

WATERMARK

COAL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

February 2013

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Agricultural Impact Statement





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**Watermark Coal Project
Agricultural Impact Statement**

**Report prepared for Hansen Bailey Environmental Consultants
on behalf of Shenhua Watermark Coal Pty Ltd**

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February 2013

Executive Summary

Scott Barnett & Associates Pty Limited was commissioned by Hansen Bailey Environmental Consultants on behalf of Shenhua Watermark Coal Pty Limited to undertake an Agricultural Impact Statement for the Watermark Coal Project (the Project). This Assessment forms part of an Environmental Impact Statement being prepared to support an Application for State Significant Development Consent for the Project under Division 4.1 of Part 4 the *Environmental Planning and Assessment Act 1979*.

The Assessment addresses the DGRs as they relate to agriculture and as required by the DGRs 'include a specific focussed assessment of impacts of the proposal on strategic agricultural land having regard to the gateway criteria in the draft New England North West Strategic Regional Land Use Plan' (Draft SRLUP). Additionally, DP&I has advised that with the release of the final *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a), it should be addressed in lieu of the Draft SRLUP. This Assessment addresses the *Strategic Regional Land Use Plan – New England North West*.

The Project is located in the Liverpool Plains region, approximately 25 km south south-east of the township of Gunnedah and to the immediate west of the village of Breeza, within the Gunnedah Local Government Area. The Project are overlooks the Breeza Plains.

The Project area is within a region which has a long history of rural land use involving a variety of agricultural activities including grazing of beef cattle and sheep and winter and summer cropping including cereals, oilseeds, pulse crops cotton and fodder. Both dryland and irrigated cropping are carried out. Many of these rural pursuits utilise the available surface and subsurface water resource of the region for irrigation.

Within the locality of the Project area, there are seven regulated and unregulated water sources including:

- The Mooki River Water Source (part of the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources);
- Lake Goran Water Source (part of the Namoi Unregulated and Alluvial Water Sources);
- Zone 3 of the Upper and Lower Namoi Groundwater Sources;
- Zone 7 of the Upper and Lower Namoi Groundwater Sources;
- Zone 8 of the Upper and Lower Namoi Groundwater Sources;
- NSW Murray – Darling Basin Fractured Rock Groundwater Source (Liverpool Ranges Basalt); and
- NSW Murray – Darling Basin Porous Rock Groundwater Source (Gunnedah – Oxley Basin).

The agricultural industry within the Liverpool Plains region (defined as the Gunnedah and Liverpool Plains Local Government Areas) is suggested to have a local regional output of approximately \$232.1M and employs 6,790 people (ABS 2007, ABS 2008).

The land that comprises the Project area (9,500 ha) is owned by Shenhua Watermark Coal Pty Limited. This land is currently licensed back to a number of previous land holders for beef cattle and sheep grazing, as well as dry land winter cropping and summer dryland and irrigated cropping.

The current gross value of agricultural production from Shenhua Watermark Coal Pty Limited owned land, based on current land use, is \$5.5M per annum. The net value of agricultural production is \$2.8M from the production and sale of:

- 400 bales of cotton;
- 12,010 tonnes of cereal grains Wheat, sorghum and barley);
- 807 tonnes of oil seeds (sunflowers and canola);
- 114 tonnes of pulse crop (mung beans);
- 4,939 head of cattle;
- 253 head of sheep; and
- 1,560 kg of wool per annum.

An area of approximately 5,630 ha (the Disturbance Boundary) will be lost to agricultural production which includes 96.1 ha of land identified as Biophysical Strategic Agricultural Land as prescribed by the *Strategic Regional Land Use Plan – New England North West* (DP&I, September, 2012a). The current gross value of agricultural production from the disturbance area, based on current land use, is \$2.7M per annum. The net value of agricultural production is \$1.6M.

In recognition of the potential ecological impacts of the Project, a substantial Biodiversity Offset Package is proposed. The Project's Biodiversity Offset Package consists of two components: onsite biodiversity offset areas (7,797 ha) and offsite biodiversity offset areas (2,878 ha).

The onsite biodiversity offset areas include land owned by Shenhua Watermark Coal Pty Limited to the north-west of the Project area. Agricultural enterprises carried out on this land include summer and winter cereal cropping, oilseed production and grazing of beef cattle and sheep. The current gross value of agricultural production from the onsite biodiversity offset areas, based on current land use, is \$1.6 M per annum and the net value of agricultural production is \$0.7 M.

The offsite biodiversity offset areas includes land located near Barraba in the Tamworth Local Government Area, approximately 110 km north north-west of the Project. The current gross value of agricultural production from the offsite biodiversity offset areas, based on current land use of beef cattle and sheep grazing, is \$0.4M per annum. The net value of agricultural production is \$0.1 M.

This Assessment considers the impacts of the Project on strategic agricultural land having regard to the 'gateway criteria' in the *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a). A relatively small area of 96.1 ha is considered to satisfy the criteria for Biophysical Strategic Agricultural Land on the basis of soil fertility and land capability. This land is situated within the disturbance area and will be removed from agricultural use during the life of the Project.

The 'gateway criteria' require a 'cost benefit consideration' as to whether the Project 'would be in the public interest' through a 'cost benefit analysis'. In this context it is relevant to note that the gross value of agricultural production from the identified 96.1 ha of Biophysical Strategic Agricultural Land is estimated to be \$0.05M which would have a net value of \$0.02M.

Part of the onsite biodiversity offset areas required for the Project are situated on 375 ha of Biophysical Strategic Agricultural Land as mapped in the *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a). Following soil validation of the onsite biodiversity offset areas (GSSE, 2013) (see Appendix Y of the EIS), a further 321 ha of Biophysical Strategic Agricultural Land was identified, thereby increasing the total area to 696 ha. These areas will be set aside as ecological offsets for the Project in perpetuity.

None of the offsite biodiversity offset areas are within areas mapped as Biophysical Strategic Agricultural Land in the *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a). Soil validation confirms this (GSSE, 2013) (see Appendix Y of the EIS).

The proposed open cut mining areas do not directly intersect the alluvial aquifers of the Narrabri and Gunnedah Formations. The Gunnedah Formation is considered to satisfy the 'highly productive groundwater' criteria of the *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a) and *Aquifer Interference Policy* (NOW, September 2012b) for yield and salinity, however it does not occur beneath Biophysical Strategic Agricultural Land impacted by the Project nor elsewhere within the Project Boundary.

The Narrabri Formation is not considered to satisfy the 'highly productive groundwater' criteria of the *Strategic Regional Land Use Plan – New England North West* (DP&I, September 2012a) and *Aquifer Interference Policy* (NOW, September 2012b) for yield and salinity and does not occur beneath land impacted by the Project.

Groundwater Impact Assessment (AGE, 2013) (see Appendix T of the EIS) and Surface Water Impact Assessments (WRM, 2013) (see Appendix S of the EIS) have identified that the Project is predicted to result in the annual average relocation of approximately 194 ML/yr of water from agricultural purposes to coal mining purposes consisting of:

- Average reduction in the rate of groundwater flow from the Permian into the overlying Narrabri and Gunnedah Formation of 33.3 ML/year;
- Average annual additional transfer of water from the Mooki River to the underlying alluvium of 10.7ML/year; and
- Average of approximately 150 ML/year of external water supply.

These water sources are also utilised by agricultural activities in the area.

The water take from the NSW Murray - Darling Basin Porous Rock Groundwater Source due to the Project has not been included in the above, as the aquifer is very deep, poor quality and yielding and is not commonly used for agricultural purposes (AGE, 2013).

The groundwater impacts directly associated to the Project are limited to the 30-year mine life and approximately 15 years thereafter. At this time, groundwater take from the alluvial aquifer sources is reversed and the alluvial groundwater source is directly replenished by the Project.

This replenishment of the alluvial system is induced by enhanced aquifer recharge to the Permian groundwater system via emplaced areas of overburden material (AGE, 2013).

Within 10 km of the Project Boundary 35 bores are predicted to experience maximum groundwater level reductions of greater than or equal to 0.1 m. Of these, four bores adjacent to the Southern Mining Area have a maximum predicted drawdown between 1 -2 m. When operations in the Eastern Mining Area and Southern Mining Area cease, the model predicts that groundwater levels in the depressurised zone recover relatively rapidly within approximately five years.

The external make-up water supply for the Project (average of approximately 150 ML/year, up to 600 ML/year with less than 10% probability) has conservatively been assumed to be water which is currently utilised for agricultural purposes. Therefore, the Project is predicted to result in the annual average reallocation of approximately 194 ML/year of water from agricultural purposes to coal mining purposes.

On this basis, the Project is not considered to materially reduce the agricultural productivity of the mapped Biophysical Strategic Agricultural Land within the Project area and surrounds through impacts to highly productive groundwater.

The impact of removing 194 ML from agricultural use within the Project area results in a gross value loss of \$0.1 M per annum. The net value lost is \$0.06 M per annum.

The gross value of agricultural production lost as a result of the Project within the Project area is predicted to be \$4.8 M per annum. This value represents 3.8% of the total agricultural production of the Gunnedah LGA, 2.1% in the Liverpool Plains region, 0.05% of New South Wales and 0.01% of Australia.

The losses to agriculture will be mitigated by the commitment from Shenhua Watermark Coal Pty to reinstate at least 1,000 ha of agricultural capability Class III land as part of the mine rehabilitation process. Based on current agricultural practices and returns, this would have an annual gross value of production of \$0.7M and a net value of production of \$0.3M per annum.

