and net value of production of $320,986. The same land used for dryland lucerne and sorghum grain production could be expected to produce 809 tonnes of lucerne hay and 364 tonnes of sorghum grain with a gross value of production of $298,456 and net value of $98,861. Based on these assumptions the quantum and value of agricultural production lost by utilising this water for mining is 2,831 tonnes of lucerne hay and 445 tonnes of grain with a gross value of production of $912,361 (present value of $9.8M at 7% discount rate) and net value of $222,125M (present value of $2.4M at a 7% discount rate).

In addition, the Groundwater Assessment (AGE, 2012) indicated a maximum annual take by the Project from alluvial sources of 220 ML/annum. Scott Barnett & Associates (2012) identify this water resource could otherwise be used to irrigate over 28.3 ha to produce 364 tonnes of lucerne hay and 81 tonnes of maize grain for a gross value of production $121,082 and net value of $32,099. The dryland quantum and value of production of the same area is 81 tonnes of lucerne hay production and 36 tonnes of grain sorghum with a gross value of $29,846 and a net value of $9,886. The quantum and value of agriculture production lost by utilising this water for mining is 283 tonnes of Lucerne hay and 44 tonnes of grain with a gross value of $91,236 ($1.0M present value at 7% discount rate) and a net value of $22,212 ($0.2 present value at 7% discount rate).

The combined quantum and value of agricultural production lost by utilising both water sources (2,420 ML) for mining is 3,114 tonnes of lucerne hay and 489 tonnes of grain with a gross value of production of $1,003,597 ($10.8 present value at 7% disctount rate) and a net value of $244,337 ($2.6M present value at 7% discount rate).

5.2 Regional Impacts

The regional impacts of the level of annual agricultural production forgone as a result of the Project (Section 5.1) were estimated from the sectors in the regional input-output table (Gillespie Economics, 2012) within which production is located i.e. the *beef sector* and the combined *grains and other agriculture sectors.* Table 5.1 and Table 5.2 summarises the estimated direct and indirect regional impacts of the Project disturbance footprint and water requirements, respectively.

Table 5.1 - Regional Economic Impacts of Agricultural Land Required for the Project Disturbance Footprint

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	129	22	29	51	180
Type 11A Ratio	*1.00*	*0.17*	*0.22*	*0.39*	*1.39*
VALUE ADDED ($'000)	81	9	13	22	104
Type 11A Ratio	1.00	0.11	0.17	0.28	1.28
INCOME ($'000)	53	7	11	18	71
Type 11A Ratio	1.00	0.12	0.21	0.33	1.33
EMPL. (No.)	1	0	0	0	1
Type 11A Ratio	1.00	0.10	0.18	0.28	1.28

Table 5.2 - Regional Economic Impacts of Foregone Agriculture from Project Water Requirements

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	1,004	231	150	381	1,385
Type 11A Ratio	1.00	0.23	0.15	0.38	1.38
VALUE ADDED ($'000)	455	93	70	163	618
Type 11A Ratio	1.00	0.20	0.15	0.36	1.36
INCOME ($'000)	243	67	58	125	368
Type 11A Ratio	1.00	0.28	0.24	0.52	1.52
EMPL. (No.)	5	1	1	2	7
Type 11A Ratio	1.00	0.18	0.17	0.35	1.35

Table 5.3 compares the annual regional production and economic impacts associated with the Project with the level of annual agricultural production that would be forgone as a result of the Project (Section 5.1).

Table 5.3 - Annual Regional Economic Impacts of Foregone Agriculture Compared to the Project

	Agriculture Land Disturbance Footprint	Agricultural Water Requirements	Agricultural IMpacts Total	Project
Production Type	Beef	Lucerne Hay, Maize Grain and Sorghum Grain		Coal
Direct Output Value ($000)	129	1,004	1,133	1,174,064
Direct Value Added ($000)	81	455	536	665,189
Direct Income ($000)	53	243	296	92,146
Direct Employment (No.)	1	5	6	738
Direct and Indirect Output Value ($000)	180	1,385	1,565	1,478,759
Direct and Indirect Value Added ($000)	104	618	721	795,275
Direct and Indirect Income ($000)	71	368	439	185,546
Direct and Indirect Employment (No.)	1	7	8	1,822

The Project is estimated to provide considerable activity to the regional economy that is far in excess of the regional economic impacts associated with the level of annual agricultural production that would be forgone as a result of the Project (Table 5.3).

The direct annual output of the Project is estimated at $1,174M. The annual agricultural production from the land and water resources that would potentially be impacted by the Project is $1.1M (Table 5.3).

The direct and indirect regional employment provided by the Project would be approximately 1,882 compared to approximately eight agricultural-related jobs that would be forgone as a result of the Project impacts on agricultural land (Table 5.3).

This stimulus provided by the Project would continue for approximately 24 years. Water required for the Project would then potentially be available for agricultural activities. Rehabilitated land may also be available for agricultural activities.

5.3 Economic Efficiency of Reallocation of Agricultural Resources to the Project

The BCA estimated present value of net production benefits of the Project to Australia at $1,773M (Table 5.4) (Gillespie Economics, 2012)[3]. In contrast, the present value of future use of agricultural land and water resources utilised by the Project is estimated at $2.7M (Table 5.4).

Table 5.4 - Net Production Benefits of Agricultural Resources Compared to the Project

	Land and Water Resources (Lucerne Hay, Maize Grain and Sorghum Grain)	**Project**
Net Production Benefits[1]	$2.7M	$1,773M

Source: Gillespie Economics (2012).

[1] Discounting is at 7%.

[3] This includes an allowance for the opportunity costs of the agricultural land and water resources.

Based on the comparative values provided in Table 5.4, excluding consideration of externalities of the Project and of agricultural production, the Project is considered to be significantly more efficient than continued agricultural production.

There are a number of potential negative and positive externalities associated with the Project (and with agricultural production). Including all externalities (including the opportunity cost of agricultural land and water resources) the Project is estimated to have net benefits to Australia of between $1,748M and $2,090M (Gillespie Economics, 2012) and therefore the Project is considered more efficient than the agricultural production that would be displaced.

5 CONCLUSION

In the Upper Hunter region:

- The regional output value of existing coal production is considerably greater than agricultural production.
- The annual output value of the Project would be greater than the output value of agriculture production in the Upper Hunter region in 2006.
- Direct employment provided by the Project would be significantly higher than that provided by continued agricultural use of the land/water resources required for the Project.
- The net production benefits of the Project would be significantly higher than the continued agricultural production and use of water in the Project area.
- Incorporating the value of environmental, cultural and social impacts, the Project is estimated to have net benefits to Australia of between $1,748M and $2,090M.

The Project is considered on this basis to be more economically efficient than the agricultural production that would be displaced.

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Appendix 7 Assumptions for carrying capacity of Disturbance Boundary (As Is)

Appendix 7 **Assumptions for carrying capacity of Disturbance Boundary (As is)**

Ag Domain			A		B		C		Total
Bengalla	Ha		43		448		473		964
	%		4.5		46.5		49.1		
CURRENT	DSE/ha		8		5.1		3.5		
	TDM/ha		2.92		1.8615		1.2775		
Total DSE			344		2,285		1,656		4,284
Total pasture			126		834		604		1,564
Enterprise			Yearlings		Inland weaner		Inland weaner		
DSE Rating	DSE/breding cow		16.68		14.88		14.88		
Total cows			21		154		111		286
Stocking rate	ha/breeder		2.1		2.9		4.3		
Gross Income	$/ha	$	291.89	$	151.46	$	103.40		
Costs	$/ha	$	51.96	$	37.40	$	25.53		
Gross Margin	$/ha	$	240.10	$	114.06	$	77.86		
Animals sold per ha			0.4		0.3		0.2		
Gross Income	$/breeder	$	597.68	$	440.61	$	440.61		
Costs	$/breeder	$	106.40	$	108.81	$	108.81		
Gross Margin	$/breeder	$	491.64	$	331.80	$	331.80		
Animals sold per breeeder			0.83		0.83		0.83		
Gross Income	$	$	12,551	$	67,854	$	48,908	$	129,313
Costs	$	$	2,234	$	16,757	$	12,078	$	31,069
Gross Margin	$	$	10,324	$	51,097	$	36,830	$	98,251
Total Animal Sold			17		128		92		237

BENGALLA Mining Company

X

Dry Creek Interim Management System and Conceptual Re-instatement Study

Dry Creek Interim Management System and Conceptual Re-establishment Study

July 2013

Bengalla Mining Company

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Signed:

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Signed:

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Contents

Contents (Continued)

Contents (Continued)

Page number

List of tables

Page number

List of figures

Page number

Appendices

Executive summary

Bengalla Mining Company is currently seeking Development Consent under Part 4 of Division 4.1 of the *Environmental Planning and Assessment Act 1979* to facilitate the continuation of open cut coal mining for a further 24 years. The Project will result in the impact to an approximate 4 km section of Dry Creek and will require the diversion of Dry Creek until it can be reinstated prior to the completion of mining in approximately Year 24. An Environmental Impact Statement is currently being prepared from which this assessment will form part of.

Bengalla Mining Company Pty Limited engaged Parsons Brinckerhoff to undertake an interim management system and conceptual Dry Creek re-establishment study that will allow mining operations to continue west for the Project.

The overall Dry Creek relocation project has seen a significant number of higher level studies completed from conceptual and prefeasibility through to feasibility phases from 2007 to 2012, to determine the preferred option for the Project. Studies previously undertaken in relation to the relocation of Dry Creek include:

- Concept Study (January 2007).
- Value Management (March 2010).
- Order of Magnitude Study (July 2010).
- Options Evaluation Workshop (July 2010).
- Pre-feasibility Study (November 2010).
- Pre-feasibility addendum (December 2010).
- Bridging Study (January 2011).
- Feasibility Study (February 2012).

This report outlines the studies listed above and how each progressed from a broad range of ideas being generated through the development and evaluation of those ideas and finally to selection of a preferred option by Bengalla Mining Company Pty Limited for the interim management system and Dry Creek re-establishment.

1. Introduction

1.1 Background

Parsons Brinckerhoff was commissioned by Bengalla Mining Company Pty Limited (BMC), to undertake an interim management system and conceptual Dry Creek re-establishment study for the Continuation of the Bengalla Mine Project (the Project). This assessment will form part of the Environmental Impact Statement (EIS) supporting an application for Development Consent under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Project is generally comprised of:

- Open cut mining towards the west at a rate of up to 15 million tonnes per annum (Mtpa) of run of mine (ROM) coal for 24 years.
- Continued use of the existing dragline, truck fleet and excavator fleet (with progressive replacement).
- An out of pit Overburden Emplacement Area (OEA) to the west of Dry Creek which may be utilised for excess spoil material until it is intercepted by mining.
- Continued use, extension or relocation to existing infrastructure, including administration and parking facilities, in-pit facilities (including dragline shut down and erection pad), helipad, tyre laydown area, explosives and reload storage facility, core shed workshop and administration buildings, roads, reject bin, ROM Hopper, water management infrastructure, supporting power infrastructure, and ancillary infrastructure.
- Construction and use of various items of new infrastructure (including radio tower, extensions to Main Infrastructure Area (MIA), Mount Pleasant Staged Discharge Dam and associated water reticulation infrastructure, additional ROM coal stockpile and upgrade to the emergency ROM coal stockpile along with associated conveyor network).
- Processing, handling and transportation of coal via the (upgraded) CHPP and rail loop for export and domestic sale.
- Continued rejects and tailings co-disposal in the Main OEA and temporary in pit reject emplacement.
- Relocation of a 3 km section of Bengalla Link Road after Year 15 near the existing mine access road to facilitate coal extraction.
- The diversion of Dry Creek via dams and pipe work with a later permanent alignment of Dry Creek through rehabilitation areas when emplacement areas are suitably advanced.
- Relocation of water storage infrastructure as mining progresses through existing dams (including the Staged Discharge Dam, raw water dam).
- A workforce of approximately 900 full time equivalent personnel (plus contractors) at peak production.

1.2 Document objectives and structure

The document initially outlines the process and options considered for the re-establishment of Dry Creek prior to selection of a preferred option.

BMC's preferred option interim management system, and final Dry Creek re-establishment are then detailed in the following areas:

- design assumptions
- design basis
- design development
- safety in design.

The content of this report has been prepared in consideration of the relevant Director General's Requirements (DGRs) dated 13 March 2012 including submission to the DGRs from NSW office of Water (NOW) which are repeated below for information.

- For flood works, drainage works and water supply works which capture, store, convey, divert or impound water (such as a tank, dam, water pipe, irrigation channel, bank, levee, or weir), the EIS must provide the following details:
  - purpose, location and construction
  - whether the work is on a watercourse
  - size, storage capacity and expected annual extraction volumes
  - whether the work is affected by flood flows
  - details of any proposal for shared use, rights and entitlement of the work.
- Assessment and design principles relating to the proposed diversion and reconstruction of Dry Creek should be in accordance with *A Rehabilitation Manual for Australian Streams* Vol 2, CRC for Catchment Hydrology, LWRRDC 2000 ISBN 0 642 76030 6.

1.3 Dry Creek catchment characteristics

The Dry Creek catchment north of Wybong Road comprises approximately 665 hectares. An additional 580 hectares contributes to flows in Dry Creek downstream of Wybong Road that is largely within the Project Boundary.

Parsons Brinckerhoff understands the catchment has been mostly cleared for agriculture and is dominated by grasslands, although some areas of scattered woodland remain. The original character of the vegetation has been greatly altered as a result of previous agricultural land use. Small patches of remnant woodland vegetation occur in the western portion of the catchment.

A photographic record which provides a visual representation of Dry Creek within the Project Boundary was prepared by Parsons Brinckerhoff and is included in Appendix A.

The catchment slopes vary from 1% along the edges of Dry Creek main channel within the Project Boundary to approximately 30% in the headwaters of the catchment to the north of the Project Boundary.

1.4 Available information

1.4.1 Client supplied

- Aerial survey to Map Grid of Australia (MGA94) datum with an accuracy level of approximately 100 mm in the vertical. This survey was sourced by Rio Tinto Coal Australia for the Mount Pleasant Project. The survey was obtained by BMC after agreement with Mount Pleasant.
- Historic discharge volumes for the existing BMC environmental dam.
- Proposed final Dry Creek landform computer model dated 1st December 2011.
- Topographical map of Bengalla mine site.
- Power load study report.
- Bengalla Power Transformers Specification - BMC-M-11.

1.4.2 Reference documents

1.4.2.1 Civil

- NSW Dams Safety Act 1978.
- NSW Dams Safety Committee (DSC) – Dam Guidance Sheets.
- NSW Dept. of Conservation & Land Management Guidelines.
- NSW Department of Housing Blue Book – Managing Urban Stormwater – Soil & Conservation.
- ANCOLD Guidelines relative to dam design, construction and management.
- Floodplain Development Manual, NSW Government 2005.
- Waterway Design – A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, AustRoads, 1994.
- Works and Watercourse Design Guideline, NSW Government Department of Natural Resources, 2007.
- Director Generals Requirements – 13 March 2012.
- A Rehabilitation Manual for Australian Streams Vol 2, CRC for Catchment Hydrology, LWRRDC 2000 ISBN 0 642 76030 6.

1.4.2.2 Pumps and pipelines

- AS/NZS 4130:2009 Polyethylene (PE) pipes for pressure applications.
- AS 2200:2006 Design charts for water supply and sewerage.
- WSA 01-2004 3rd Edition Polyethylene Pipeline Code.
- WSA 03-2002 Product and Material Information and Guidance for Water Supply Code of Australia.
- US Department of Transport, Federal Highway Administration – Hydraulic Engineering Circular No 14 – Hydraulic Design of Energy Dissipators for Culverts & Channels (HEC 14).

1.4.2.3 Electrical and communications

- NSW Electricity Supply Act 1995.
- NSW Electricity Supply (General) Regulation 2001.
- NSW Service and Installation Rules 2006.
- AS 2067-2008 Substation and high voltage installations exceeding 1 kV ac.
- AS 3007 Set-2007 – Electrical installations for surface mines.
- AS/NZS 3000-2007 – Electrical Installations.
- AS 3008.1.1-2009 – Electrical installations – selection of cables.
- AS 2081 Electrical equipment for coal and shale mines.
- AS 4871 Electrical equipment for mines and quarries.

2. Options considered

Parsons Brinckerhoff has completed a significant number of higher level studies for the Dry Creek relocation project. These studies included conceptual, prefeasibility through to feasibility phases completed over a five year period from 2007 to 2012.

A summary of each of the previous studies including options considered is provided below.

2.1 Concept study (2007)

In 2007, Parsons Brinckerhoff prepared a preliminary design and construction cost estimate for BMC for the diversion of Dry Creek to enable the continuation of mining operations west of existing approved operations. The design was limited spatially by the presence of Wybong Road and the western boundary of the existing BMC mining lease ML 1397.

The vertical profile was limited by the invert of the culverts conveying Dry Creek beneath Wybong Road. The proposed Dry Creek diversion was designed on an open channel that drained by gravity west from the existing culverts under Wybong Road and then south outside the western boundary of ML 1397. It was characterised by a depth of cut up to 20 m.

2.2 Value management workshop (March, 2010)

Project conditions for the Dry Creek relocation had changed since the 2007 concept study, primarily:

- The creek diversion alignment was required to not preclude mining activities in ML1397.
- There were now potential opportunities to modify the catchment via mine water and clean water dams north of Wybong Road in consultation with the Mount Pleasant Project.

As such, BMC engaged Parsons Brinckerhoff to develop options for the Dry Creek relocation project through a value management/value engineering process. The process was designed to develop broad Dry Creek relocation schemes for development in a future Order of Magnitude study.

A value management workshop was held at Bengalla Mine with representatives from the Bengalla Joint Venture, Rio Tinto's Mount Pleasant Mine project team, Hansen Bailey (HB) and Parsons Brinckerhoff. Based on initial discussions at the workshop, the following three functions were considered to be essential in developing an option:

- Environmental: environmental considerations, final option to enable approvable option (internal and external).
- Engineering: maintain a waterway/flow.
- Cost: create/maximise value.

An initial list of options was put forward at the workshop for discussion by the whole group. After syndicate group discussions to develop the ideas on the list, a reviewed list of options with reasons for rejection or refinement was prepared. Table 2.1 describes the reviewed options. The names and descriptions of the options are as were described at the workshop.

Table 2.1 Initial Dry Creek relocation options

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
INTERIM OPTIONS		
A + Diversion source at RW1 spillway	▪ Deleted ▪ Does not fit with Mount Pleasant and BMC mine plans	
B + Diversion source at RW1 spillway	Deleted ▪ Excessive cost	
C + Diversion source at RW1 spillway	Deleted but could incorporate into Option G ▪ Not current option ▪ Stage 1 – west – stage 2 (30years) up and over the rehabilitation area	
D + Diversion source at RW1 spillway	Deleted, same as spillway + x metres	
E + Diversion source at RW1 spillway	Deleted, same as spillway + x metres	
A + Diversion source at RW1 spillway + x metres	Deleted ▪ Does not fit with MTP and BMC mine plan	
B + Diversion source at RW1 spillway + x metres	Deleted ▪ Excessive cost	
C + Diversion source at RW1 spillway + x metres	Deleted but could incorporate into Option G ▪ Not current option ▪ Stage 1 – west – stage 2 (30years) up and over the rehabilitation area	
D + Diversion source at RW1 spillway + x metres	Retained ▪ Look to modify location of MTP dam to allow construction of water course/contour drain	Accepted
E + Diversion source at RW1 spillway + x metres	Retained	Accepted
D + Split northern catchment into two dams	D + Split northern catchment into two dams & E + Split northern catchment into two dams merged but then deleted as D + diversion and E + diversion need to be treated separately and cover this merged option. ▪ Same for both options as delivery gravity to same point at NW corner for flow to river	

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
E + Split northern catchment into two dams	▪ High dam allows MTP to separate clean catchment (for harvest rights) from pitwater ▪ Diversion channel allows to cut off more catchment above pitwater ▪ Reduces cut and length ▪ Higher impact on MTP infrastructure ▪ Relatively high cost and low risk	
G = dam, pipe and pump (Wybong Road)	Retained ▪ Short term solution (10 years) ▪ Relies on long term land form solution (long term solution to be combined with Option C) ▪ Sterilise small area of coal to pit floor to create clean water pump well ▪ High risk/low capital ▪ Is it a diversion – is there a precedent	Accepted
DRY CREEK RELOCATION		
A = Gravity (culverts at Wybong Road) to East (adjacent Wybong Road)	Deleted due to: ▪ Sterilise coal along Wybong Road ▪ Potentially 50 m cut ▪ Mining catchments (water quality, increased flow)	
B = Gravity (culverts at Wybong Road) to North	Deleted due to: ▪ Significant cut due to topography ▪ Intersects/restricts mining area	
C = Gravity (culverts at Wybong Road) to East across the BMC rehabilitation area	Deleted as a standalone option ▪ May prove feasible when combined with Option G, provided the construction timing fits the BMC dump plan ▪ Would only work as a pump option or pump /gravity hybrid solution	
D = Gravity (culverts at Wybong Road) to West	Deleted ▪ Feasible as a hybrid solution – pump to the north east corner of AL13, then drain by gravity ▪ Avoids the mining area and infrastructure ▪ Environmental offset requirements	
E = Gravity (culverts at Wybong Road) to South (west then south)	Retained ▪ Original concept is feasible subject to NPV and as the first stage of a multiple stage solution	Accepted

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
H = Mt Arthur pit solution (2,000ML)	Retained ▪ Turns all clean water into dirty water	Accepted
I = Leave creek essentially in same location	Retained ▪ Straighten creek and mine up to creek alignment ▪ Lower cost ▪ Lower mine efficiency versus need to change direction	Rejected ▪ Size of pillar would decrease net present value (NPV) ▪ Environmental impact ▪ Untenable from land acquisition ▪ Severely compromises development programs

2.3 Order of magnitude study (July, 2010)

In July 2010, Parsons Brinckerhoff prepared an Order of Magnitude Study to further investigate the options identified as potentials in the value management workshop. The five potential options formed the basis for seven options that were developed in the order of magnitude study. The seven options prepared at the time are described below. General arrangement drawings for the options are contained within Appendix B.