The losses to agriculture from the reallocation of water from agricultural purposes to coal mining purposes will be mitigated by obtaining appropriate water licences. There is sufficient water available on the open market for Shenhua Watermark Coal Pty Limited to obtain the additional water licences required without significantly affecting agricultural activities in the region or impact on the water market.

The loss of agricultural production from the area within of the disturbance footprint, the onsite biodiversity offset areas and the offsite biodiversity offset area resulting from the Project is small. The reduction of rural production will be minimal and of no materiality to local regional and state agricultural capacity or production during the Project life.

The Project will not have any impact on the alluvial soils or agricultural productivity of land outside the Project Area and the Biodiversity Offset Areas.

Other potential impacts on agricultural resources and enterprises within the locality, including air quality, noise, soils, traffic and transport, visual, labour supply, have been assessed as having a minimal effect.

To maintain and where possible enhance the agricultural productivity of the land outside the Project area, it is recommended that Shenhua Watermark Coal Pty Limited:

- Minimise the disturbance of agricultural land at any one time;
- Continue to work with land managers to effectively utilise agricultural land owned by Shenhua Watermark Coal Pty Limited;
- Develop and implement a weed and pest management plan to control the distribution of invasive species and feral animals at the Project and Biodiversity Offset Areas;
- Consult with the Central North Livestock Health and Pest Authority as to the appropriateness of the weed and pest management plan;
- Implement sustainable farming practices, including reduced till farming and rotational grazing techniques in available areas outside of the Disturbance Boundary. Further, consider the implementation of measures as proposed by the Namoi Catchment Management Authority for Best Management Practices of the relevant Land Management Units;

- Ensure that as part of the Licences to Occupy, land managers will be required to commit to the implementation of the program as outlined in any collaboration agreement that Shenhua Watermark Coal Pty Limited and the Catchment Management Authority may develop to manage the natural resources while managing the land to its full potential;
- In the event that the onsite biodiversity offset areas are managed in part for agricultural purposes, ensure sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate Land Management Units as set out by the Namoi Catchment Management Authority land;
- In the event that the offsite biodiversity offset areas are managed in part for agricultural purposes, ensure sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate Land Capability and Agricultural Suitability Class as set out by the relevant Catchment Management Authority; and
- Reinstate agricultural production on rehabilitated land as soon as practicable having consideration of safety and legislative requirements relating to mine operations.

Table of Contents

1	Introduction	1
1.1	Project Description.....	1
1.2	Assessment Objectives	4
1.3	Assessment Areas	4
1.4	Related Studies.....	5
2	Regulatory Framework.....	8
2.1	Environmental Planning and Assessment Act 1979.....	8
2.2	Strategic Regional Land Use Plan – New England North West	11
2.3	Guideline for Agricultural Impact Statements.....	11
2.4	Water Management Act 2000.....	12
3	Existing Environment.....	13
3.1	Climate	13
3.2	Topography and Slope	15
3.3	Soils	16
3.4	Land Management Units	26
3.5	Agricultural History	31
3.6	Regulated Water Sources	35
3.7	Breeza State Forest	36
4	Existing Agricultural Enterprises and Resources	38
4.1	Agricultural Enterprises	38
4.2	Supporting Infrastructure and Services.....	41
4.3	Agricultural Resources	42
4.4	Agricultural Value	44
4.5	Employment.....	44
5	Agricultural Assessment	45
5.1	Methodology	45
5.2	Agricultural Domains	45
5.3	Current Agriculture Production and Value.....	53
5.4	Potential Agricultural Production.....	63
5.5	Alternative Agricultural Land Uses	67
6	Stakeholder Consultation	68
6.1	Overview.....	68
6.2	Issues Identified	68

6.3	Ongoing Stakeholder Engagement	71
7	Risk Assessment	72
8	Impact Assessment.....	73
8.1	Availability and Productivity of Agricultural Land	73
8.2	Groundwater	79
8.3	Surface water	86
8.4	Movement of Water from Agriculture	87
8.5	Soils and Land Capability.....	88
8.6	Impact on Biophysical Strategic Agricultural Land.....	91
8.7	Air Quality	97
8.8	Noise	99
8.9	Visual.....	100
8.10	Traffic and Support Infrastructure and Services	100
8.11	Labour Supply	101
9	Mitigation and Management Measures	103
9.1	Project Design Review	103
9.2	Environmental Management System	105
9.3	Proposed Agricultural Management Measures.....	107
9.4	Demonstrated Capacity of Rehabilitation	111
9.5	Progressive Rehabilitation.....	112
10	Conclusion.....	122
11	References.....	125

List of Tables

Table 1	Director-General's Requirements.....	8
Table 2	Relevant Agency Comments.....	9
Table 3	Guidelines for Agricultural Impact Statements Requirements.....	11
Table 4	Soil Types	19
Table 5	Land Management Units in Locality of Project	26
Table 6	Water Sharing Plans within Locality of the Project	35
Table 7	Value of Agricultural Production	44
Table 8	Liverpool Plains Region Agricultural Industry Employment	44
Table 9	Agricultural Domains within Shenhua Watermark Owned Land	46
Table 10	Agricultural Domains within the Project Area.....	50
Table 11	Agricultural Domains within the Residual Onsite Biodiversity Offset Area ...	51

Table 12	Agricultural Domains within the Offsite Biodiversity Offset Area	51
Table 13	Current Enterprises per Agricultural Domain of Shenhua Watermark Owned Land	53
Table 14	Quantum and Value of Agricultural Production from Shenhua Watermark Owned Land	54
Table 15	Current Enterprises per Agricultural Domain of the Project Area.....	55
Table 16	Quantum and Value of Agricultural Production from the Project Area	56
Table 17	Value Comparison of Agricultural Production	57
Table 18	Current Enterprises per Agricultural Domain of the Residual Onsite Biodiversity Offset Area	58
Table 19	Quantum and Value of Agricultural Production from the Residual Onsite Biodiversity Offset Area	58
Table 20	Current Enterprises per Agricultural Domain of the Offsite Biodiversity Offset Areas.....	59
Table 21	Quantum and Value of Agricultural Production from the Offsite Biodiversity Offset Areas.....	59
Table 22	Gross Margin of Irrigation Water for Summer Crops.....	61
Table 23	Quantum and Value of Production of Irrigated and Dryland Cotton.....	61
Table 24	Total Combined Agricultural Production	62
Table 25	Changes to Models to Represent Potential Agricultural Production from Project Area	63
Table 26	Maximum Potential of Agricultural Production from the Project Area	64
Table 27	Changes to Models to Represent Potential Agricultural Production from the Residual Onsite Biodiversity Offset Area.....	64
Table 28	Maximum Potential of Agricultural Production the Residual Onsite Biodiversity Offset Area	65
Table 29	Changes to Models to Represent Potential Agricultural Production within Offsite Biodiversity Offset Areas	65
Table 30	Maximum Potential of Agricultural Production from Offsite Biodiversity Offset Areas.....	66
Table 31	Maximum Potential of Agricultural Production from Water	66
Table 32	Regulatory Stakeholder Issues.....	69
Table 33	Community Stakeholder Issues	70
Table 34	Risk Assessment.....	72
Table 35	Quantum and Value of Agricultural Production Affected within the Disturbance Area.....	73
Table 36	Quantum and Value of Agricultural Production Affected within the Onsite Biodiversity Offset Areas	76

Table 37	Quantum and Value of Agricultural Production Affected within the Offsite Biodiversity Offset Areas	76
Table 38	Value of Total Agricultural Production Impacted and Outputs	77
Table 39	Annual Regional Production, Economics Impacts of the Foregone Agriculture and the Project	78
Table 40	Reduction in Transfer Rate from Permian to Alluvium	81
Table 41	Water Allocations	83
Table 42	Pre and Post Mining Land Capability	89
Table 43	Pre and Post Mining Agricultural Suitability	90
Table 44	BSAL Site Verification	91
Table 46	Proposed Monitoring Programs and Management Plans.....	106

List of Figures

Figure 1	Regional Locality	2
Figure 2	Project Layout and Onsite Biodiversity Offset Areas	3
Figure 3	Offsite Biodiversity Offset Areas	6
Figure 4	Land Ownership	7
Figure 5	Climatic Indicators of the Breeza Locality	13
Figure 6	Climatic Indicators of the Barraba Locality	14
Figure 7	Project Soil Landscapes.....	19
Figure 8	Offsite Biodiversity Offset Areas Soil Landscapes	25
Figure 9	Land Management Units	30
Figure 10	Historical Aerial Photograph (1954).....	32
Figure 11	Historical Aerial Photograph (1989).....	33
Figure 12	Historical Aerial Photograph (2003).....	34
Figure 13	Water Users and Management Zones	37
Figure 14	Agricultural Resources and Enterprises	43
Figure 15	Agricultural Domains (Shenhua Watermark Owned Land)	49
Figure 16	Agricultural Domains (Offsite Biodiversity Offset Areas)	52
Figure 17	Post Mining Land Capability	74
Figure 18	Gunnedah Formation	85
Figure 19	Site Verification for Biophysical Strategic Agricultural Land (Project Area)	93
Figure 20	Site Verification for Biophysical Strategic Agricultural Land (Offsite Biodiversity Offset Area)	94
Figure 21	Project Design Constraints	104
Figure 22	Conceptual Year 1 Mine Plan	113

Figure 23	Conceptual Year 5 Mine Plan	114
Figure 24	Conceptual Year 10 Mine Plan	115
Figure 25	Conceptual Year 15 Mine Plan	116
Figure 26	Conceptual Year 21 Mine Plan	117
Figure 27	Conceptual Year 25 Mine Plan	118
Figure 28	Conceptual Year 30 Mine Plan	119
Figure 29	Conceptual Final Landform	120
Figure 30	Conceptual Final Landform Slope Analysis	121

Appendices

Appendix 1	Value and Quantum of Agricultural Production from Shenhua Watermark Owned Land
Appendix 2	Value and Quantum of Agricultural Production from the Project Area
Appendix 3	Value and Quantum of Agricultural Production from the Residual Onsite Biodiversity Offset Areas
Appendix 4	Value and Quantum of Agricultural Production from the Offsite Biodiversity Offset Areas
Appendix 5	Potential Value and Quantum of Total Combined Agricultural Production
Appendix 6	Risk Assessment Matrix
Appendix 7	Economic Review of Potential Agricultural Impacts
Appendix 8	Desktop Investigation of the Potential for Coal Dust to Impact on Cotton Fibre Colour (Quality)

1 Introduction

Scott Barnett & Associates Pty Limited (SBA) was commissioned by Hansen Bailey Environmental Consultants Pty Limited (Hansen Bailey) on behalf of Shenhua Watermark Coal Pty Limited (Shenhua Watermark) to undertake an Agricultural Impact Statement for the Watermark Coal Project (the Project). The purpose of the assessment is to form part of an Environmental Impact Statement (EIS) being prepared to support an Application for State Significant Development Consent for the Project under Division 4.1 of Part 4 the *Environmental Planning and Assessment Act 1979* (EP&A Act).

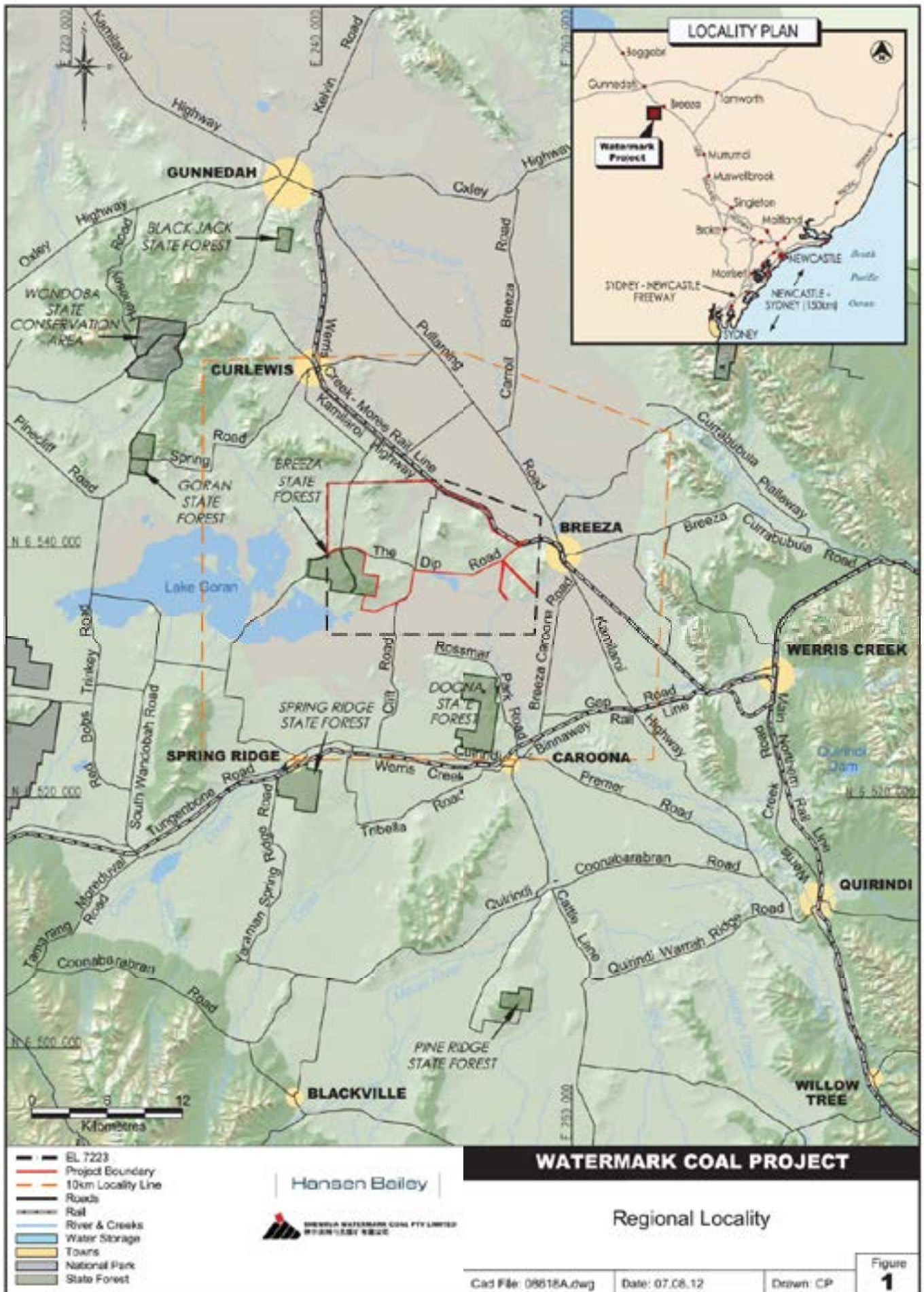
In October 2008, Shenhua Watermark was granted Exploration Licence (EL) 7223. Shenhua Watermark is a subsidiary of the Shenhua Group.

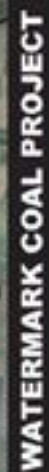
The Project is located within EL 7223, approximately 25 km south south-east of the township of Gunnedah and to the immediate west of the village of Breeza, within the Gunnedah Local Government Area (LGA). The Project is approximately 282 km by rail from the export Port of Newcastle. **Figure 1** illustrates the regional locality of the Project in relation to the nearest town centres of Breeza, Curlewis and Gunnedah.

1.1 Project Description

The Project generally comprises (see **Figure 2**):

- The construction and operation of an open cut mining operation extracting up to 10 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal for a 30 year period;
- An open cut mining fleet of excavators and shovels, supported by haul trucks, dozers, graders, drill rigs and water carts;
- Progressive rehabilitation of all disturbed areas;
- The construction and operation of a Coal Handling and Preparation Plant (CHPP) with a throughput of 10 Mtpa ROM coal;
- The co-disposal of tailings and coarse reject within the Overburden Emplacement Areas (OEA);
- The construction and operation of a rail spur, rail loop, Kamilaroi Highway rail overpass, associated load out facility and connection to the Werris Creek - Moree Railway Line;
- The construction and operation of a Mine Access Road;
- The construction and operation of administration, workshop and related facilities;
- The construction and operation of ground and surface water management and reticulation infrastructure including pipelines, pumping stations and associated infrastructure for access to water from groundwater aquifers, the Mooki River and private dams to the north-east of the Project Boundary;
- The installation of communications and electricity reticulation infrastructure; and
- A workforce of up to approximately 600 full-time equivalent employees during construction and up to 600 full-time equivalent employees during the operation of the Project.





Project Layout & Onsite Biodiversity Offset Areas

Figure 10

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1.2 Assessment Objectives

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

- Addressing the Director-General's Requirements (DGRs) relating to agriculture as issued on 19 April 2012 (see **Section 2.1**);
- Addressing relevant policies and plans relating to agriculture (see **Section 2**);
- Describing the agricultural resources and enterprises in the general locality (see **Section 4**);
- Identifying the agricultural domains of the land within the assessment areas (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 **Sections 5.3 and 5.4**);
- Assessing the loss of agricultural production within the assessment areas during the life of the Project in terms of value of agricultural production and downstream activities within the value chain and support activities (see **Section 8**);
- 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 **Section 8.1.4**);
- Assessing the potential impacts of the Project on the agricultural resources and enterprises within the locality (see **Sections 8.1.6 and 8.1.7**); and
- Providing appropriate mitigation and management measures (see **Section 9**).