- Options 1 and 6 – gravity drainage solutions that drain west then south around AL13. These options were characterised by deep cuts (up to 75 m) and extensive earthworks (up to 21 million bank cubic metres of cut).
- Options 2 to 5 – taking into account that the Mount Pleasant Project team were considering various options for their raw water management system at the time, a clean water runoff dam was included immediately upstream of Wybong Road to provide protection against inundation of the BMC void as mining at Bengalla progresses past the existing creek line. These options drained south to the Hunter River or west to Sandy Creek. It should be noted that Option 4 included a combined BMC/Mount Pleasant Project discharge dam.
- Option 7 – this option comprised a dam immediately downstream of Wybong Road on the Dry Creek alignment. The dam storage was to be pumped to a notional Dry Creek channel realigned west of AL13 and draining south to the Hunter River.

Options 1 and 6 were considered long term options as they provided free draining solutions. The other five options required pumps and pipelines and were hence considered to be interim options. These interim options then required Dry Creek to be reinstated through the proposed BMC OEA.

2.4 Value management (options evaluation) workshop (July, 2010)

The options evaluation workshop focused on developing suitable evaluation criteria that represented the priorities of the individual project stakeholders attending the workshop.

An initial list of 22 evaluation criteria identified by the attendees was refined to six items. The adopted evaluation criteria comprised:

- Approvability (statutory) – potential to gain all of the required regulatory approvals required to build and operate the infrastructure.
- Design robustness – the ability of the option to satisfy the design intent risk.
- Operational interaction – clarity of responsibility for ownership and operation between the stakeholders.
- Resource recovery – potential to affect efficient resource recovery.
- Owner's approval.
- Schedule – potential for extended program to adversely impact the Bengalla Mine or proposed Mount Pleasant Project operations.

By consensus, the attendees assigned each criterion a relative weighting and then scored each option on the above criteria. The estimated cost was subsequently factored into the assessment to give a value ratio for each option.

Based on the value ratios, Option 7 was taken to the pre-feasibility study as the base case. Options 3 and 4 were identified for further development in the pre-feasibility phase given there was negligible difference separating them as the next preferred option.

2.5 Pre-feasibility study (2010)

This study aimed to refine the three preferred options identified in the Order of Magnitude study (renamed in this study Options 1, 2 and 3) to increase the order of accuracy of the capital cost estimate, and to recommend an option(s) to take forward to the feasibility stage.

Geotechnical assumptions, environmental characteristics and design criteria were assumed based on Parsons Brinckerhoff's previous project experience with creek diversions in the Hunter Valley, aerial survey data and aerial photography.

The study recommended that Option 3 be adopted for the feasibility stage as the base case. Option 2 was also to be considered for further development to provide operational flexibility for BMC in relation to when Dry Creek is reinstated through the spoil dump area and to minimise the risks associated with constrained dump profiles.

2.5.1 Pre-feasibility addendum

BMC requested Parsons Brinckerhoff to prepare an addendum to the pre-feasibility study to develop sub-options that were called Options 2A, 2B, 3A and 3B. These options were variations to Option 2 and 3 and were developed during the review phase of the pre-feasibility study. These variations offered additional alternatives for the relocation of Dry Creek previously not explored. They were identified as they would:

- Increase flexibility for BMC in the alignment and timing of the Dry Creek reinstatement across the rehabilitation area.
- Provide flexibility for BMC to extend their mining operations west of AL13.

2.5.2 Bridging study

In Option 2 of the pre-feasibility study, a dam for the purpose of discharging water to the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) that was separate to the Mount Pleasant Project's raw water dam was proposed to be located west of AL13. This dam also included storage capacity equivalent to BMC's existing environmental dam that is proposed to be mined out. At the Value Management workshop held on 29 July 2010 prior to the pre-feasibility study, this arrangement was assessed as feasible by assuming a management plan, procedures and monitoring were able to be established to track volumes of water and water quality in the dam contributed by Mount Pleasant and BMC. This management plan would allow tracking of salinity credits under the HRSTS when discharges were possible. It is noted that in the workshop the criteria 'operational interaction', which related to this sharing, was ranked as the least important factor, out of a total of six factors, when comparing various options.

The intent of the bridging study was to investigate the construction cost of two separate dams having the same total volume as the proposed combined discharge dam. This would eliminate operational issues associated with having a combined discharge dam. The additional sub-options that emerged from this study were known as Option 2A1 and 2A2, and 3A1 and 3A2.

2.6 Feasibility Study (2012)

The feasibility study initially aimed to refine the two preferred options and sub-options, Option 2A1 and 2A2 and Option 3A1 and 3A2, identified in the pre-feasibility addendum to increase the order of accuracy of the capital cost estimates for these options. The options represented the preferred arrangements covering the two different scenarios of the adjacent Mount Pleasant Project proceeding or not proceeding in a timeframe that would facilitate the continuation of the Bengalla Mine Project.

During this study, BMC requested that Option 2B and Option 3B from the pre-feasibility addendum also be included in this feasibility study.

3. Selected interim management system

Subsequent to the feasibility study, BMC selected Option 2A2 as the preferred interim management system option for the Project. As for the feasibility study, all the interim management system options were to be followed by the re-establishment of Dry Creek across final rehabilitated landform of the emplacement areas.

Option 2A2 was adopted by BMC for the interim management system as to mitigate the Project interrupting the Mount Pleasant Project's currently approved discharge route (via RW1 into Dry Creek) it is proposed that BMC, as part of the Project, will construct a 300 ML Mount Pleasant Discharge Dam 1 (MTP DW1) and associated pipeline (see Figure 3.1) in accordance with relevant guidelines and standards.

Following the receipt of Development Consent, if granted, BMC will construct MTP DW1 within a mutually agreeable timeframe, but prior to the commencement of mining operations associated with the Mount Pleasant Project. MTP DW1 will not be utilised in the Project water management system.

Option 2A2 was adopted by BMC for the interim management system as it allows that mining efficiency for the Project is maximised, was compatible with the Mount Pleasant Project's approved works and includes the two separate discharge dams that allow the two mines to remain independent for the HRSTS.

Appendix C contains drawings prepared for this study including general arrangements that summarises Option 2A2, referred to from here in this report as the 'preferred option' or just the interim water management system.

3.1 Option details

The preferred option as presented and assessed in the Mount Pleasant Mine Environmental Impact Statement (MTP EIS) (ERM Mitchell McCotter 1997) demonstrates that the interim water management system developed for the Project is practical with extensive consideration provided in relation to the layout of the approved Mount Pleasant Project. Figure 3.1 illustrates the layout of the interim water management system.

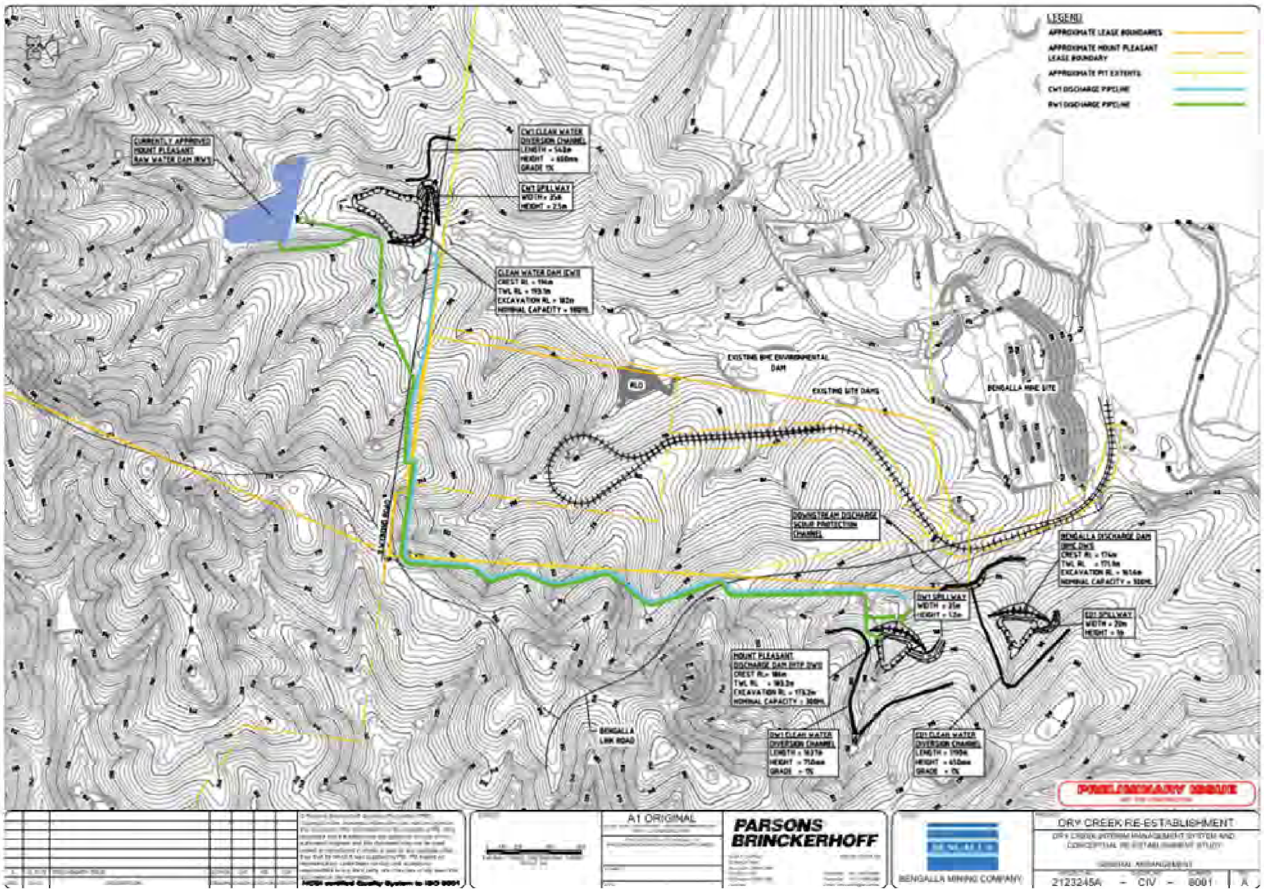


Figure 3.1 Interim management system option – general arrangement

A summary of the interim water management system for the Project is provided below:

- Construction of a clean water dam (CW1) for BMC north of Wybong Road. The dam has been designed to capture the runoff generated from the 1 in 200 year average recurrence interval (ARI), 72 hour storm prior to passing under Wybong Road. Noting that this dam is essentially all surcharge capacity, CW1 has a surcharge capacity of 900 ML to reduce the potential for runoff entering the Project's void. Should the Mount Pleasant Project proceed, the clean water catchment would decrease due to their infrastructure occupying part of the catchment.

- Two separate 300 ML discharge dams located in the west of the Project Boundary. One would be Mount Pleasant's discharge dam (MTP DW1). The other would act as BMC's discharge dam (BMC DW1) and would be a relocation of the existing BMC environmental (or staged discharge) dam; During periods of high rainfall, excess water from the Project can be discharged via BMC DW1 into the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) during periods of 'high' or 'flood' flows. Discharges will be conducted in accordance with BMC's Environment Protection Licence (EPL) 6538 (which will be varied for the Project) and the *Hunter River Salinity Trading Scheme Regulation 2002*.

- Construction of an approximately 6.4 km long raw water pipeline system from RW1 to the proposed MTP DW1. The pipeline would be bi-directional to allow water to be pumped back to the raw water dam should it be needed back for the Mount Pleasant Project. MTP DW1 and associated pipeline will be constructed by BMC for the Project however Coal & Allied would seek any additional required approvals under the EP&A Act or other relevant legislation to facilitate its use.

- Construction of an approximately 5.4 km long clean water pipeline system from CW1 to a release point in the west of the Project Boundary for release of clean water into the Dry Creek catchment. An energy dissipating structure would be constructed at the end of the pipeline.

- Construction of a pumping station at the outlet of CW1 for the pipeline mentioned in the point above.

- Construction of a downstream scour protection channel to reduce the potential for further scour to the existing topography as a result of both discharge dam and clean water discharge.

- Associated electrical work required for the above to be constructed and operated.

- Construction of the re-established Dry Creek once the final landform is developed following mining operations (see Section 10).

4. Design assumptions

This chapter outlines assumptions made in the design process to date.

4.1 Dams and channels

4.1.1 Clean water dam (CW1)

The following assumptions have been made during the development of the design for CW1:

- The dam capacity is based on normally being empty at the start of the 1 in 200 year average recurrence interval (ARI), 72 hour storm event with a requirement to empty the dam within 14 days following a storm event in order to deal with the same design event again. This time period equates to a design flow of approximately 1,085 L/s. The outlet structure is to be designed to accommodate this flow.
- Based on available geotechnical data, a key trench depth of 3 m into hard clay has been nominated with vertical and horizontal sand filters.
- Select clay fill material for use in the embankments would be won from the excavated storage area.
- The Dams Safety Committee (DSC) would in principle endorse the dam cross sectional design based on the consequence category estimated by Parsons Brinckerhoff. The Project team attended a meeting on 22 August 2012 to discuss the Project including the proposed CW1 construction.
- An access track from Wybong Road to the dam would be required.
- Some excess clay fill material may be sourced from the excavated storage area to assist the Mount Pleasant Project in the construction of their RW1 embankment location if required. Should this material not be required, it would be transferred across Wybong Road under a strict Traffic Control Plan to the approval of Muswellbrook Shire Council.

4.1.2 Discharge dams (MTP DW1 & BMC DW1)

The following assumptions have been made during the development of the design of the two DW1 dams:

- Based on available geotechnical data, a key trench base founded 1 m into extremely weathered rock (approximate depth 3 m) has been nominated for BMC DW1 with vertical and horizontal sand filters.
- Based on available geotechnical data, a key trench base founded 0.5 m into low permeability rock (approximate depth 9.5 m for the highest section of the dam alignment) has been nominated for MTP DW1 with vertical and horizontal sand filters. This is due to the presence of a highly permeable zone of weathered rock.
- Select clay fill material for use in the embankments would be won from the excavated storage area of each dam.

- Outlet structures have been sized for an average discharge rate of 125 ML/day which equates to the largest single day discharge recorded for the existing BMC environmental dam.
- Clean water diversion channels would be constructed upslope of both dams to minimise the external catchment reporting to the dam.
- The DSC would in principle endorse the dam cross sectional designs based on the consequence category estimated by Parsons Brinckerhoff. The Project team attended a meeting on 22 August 2012 to discuss the Project including the proposed BMC DW1 and BMC DW1 construction.
- Access tracks from Bengalla Link Road to the dams would be required.

4.1.3 Downstream scour protection channel

The following assumptions have been made during the development of the design of the downstream scour protection channel:

- The existing topography downstream of the proposed clean water pipeline discharge is already extensively scoured.
- This work is to formalise an already existing natural channel with a minimum width of 10 m.
- Rock rip rap scour protection has been provided where velocities are in excess of 2 m/s for the 1 in 100 year peak flows.

4.1.4 Re-establishment of Dry Creek

The following assumptions have been made during the development of the design of the re-establishment of Dry Creek:

- The design has been based on the Project Year 24 Mine Plan supplied by BMC dated 1 December 2011.
- The horizontal alignment supplied in the landform has been followed however widening has been undertaken where necessary based on hydraulic modelling.
- The vertical alignment has been used as a guide however changes to the vertical geometry are required based on hydraulic modelling and to minimise zones and extents of rip rap scour protection.
- A low flow channel is to convey the two year ARI flows with the overall channel cross section to contain flows up to and including the 100 year ARI event.
- The final landform would be constructed of mine spoil and as such a 2 m thick select clay fill layer would be required for the length of the alignment. It is assumed that BMC over years of mining would stockpile clay in a suitable location for an experienced contractor to condition and use in the construction of the re-establishment of Dry Creek.
- Stabilisation of the top 300 mm of select clay fill with 2% gypsum would be required.

- The re-established Dry Creek would be topsoiled, seeded and hydro mulched to the extents of the select clay fill. Any vegetation outside these limits is considered to be included in BMC's rehabilitation program. The final design criteria and objectives for the re-establishment of Dry Creek would be included in a Rehabilitation and Final Landform Management Plan to be developed in consultation with the relevant authorities and to the satisfaction of the Department of Infrastructure and Planning.
- The termination of the re-established Dry Creek has been selected at a location which is assumed not to be affected by future proposed mining operations and returns to the current Dry Creek catchment.

4.2 Pumps and pipelines

The following assumptions have been made during the development of the design for the pumps and pipelines component of the study:

- The clean water system has been designed based on the requirement to drain the clean water dam CW1 in 14 days, resulting in a design flow of 1085 L/s.
- The raw water system has been designed to deliver a maximum flow of 40 L/s to discharge dam (MTP DW1).
- Geotechnical conditions below the dam foundations support the construction of below dam wall outlet pipelines.
- Geotechnical conditions at proposed pump station sites support a slab-on-the-ground type structure without the need for footings.
- Muswellbrook Shire Council may require that trenchless construction technology be adopted where pipelines cross local roads in order to minimise disruptions to the public road users.

4.3 Electrical and communications

The following assumptions have been made during the development of the design for the electrical and communications component of the study:

- Mount Pleasant Project raw water dam power supply would be available for raw water pumps.
- BMC and the Mount Pleasant water management systems would operate independently.
- Where the impedance values of the transformers are not known, transformer impedance values based on the worst case values given in AS 2374 are suitable for use in the calculations.
- Discrimination settings can be achieved using the selected breakers. Discrimination settings were not checked for circuit breaker sizing.
- Fault limiting fuses can be added to ensure the fault current rating of the circuit breakers is greater than the board fault level. Fuse sizes and locations would need to be confirmed during detailed design.

- Pumps at the CW1 can be started sequentially to minimise the voltage drop across the transformer and cables.
- Cables are sized based on AS3008 with an assumed soil thermal resistivity of 1.2 and an ambient air temperature of 40 degrees C.
- 22kV is the nominal voltage available at the transformer HV terminals. The nominal voltage would be used for motor starting voltage drop calculations.
- Earthing cables specified are sufficient to carry the maximum fault current.
- Motor heaters are required.

The design for the transmission line infrastructure is based on the following assumptions:

- A multiple voltage transmission line (66kV with underslung 22kV) is permitted on site. The new 66kV transmission line is required due to the relocation of the existing 66kV transmission line.
- The 66kV transmission line would need to be commissioned while the CW1 is operational. Prior to commissioning, the 66kV transmission line would be de-energised and earthed at both ends.
- The mine site uses a reticulated earth system.

The design for the generator (auxiliary power supply) infrastructure is based on the following assumptions:

- Two emergency power generators for the pump station options are required as the clean water dam (CW1) is deemed critical infrastructure. An additional generator would be installed as a standby.
- A mine infrastructure area located containerised central generation system (generators and fuel storage) is required. This would allow relocation of the generators and fuel storage to a laydown area next to the pump station should the supply transmission line be compromised.
- The generators would have the ability to synchronise to the site network power. This is required to reduce the risk associated with possible delays with a future Ausgrid application to upgrade supply Bengalla.
- Site has a minimum of 14 days diesel storage (approx. 140,000L) at all times.

The design for the communications infrastructure is based on the following assumptions:

- Optical Ground Wire (OPGW) connection is possible using the proposed electrical infrastructure from BMC.
- A backup or diverse link to CW1 is required due to the criticality of the control required.
- Separate communications equipment and towers are required for both Bengalla and Mount Pleasant Project.
- A 30 m tower is adequate to provide a point to point link to each respective mine. This would be reviewed in the next phase with radio analysis.

5. Design basis

The design basis for the Dry Creek study was broken down into three disciplines: dams and channels, pumps and pipelines, and electrical and communications. The following sections outline the design basis for each of the disciplines.

5.1 Dams and channels

5.1.1 Clean water dam (CW1)

CW1 provides protection for the Bengalla void as mining progresses for the Project. As RW1 has clean water diversion channels around its storage to minimise the effects of the catchment, CW1 captures the remaining overland flows from the catchment north of Wybong Road. The storage of CW1 can be released (via pumps and pipelines) at any time as it is clean water and also guards against associated clean water harvesting rights issues in the catchment. It is proposed that CW1 will be maintained empty to ensure that clean water movement to the Hunter River will not be significantly impaired.