1.3 Assessment Areas

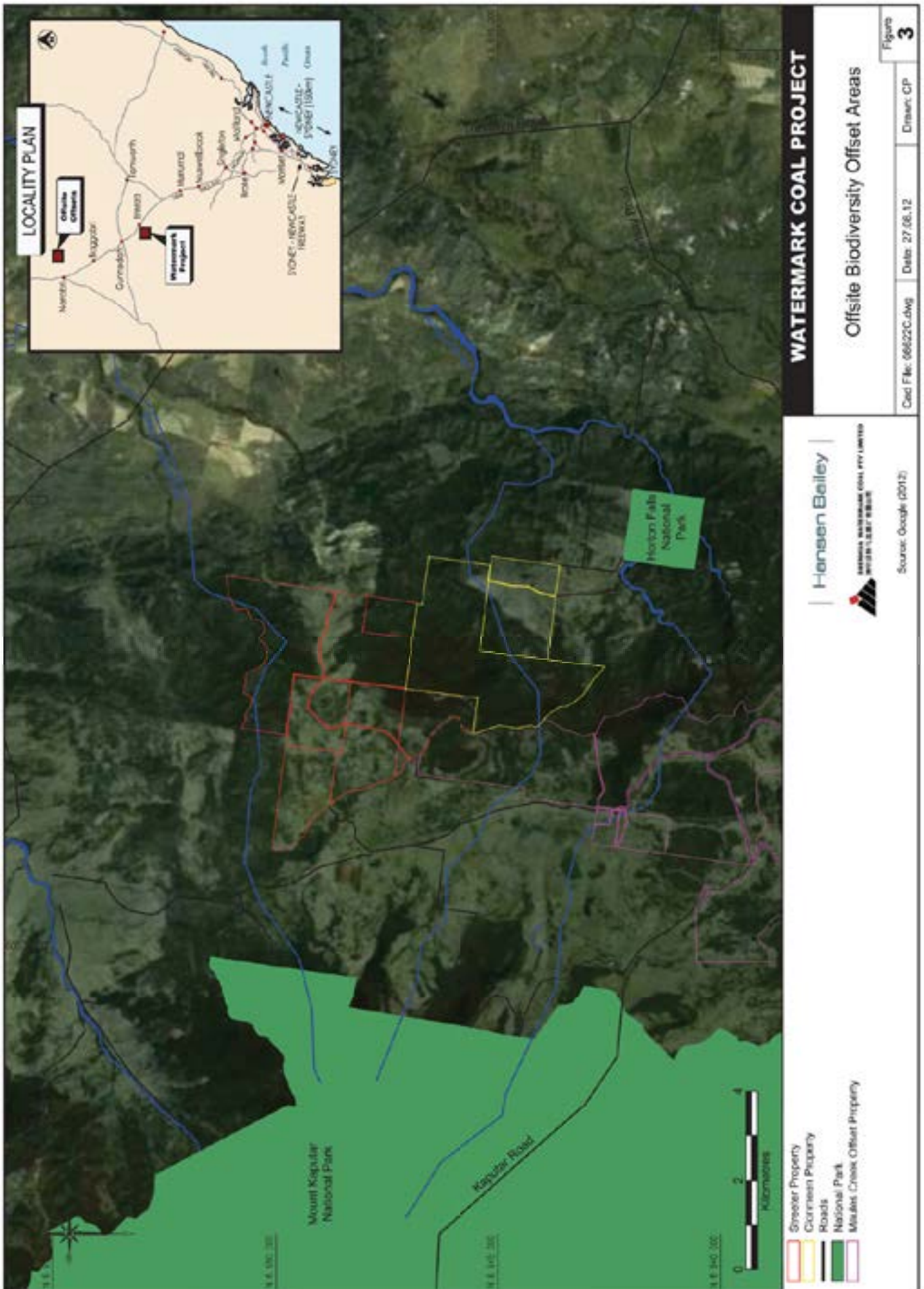
The assessment areas for the Agricultural Impact Statement include the following:

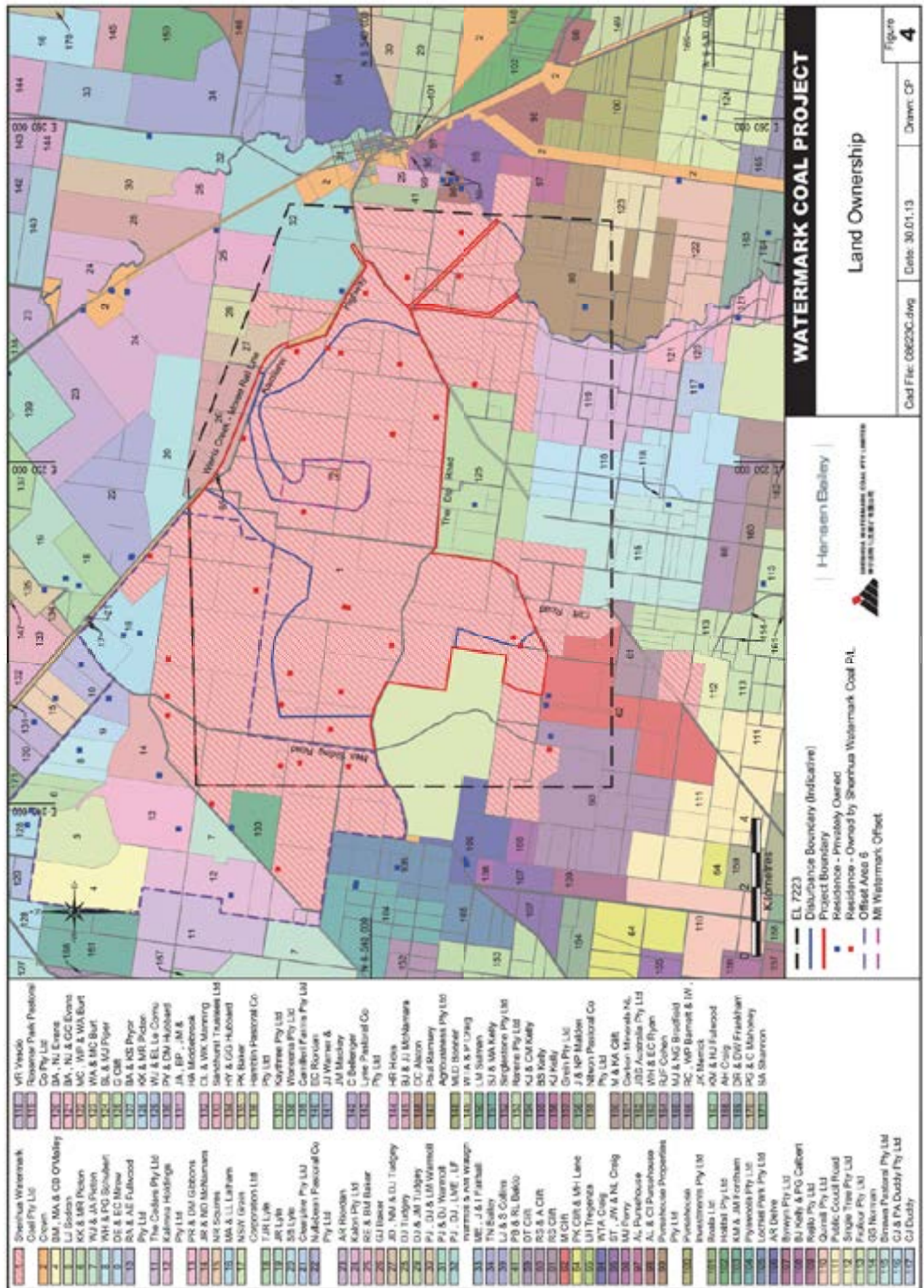
- Land currently owned by Shenhua Watermark – comprising of 14,843 ha (see **Figure 4**);
- Land within the Project Boundary (Project area) – comprising 9,500 ha, which is the application area for the Project (**Figure 2**). This includes the disturbance boundary, onsite biodiversity offset areas (Mt Watermark offset area and part of Offset Area 6) and non-disturbed areas. All of the land associated with the Project area is owned by Shenhua Watermark;
- Land within the disturbance boundary (disturbance area) – comprising 5,360 ha within the Project Boundary, which will be required for mining operations and infrastructure (**Figure 2**);
- Onsite biodiversity offset areas – comprising 7,797 ha. Onsite biodiversity offset areas include Offset Area 6 (7,457 ha), the Mt Watermark Offset Area (296 ha) and the Mooki River Offset Area (44 ha) and are located within and adjacent to the Project area (**Figure 2**);
 - Residual onsite biodiversity offset area – a portion of land comprising of 3,827 ha within Offset Area 6, which is not currently owned by Shenhua Watermark.
- Offsite biodiversity offset areas – comprising 2,878 ha near Barraba in the Tamworth Regional Council LGA, approximately 110 km north north-west of the Project area, which are proposed to be included as part of the Biodiversity Offset Package (see **Figure 3**); and
- Agriculture in the general locality – defined as the land within a 10 km radius of the Project (see **Figure 1**) (referred to as the locality).

1.4 Related Studies

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

- The EIS Soil Survey and Land Capability Impact Assessment (GSSE, 2013);
- The EIS Ecological Impact Assessment (Cumberland Ecology, 2013);
- The EIS Surface Water Impact Assessment (WRM Water & Environment, 2013);
- The EIS Groundwater Impact Assessment (AGE Consultants, 2013);
- The EIS Air Quality and Greenhouse Gas Impact Assessment (PAE Holmes, 2012);
- The EIS Acoustics Impact Assessment (Bridges Acoustics, 2013);
- The EIS Visual Impact Assessment (JVP Planning & Design, 2012);
- The EIS Traffic and Transport Impact Assessment (DC Traffic & Engineering, 2013);
- The EIS Social Impact Assessment (Hansen Bailey, 2013);
- The EIS Economic Impact Assessment (Gillespie Economics, 2012); and
- The EIS Blasting Impacts on Landforms and Slopes (SCT, 2012).





2 Regulatory Framework

This section describes the regulatory framework relevant to the Project and this assessment.

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. This Division provides for a new planning assessment and determination regime for State Significant Development (SSD). The Project has been deemed a SSD.

All applications for SSD under Division 4.1 of Part 4 of the EP&A Act must be supported by an EIS. The EIS is to be prepared in accordance with the Director-General's DGRs. This assessment, which forms part of the EIS, addresses the DGRs relating to agriculture. **Table 1** lists the DGRs that are relevant to this assessment and the sections in this report where these DGRs are addressed.

Table 1
Director-General's Requirements

Key Issue	Requirement	Report Section Where Addressed
Agricultural and Other Land Resources	Include an Agricultural Impact Statement that includes a specific focused assessment of the impacts of the proposal on strategic agricultural land, having regard to the gateway criteria in the New England North West Strategic Regional Land Use Plan. The EIS must also include a detailed description and assessment of the potential impacts on:	Complete assessment. See Section 2 and 8 for SRLUP.
	soils and land capability (including salinisation and contamination);	Soil Survey and Land Capability Impact Assessment (GSSE, 2013) (Section 3.3 and 5.2)
	landforms and topography, including cliffs, rock formations, steep slopes, etc;	Blasting Impacts on Landforms and Slopes (SCT, 2012).
	land use, including agricultural, forestry, conservation and recreational use, with particular reference to agricultural land use and Breeza State Forest;	Section 3 and 4
	agricultural resources and/or enterprises in the local area, with particular reference to highly productive alluvial soils that may be impacted directly or indirectly by the project, and including:	Section 4
	pre-mining and post-mining agricultural assessment and mapping (including Land Capability and Agricultural Suitability mapping) of soil characteristics across all proposed disturbance areas, and an assessment of their value and rehabilitation limitations;	Soil Survey and Land Capability Assessment (GSSE, 2013)
	definition of the limit of the Upper Namoi Alluvium, and justification for the nominated limit;	Groundwater Impact Assessment (AGE, 2013)
	any change in land-use arising from requirements for biodiversity offsets;	Section 8.1 to 8.1.3

Key Issue	Requirement	Report Section Where Addressed
	a detailed description of the measures that would be implemented to avoid, reduce or mitigate impacts of the development on local agricultural resources and/or enterprises; and	Section 9
	justification for any significant long term changes to agricultural resources, particularly highly productive soils potentially affected by the development;	Section 8, Economic Impact Assessment (Gillespie Economics, 2012), Socio Economic Impact Assessment (Hansen Bailey, 2013)

This Agricultural Impact Statement has also been prepared in consideration of the relevant DGRs input from Department of Primary Industries – Agriculture, NSW Farmers Association (NFA) and Gunnedah Shire Council (GSC). This is shown in **Table 2** below.

Table 2
Relevant Agency Comments

Agency	Requirement	Report Section Where Addressed
DPI	The Department of Primary Industries wishes to draw the attention of the proponent to the imminent release of guidelines for the completion of Agricultural Impact Statements arising out of the Strategic Regional Land use Policy. The comments provided do not override or seek to reduce or refine the Agricultural Impact Statement to only address the below points. These comments are provided to guide the proponent to particular areas in which they should provide greater attention.	Complete assessment
	The impact on surrounding Agriculture from the disturbance to surface and ground water flow, pressure, recharge and quality is critical. The productive potential of the Liverpool plains is limited primarily by water availability. Irrigation industry has significant investment and dependence based on the present water resource. Also the importance of ground water for livestock must not be overlooked. The loss of water from the irrigation sector needs to be considered. The accumulated impact of water moving from the irrigation sector to the mining sector over the long term will also have an impact that needs to be assessed.	Groundwater Impact Assessment (AGE, 2013), Surface Water Impact Assessment (WRM, 2013), and Section 8.1.4, 8.2, 8.3
	The impact on rural labour and rural communities. eg. what will the development mean for the maintenance of rural communities and rural fire service membership etc. will a farming community be displaced or significantly weakened as a result of the development	Section 8.10 and 8.11
	How will the development increase competition for rural sector to attract labour, particularly the irrigation industry which requires higher labour inputs	Section 8.11
	How much competition and capacity is there for access to rail for the transport of grain out of Gunnedah, Narrabri, Moree, Weemelah	Traffic & Transport Impact Assessment (DC Engineering, 2013)

Agency	Requirement	Report Section Where Addressed
	The accumulated effect of mining changing the rural nature in the region. The presence of another mine is changing a predominately rural area to that with a high mining presence. Regionally there is a greater presence of mining due to the numerous mines operated by Whitehaven and Idemitsu. This not only refers to the visual impact of the site and greater presence of mining related vehicles laden with coal fines and warning flags commuting to and from the site and in towns but, the accumulative effect of dust particles below the PM10 on the rural community and rural landscape values. The initiative to monitor dust at the 2.5 level is noted and commended.	Section 3, 8.9 and 8.10 Air Quality and Greenhouse Gas Impact Assessment (PAEHolmes, 2012), Visual Impact Assessment (JVP, 2012) and Traffic and Transport Impact Assessment (DC Engineering, 2013)
	The use of biodiversity offsets on Agricultural land needs to be explored. The tying up of current and future productive agricultural land under biodiversity offsets is not in the interest of the agricultural community.	Sections 8.1.1 to 8.1.3
	Significant weed species and risks within the proposed development footprint and develop weed suppression, management and containment strategies to ensure they are not spread. Particular attention should be paid to soil stockpiles, roadsides and disturbed areas.	Section 9.3.8
	Post mining land use and land capability and agricultural land capability	Soil Survey and Land Capability Impact Assessment (GSSE, 2013)
	The strategic approach to how the development is to be staged so as to minimise the placement of over burden on agricultural land is noted and commended. The commitment to placement of over burden on/in pre mined areas is commended. This staging of the development could be further highlighted along with any other initiatives to minimise the impact of final voids.	See staged mine plans in main volume of EIS
	Mine Rehabilitation. The standard of mine rehabilitation being demanded by the community is to a higher standard. The significance of agricultural production of the area will also draw greater attention to the rehabilitation standard with particular focus on its productive potential component, including but not limited to subsoil constraints and soil fertility.	Soil Survey and Land Capability Impact Assessment (GSSE, 2013) and Section 8.1.1, Rehabilitation and Mine Closure Strategy (GSSE, 2013)
NFA	The projected impacts on short and long term agricultural productivity (based on expert third party assessment);	Section 8
GSC	A full review of agricultural impacts relative to the area subject of the proposal and the surrounding rural lands is required. The assessment must particularly analyse the potential impacts on livestock and crops on properties in the vicinity of the development of dust residual which could have significant financial implication for farmers. Methods by which such impacts can be mitigated or compensated should be produced.	Air Quality and Greenhouse Gas Impact Assessment (PAE Holmes, 2012) Section 8 and 9

2.2 Strategic Regional Land Use Plan – New England North West

The *Strategic Regional Land Use Plan – New England North West* (SRLUP) (DP&I, September 2012a) 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 areas of Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Clusters.

The Assessment addresses the DGRs as they relate to agriculture and as required by the DGRs 'include a specific focussed assessment of impacts of the proposal on strategic agricultural land having regard to the gateway criteria in the draft New England North West Strategic Regional Land Use Plan' (Draft SRLUP). Additionally, DP&I has advised that with the release of the SRLUP, it should be addressed in lieu of the Draft SRLUP. This Assessment addresses the SRLUP.

The DGRs require an assessment of BSAL and Critical Industry Clusters, having regard to the SRLUP and the gateway criteria. An assessment of the Project on BSAL and Critical Industry Clusters has been undertaken and is provided in **Section 8.6**.

The provisions of the *Aquifer Interference Policy* (AIP) (NOW, September 2012) have been considered and addressed as part of the Groundwater Impact Assessment (AGE, 2013) that was prepared for the EIS, a summary of which is included as relevant to this assessment in **Section 8.2**.

2.3 Guideline 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 3**). It is a supplementary document to the SRLUP.

Table 3
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	Sections 4 and 5
Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the Project area	Sections 4
Identification and assessment of the impacts of the project on agricultural resources or industries	Section 8
Account for any physical movement of water away from agriculture	Sections 8.1.4, 8.2, 8.3, 8.4
Assessment of socio-economic impacts	Section 8.10, 8.11 and Social Impact Assessment (Hansen Bailey, 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 land users and government departments	Section 6

This report has been prepared in accordance with the Guidelines for Agricultural Impact Statements.

2.4 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.

Within the locality there are seven regulated and unregulated water sources which are subject to the WM Act (AGE, 2013) (see Appendix T of the EIS). These are:

- The Mooki River Water Source (part of the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources);
- Lake Goran Water Source (part of the Namoi Unregulated and Alluvial Water Sources);
- Zone 3 of the Upper and Lower Namoi Groundwater Sources;
- Zone 7 of the Upper and Lower Namoi Groundwater Sources;
- Zone 8 of the Upper and Lower Namoi Groundwater Sources; and
- NSW Murray – Darling Basin Porous Rock Groundwater Source (Gunnedah – Oxley Basin).

As advised by AGE (2013), each of the water sources operate (or are proposed to operate) under a Water Sharing Plan. These plans are legal documents made under the WM Act. The plans contain the rules for how water is shared between the environment and water uses and different categories of licences. They also document the rules how water entitlements and allocations can be traded between water users within the water source and, where applicable, between water sources.

The Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources (NSW Department of Infrastructure, Planning and Natural Resources, 2005) commenced on the 1 July 2004 and applies for a period of 10 years to 30 June 2014.

The Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources commenced on 4 October 2012 and applies for a period of 10 years (NSW Office of Water, 2011).

The Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources commenced on 1 November 2006 and will be in effect until 30 June 2017 (Green *et. al*, 2011).

The Water Sharing Plan for the Gunnedah – Oxley Basin of the NSW Murray – Darling Basin Porous Groundwater Source came in to effect on the 16 January 2012 for a period of 10 years (NSW Office of Water 2012b).

The Project is situated in an area where a potential source of water is any of the above water sources and therefore any water extraction for the Project is subject to the provisions of the WM Act and the relative Water Sharing Plan (AGE, 2013).