The following design criteria have been adopted for the purposes of the study:

▪ Design life	Approximately 20 years (decommissioned once Dry Creek is re-established).
▪ Catchment area	Total catchment – 603 ha (designed to capture all clean water runoff with or without mining operations commencing for the Mount Pleasant Project).
▪ Storage capacity	900 ML (including excavated storage).
▪ Surcharge capacity	The dam is designed to be operated empty and as such the entire dam volume to the invert of the spillway is surcharge capacity. This has been sized for a 1 in 200 year ARI, 72 hour storm event less the pumping capacity required to empty the storage in 14 days.
▪ Embankment	Zoned earthfill embankment with selected clayfill core and horizontal and vertical sand filters with 3H:1V upstream and downstream batters 3 m trafficable crest width comprising 200 mm gravel capping layer and 2.0 m wide safety bunds (0.5 m high).
▪ Embankment height	13.5 m maximum height at centreline.
▪ Spillway capacity	Sized to pass 1 in 100,000 year ARI event to satisfy DSC requirements for High C consequence category. Rock rip rap scour protection provided to minimise erosion and scour within outlet channel and at sections of the base of the dam embankment.
▪ Spillway section	Trapezoidal cross section with 35 m base width and 3H:1V side slopes.
▪ Estimated DSC Consequence Category	High C.
▪ Minimum freeboard (DSC 3B)	0.4 m.

relocation of the existing BMC Staged Discharge Dam).

The following design criteria have been adopted for the purposes of the study:

▪ Design life	Assume life of mine.
▪ Catchment area (MTP DW1)	Total catchment – 104 ha. Catchment area – 15 ha (excluding catchment area contained by diversion channels).
▪ Catchment area (BMC DW1)	Total catchment – 58 ha. Catchment area – 13 ha (excluding catchment area contained by diversion channels).
▪ Storage capacity	300 ML for individual dams including excavated storage @ top operating level.
▪ Surcharge capacity	Storage between top operating water level and the spillway invert sized for a 1 in 100 year ARI, 72 hour storm event. ≈ 63 ML – MTP DW1. ≈ 40 ML – BMC DW1.
▪ Embankment	Zoned earthfill embankment with selected clayfill core and horizontal and vertical sand filters with 3H:1V upstream and downstream batters 3 m trafficable crest width comprising 200 mm gravel capping layer and 2.0 m wide safety bunds (0.5 m high).
▪ Embankment height (MTP DW1)	16.6 m maximum height at centreline.
▪ Embankment height (BMC DW1)	17.9 m maximum height at centreline.
▪ Spillway capacity (MTP DW1)	Sized to pass 1 in 100,000 year ARI event to satisfy DSC requirements for High C consequence category. Nominal 6 m rock rip rap scour protection provided to minimise erosion and scour within outlet channel.
▪ Spillway section (MTP DW1)	Trapezoidal cross section with 35 m base width and 3H:1V side slopes.
▪ Estimated DSC Consequence Category (MTP DW1)	High C.
▪ Estimated DSC Consequence Category (BMC DW1)	Significant.
▪ Minimum freeboard (DSC 3B)	0.4 m.

5.1.3 Diversion channels

Permanent diversion channels are located upstream of both DW1s to divert clean stormwater runoff away from the dams.

The following design criteria have been adopted for the purposes of the study:

- Design life — Life of mine.
- Design capacity ARI — 1 in 100 year ARI peak flow event.
- Channel cross section — 3 m base width, 3H:1V side slopes.
- Minimum grade — 0.65%: Desirable minimum 1.0%.
- Manning's n — 0.020 (velocity assessment).
  0.035 (capacity assessment).
- Channel lining — Channel linings suitable to provide stable channel for: 1 in 10 year ARI event
  Grass lining provided where V_{50} < 2 m/s.
  Rock scour protection where $V_{50} \geq 2$ m/s.

5.1.4 Scour protection for channel downstream of discharge dams

A downstream scour protection channel is proposed to formalise the downstream flow path from the CW1 and MTP DW1 discharges and protect the already extensively scoured natural channel in the area.

The following design criteria have been adopted for the purposes of the study:

- Design life — Life of mine.
-
- Design capacity ARI — 1 in 100 year ARI peak flow event.
- Channel cross section — 10 m base width, 3H:1V side slopes.
- Minimum grade — 1.0%.
- Manning's n — 0.020 (velocity assessment).
  0.035 (capacity assessment).
- Channel lining — Channel linings suitable to provide stable channel for 1 in 50 year ARI event.
  Grass lining provided where V_{50} < 2 m/s.
  Rock scour protection where $V_{50} \geq 2$ m/s.

5.1.5 Re-establishment of Dry Creek

Dry Creek is to be re-established once mining operations have passed through the existing natural alignment of the creek and are sufficiently advanced to allow the overburden emplacement area to be established back to sufficient height. This is anticipated to occur after Year 15 of the Project. This is to be constructed to remove the requirement for a clean water dam and pumping system to divert flow around mining.

The following design criteria have been adopted for the purposes of the study:

- The channel is to follow as close as possible the plan/horizontal alignment indicated in the Year 24 computer model supplied to Parsons Brinckerhoff dated 1st December 2011.
- Provide a 2-stage flow channel with the lower stage capable of safely conveying flood events to and including the 2 year ARI event, and the upper stage capable of safely conveying events up to and including the 100 year ARI event, consistent with good practice flood management guidelines.
- Provide a channel cross section and roughness that allows opportunity for environmental enhancement.
- Provide a channel horizontal and vertical alignment that minimises flow velocities and erosion potential and allows opportunities for environmental enhancement.
- Provide a stable channel that would resist erosion and scour under flood events up to and including the 50 year ARI flood event, consistent with good practice erosion and sedimentation control guidelines.

5.2 Pumps and pipelines

The pumps and pipelines component of the Project comprises of two separate water systems. The first system is to drain clean stormwater runoff captured in BMC's proposed CW1 and release it to a downstream creek, in a manner that does not impede the Project. The second system is to construct the necessary infrastructure components to convey raw water from the Mount Pleasant raw water dam (RW1) to a discharge water dam. As discussed in Section 3 MTP DW1 and associated pipeline will be constructed by BMC for the Project however, Coal & Allied would seek any additional required approvals under the EP&A Act or other relevant legislation to facilitate its use.

Reference guidelines and codes that have been utilised in compiling the design basis for the respective systems can be found in Section 1.4.2.2.

5.2.1 General

General design considerations applicable to the water management systems described above are as follows:

- Pipelines to comprise butt welded co-extruded thermally protected (white) high density polyethylene pipes (PE100) laid on an engineered pipeline formation above ground.
- Pipelines would not incorporate flanged joints unless they are required for the inclusion of fixtures or appurtenances. Should pipelines require relocation in the future they would have to be cut into moveable sections before relocation and re-welded once relocated.
- Both pipelines would be co-aligned in a services corridor including combined pipeline and access track formation, environmental bunding, an overhead powerline easement and a catch water berm. The formation has been widened to allow for snaking of the pipelines above ground.

- Pipes are to be sized such that they deliver the required design flow in an aged condition.
- Pipeline appurtenances such as air valves and scour valves are to be located above ground to avoid valve chambers that would constitute a confined space.
- Both pipeline systems would incorporate pigging facilities for cleaning the pipeline.
- Pipe pressure classes have been determined based on required delivery pressures, making allowances for de-rating due to temperature and surge effects, but not, after taking into account all factors, to be less than PN10.
- No allowance has been made for cyclic fatigue de-rating of pressure classes due to the infrequent use of the pipelines.

5.2.2 Raw water system

The specific design criteria adopted for the raw water system for the purposes of the study is listed in Table 5.1.

Table 5.1 Raw water system criteria

System element	Criteria
Operational requirements	
System delivery	3.45 ML/day or 40 L/s (nominated during the pre-feasibility study)
Design flow envelope (ML/day)	No envelope – considered to be a batch flow system with no allowance for augmentation
Design life of system	50 years for pipeline and fixed structures
	15 years for fixed mechanical equipment
System configuration	Transfer facility to be bi-directional between raw water dam RW1 and MTP discharge dam DW1. No pump station is required downstream of the BMC DW1 dam.
Pigging	Pig launching facility provided at RW1 pump station and receiving station at the bifurcation valve station near the DW1 discharge dam embankment
Pressure pipeline design criteria	
Pumped medium	Saline raw water collected from mining areas at the Mount Pleasant mine
Pipeline configuration	Single pipeline above ground, with buried sections below roadways and access tracks, laid parallel to the clean water system pipeline wherever possible
Pipeline optimisation	Not considered due to infrequent pipeline use
Kinematic viscosity of water	1.01 x 10^{-6} m^2/s for water at 20°C (AS 2200 – 2006)
Colebrook –White friction factor (k)	0.015 mm (range in AS 2200 – 2006 : 0.003 – 0.015 mm)
Pipeline sizing	Based on acceptable velocity envelope
Acceptable velocity range	$1.0 \le v \le 2$ m/s
Selected pipe size	Based on criteria a DN250mm pipeline was selected
Design pipeline temperature	35°C
Permissible system operating head after temperature de-rating	PN10 (80 m), PN12.5 (100 m), PN16 (128 m), PN20 (160 m) – (Vinidex HDPE Design Manual – Table 4.7)

System element	Criteria
Allowance for thermal movements	Snaking induced by anchoring the pipe at 60m intervals to allow for a 2.5m lateral deflection based on a maximum diurnal temperature fluctuation of 18°C
Minimum Hydraulic Grade Line (HGL) at any point	10 m above natural ground level at all locations
Wave celerity to determine transients	PN10 (290 m/s), PN12.5 (320 m/s), PN16 (360 m/s)
Pipeline appurtenances	
Air valves	At all high points
Air valve sizing	In accordance with American Water Works Association (AWWA) Manual M51 – Air Release, Air Vacuum and Combination Air Valves
Scour valves	At all low points with Camlok fittings to allow for scouring to tankers rather than release into local creeks
Pipeline bunding	In the event of rupture the pipeline spills into an environmental bund which discharges to environmental dams at low points, sized to hold an hour of pumped flow
Fittings	All fittings and appurtenances to be PN16
Transient mitigation measures	None required
Pipeline outlet	
Outlet configuration	The raw water pipeline discharges into either DW1 or RW1 depending on the direction of pumping. In order to achieve bi-directionality a valve-controlled branch facility is provided near each dam embankment (bifurcation station)
Discharge to dam	A pipeline from the valve-controlled branch facility discharges into both DW1 and RW1 via a precast concrete headwall with downstream riprap protection located in the impoundment zone of the dam
Velocity	Discharge velocities are low at approximately 1.2 m/s, and hence no special erosion protection requirements are necessary at the pipe discharge point
Pump station	
Pump station configuration	Two land based stations downstream of the dam embankments, one at DW1 and one at RW1 comprising of an uncovered concrete slab-on-ground on which pumps, valves and motor control centres are mounted
Pig launching facility	Provided at RW1 pump station due to the lower operating head from RW1 to DW1, with the retrieval station located at the bifurcation valve station
Pump configuration	Single duty and single standby pump
Maximum dynamic pumping head	RW1 to MTP DW1 – 70 m
(RW1 and CW1 on Mount Pleasant land)	MTP DW1 to RW1 –105 m
Fixed pump type	Centrifugal single stage end suction pumps
Pump motor	Fixed speed electrically driven with direct coupled drive
Pump control	Manual operation by way of remote SCADA system at the Mount Pleasant mine infrastructure area control centre
Leak detection	Electromagnetic flow meters are provided at the RW1 and DW1 pump stations and at the dam discharge points. These would be used to monitor the water balance in the system, if the meters detect an imbalance pumps would be switched off and an alarm signal displayed on the Mount Pleasant SCADA system.

5.2.3 Clean water system

The specific design criteria adopted for the clean water system for the purposes of the study is listed in Table 5.2.

Table 5.2 Clean water system criteria

System element	Criteria
Operational requirements	
System delivery	Drain CW1 in 14 days or 1,085 L/s (nominated during the pre-feasibility study)
Design flow envelope (ML/day)	No envelope – considered to be a batch flow system with no allowance for augmentation
Design life of system	50 years for pipeline and fixed structures
	15 years for fixed mechanical equipment
System configuration	Transfer to be uni-directional from CW1 to the creek outlet
Pigging	Pig launching facility provided at CW1 pump station and receiving station at the flow control station immediately upstream of the discharge point
Pressure pipeline design criteria	
Pumped medium	Stormwater runoff from the CW1 catchment consistent with slightly turbid surface water with little to no salinity
Pipeline configuration	Single pipeline above ground with buried sections below roadways and access tracks laid parallel to the raw water system pipeline wherever possible
Pipeline optimisation	Undertaken during pre-feasibility study and determined to be a DN710mm size
Kinematic viscosity of water	1.01×10^{-6} m^2/s for water at 20°C (AS 2200 – 2006)
Colebrook –White friction factor (k)	0.015 mm (range in AS 2200 – 2006 : 0.003 – 0.015mm)
Pipeline sizing	Based on acceptable velocity envelope
Acceptable velocity range	$1.0 \leq v \leq 4.0$ m/s (infrequently used) maximum velocity more a function of tolerable transients resulting from changes to steady state hydraulics
Selected pipe size	Based on optimisation undertaken during pre-feasibility study a DN710mm pipeline was selected
Design pipeline temperature	35°C
Permissible system operating head after temperature de-rating	PN10 (80 m), PN12.5 (100 m), PN16 (128 m), PN20 (160 m) – (Vinidex HDPE Design Manual – Table 4.7)
Allowance for thermal movements	Snaking induced by anchoring the pipe at 60 m intervals to allow for a 2.5 m lateral deflection based on a maximum diurnal temperature fluctuation of 18°C
Minimum Hydraulic Grade Line (HGL) at any point	10 m above natural ground level at all locations
Wave celerity to determine transients	PN10 (290 m/s), PN12.5 (320 m/s), PN16 (360 m/s)
Pipeline appurtenances	
Air valves	At all high points
Air valve sizing	In accordance with American Water Works Association (AWWA) Manual M51 – Air Release, Air Vacuum and Combination Air Valves
Scour valves	At all low points with discharge directly to local creeks
Pipeline bunding	Not specifically required

System element	Criteria
Fittings	All fittings and appurtenances to be PN16
Transient mitigation measures	None required
Pipeline outlet	
Flow control	Orifice plate incorporated immediately upstream of outlet point to raise the upstream HGL and achieve an HGL at least 10 m above ground level for the extent of the pipeline
Outlet configuration	Pipeline discharge to creek via an impact energy dissipation structure designed in accordance with the HEC-14 guideline (see listed references)
Pump station	
Pump station configuration	Land based pump station comprising of an uncovered slab-on-ground structure.
Pig launching facility	Provided at CW1 pump station with the retrieval station located at the flow control station immediately upstream of the discharge point
Pump configuration	Three duty and single standby pumps (subject to confirmation from supplier)
Maximum dynamic pumping head	CW1– 100 m
Fixed pump type	Centrifugal single stage split case pumps (land based and mounted on pontoons i.e. same pump type for both configurations)
Pump motor	Fixed speed electrically driven with direct coupled drive
Pump control	Manual operation by way of remote SCADA system at the Bengalla mine infrastructure area control centre
Leak detection	Not specifically provided as pumped medium is not environmentally detrimental

5.3 Electrical and communications

Due to limited availability of technical information, assumed specifications and design documentation have been used as the basis for the electrical design criteria in conjunction with the following site specific criteria:

- BMC water infrastructure within the Project Boundary would be fed from the BMC power system.
- Water infrastructure located outside of the Project Boundary would be fed from Ausgrid.
- Independent electrical and communications infrastructure would be used to operate and communicate from the dams to each mine.
- To minimise CAPEX transmission lines would follow pipeline routes.
- Transmission lines would be located to avoid coal sterilisation.
- 66kV and 22kV systems would be based on the existing conductors used on site.

6. Geotechnical site conditions

As part of the feasibility study, Parsons Brinckerhoff undertook geotechnical investigations at the proposed infrastructure locations. An interpretive report was prepared following the investigations which covered all six options in the feasibility study.

The investigation comprised drilling fourteen boreholes with packer testing and excavating thirty-two test pits across the various locations. Boreholes and test pits at the CW1 locations both north and south of Wybong Road typically encountered a deep residual sandy clay/clayey sand soil through the drainage lines overlying extremely low to very low strength rock. The investigation for the discharge dams located to the west of the existing Bengalla Link Road generally encountered a shallow residual soil profile overlying very low to medium strength rock. The dam locations are generally disused farmland previously used for grazing.

Laboratory results indicated that the residual soil across the site was generally low to medium plasticity, moderately reactive and partially to fully dispersive. The site soils are likely to be generally suitable for use in the construction of the dam embankments following some treatment to control dispersion and shrink/swell.

Packer testing and water losses recorded during drilling indicated that the rock mass across the site generally has a low to moderate permeability with some higher permeable layers.

6.1 Clean water dam (CW1)

Topsoils generally comprised low plasticity sandy clay/silt to depths of 0.05–0.25 m underlain by colluvial silty clay on the hill slopes, which was between 0.1 m to 0.4 m thick and alluvial silty clay between 0.4 m to 1.0 m thick in the drainage lines. These soils were underlain by very stiff to hard, medium plasticity, residual sandy clay/clayey sand. Residual soils were encountered to depths of 7.0 m to 15.0 m in drainage lines.

Residual soils were underlain by weathered rock. Weathered rock consisted of generally highly to distinctly weathered siltstone and sandstone of extremely low to low strength. Typically rock strength increased with depth.

6.2 Discharge dams (MTP DW1 & BMC DW1)

Topsoil was generally found to depths between 0.05 m to 0.2 m and occasionally underlain by soft alluvial/colluvial silty clay between 0.2 m to 0.9 m thick. Residual, very stiff to hard, medium plasticity sandy clay was typically found underlying the alluvial/colluvial material overlying weathered rock.

Weathered siltstone and sandstone was generally encountered between depths of 1.0 m and 3.6 m and was typically moderately to distinctly weathered (which is slightly less weathering than the CW1 sites).

No groundwater was encountered during the investigation at the discharge dam locations.

7. Dam and channel design development

The design criteria outlined in Section 5.1 was used as a basis for the development of the designs to 'feasibility stage'.

A geotechnical design report for the dams was prepared following assessment of the site conditions. The report outlines the detailed design of the dam cross sections and forms the basis for the design development.

Drawings for the infrastructure are included in Appendix C.

7.1 Clean water dam (CW1)

Several concept options for the location of CW1 were assessed by Parsons Brinckerhoff. The options assessed possible locations given the constraint of Mount Pleasant's approved infrastructure and potential future options. BMC's proposed CW1 location consists of an embankment and excavated storage to achieve the required storage volume without encroaching on Mount Pleasant's approved RW1 embankment to the north.

7.1.1 Outlet structure

An outlet structure is required for CW1 to enable the clean water from the dams to be pumped around the proposed mine void and released into the Dry Creek catchment.

The outlet pipe is a single 750 mm diameter pipe and has been designed as a trench installation to be constructed below the dam foundation and cut off trench. The trench would be backfilled using Zone 1 clays to prevent seepage paths developing along the pipe trench. A concrete plug 5 m long is provided directly below the dam cut off trench. The pipes shall comprise spigot and socket joined cement mortar lined ductile iron pipes (DICL).

7.1.2 Spillway

Emergency spillways are located to the east of the dam embankments and have been sized for a 1 in 100,000 year annual exceedance probability storm event based on DSC requirements. The spillway channels incorporate rip rap scour protection with an allowance for rock filled mattresses and gabions to the toe of the dam embankments due to the close proximity of the spillway channels which are constrained by Wybong Road in the south.

7.2 Discharge dams (MTP DW1 & BMC DW1)

Release of raw water to the Hunter River under the HRSTS is proposed to be undertaken separately for Mount Pleasant (MTP DW1) (following receipt of appropriate approvals) and BMC (BMC DW1).

The locations selected for the discharge dams follow the pre-feasibility bridging study locations of suitable natural valleys west of Bengalla Link Road. During geotechnical investigations it was discovered that there are higher seepage results at the northern of the two locations due to the presence of a higher permeability zone of weathered rock. This high seepage would require a much deeper key trench than the southern location.

7.2.1 Outlet structure

Similar to the CW1 embankment, outlet structures for the discharge dams have been designed as trenched installations to be constructed below the dam foundation and cut off trench. Pipe trenches would be backfilled using Zone 1 clays to prevent seepage paths developing along the pipe trench. A concrete plug 5 m long would be provided directly below the dam cut off trenches. Pipelines would comprise spigot and socket joined cement mortar lined ductile iron pipes (DICL).

The pipelines have been sized so as to restrict the maximum discharge rate when the dam is full to equate to a pipeline velocity of less than 4.5 m/s while achieving an average discharge rate of 125 ML/day. Prolonged operation of DICL pipelines at greater than this velocity can damage linings. In order to reduce velocities in the pipelines, orifice plates have been incorporated at the valve and metering station sized to creating a headloss sufficient to reduce outlet velocities.

A valve and metering station has been provided at the outlet from each discharge dam to facilitate automatic release of water by way of a motor actuated valve as well as a metering system so the volume of water released can be accurately measured and reported under the HRSTS.