3 Existing Environment

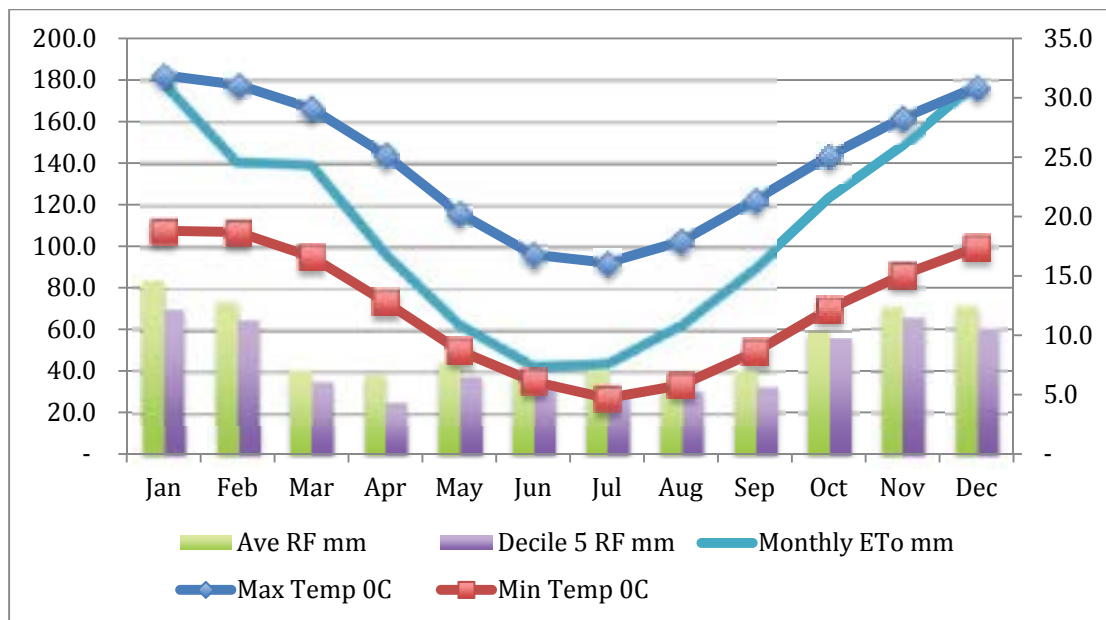
3.1 Climate

3.1.1 Project and Surrounding Locality

The Project is located in the Liverpool Plains region within the Gunnedah LGA overlooking the Breeza Plain. It is situated in the interzonal region between the tropical and temperate climate areas. A general description of the climate is a dry sub-humid climate (Banks, 1995).

The nearest Bureau of Metrology site is located at the Gunnedah Resource Centre (Site number 055024 (www.bom.gov.au)), located approximately 34 km north of the Project. Key climatic elements of the Project and the surrounding locality is summarised in **Figure 5**.

Figure 5
Climatic Indicators of the Breeza Locality



Source: (Gunnedah Resource Centre – Site 055024) BOM, 2012

The area experiences hot summers with cool winters. The highest monthly maximum is experienced in January (31.9°C) and the lowest being in July (15.4°C). On average the area experiences 20 days per year when the maximum temperature is 35°C or higher. Frosts (Stephenson Screen temperatures equal or less than 2°C) can be expected between May and September with a peak (average 7.3 days) in July. May averages 1.0 day and September 0.7 days when minimum screen temperature is at or below 2°C.

Mean annual rainfall is 643.1 mm while median rainfall (Decile 5) is 648.8 mm. Only one year in ten (Decile 1) has rainfall less than 406.7 mm while the one year in ten (Decile 9) has rainfall greater than 850.9 mm. This indicates a highly reliable annual rainfall as per the BSAL criteria.

There is a predominance of rainfall in the warmer months with spring averaging 170.7 mm and summer being the wettest season averaging 229.7 mm. The warmer season dominance is reflected in that fact 47% of average annual rainfall falls between November and February. Autumn and winter are comparatively dry, averaging 125.1 mm and 117.4 mm respectively. This corresponds to lower temperatures and evaporation.

Mean daily solar radiation averages 19.4 MJ/m² across the year, peaking in December (27.2 MJ/m²) while the lowest (10.7 MJ/m²) occurs in June.

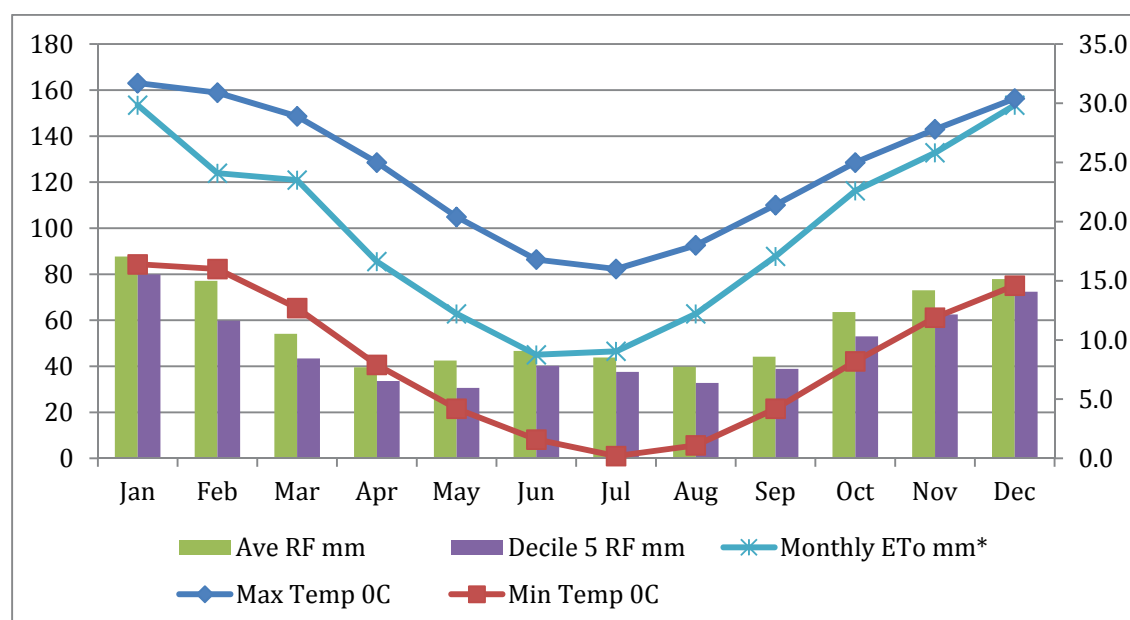
Figure 5 shows an estimate of monthly evapotranspiration (Pan A evaporation X 0.75) (ET_o). This shows that evapotranspiration exceeds average rainfall and median rainfall in all months. The difference between rainfall and evapotranspiration shows that soil moisture storage is greatest during the winter spring period.

Banks (1995) reports that there is a year round growing season in the Liverpool Plains region. The locality is suited to both temperate crops and annual pastures and summer crops and tropical (and sub-tropical) pasture species.

3.1.2 Offsite Biodiversity Offset Areas

The offsite biodiversity offset areas are located at the western side of the Nandewar Range, draining north into the Gwydir River catchment. They are part of the Tamworth LGA. The nearest Bureau of Meteorology Site is located at Barraba (Site Number 056018 (www.bom.au)), approximately 29 km south-east of the Offsite Offset Areas and approximately 100 m to 200 m lower in elevation. The Barraba climate is summarised in **Figure 6**.

Figure 6
Climatic Indicators of the Barraba Locality



Source: (Barraba – Site 056018) BOM, 2012

Barraba experiences hot summers with cool winters. The highest monthly maximum temperature is experienced in January (31.7°C) and the lowest being in July (16.0°C). Average monthly minimum temperatures vary from a high of 16.4°C in January and 0.2°C in July.). On average the area experiences 15.0 days per year when the maximum temperature is 35°C or higher. Frosts (Stephenson Screen temperatures equal or less than 2°C) can be expected between April and October with a peak (average 21.4 days) in July. April averages 1.2 day and October 2.4 days when minimum screen temperature is at or below 2°C. Both April and November would experience a frost one year in ten.

Mean annual rainfall is 689.5 mm while median rainfall (Decile 5) is 685.4.8 mm. Only one year in ten (Decile 1) has rainfall less than 456.4 mm while the one year in ten (Decile 9) has rainfall greater than 905.5 mm. This indicates a reliable annual rainfall.

There is a predominance of rainfall in the warmer months with spring averaging 180.8 mm and summer being the wettest season averaging 242.7 mm. The warmer season dominance is reflected in that fact 55% of average annual rainfall is falls between October and February. Autumn and winter are comparatively dry, averaging 136.2 mm and 130.3 mm respectively. This corresponds to lower temperatures and evaporation.

Mean daily solar radiation averages 18.8 MJ/m² across the year, peaking in December (25.7 MJ/m²) while the lowest (10.5 MJ/m²) occurs in June.

The Barraba Automatic Weather Station does not record daily evaporation. In lieu of evaporation data being available for Barraba, the evaporation data for the BOM Site 056018 (Inverell Research Centre) was used to evaluate evapotranspiration as this was considered the closest station with evaporation data to approximate the offsite biodiversity offset areas. **Figure 6** shows an estimate of monthly evapotranspiration (Pan A evaporation X 0.75) (ET_o). This shows that evapotranspiration exceeds average rainfall and median rainfall in all months. The difference between rainfall and evapotranspiration shows that soil moisture storage is greatest during the winter spring period.

Personal interviews with the landowners indicated that the climate was wetter and cooler than that experienced at Breeza. They reported that the extreme heat of summer was alleviated by the altitude and rainfall was wetter with annual rainfall often exceeding 1,000 mm. They also reported that the severe frosts experienced in Barraba were not experienced up in the higher country.

3.2 Topography and Slope

3.2.1 Project and Surrounding Locality

The topography of the surrounding locality includes the Breeza Plains which forms part of the more extensive Liverpool Plains as identified by Banks (1995). This area lies to the south, east and north of the Project. The plain is level to gently sloping flat with many primary and secondary watercourses meandering across the alluvial plain. The major water feature is the Mooki River which flows in a generally northern direction. General elevation of the plain is 295-280 metres above sea level. To the south-east of the Project Boundary is the Goran Basin, which is characterised by a flat to gently sloping alluvial plain sloping to Goran Lake. Elevation is similar to the Liverpool Plains.

The area to the north-west of the locality includes the Project area, which is situated in the ridge area off the plains and consists of the physiographical area known as the Curlewis Hills. GSS Environmental (2013) describes this as "...elevated, gently undulating cleared grasslands with small steeper sections of rock outcrops ...".

These are associated with alluvial footslopes and broad drainage plains. The elevation varies between 550 m associated with the steeper hills and rock outcrops to 290 m at the interface with the Breeza Plain or Goran Basin. The area is drained by a number of lower order watercourses.

3.2.2 Offsite Biodiversity Offset Areas

The offsite biodiversity offset areas are located on the northern watershed of the western edge of the Nandewar Range in the locality of Mount Lindsay. The northern watershed drains into the Gwydir Valley. The landscape is dominated by steep slopes and gorges with large areas of uncleared land. Local elevation varies from over 1,000 m to 600 m. Slopes are in the order of 8% to over 32%.

High intensity summer storms coupled with the steep slopes create the potential for highly erosive runoff to occur, especially on cleared land or areas with limited groundcover due to canopy closure of the overstorey. This erosive pattern is in part responsible for the highly fertile agricultural landscapes of the Gwydir and Namoi Valleys.

3.3 Soils

3.3.1 Project and Surrounding Locality

A Soil Survey and Land Capability Impact Assessment was undertaken by GSS Environmental (GSSE) and is provided in Appendix Y of the EIS. The purpose of the assessment was to:

- Define the soil types present within the Project Boundary;
- Determine the boundary of the alluvial black soils derived from the Mooki River catchment;
- Provide a description of the pre and post-mining land capability and agricultural land suitability within the Project Boundary;
- Identify the extent of BSAL in the Project Boundary and biodiversity offset areas with consideration of the SRLUP;
- Determine the available topsoil resource for post-mining rehabilitation; and

Provide selective topsoil and subsoil management recommendations.

This section outlines the soil survey methodology and subsequent soil types identified within the Project Boundary to provide context of the existing environment. Details on the impacts to soil resources within and adjacent to the Project Boundary, along with the change in land capability and agricultural suitability due to the Project is presented in **Section 8.5**.

3.3.2 Methodology

Soil Survey

A preliminary soil landscape map for the Project Boundary was developed using aerial photography, topographic maps and previous soil assessments, including the Soil Landscapes of the Curlewis 1:100,000 Sheet (Banks, 1995). The mapping was used to predict the distribution of all soil landscape attributes and guide the field survey.

The field survey was undertaken at a medium to high intensity scale between 1:50,000 and 1:25,000. A total of 131 reference soil profile sites were assessed, comprising of 62 sites for the desktop component and 69 sites for the three GSSE field programs. Furthermore, numerous field observations were made during the field programs to confirm or adjust previous mapping boundaries.

According to the Guidelines for Surveying Soil and Land Resources (McKenzie et al., 2008), between 10% to 30% of observations should consist of detailed profile descriptions for a survey scale of between 1:50,000 and 1:25,000. The percentage of detailed profile descriptions for the Watermark EIS soils survey is approximately 16%, which meets this requirement. Following the three GSSE soil field programs, a total of 103 samples were tested from 36 separate test pits for laboratory analysis. The soil types were classified in accordance with the nomenclature outlined in the Australian Soil Classification system.

The procedures devised by Elliot and Veness (1981) (revised by Elliot and Reynolds, 2007) were adopted to assess the grading, texture, structure, consistency, mottling and root presence of soil profiles. This assessment was undertaken in conjunction with the practices described in the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009).

The samples were sent for laboratory analysis to determine physical (coarse fragments, particle size distribution and aggregate stability) and chemical (pH, EC and Cation Exchange Capacity) characteristics of the soil types in the Project Boundary.

Further details are presented in Appendix Y of the EIS.

BSAL Site Verification

On 11 September 2012, the government formally released the SRLUP. Map 6 of the SRLUP identified areas as being BSAL throughout the New England North West region. **Figure 19** illustrates the location of the Project Boundary and Disturbance Boundary relative to areas mapped as BSAL. There are 96 ha of land mapped in the SRLUP as BSAL within the Disturbance Boundary. BSAL was also mapped within the Onsite Offset Areas.

The mapping of BSAL (Map 6 of the SRLUP) is merely indicative of areas that constitute BSAL. As such, site verification is required to determine whether or not the land actually constitutes BSAL. Site verification involves assessing the land against the range of criteria. The land is only verified as being BSAL if the criteria are satisfied.

The BSAL criteria relevant from a Soils Survey and Land Capability assessment and site verification perspective include:

- If the land that falls under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH); and
- If the land is of land capability classes I, II or III under the Land and Soil Capability Mapping of NSW (OEH).

A targeted field visit of the Project Boundary, Onsite Offset Areas and Offsite Offset Areas was completed between 18 – 20 September 2012 to verify the extent of BSAL in consideration of the SRLUP criteria. **Section 8.5.5** outlines the results of the site verification.

Alluvial Black Soil Assessment

One of the key aims of the assessment was to delineate the extent of alluvial black soils (Black Vertosols) within the Project Boundary and to understand how this may interact with the mine plan.

For this assessment, alluvial black soils are defined as soils derived from alluvial flows from the Mooki River catchment. Generally, alluvial soils are defined as soils formed by recent deposition along rivers and streams, normally characterised by little or no modification of the deposited material by soil forming processes, particularly with respect to soil horizon development (Charman and Murphy, 2007). Recent deposition refers to alluvium that has been deposited within the last 5,000 to 10,000 years.

A desktop assessment was undertaken which included a review of satellite imagery, topographic maps, geological and hydrological data and previous assessments, including The Watermark Coal Project – Quaternary Alluvial Boundary Definition Report (GHD, 2009).

Transect surveys were undertaken in January and August 2011 to confirm the distribution of alluvial black soils in the Project Boundary and immediate surrounds.

A total of nine transects were established in areas where mining activities could potentially encroach on alluvial black soils. A series of survey points were established along each transect, with 20 soil profiles later selected for chemical analysis.

Land Capability Assessment

The land capability assessment was conducted in accordance with *Systems Used to Classify Rural Lands in New South Wales* (Cunningham et.al., 1988). The system consists of eight classes, which classifies land generally based on soil erosion, stability hazard and decreasing versatility of use. These classes correspond to land suitability for cultivation, grazing and rural production.

Agricultural Suitability Assessment

The agricultural land suitability assessment was conducted in accordance with the Agricultural Land Classification (NSW Agriculture, 2002) and the Agricultural Suitability Maps – Uses and Limitations (Agriculture and Fisheries, 1990). The system consists of five classes, which have been designed to assess land on the basis of increasing suitability and potential for agricultural production. As well as assessing land capability, agricultural suitability considers industry specific factors that may influence potential production.

3.3.3 Project Boundary Soil Types

Table 4 provides an overview and a quantitative distribution of each soil type identified within the Project Boundary. **Figure 7** provides an illustration of the spatial distribution of each soil type. Eighteen soil types were identified within the Project Boundary.



Table 4
Soil Types

Soil Type	Soil Landscape Unit	Australian Soils Classification	Project Boundary	
			ha	%
1	Fullwoods Road (fr)	Brown Sodosol	2,725	28.7
2	Conadilly (cd)	Brown Vertosol	150	1.6
3a	Goscombes Road (go)	Brown Sodosol	881	9.3
3b		Brown Chromosol		
4a	Watermark (wa)	Brown Sodosol	1,758	18.5
4b		Brown Kandosol		
5	Stafford Gap (sg)	Red Chromosol	1,006	10.6
6a	Booloocooroo (bo)	Sodic Brown Dermosol	1,541	16.2
6b		Brown Vertosol		
7	Ponderosa (po)	Red Ferrosol	663	7.0
8	Carinya (cr)	Brown Vertosol	438	4.6
10	Black Jack (bj)*	Shallow Black Vertosol	53	0.6
11	East Lynne (el)*	Orthic Tenosol	15	0.2
12	Long Mountain (lm)*	Lithic Rudosol	137	1.4
13	Pit Hill (ph)*	Brown Dermosol	96	1.0
17	Mooki River (mo)*	Brown Vertosol	14	0.1
18	Mount Wilga (mw)*	Orthic Tenosol	7	0.1
n/a	Disturbed Terrain*	Disturbed	17	0.2
Total			9,500.0	100.0

* Soil type occurs in small and isolated fringes of the Project Boundary. Fieldwork did not target these soil landscape units as they were either outside of the Disturbance Boundary or made up less than 1% of the area within the Disturbance Boundary

Soil Type 1

Soil type 1 generally comprises of dark brown clay loams overlying strong brown heavy clays. The soil type is typically characterised by poor drainage, an alkaline trend, high salinity and moderate to high fertility.