For discharge dam MTP DW1 the valve station incorporates a reducing tee that supplies water to the raw water pump station for raw water return to RW1. The tee occurs upstream of the discharge flow meter so pumped flow back to RW1 is not erroneously recorded as a discharge to the creek. Independent flow meters are provided immediately downstream of the pump station to record the volume of water returned to RW1.

Once discharge water has passed through the valve and metering station it is discharged into the creek through an impact energy dissipater, which is a relatively small concrete box-like structure that requires no tailwater for successful performance. Energy dissipation is initiated by flow striking a vertical baffle and being redirected upstream by the horizontal portion of the baffle and the floor creating horizontal eddies.

7.2.2 Spillway

Emergency spillways have been incorporated into the discharge dams to prevent failure of the dam by overtopping during large storm events. The emergency spillways direct dam overflows away from the dam embankments and are excavated into the natural topography.

7.3 Diversion channels

A single diversion drain diverts upstream clean water runoff from the east of CW1 to the clean water dam storage.

Additional clean water diversion channels are located upstream of the discharge dams. These channels would minimise the volume of water entering the discharge dams. Runoff generated from extreme storm events that exceed the capacity of the diversion channels would be captured by the discharge dams.

7.4 Scour protection for channel downstream of discharge dams

The additional flows to the natural downstream topography due to the clean water and discharge dam outlets were assessed for their effects on scour in the natural downstream topography. A HECRAS analysis (a computer model developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers) was undertaken to estimate velocities along the channel and assess if any rock scour protection was necessary.

The 1 in 100 year ARI peak flow event for the existing natural catchment was estimated to be 13.7 m^3/s. The peak flow storm event for this catchment has a time of concentration of 80 minutes with a resulting storm duration of 210 minutes.

The combined flow rate of the pumped flow from CW1, MTP DW1 and BMC DW1 is 4.6 m^3/s including 1.0 m^3/s direct from CW1. We note the probability of a licensed discharge event from both discharge dams (adequate flow in the Hunter River) coinciding with a peak flow storm event (localised, relatively short duration storm) is relatively low. The probability of the peak flow storm event occurring and the CW1 pumps running is higher. In this case 1.0 m^3/s flow would be added to the existing estimated peak flow of 13.7 m^3/s.

A 600 m section was assessed as requiring formalisation to lower longitudinal grades and reduce velocities. A 10 m wide channel has been designed to accommodate these flows with rock scour protection also nominated in sections. An allowance for gypsum stabilising of the base is also included to minimise dispersion of material.

8. Pumps and pipelines design development

The design criteria outlined in Section 5 was used as a basis for the development of the designs to 'feasibility stage'.

The following sections summarise the key issues that have driven the development of the pumps and pipelines design.

8.1 Pipeline alignment and services corridor

Key issues that have driven the pipeline alignment and services corridor are:

- Alignments of clean and raw water pipelines are included in a services corridor that can be serviced by a single access track and includes an overhead powerline.
- Criteria for the selection of the proposed services corridor included:
  - location of relevant Dry Creek relocation infrastructure
  - locating the corridor to the west of the future BMC mine extent
  - minimising the length of the pipelines while restricting corridor vertical grades to those acceptable to all weather trafficability
  - avoiding crossing rail and road infrastructure where possible
  - clustering pipeline outlet and dam discharge locations to simplify power and communications provision
  - containing the corridor within mine owned land.
- The formation for the services corridor incorporates a 4 m wide gravelled access track adjacent to a 4 m wide platform on which parallel DN710mm and DN250mm pipes are laid for the clean water and raw water systems respectively. The 4 m wide pipeline formation includes a 2.5 m wide expansion zone for the polyethylene pipes (PE100). This is provided to accommodate the 'snaking' of above ground PE100 pipelines that occurs due to thermal expansion and contraction. The pipelines would be anchored or staked at 60 m intervals to restrict the lateral movement of the pipelines to within the allocated 2.5 m width.
- The corridor includes an overhead powerline easement parallel and off-set by 16 m, from the edge of the access track. This easement zone would not be on a formed surface and would essentially be on cleared natural ground. An upstream catch water berm is provided along the corridor to reduce the stormwater runoff reporting to the services corridor. This berm is sized to divert a 10 year ARI storm event away from the services corridor. The services corridor would have a total width of 45 m.
- Pipelines would be laid above ground to reduce the capital cost of the systems but would be buried below watercourses to prevent wash-away during high ARI rainfall events in addition to below road crossings.
- In order to provide all weather access to the pipelines for inspection and maintenance purposes, floodway crossings would be provided where the access track crosses watercourses. These crossings would comprise twin DN600mm reinforced concrete pipes below a 10 m long by 4 m wide concrete causeway. These have nominally been designed to be trafficable in a 5 year ARI peak flow storm event.

- The services corridor incorporates an environmental drain or bund that captures any raw water that may escape from the raw water system due to pipe rupture. These drains report to environmental ponds at low points on the alignment, which are sized to capture an hour of pumped flow. The raw water system has been equipped with flow totalising instrumentation that would monitor the water balance in the system and detect any difference between the volume of water leaving the pump station and that arriving at the receiving dam. An imbalance in flow readings would trigger a pump shut down and activate an alarm.

- No pipeline appurtenances such as air and scour valves are to be located in buried pits or chambers avoiding the need for operating staff to enter confined spaces to access infrastructure.

- Pipelines have been specified as co-extruded PE100 (white pipes) to counter the detrimental effect of temperature on the pressure capability of PE100 pipes. An operating temperature of 35°C has been used for design purposes.

- Where there is a possibility of vacuum conditions arising in the pipeline due to any operating condition, a minimum pressure class of PN12.5 has been adopted to eliminate the possibility of buckling collapse of pipelines.

- A pigging facility has been introduced for each system to facilitate cleaning of pipelines periodically, after comments received during the Safety in Design workshop.

- The clean water pipeline releases directly to a creek adjacent to the discharge dams while the raw water pipeline discharges directly into the impoundment area of RW1 on the one end and the MTP DW1 on the other. Erosion protection is provided at the discharge point for all pipelines, comprising an impact energy dissipater for the clean water pipeline and a simple precast concrete headwall with downstream rip rap protection for the raw water pipeline.

8.2 Pump stations

Where possible, pump stations have been designed as land-based installations located approximately 20 m from the toe of the downstream embankment of the relevant dams. From a design perspective, this results in a permanent positive suction head on the pump inlet so no priming of pumps would be required and low pressure cavitation issues are eliminated. It also allows for easy access for maintenance.

Pump stations all comprise a simple slab-on–ground structure with pumps, valves and meters mounted on it. No covering structure has been provided. Valves have been allowed for so that pump stations may be isolated from supply dams and discharge pipelines for maintenance.

All pump stations are provided with a redundancy of at least one pump.

9. Electrical and communications design development

9.1 High voltage

Key issues during the design development included:

- The likelihood that the existing Ausgrid 11kV infrastructure could not manage the anticipated increased load to CW1.
- The discharge dams are proposed to be connected to the Ausgrid network due to the small loads, close proximity to the Ausgrid network and the discharge dams being located outside of the mine lease.
- The use of an interim transmission line for CW1 was discounted early in the investigation as mining would occur in that area during the operational time frame.
- The Safety in Design review identified that as part of the mine development plan a 66KV transmission line would be required to be relocated to along the proposed 22kV CW1 supply long term route. Options investigated following the Safety in Design meeting included:
  - Building separate 22kV and 66kV transmission lines when they are required. This was discarded as the additional costs and increased easement required resulted in lost mine production.
  - Building a 66kV transmission line and utilising it at 22kV until the 66kV relocation is required. This was discarded due to the requirement for a HV substation resulting in additional costs and space requirements to transform the voltage from 66kV to 22kV and then 22kV to 0.415kV within the limited space that is available at the CW1 site.
  - Building a 66kV transmission line and operating at 66kV. This option was discarded due to the cost and space issues noted above on item (ii).
  - Building a 66kV transmission line with 22kV underslung. The 66kV transmission line would be de-energised and earthed at both ends until required. This was the recommended option as it provides the ability to relocate the 66kV transmission line in the future at minimal additional cost while minimising easement requirements for CW1 substations and transmission lines.

9.2 Clean water pump station (CW1)

Key issues during the design development included:

- Power to the pump station would be supplied from the BMC high voltage power supply network or generators.

9.3 Discharge dam pump station (MTP DW1 & BMC DW1)

Key issues during the design development included:

- Separate switchboards would be required for Mount Pleasant and Bengalla discharge dams.
- Separate local Ausgrid 11kV connections have been provided for each discharge dam. The proposed power supply to the dams would be from a dedicated local Ausgrid 11kV overhead line.

9.4 PLC control system and SCADA

9.4.1 Clean water pump station (CW1)

The pump station would be controlled via a Programmable Logic Controller (PLC) to start and stop the pumps according to measured dam levels (primary control). When the dam level is detected at the minimum height practical to start the pumps, the pumps would be started and when the dam level is detected as low, pumps would be stopped.

9.4.2 Discharge dam control station – Bengalla (BMC DW1)

The control station would be controlled via a Programmable Logic Controller (PLC) to open the discharge valve and release water from the discharge dam (flowing to the Hunter River). This would only occur when a permit to release water under the HRSTS is provided to BMC.

9.5 Communications

The communications strategy is based around both radio and optical ground wire (OPGW) fibre links. 30 m towers at discharge dams and CW1 are proposed to provide a point to point link to each respective mine. It is assumed that BMC already has Motorola Canopy towers that can be used to complete each link. This would be reviewed in the next phase with a radio analysis.

10. Dry Creek re-establishment design development

The option presented in this study relies on pumping from a clean water dam to discharge clean water harvested to protect the BMC mining area. This option is considered an interim management system as the pumping arrangement would not be acceptable as a permanent configuration when the mine moves into care and maintenance prior to closure.

The re-establishment of Dry Creek is the final permanent solution and is based on constructing a channel through the overburden emplacement area. Section 2 of this report summarises all the options reviewed to arrive at this permanent solution.

10.1 Flows

To assess the provided alignment and refine as required, a HECRAS hydraulic model of the creek was developed to assess channel capacities for flood conveyance, and channel geometry and alignment for minimisation of scour potential and provision of environmental enhancement opportunities.

Existing catchment flows were determined using the Rational Method and a summary of the flows is presented in Table 10.1. The total catchment area was estimated to be 1,644 hectares and is unchanged from the catchment area prior to development. It is noted that this area includes the catchment area near the downstream extent of the re-established Dry Creek (hence flows adopted are conservative in the upstream reaches of the channel). Any future drop structures from the final landform catchments would be documented in a Dry Creek Management Plan and accounted for in design.

Table 10.1 Dry Creek catchment flows

1yr ARI	2yr ARI	5yr ARI	10yr ARI	20yr ARI	50yr ARI	100yr ARI
6.3 m^3/s	9.5 m^3/s	14.3 m^3/s	18.4 m^3/s	23.9 m^3/s	33.0 m^3/s	41.8 m^3/s

10.2 Geometry

10.2.1 Overview

Several options were assessed to determine an optimum solution which would strike a balance between:

- Minimising modifications to the provided final landform channel geometry.
- Providing the required capacity for flood conveyance.
- Providing opportunities for environmental enhancement within the re-established creek corridor.
- Providing long term stability.

The option presented in this study closest follows the vertical alignment with modifications where necessary to keep grades and hence velocities at a level that minimises the erosion and scour potential under extreme flood events. It is assumed that the final landform would be shaped as per the proposed re-established Dry Creek alignment to minimise the amount of bulk earthworks construction required prior to an experienced contractor being engaged for the final shaping, lining and scour protection. Drawing 8005 in Appendix C illustrates the conceptual proposed re-established Dry Creek design and is shown in Figure 10.1.

The termination of the creek alignment was selected based on the provided final landform contours and at a location in which is reconnected to the existing Dry Creek alignment west of the Bengalla Rail Loop.

10.2.2 Channel cross section

The proposed cross section is shown on Drawing 8006 in Appendix C and is portioned into two sections. A low flow channel to cater for relatively frequent flood events up to the 2 year ARI event and a larger high flow channel to contain flows up to and including the 100 year ARI event. Details of the re-established Dry Creek are summarised in Table 10.2.

Table 10.2 Re-established Dry Creek design characteristics

Parameter	Design size
Channel length	4,500 m
Base width	8 m
Low flow channel side slopes	1V:4H
Low flow channel depth	0.77 m
High flow channel side slopes	1V:10H
High flow channel depth	varies
Manning's n	0.04
Channel slope	varies
Rock scour protection	where velocity > 2m/s for the 1 in 50 ARI event

As the re-establishment of the creek would be constructed on mine spoil, a 2 m thick select clay fill layer has been included in the design for the length of the alignment to reduce seepage into the spoil. Within the last five years, a similar but shorter arrangement was approved and then constructed for Xstrata's Mount Owen operations. The clay required is assumed to be won by BMC during its mining operations and stockpiled for later use by a construction contractor. As the quality of this material is unconfirmed at this stage, an allowance for gypsum stabilising the top 300 mm has also been included. This allowance would be reviewed prior to construction when material proposed for the clay lining is available for testing.

The channel cross section incorporates a wide flow channel with shallow gradient side slopes in both the low and high flow channels. This minimises flood depths and velocities, therefore minimising the level of flood hazard and erosion potential within the channel when conveying significant flows. The wide, open and shallow gradient features of the cross section provide opportunity for environmental enhancement of the channel through establishment of vegetation. A relatively high value of Manning's roughness has been assumed which would allow significant vegetation growth to establish within the channel in the long term without affecting flood capacity. Figure 10.2 shows the proposed channel cross section.

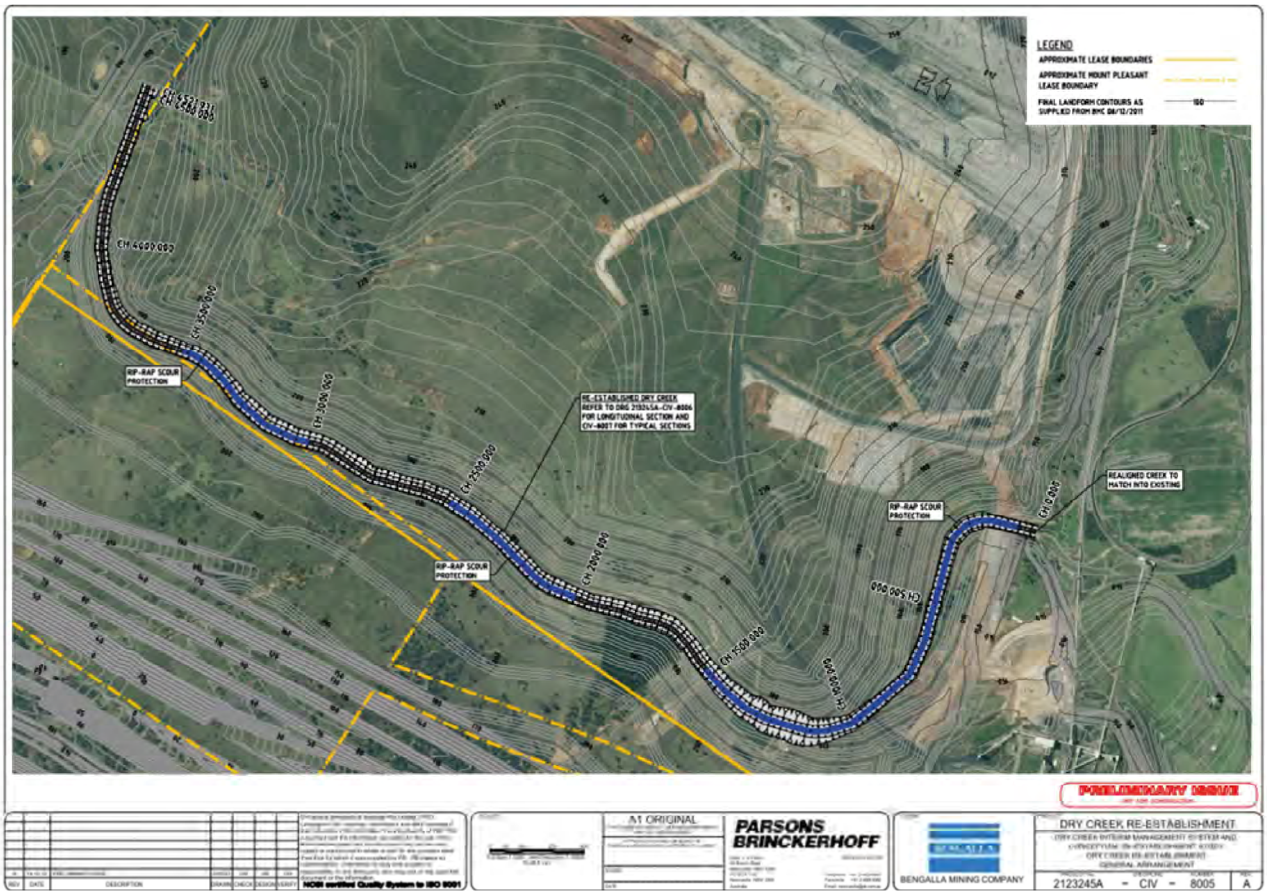


Figure 10.1 Conceptual proposed re-established Dry Creek alignment

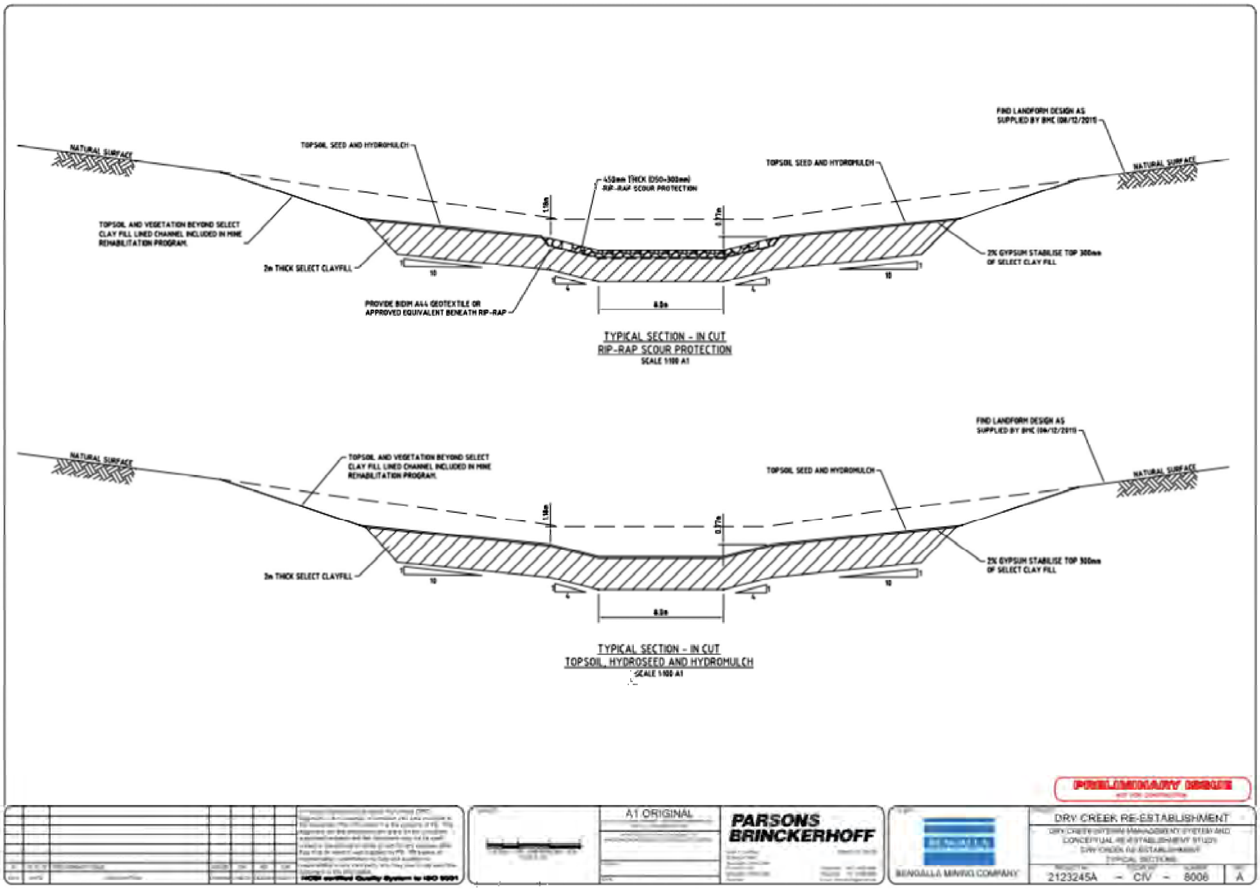


Figure 10.2 Conceptual proposed cross section for Dry Creek

10.2.3 Alignment and longitudinal profile

The proposed alignment and longitudinal profile are shown on Drawings 8005 and 8007 in Appendix C. The landform design provided the opportunity to design the re-established creek with a reasonably meandering course, which provides some variation in flow energy and velocity that is typically displayed in natural creeks. The longitudinal profile was designed to minimise steep gradients and drops that would produce excessive flow velocities requiring extensive rock protection and armouring of the channel to resist scour.

However, given the site constraints it was not possible to design out all steep gradients within the channel, and some areas of rip rap protection to resist scour and erosion are required. The rip rap design is indicated on Drawing 8005 in Appendix C. In these steep sections the rip rap is designed to resist erosion and scour for events up to and including the 50 year ARI event. Therefore, the design provides a highly stable channel that would resist erosion and sedimentation processes under extreme flood events.

10.3 Impacts of the creek re-establishment

The re-established creek has been designed to safely convey flood flows in accordance with good practice flood management and watercourse stability guidelines. The catchment area and design flood flows are unchanged from the pre-development condition; therefore, the re-established creek does not result in increased peak flows from the catchment. It is likely that the re-established creek results in a modified flow hydrograph at its downstream end where it re-joins the natural channel, due to the modified stream length and floodplain characteristics. While the re-established creek is likely to be more efficient at conveying flow than in the pre-development case, a longer stream length has been introduced which would offset the effect of increased flow efficiency. Further assessment of the impacts on the flow hydrograph would be investigated at the next stage of design; however, at this stage it is envisaged that these impacts are likely to be minor.

The design also provides opportunity for environmental enhancement of the creek corridor through provision of a reasonably meandering horizontal alignment with generally shallow longitudinal gradients; and a varied two-stage cross section with shallow side slopes and significant capacity for vegetation growth.

10.4 Monitoring and maintenance

BMC will develop a Dry Creek Rehabilitation Management Plan in consultation with the relevant regulators which will outline monitoring requirements and maintenance works during establishment of the channel.

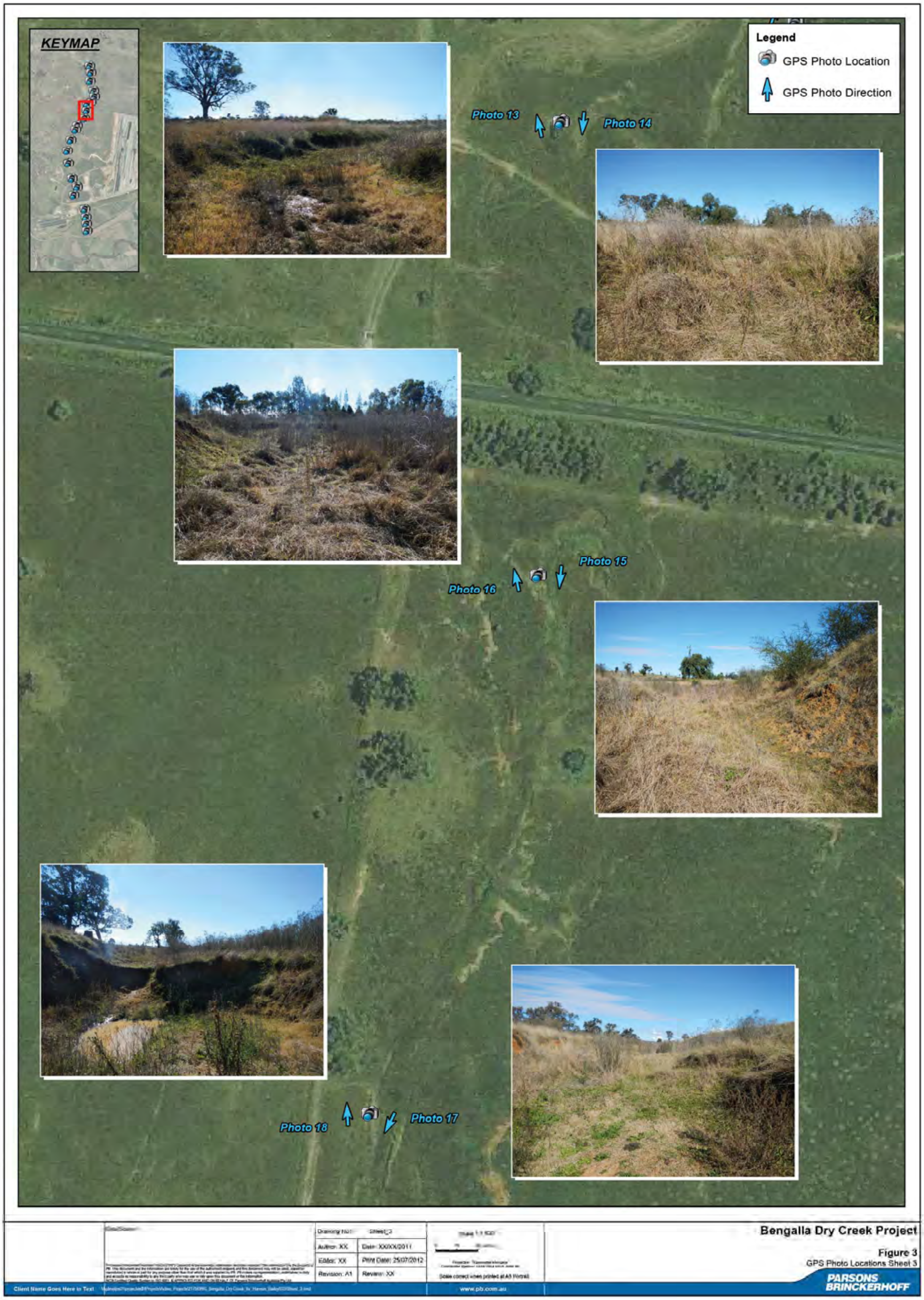
Appendix A

Photographic record of Dry Creek


Legend
GPS Photo Location
GPS Photo Direction
Photo 1
Photo 2
Photo 3
Photo 4
Photo 5
Photo 6
Photo 7
Photo 8
Photo 9
Photo 10
Photo 11
Photo 12
Photo 13
Photo 14
Photo 15
Photo 16
Photo 17
Photo 18
Photo 19
Photo 20
Photo 21
Photo 22
Photo 23
Photo 24
Photo 25
Photo 26
Photo 27
Photo 28
Photo 29
Photo 30
Photo 31
Photo 32
Photo 33
Photo 34
Photo 35
Photo 36
Photo 37
Photo 38
Photo 39
Photo 40
Photo 41
Photo 42
Bengalla Dry Creek Project
Overview
PARSONS BRINCKERHOFF
www.pb.com.au


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 1
Photo 2
Photo 3
Photo 4
Photo 5
Photo 6
Bengalla Dry Creek Project
Figure 1
GPS Photo Locations Sheet 1
Drawing No:
Sheet: 1
Author: XX
Date: XX/XX/2011
Editor: XX
Print Date: 25/07/2012
Revision: A1
Reviewer: XX
Scale correct when printed at A3 Portrait
Client Name Goes Here in Text
www.pb.com.au
PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 7
Photo 8
Photo 10
Photo 9
Photo 12
Photo 11
Bengalla Dry Creek Project
Figure 2
GPS Photo Locations Sheet 2
PARSONS BRINCKERHOFF
www.pb.com.au
Client Name Goes Here in Text


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 13
Photo 14
Photo 15
Photo 16
Photo 17
Photo 18
Drawing No:
Sheet 3
Author: XX
Date: XX/XX/2011
Editor: XX
Print Date: 25/07/2012
Revision: A1
Reviewer: XX
Scale correct when printed at A3 Format
Client Name Goes Here in Text
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Bengalla Dry Creek Project
Figure 3
GPS Photo Locations Sheet 3
PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 20
Photo 19
Photo 22
Photo 21
Photo 24
Photo 23
Bengalla Dry Creek Project
Figure 4
GPS Photo Locations Sheet 4
PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 26
Photo 25
Photo 28
Photo 27
Drawing No:
Sheet_5
Author: XX
Date: XX/XX/2011
Editor: XX
Print Date: 25/07/2012
Revision: A1
Review: XX
Scale correct when printed at A3 Portrait
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Bengalla Dry Creek Project
Figure 5
GPS Photo Locations Sheet 5
PARSONS BRINCKERHOFF


Photo 30
Photo 29
Legend
GPS Photo Location
GPS Photo Direction
KEYMAP
Photo 31
Photo 32
Photo 34
Photo 33
Bengalla Dry Creek Project
Figure 6
GPS Photo Locations Sheet 6
PARSONS BRINCKERHOFF
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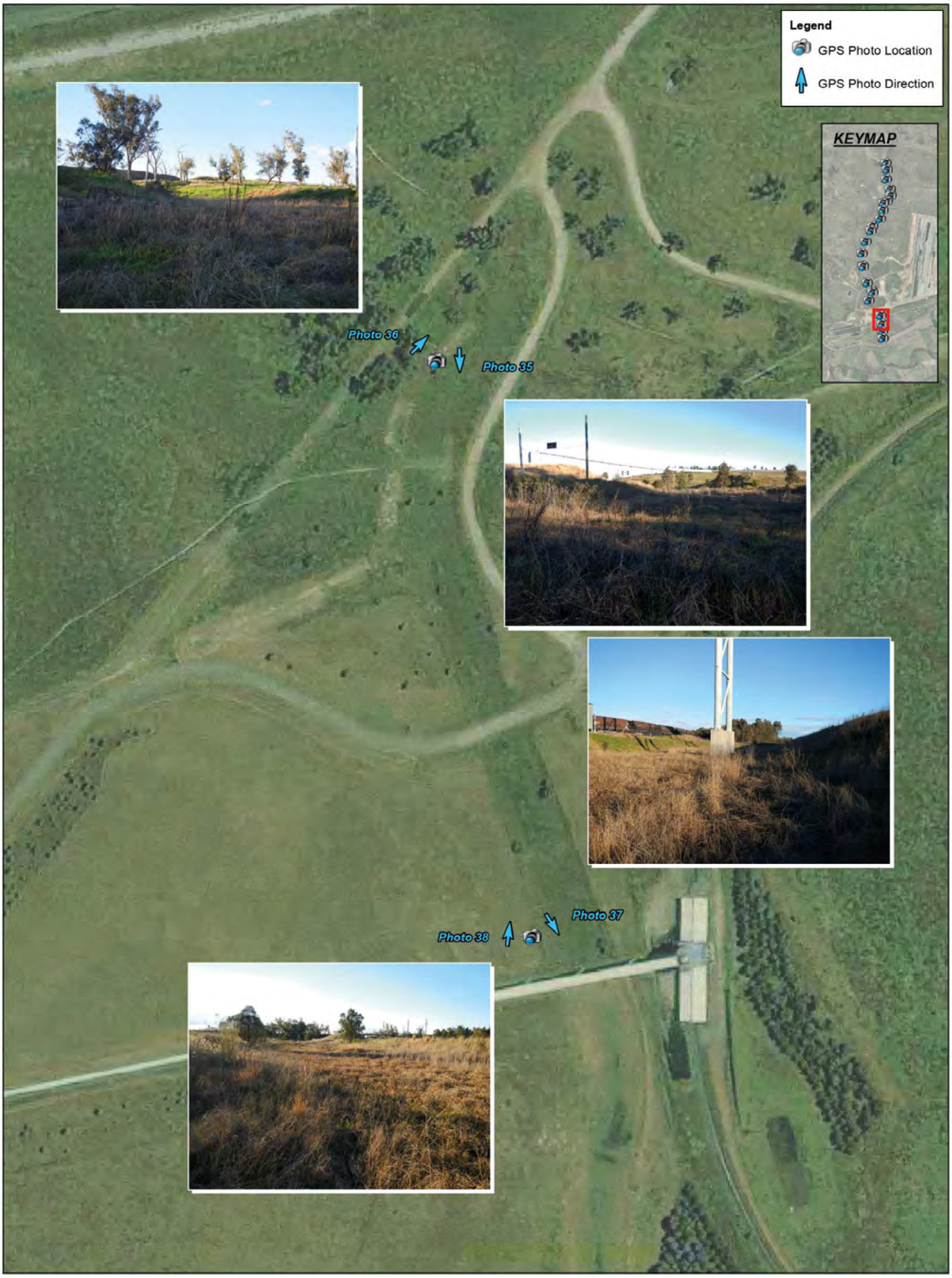

Bengalla Dry Creek Project

Figure 7

GPS Photo Locations Sheet 7

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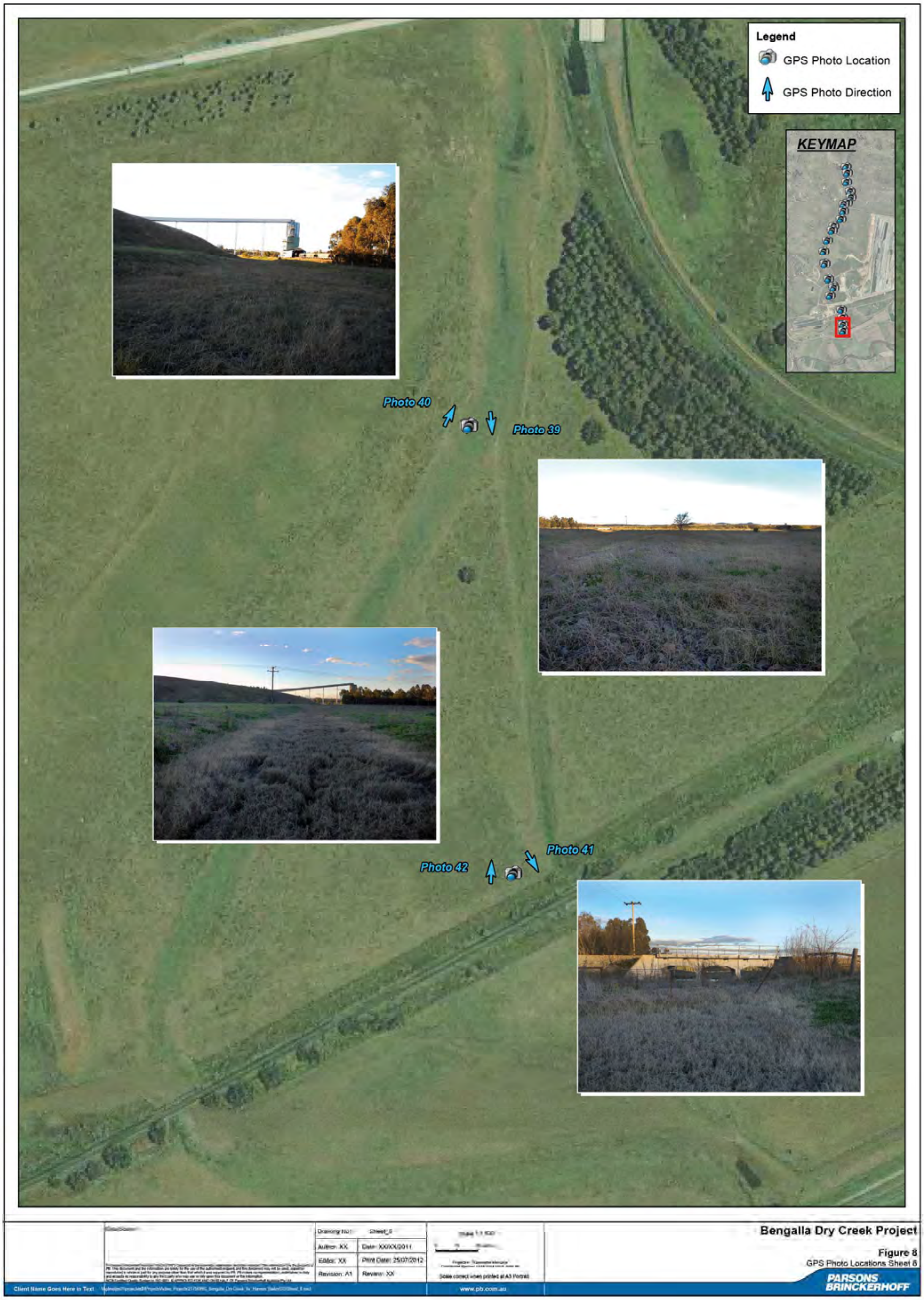
Legend
GPS Photo Location
GPS Photo Direction
KEYMAP
Photo 40
Photo 39
Photo 41
Photo 42
Bengalla Dry Creek Project
Figure 8
GPS Photo Locations Sheet 8
PARSONS BRINCKERHOFF
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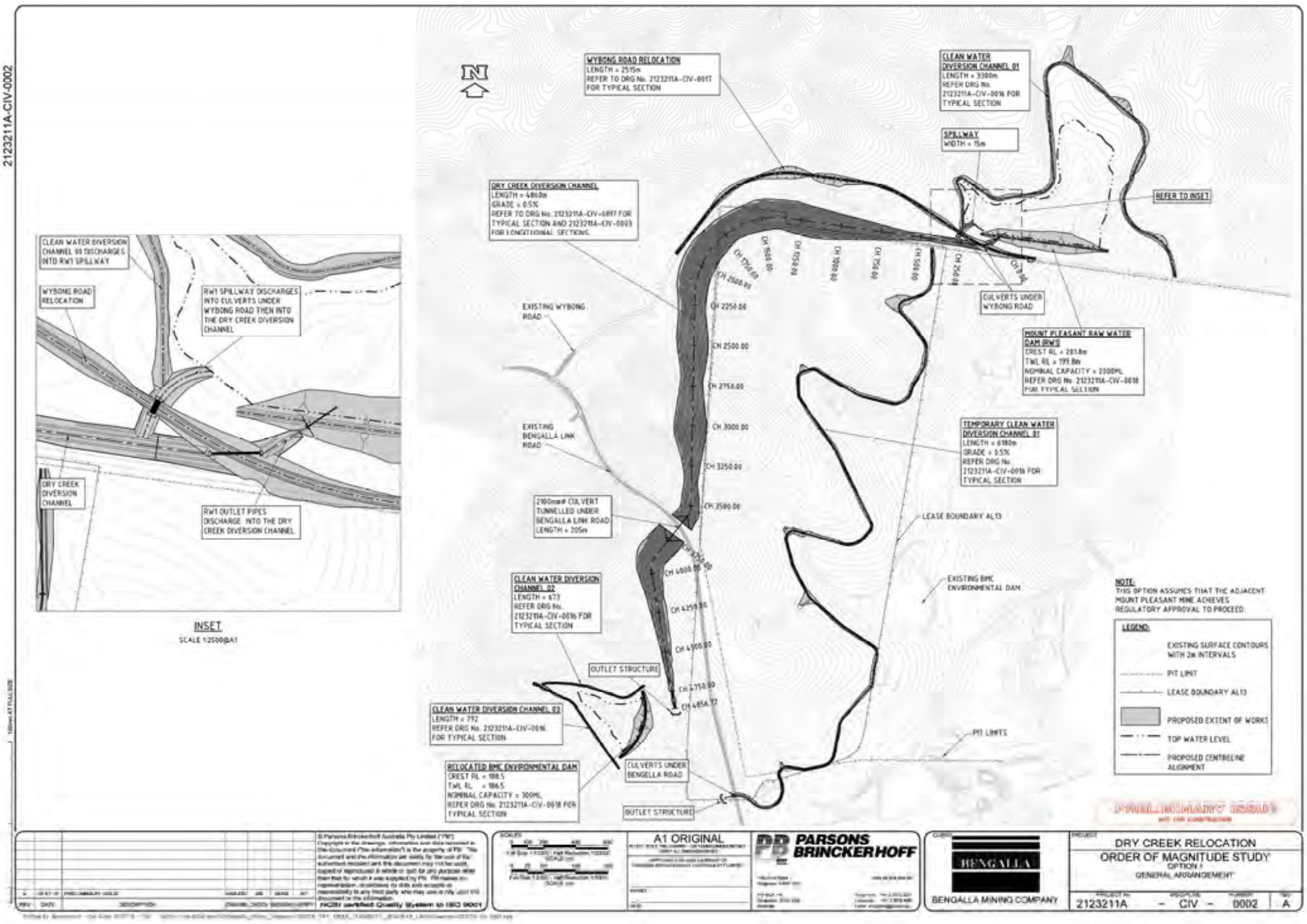
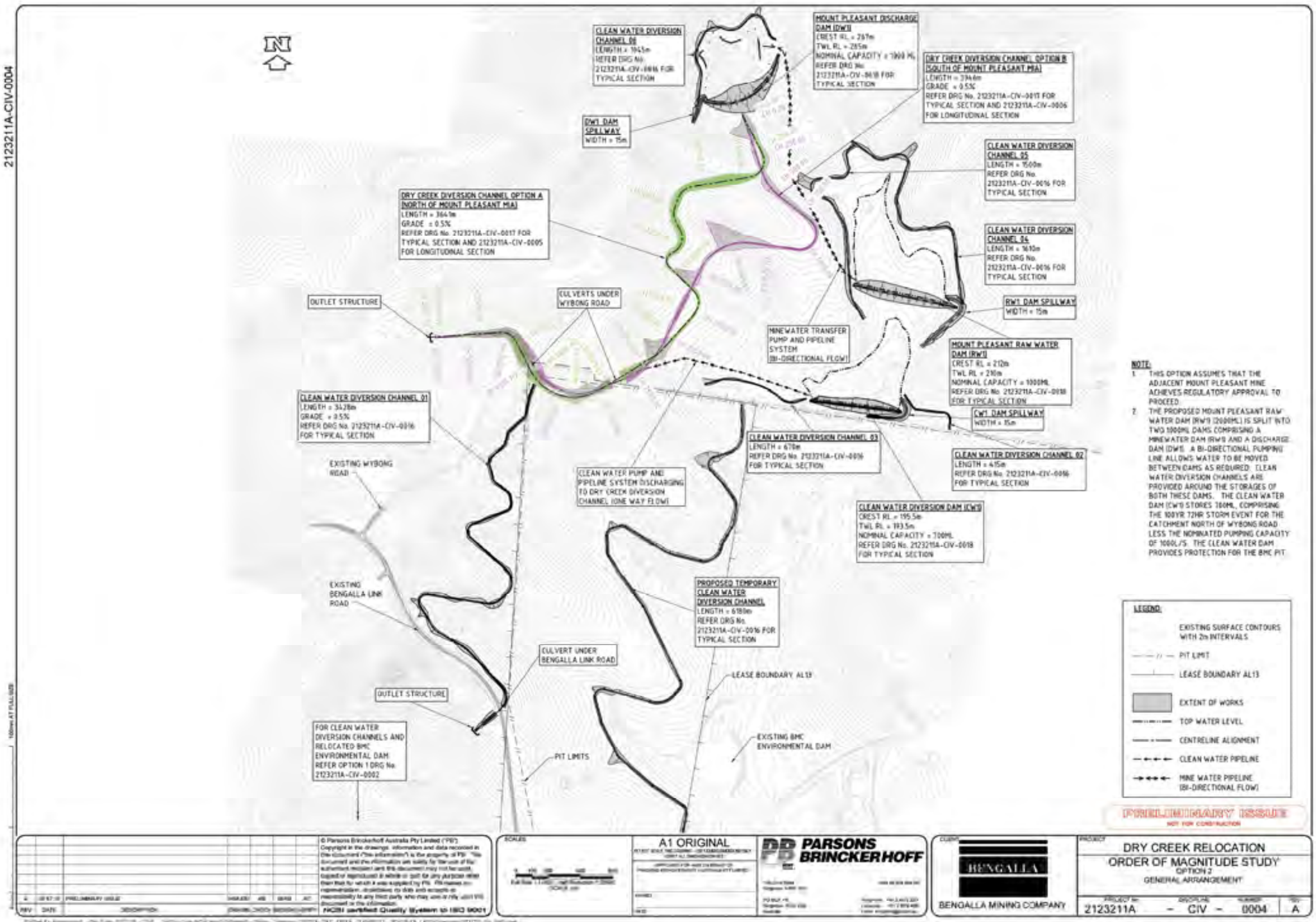
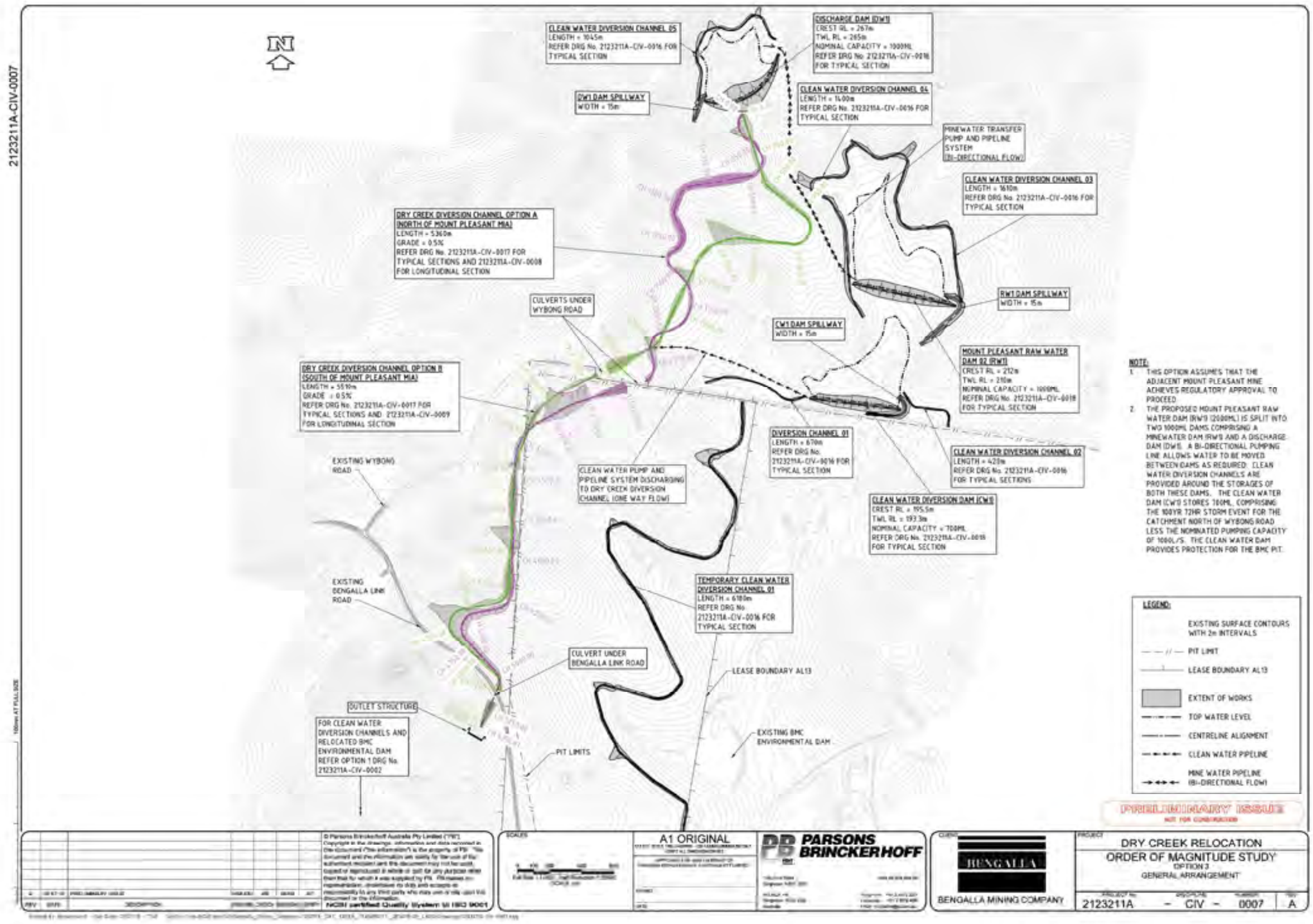
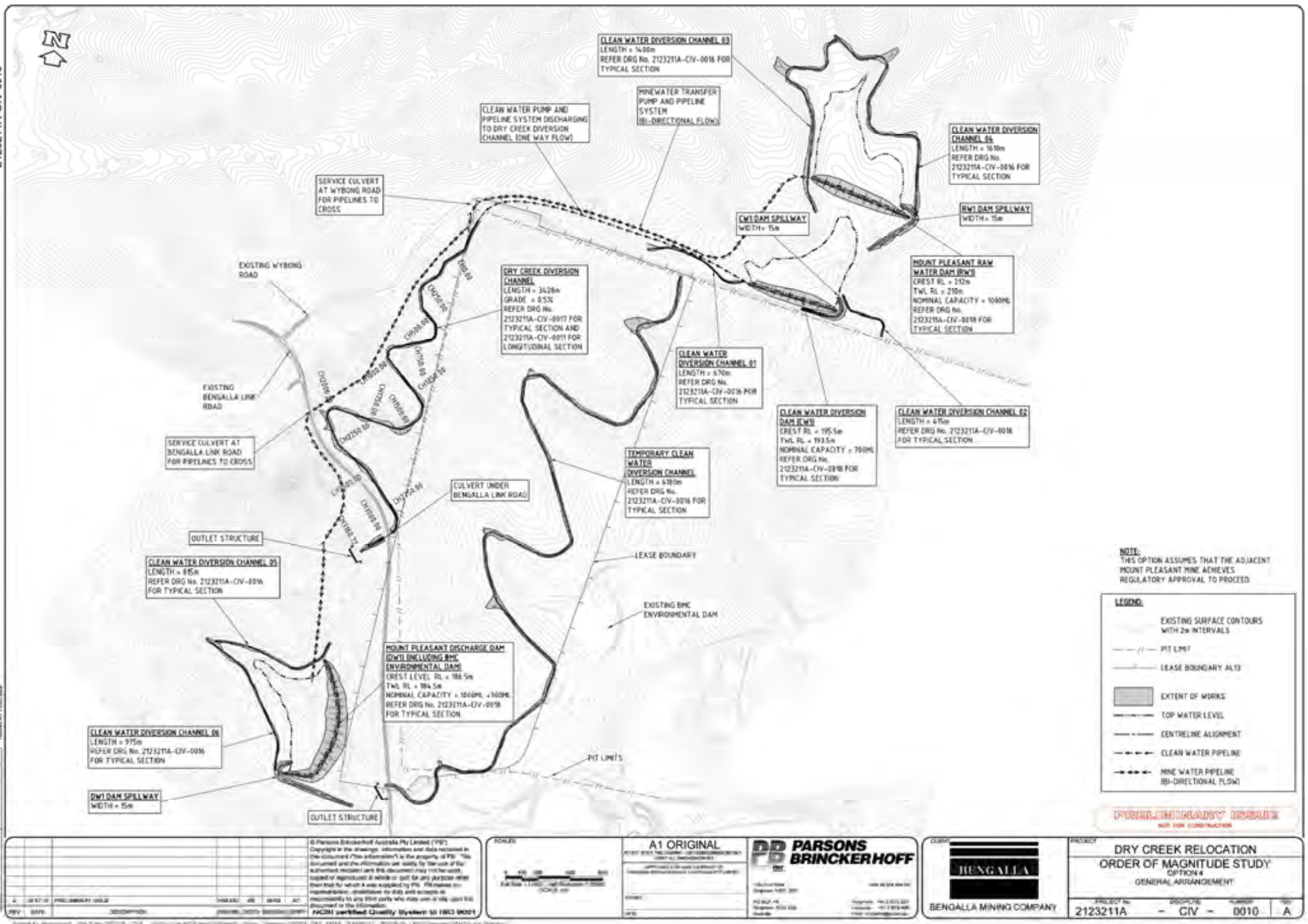
Appendix B

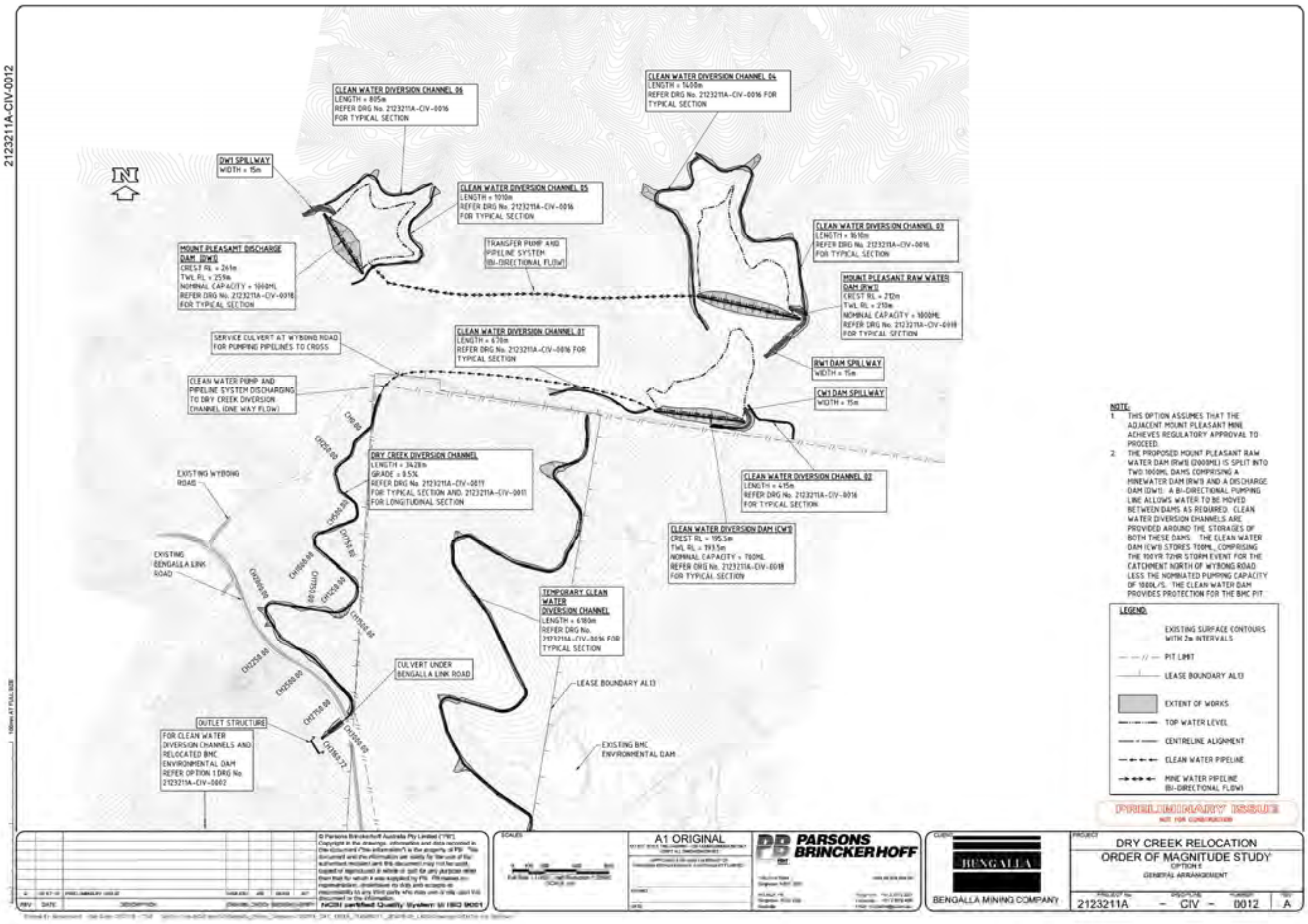
Order of magnitude study
Dry Creek relocation options
drawings

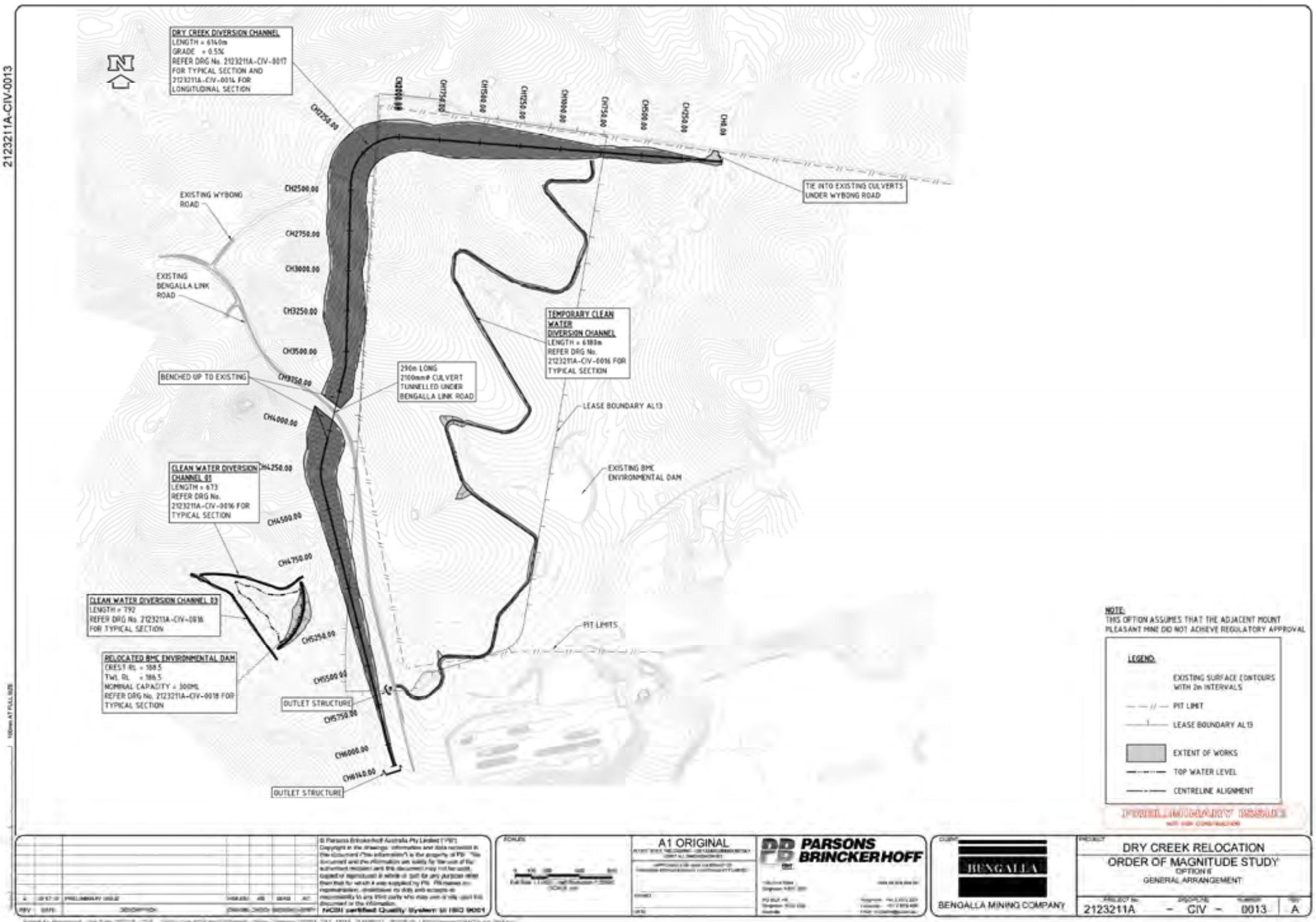

2123211A-CIV-0002
CLEAN WATER DIVERSION CHANNEL 01 DISCHARGES INTO RW1 SPILLWAY
WYBONG ROAD RELOCATION
RW1 SPILLWAY DISCHARGES INTO CULVERTS UNDER WYBONG ROAD THEN INTO THE DRY CREEK DIVERSION CHANNEL
DRY CREEK DIVERSION CHANNEL
RW1 OUTLET PIPES DISCHARGE INTO THE DRY CREEK DIVERSION CHANNEL
INSET
SCALE 1:2500@A1
N
WYBONG ROAD RELOCATION
LENGTH = 2515m
REFER TO DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 3300m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SPILLWAY
WIDTH = 15m
REFER TO INSET
DRY CREEK DIVERSION CHANNEL
LENGTH = 4860m
GRADE = 0.5%
REFER TO DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0003 FOR LONGITUDINAL SECTIONS
CULVERTS UNDER WYBONG ROAD
EXISTING WYBONG ROAD
MOUNT PLEASANT RAW WATER DAM (RW1)
CREST RL = 201.8m
TWL RL = 199.8m
NOMINAL CAPACITY = 2000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 6180m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
2100mm⌀ CULVERT TUNNELLED UNDER BENGALLA LINK ROAD
LENGTH = 205m
LEASE BOUNDARY AL13
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 673
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING BMC ENVIRONMENTAL DAM
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
PROPOSED EXTENT OF WORKS
TOP WATER LEVEL
PROPOSED CENTRELINE ALIGNMENT
OUTLET STRUCTURE
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 792
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
PIT LIMITS
RELOCATED BMC ENVIRONMENTAL DAM
CREST RL = 188.5
TWL RL = 186.5
NOMINAL CAPACITY = 300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CULVERTS UNDER BENGELLA ROAD
OUTLET STRUCTURE
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
GENERAL ARRANGEMENT
2123211A - CIV - 0002 A

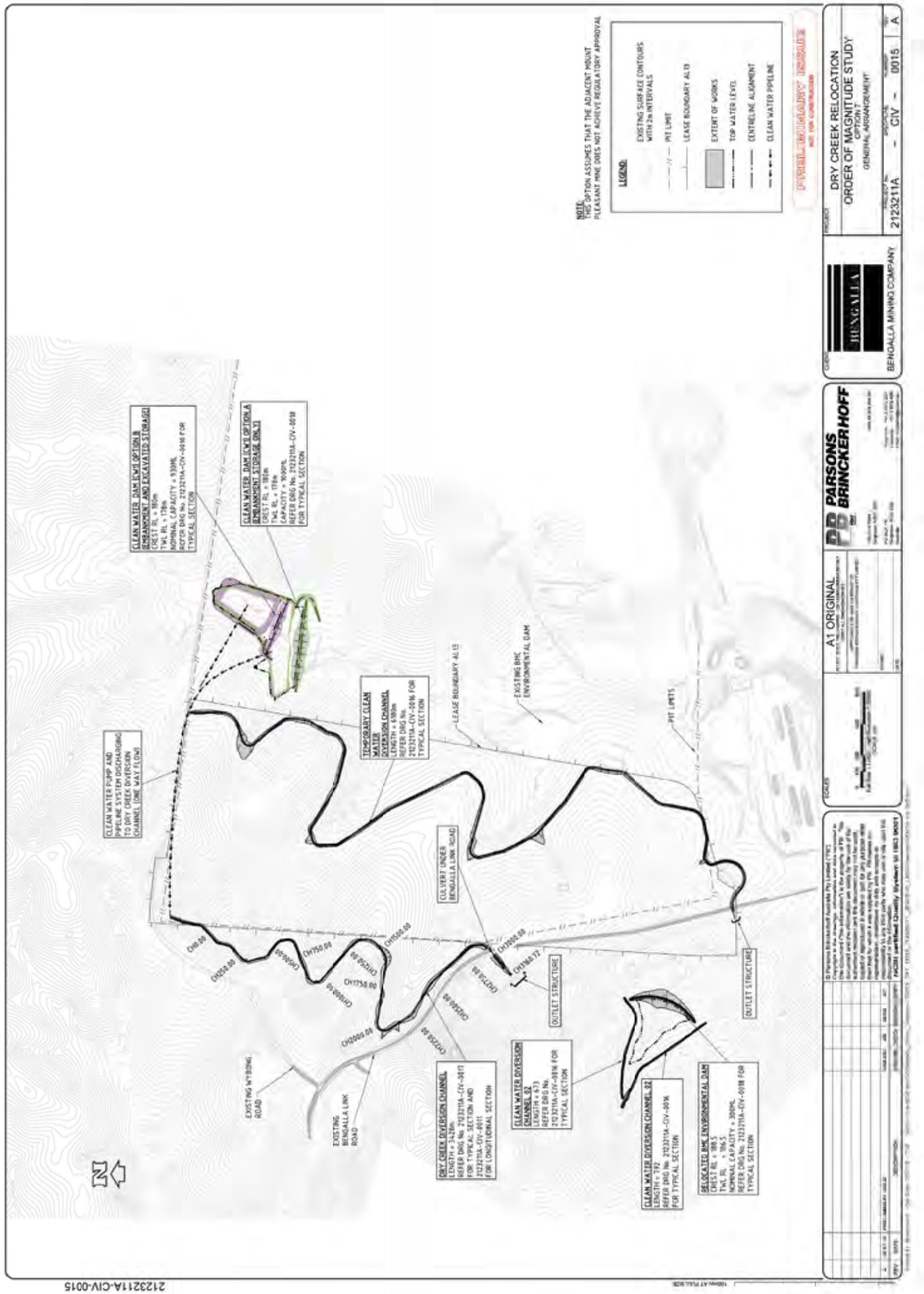

2123211A-CIV-0004
CLEAN WATER DIVERSION CHANNEL 06
LENGTH = 1045m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
MOUNT PLEASANT DISCHARGE DAM (DW1)
CREST RL = 287m
TWL RL = 285m
NOMINAL CAPACITY = 1000 ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION B (SOUTH OF MOUNT PLEASANT MIA)
LENGTH = 3946m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0006 FOR LONGITUDINAL SECTION
DW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 1500m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION A (NORTH OF MOUNT PLEASANT MIA)
LENGTH = 3641m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0005 FOR LONGITUDINAL SECTION
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
OUTLET STRUCTURE
CULVERTS UNDER WYBONG ROAD
RW1 DAM SPILLWAY
WIDTH = 15m
MINEWATER TRANSFER PUMP AND PIPELINE SYSTEM (BI-DIRECTIONAL FLOW)
MOUNT PLEASANT RAW WATER DAM (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 3428m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 415m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING WYBONG ROAD
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.5m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
EXISTING BENGALLA LINK ROAD
PROPOSED TEMPORARY CLEAN WATER DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CULVERT UNDER BENGALLA LINK ROAD
LEASE BOUNDARY AL13
OUTLET STRUCTURE
FOR CLEAN WATER DIVERSION CHANNELS AND RELOCATED BMC ENVIRONMENTAL DAM REFER OPTION 1 DRG No. 2123211A-CIV-0002
PIT LIMITS
EXISTING BMC ENVIRONMENTAL DAM
NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 2
GENERAL ARRANGEMENT
2123211A - CIV - 0004 A


2123211A-CIV-0007
N
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 1045m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DISCHARGE DAM (DW1)
CREST RL = 267m
TWL RL = 265m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
DW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
MINEWATER TRANSFER PUMP AND PIPELINE SYSTEM (BI-DIRECTIONAL FLOW)
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION A (NORTH OF MOUNT PLEASANT MIA)
LENGTH = 5360m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTIONS AND 2123211A-CIV-0008 FOR LONGITUDINAL SECTION
RW1 DAM SPILLWAY
WIDTH = 15m
CULVERTS UNDER WYBONG ROAD
CW1 DAM SPILLWAY
WIDTH = 15m
MOUNT PLEASANT RAW WATER DAM 02 (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION B (SOUTH OF MOUNT PLEASANT MIA)
LENGTH = 5510m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTIONS AND 2123211A-CIV-0009 FOR LONGITUDINAL SECTION
DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 420m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTIONS
EXISTING WYBONG ROAD
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.3m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CULVERT UNDER BENGALLA LINK ROAD
LEASE BOUNDARY AL13
OUTLET STRUCTURE
FOR CLEAN WATER DIVERSION CHANNELS AND RELOCATED BMC ENVIRONMENTAL DAM REFER OPTION 1 DRG No. 2123211A-CIV-0002
EXISTING BMC ENVIRONMENTAL DAM
PIT LIMITS
NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
NCSI certified Quality System to ISO 9001
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 3
GENERAL ARRANGEMENT
2123211A - CIV - 0007 A


2123211A-CIV-0010
N
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
MINEWATER TRANSFER PUMP AND PIPELINE SYSTEM (BI-DIRECTIONAL FLOW)
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SERVICE CULVERT AT WYBONG ROAD FOR PIPELINES TO CROSS
RW1 DAM SPILLWAY
WIDTH = 15m
CW1 DAM SPILLWAY
WIDTH = 15m
EXISTING WYBONG ROAD
DRY CREEK DIVERSION CHANNEL
LENGTH = 3428m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0011 FOR LONGITUDINAL SECTION
MOUNT PLEASANT RAW WATER DAM (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING BENGALLA LINK ROAD
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.5m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 415m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SERVICE CULVERT AT BENGALLA LINK ROAD FOR PIPELINES TO CROSS
TEMPORARY CLEAN WATER DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CULVERT UNDER BENGALLA LINK ROAD
OUTLET STRUCTURE
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 815m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
LEASE BOUNDARY
EXISTING BMC ENVIRONMENTAL DAM
MOUNT PLEASANT DISCHARGE DAM (DW1) INCLUDING BMC ENVIRONMENTAL DAM)
CREST LEVEL RL = 186.5m
TWL RL = 184.5m
NOMINAL CAPACITY = 1000ML +300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 06
LENGTH = 975m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
PIT LIMITS
DW1 DAM SPILLWAY
WIDTH = 15m
OUTLET STRUCTURE
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY ALT3
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
NCSI certified Quality System to ISO 9001
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 4
GENERAL ARRANGEMENT
2123211A - CIV - 0010
A

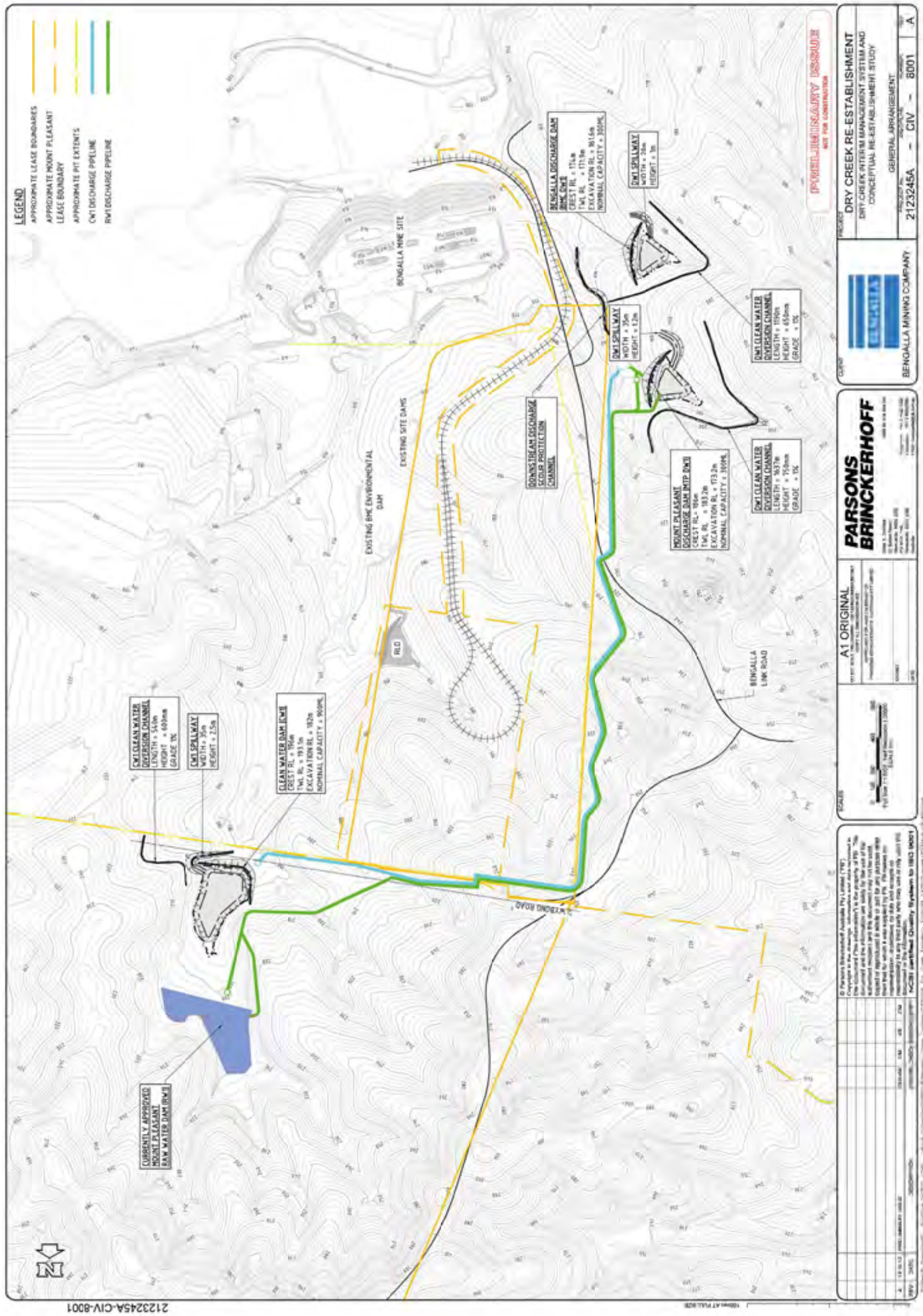

2123211A-CIV-0012
CLEAN WATER DIVERSION CHANNEL 06
LENGTH = 805m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR
TYPICAL SECTION
DW1 SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 1010m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
TRANSFER PUMP AND
PIPELINE SYSTEM
(BI-DIRECTIONAL FLOW)
MOUNT PLEASANT DISCHARGE
DAM (DW1)
CREST RL = 261m
TWL RL = 259m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
MOUNT PLEASANT RAW WATER
DAM (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
SERVICE CULVERT AT WYBONG ROAD
FOR PUMPING PIPELINES TO CROSS
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR
TYPICAL SECTION
RW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER PUMP AND
PIPELINE SYSTEM DISCHARGING
TO DRY CREEK DIVERSION
CHANNEL (ONE WAY FLOW)
CW1 DAM SPILLWAY
WIDTH = 15m
DRY CREEK DIVERSION CHANNEL
LENGTH = 3428m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017
FOR TYPICAL SECTION AND, 2123211A-CIV-0011
FOR LONGITUDINAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 415m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
EXISTING WYBONG
ROAD
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.5m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
EXISTING
BENGALLA LINK
ROAD
TEMPORARY CLEAN
WATER
DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No.
2123211A-CIV-0016 FOR
TYPICAL SECTION
CULVERT UNDER
BENGALLA LINK ROAD
LEASE BOUNDARY AL13
OUTLET STRUCTURE
FOR CLEAN WATER
DIVERSION CHANNELS AND
RELOCATED BMC
ENVIRONMENTAL DAM
REFER OPTION 1 DRG No
2123211A-CIV-0002
EXISTING BMC
ENVIRONMENTAL DAM
CH0.00
CH250.00
CH500.00
CH750.00
CH1000.00
CH1250.00
CH1500.00
CH1750.00
CH2000.00
CH2250.00
CH2500.00
CH2750.00
CH3000.00
CH3160.72
NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
© Parsons Brinckerhoff Australia Pty Limited ("PB")
NCSI certified Quality System to ISO 9001
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 5
GENERAL ARRANGEMENT
2123211A - CIV - 0012
A

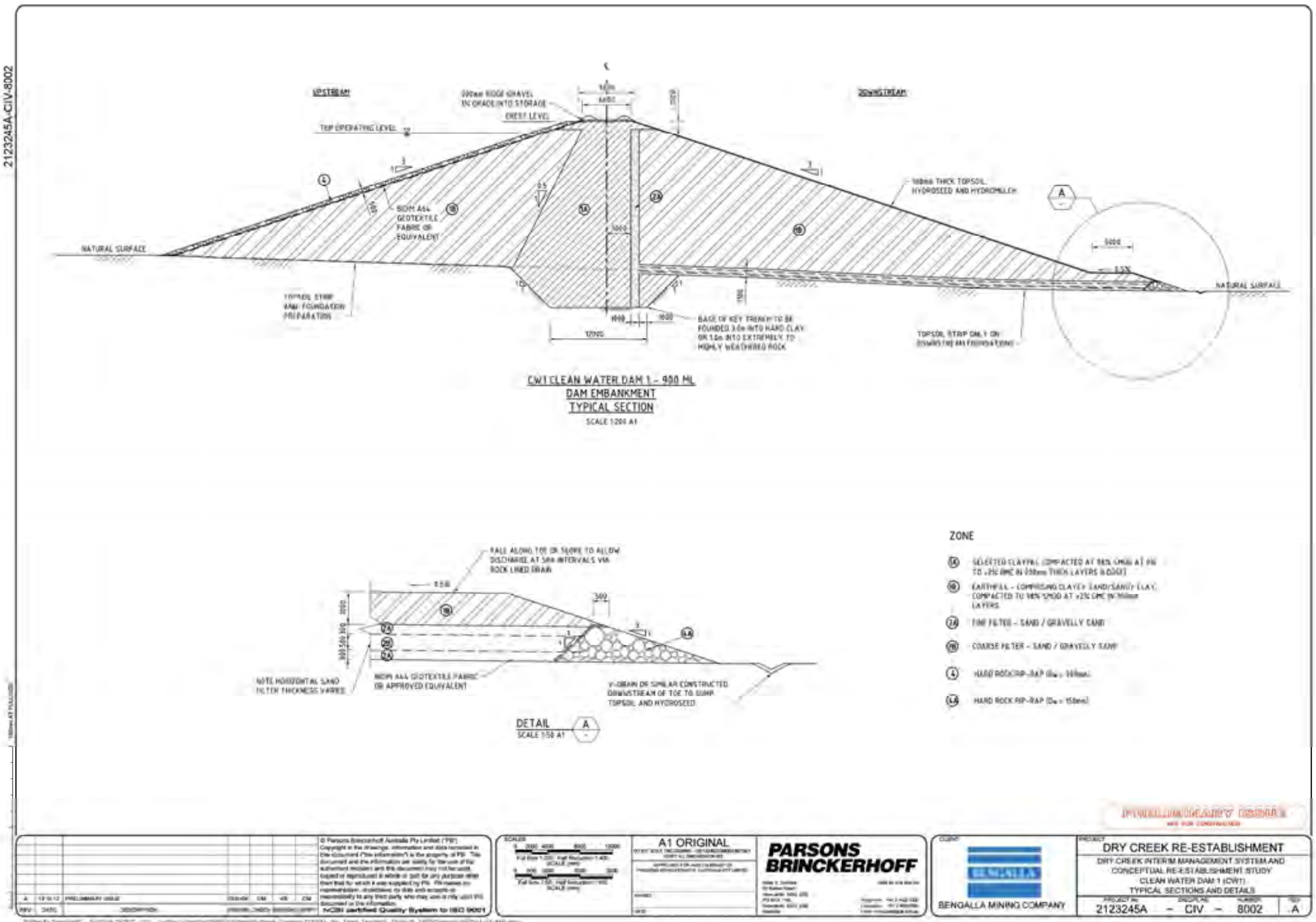

2123211A-CIV-0013
DRY CREEK DIVERSION CHANNEL
LENGTH = 6140m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0014 FOR LONGITUDINAL SECTION
EXISTING WYBONG ROAD
EXISTING BENGALLA LINK ROAD
BENCHED UP TO EXISTING
290m LONG 2100mm⌀ CULVERT TUNNELLED UNDER BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
LEASE BOUNDARY AL13
EXISTING BMC ENVIRONMENTAL DAM
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 673
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 792
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
RELOCATED BMC ENVIRONMENTAL DAM
CREST RL = 188.5
TWL RL = 186.5
NOMINAL CAPACITY = 300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
PIT LIMITS
OUTLET STRUCTURE
OUTLET STRUCTURE
TIE INTO EXISTING CULVERTS UNDER WYBONG ROAD
CH0.00
CH250.00
CH500.00
CH750.00
CH1000.00
CH1250.00
CH1500.00
CH1750.00
CH2250.00
CH2500.00
CH2750.00
CH3000.00
CH3250.00
CH3500.00
CH3750.00
CH4000.00
CH4250.00
CH4500.00
CH4750.00
CH5250.00
CH5500.00
CH5750.00
CH6000.00
CH6140.00
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE DID NOT ACHIEVE REGULATORY APPROVAL
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
PRELIMINARY ISSUE
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 6
GENERAL ARRANGEMENT
2123211A - CIV - 0013 A
NCSI certified Quality System to ISO 9001

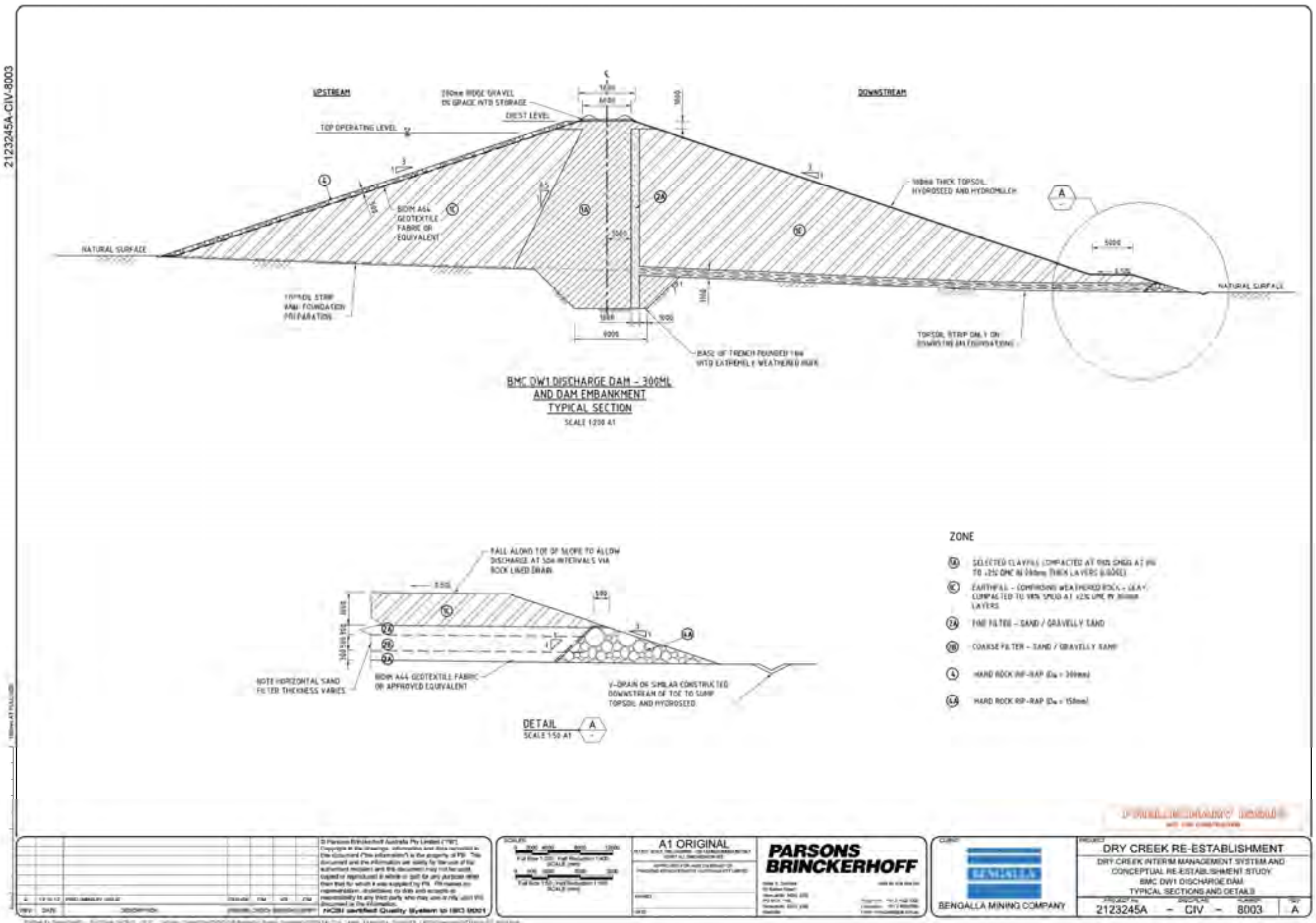

CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
EXISTING WYBONG ROAD
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL
CULVERT UNDER BENGALLA LINK ROAD
LEASE BOUNDARY AL13
EXISTING BMC ENVIRONMENTAL DAM
OUTLET STRUCTURE
PIT LIMITS
DRY CREEK DIVERSION CHANNEL
CLEAN WATER DIVERSION CHANNEL 02
RELOCATED BMC ENVIRONMENTAL DAM
LEGEND
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
2123211A - CIV - 0015 A
2123211A-CIV-0015

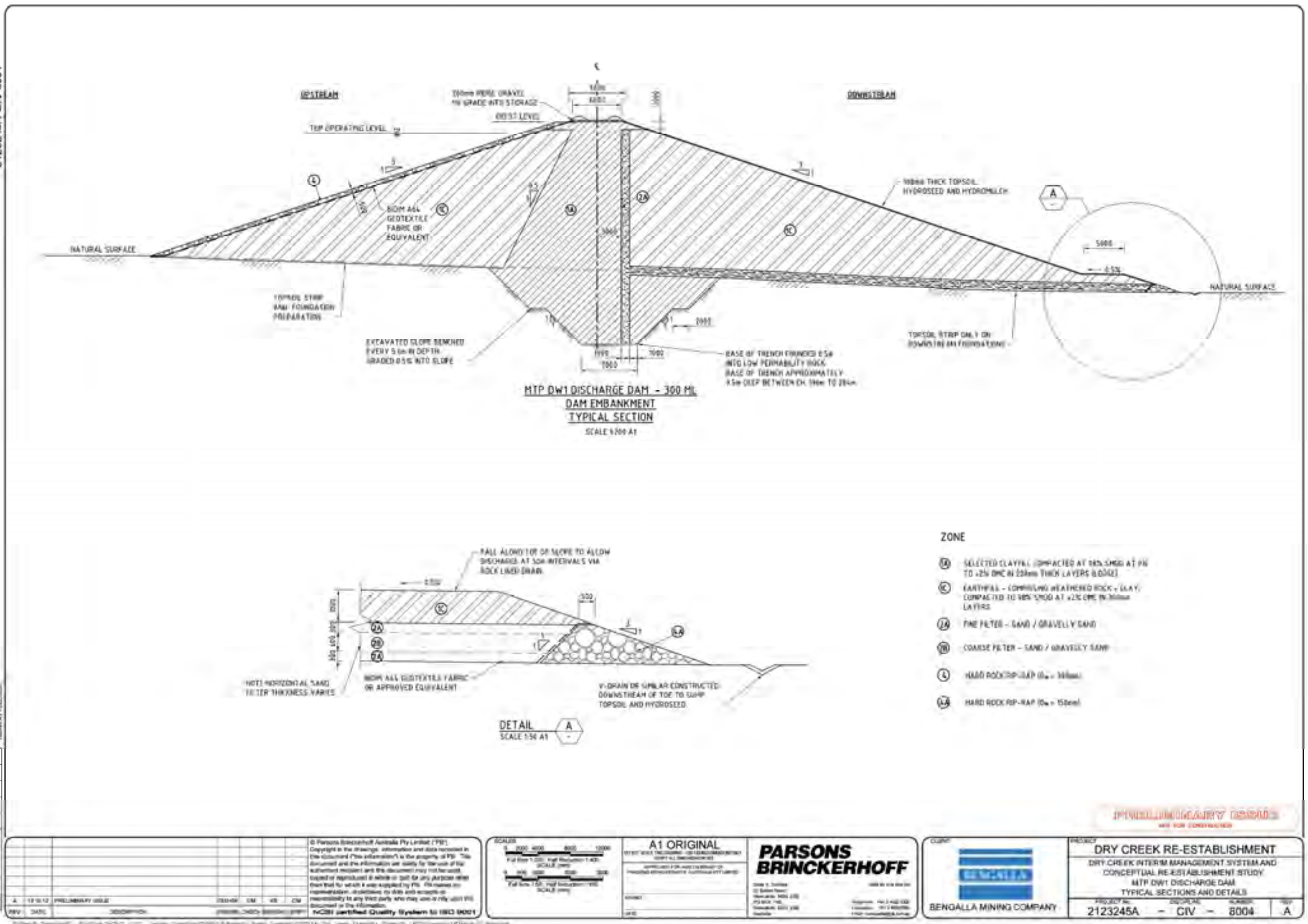
Appendix C

Dry Creek interim management system and conceptual re-establishment drawings

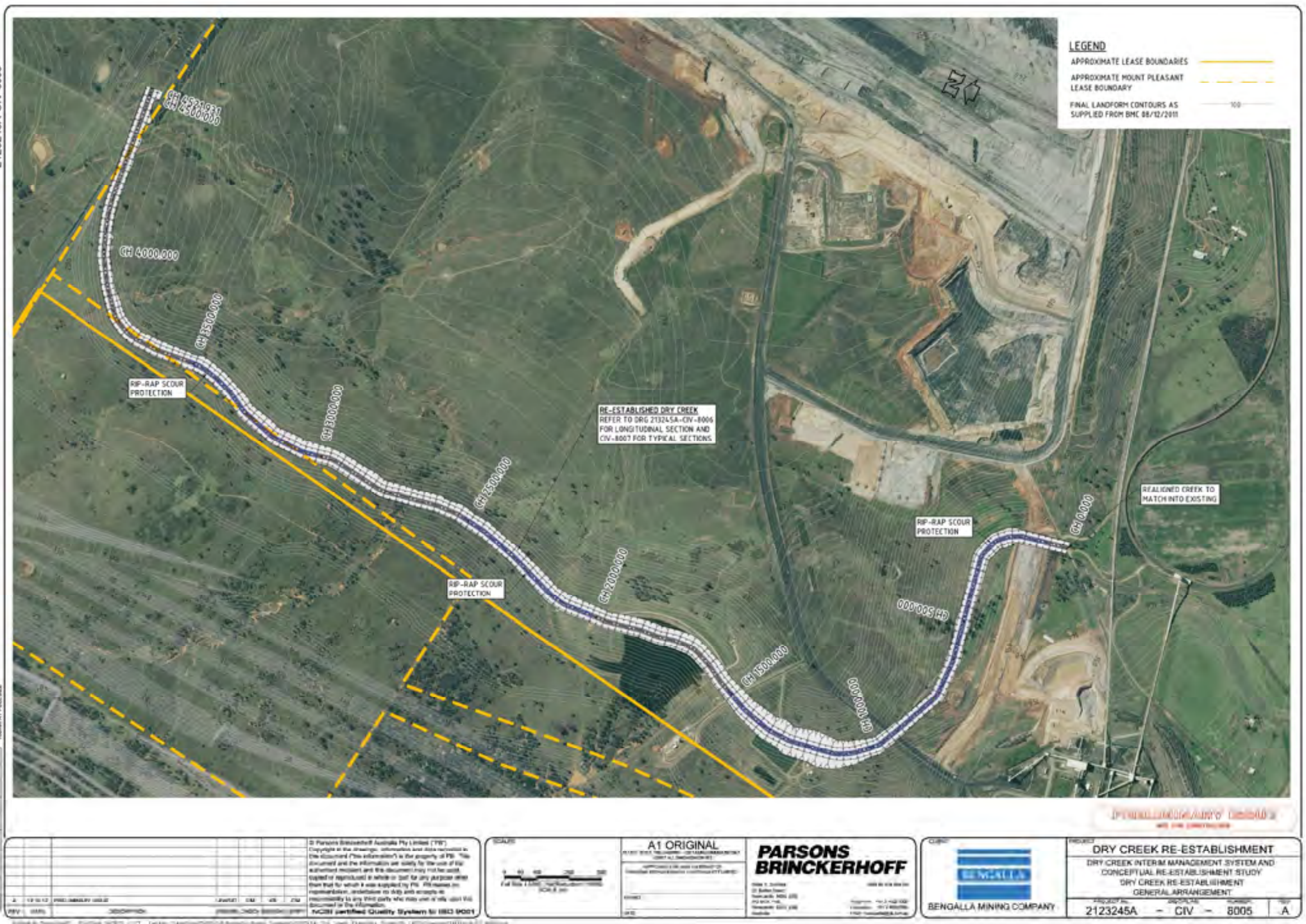

LEGEND
APPROXIMATE LEASE BOUNDARIES
APPROXIMATE MOUNT PLEASANT LEASE BOUNDARY
APPROXIMATE PIT EXTENTS
CW1 DISCHARGE PIPELINE
RW1 DISCHARGE PIPELINE
CURRENTLY APPROVED MOUNT PLEASANT RAW WATER DAM (RW1)
CW1 CLEAN WATER DIVERSION CHANNEL
LENGTH = 540m
HEIGHT = 600mm
GRADE 1%
CW1 SPILLWAY
WIDTH = 35m
HEIGHT = 2.5m
CLEAN WATER DAM (CW1)
CREST RL = 196m
TWL RL = 193.1m
EXCAVATION RL = 182m
NOMINAL CAPACITY = 900ML
EXISTING BMC ENVIRONMENTAL DAM
EXISTING SITE DAMS
BENGALLA MINE SITE
RLO
DOWNSTREAM DISCHARGE SCOUR PROTECTION CHANNEL
BENGALLA DISCHARGE DAM (BMC DW1)
CREST RL = 174m
TWL RL = 171.9m
EXCAVATION RL = 161.6m
NOMINAL CAPACITY = 300ML
DW1 SPILLWAY
WIDTH = 35m
HEIGHT = 1.2m
DW1 SPILLWAY
WIDTH = 26m
HEIGHT = 1m
MOUNT PLEASANT DISCHARGE DAM (MTP DW1)
CREST RL = 186m
TWL RL = 183.2m
EXCAVATION RL = 173.2m
NOMINAL CAPACITY = 300ML
DW1 CLEAN WATER DIVERSION CHANNEL
LENGTH = 1637m
HEIGHT = 750mm
GRADE = 1%
DW1 CLEAN WATER DIVERSION CHANNEL
LENGTH = 1190m
HEIGHT = 650mm
GRADE = 1%
BENGALLA LINK ROAD
KYBONG ROAD
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
GENERAL ARRANGEMENT
2123245A - CIV - 8001 A
2123245A-CIV-8001
NCSI certified Quality System to ISO 9001

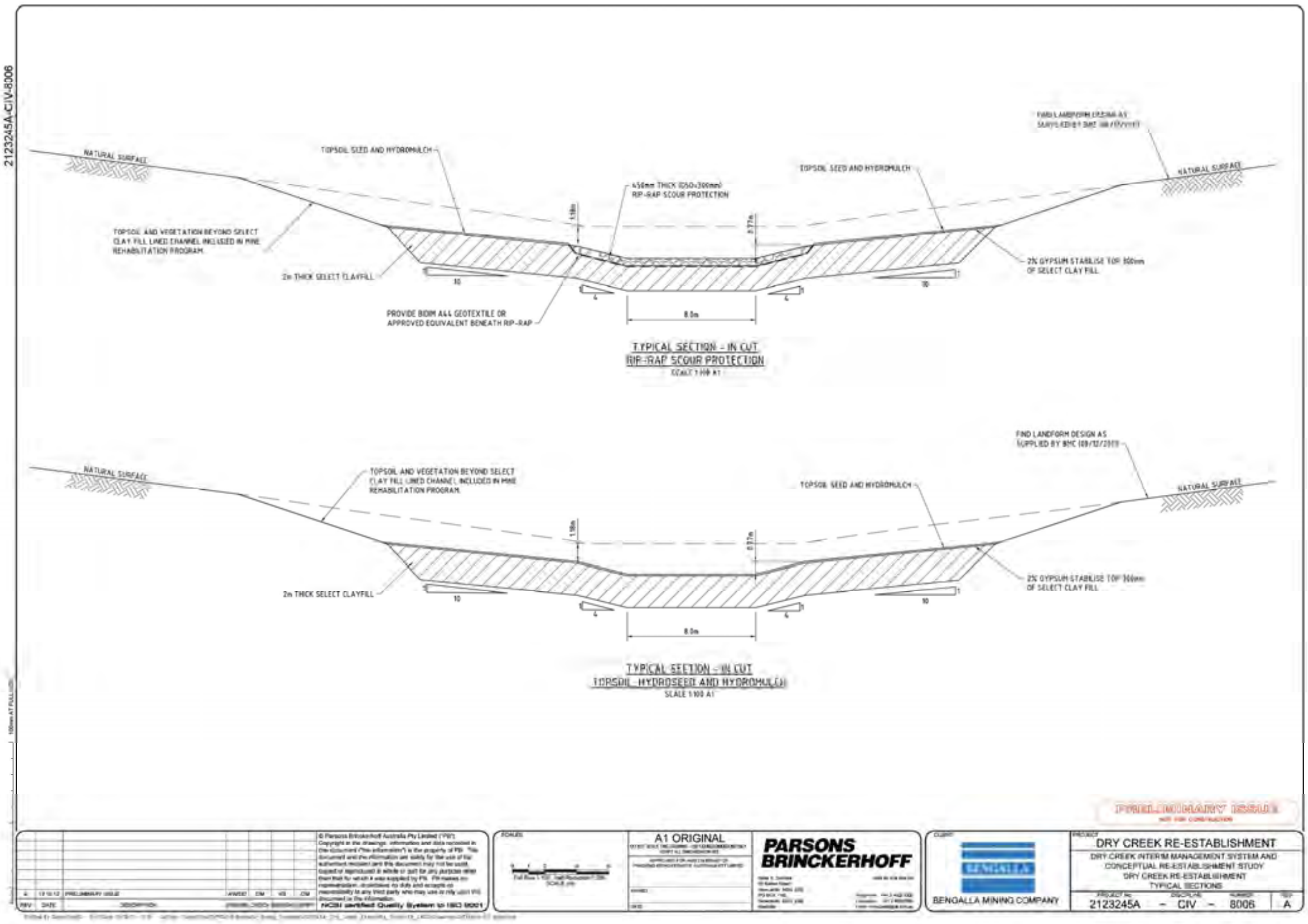

2123245A-CIV-8002
UPSTREAM
DOWNSTREAM
CREST LEVEL
NATURAL SURFACE
CW1 CLEAN WATER DAM 1 - 900 ML
DAM EMBANKMENT
TYPICAL SECTION
DETAIL A
ZONE
FINE FILTER - SAND / GRAVELLY SAND
COARSE FILTER - SAND / GRAVELLY SAND
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
CLEAN WATER DAM 1 (CW1)
TYPICAL SECTIONS AND DETAILS
2123245A - CIV - 8002
A


2123245A-CIV-8003
UPSTREAM
DOWNSTREAM
TOP OPERATING LEVEL
CREST LEVEL
NATURAL SURFACE
BIDIM A64 GEOTEXTILE FABRIC OR EQUIVALENT
TOPSOIL STRIP AND FOUNDATION PREPARATION
BMC DW1 DISCHARGE DAM - 300ML AND DAM EMBANKMENT TYPICAL SECTION
SCALE 1:200 A1
DETAIL A
ZONE
FINE FILTER - SAND / GRAVELLY SAND
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
BMC DW1 DISCHARGE DAM
TYPICAL SECTIONS AND DETAILS
2123245A - CIV - 8003
A



Dry Creek Interim Management System and Conceptual Re-establishment Study


2123245A-CIV-8005
LEGEND
APPROXIMATE LEASE BOUNDARIES
APPROXIMATE MOUNT PLEASANT LEASE BOUNDARY
FINAL LANDFORM CONTOURS AS SUPPLIED FROM BMC 08/12/2011
CH 4000.000
CH 3500.000
CH 3000.000
CH 2500.000
CH 2000.000
CH 1500.000
CH 1000.000
CH 500.000
CH 0.000
RIP-RAP SCOUR PROTECTION
RE-ESTABLISHED DRY CREEK REFER TO DRG 2123245A-CIV-8006 FOR LONGITUDINAL SECTION AND CIV-8007 FOR TYPICAL SECTIONS
REALIGNED CREEK TO MATCH INTO EXISTING
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
DRY CREEK RE-ESTABLISHMENT GENERAL ARRANGEMENT
2123245A - CIV - 8005 A
NCSI certified Quality System to ISO 9001


2123245A-CIV-8006
NATURAL SURFACE
TOPSOIL SEED AND HYDROMULCH
450mm THICK (D50=300mm) RIP-RAP SCOUR PROTECTION
TOPSOIL AND VEGETATION BEYOND SELECT CLAY FILL LINED CHANNEL INCLUDED IN MINE REHABILITATION PROGRAM.
2m THICK SELECT CLAYFILL
10
4
8.0m
PROVIDE BIDIM A44 GEOTEXTILE OR APPROVED EQUIVALENT BENEATH RIP-RAP
2% GYPSUM STABILISE TOP 300mm OF SELECT CLAY FILL
TYPICAL SECTION - IN CUT
RIP-RAP SCOUR PROTECTION
FIND LANDFORM DESIGN AS SUPPLIED BY BMC (08/12/2013)
TYPICAL SECTION - IN CUT
TOPSOIL HYDROSEED AND HYDROMULCH
SCALE 1:100 A1
PRELIMINARY ISSUE
A1 ORIGINAL
PARSONS BRINCKERHOFF
NCSI certified Quality System to ISO 9001
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
DRY CREEK RE-ESTABLISHMENT
TYPICAL SECTIONS
2123245A - CIV - 8006
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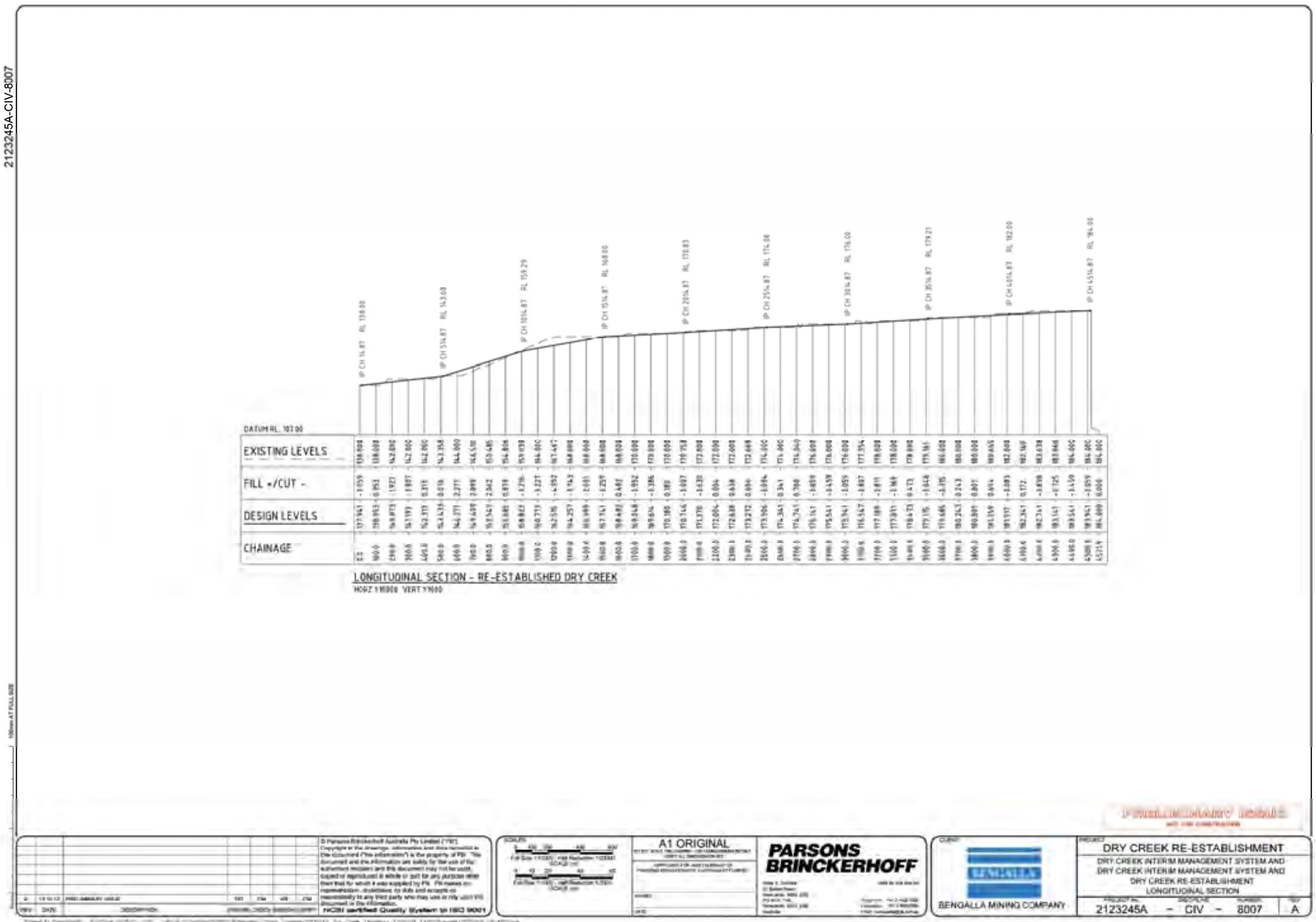
2123245A-CIV-8007
DATUM RL 107.00
EXISTING LEVELS
FILL +/CUT -
DESIGN LEVELS
CHAINAGE
LONGITUDINAL SECTION - RE-ESTABLISHED DRY CREEK
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND
DRY CREEK INTERIM MANAGEMENT SYSTEM AND
DRY CREEK RE-ESTABLISHMENT
LONGITUDINAL SECTION
2123245A - CIV - 8007 A
PRELIMINARY ISSUE