The topsoil has moderate structure, whilst the subsoil has a strong structure. The subsoil tends to be marginally sodic to sodic and is slightly dispersive in wet conditions leading to hard setting surfaces and erodible topsoil. The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation. The subsoil is not recommended for reuse in rehabilitation due to its dispersion and sodicity properties.

Most of this landscape was originally cleared for cultivation but is now largely used for grazing (improved and naturalized pastures). Some cropping (mainly for winter fodder such as oats) is carried out as part of a rotation with Lucerne and pastures.

Soil Type 2

Soil type 2 generally comprises of dark brown to strong brown heavy clays. The soil type is typically characterised by poor drainage, an alkaline trend, high salinity and high fertility. These soils are used for winter and summer cropping (dryland and irrigated) and grazing.

Structure of this soil type varies from moderate in the topsoil and subsoil, to strong in the mid profile. The subsoil tends to be marginally sodic to sodic and are highly dispersive in wet conditions leading to hard setting surfaces and severe erosion.

Due to the high clay content and sodic nature of the soil, it is not suitable for reuse in rehabilitation without treatment. The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation if suitable blending is applied.

Soil Type 3a

Soil type 3a generally comprises of dark brown to medium brown loams overlying strong brown light medium clays, with a bleached A2 horizon situated between the topsoil and the subsoil. The soil type is typically characterised by poor drainage, an acid to alkaline trend, low salinity and low fertility. Land use includes grazing and timber (State Forests) though some cropping still occurs.

The topsoil and subsoil has a massive structure, where the entire soil horizon appears cemented in one great mass. The subsoil has sodic properties and a tendency to be dispersive. The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer.

Soil Type 3b

Soil type 3b generally comprises of dark brown silty loams to silty clay loams overlying yellowish brown clays. The soil type is typically characterised by well drained upper horizons, poorly drained clay subsoils, an acid to alkaline trend, low salinity and low to very low fertility. Land use includes grazing and timber (State Forests) though some cropping still occurs.

The topsoil consists of a hard setting, stony veneer. It has strong acidity and weak structure with aggregates exhibiting limited soil stability; leading to sheet erosion. The subsoil generally has non-sodic properties, a moderate structure with aggregates exhibiting a degree of soil stability and a tendency to be slightly dispersive.

The topsoil is suitable for stripping to 0.5 m and reuse as topdressing in rehabilitation, provided lime is applied in respreading. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer if suitable blending is applied.

Soil Type 4a

Soil type 4b generally comprises of brown to strong brown silty loam horizons overlying reddish brown clay loams. The soil type is typically characterised by well drained upper horizons, poorly drained clay subsoils, alkaline trend, non-saline and moderate to high fertility. The upper horizons tend to be marginally sodic to sodic, while the subsoil is non sodic, and dispersivity throughout the profile varies from negligible to slight. Land use is limited by slope, length of water run and rocky outcrops. These soils are suited to pasture improvement and are unsuitable for cultivation.

The soil type (topsoil and subsoil) is suitable for stripping and reuse as topdressing in rehabilitation. The topsoil will be a suitable blending medium for clays that may require treatment before reuse.

The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer.

Soil Type 4b

Soil type 4b generally comprises of brown to strong brown silty loam horizons overlying yellowish brown clay loams. The soil type is typically characterised by good drainage, an acid to alkaline trend, non-saline and low fertility. The profile is consistently non sodic, and is slightly dispersive.

The gravelly surface of this soil is subject to sheet erosion. Land use is limited by slope, length of water run and rocky outcrops. These soils are suited to pasture improvement and are unsuitable for cultivation.

The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer.

Soil Type 5

Soil type 5 generally comprises of dark brown loam and clay loam horizons overlying yellowish red clays. The soil type is typically characterised by well drained topsoil, poorly drained subsoil, high alkalinity, low salinity and low to moderate fertility. The surface condition is scalded with a high presence of stones and evidence of sheeting and rill erosion. The subsoil has non-sodic properties and limited dispersivity.

The topsoil is suitable for stripping to 0.30 m and reuse as topdressing in rehabilitation. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer if suitable blending is applied.

The predominant land use is timbered areas including, white cypress pine (*Callitrus glaucophylla*) regrowth and native and improved pastures. Cleared areas tend to have experienced sheet erosion under previous continuous cropping regimes.

Soil Type 6a

Soil type 6a generally comprises of uniform brown to strong brown heavy clay. The soil type is typically characterised by well drained topsoil, poorly drained subsoil, high alkalinity, high salinity and high fertility. The topsoil and subsoil has sodic properties and a tendency to be moderately to highly dispersive; leading to seasonally hard setting surface conditions. Due to the high clay content and sodic nature of the soil type (topsoil and subsoil), it is not suitable for reuse in rehabilitation.

Soil Type 6b

Soil type 6b generally comprises of uniform dark brown to brown heavy clays. The soil type is typically characterised by moderately drained topsoil, poorly drained subsoil, high alkalinity, low salinity and low to high fertility.

The topsoil has sodic properties and a tendency to be slightly dispersive; leading to seasonally hard setting surface conditions. The underlying subsoil has sodic properties and limited dispersivity.

The topsoil is suitable for stripping to 0.35 m and reuse as topdressing in rehabilitation. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer if suitable blending is applied.

Soil Type 7

Soil type 7 generally comprises of uniform very dark brown light medium clays overlying red heavy clays. The soil type is typically characterised by well drained soils, high alkalinity, low salinity and high fertility.

The topsoil and subsoil has non-sodic properties and a tendency to be slightly dispersive. The surface condition is friable and there is evidence of sheet erosion.

The topsoil is suitable for stripping to 0.60 m and reuse as topdressing in rehabilitation if suitable blending is applied. The subsoil (up to 1.2 m) is suitable for reuse in rehabilitation as an intermediate layer if suitable blending is applied.

Soil Type 8

Soil type 8 generally comprises of brownish black clay loams overlying dark reddish brown heavy clays. The soil type is typically characterised by well drained upper horizons, poorly drained subsoil, moderate alkalinity to slight acidity and high fertility. The surface condition is hard setting with evidence of sheet and gully erosion. The topsoil is suitable for stripping to 0.25 m and reuse as topdressing in rehabilitation. The subsoil is not suitable for reuse in rehabilitation as an intermediate layer.

Soil Type 9

Soil type 9 generally comprises of shallow black vertosols on crests and benches. The soil type is characterised by low wet bearing strength, stoniness, low permeability, and high shrink swell potential (Banks, 1995). The topsoil and subsoil is not recommended for reuse in rehabilitation.

Soil Type 10

Soil type 10 generally comprises of orthic tenosols. The soil type is characterised by steep slopes, mass movement hazard, rock outcrops and high water erosion hazards (Banks, 1995). The topsoil and subsoil is not recommended for reuse in rehabilitation.

Soil Type 11

Soil type 11 generally comprises of lithic rudosols. The soil type is characterised by shallow soils, rocky outcrops, water erosion, localised hard setting surfaces and shrink / swell hazards (Banks, 1995). This soil type will not be disturbed due to the Project.

Soil Type 12

Soil type 12 generally comprises of brown dermosols. The soil type is characterised by steep slopes, mass movement hazard, water erosion hazard, stoniness and shallow soils (Banks, 1995). The topsoil and subsoil is not recommended for reuse in rehabilitation.

Soil Type 13

Soil type 13 generally comprises of brown vertosols. The soil type is characterised by extreme flooding hazard, water erosion hazard, salinity hazard, localised seasonal and permanent water logging, low soil wet bearing strength, high shrink-swell potential and low permeability (Banks, 1995). This soil type will not be disturbed due to the Project.

Soil Type 14

Soil type 14 generally comprises of orthic tenosols. The soil type is characterised by steep slopes, water erosion hazard, shallow soils, rocky outcrops, sporadic shrink / swell hazard and low wet bearing strength (Banks, 1995). This soil type will not be disturbed due to the Project.

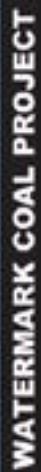
Soil Type 15

Soil type 15 is characterised by land that has been disturbed by human activity whereby the original soil has been removed, greatly disturbed or buried. The topsoil and subsoil is not recommended for reuse in rehabilitation.

3.3.4 Offsite Biodiversity Offset Areas

Based on the *Soils of NSW* prepared for the *Bicentennial Atlas of NSW* (DIPNR, 1988), the soils of the offsite biodiversity offset areas are characterised by shallow loams. Observations and reports from land managers also indicate that the offsite biodiversity offset areas are associated with Trap Soils, light sandy granite derived soils with low moisture holding capacity. As such they are not suitable to cropping but are suited to extensive grazing of pasture. Smaller areas of basalt derived soils are also present, which provides the opportunity for limited establishment of improved pastures and a more intense management regime.

The soil landscapes associated with the offsite biodiversity offset areas are illustrated in **Figure 8**.



3.4 Land Management Units

3.4.1 Project and Surrounding Locality

In 2009 as part of developing Best Management Plans (BMP) for the Namoi Catchment the Namoi Catchment Management Authority (CMA) classified the catchment into 22 Land Management Units (LMU) (Namoi CMA, 2009). These are based on soils, vegetation and hydrogeology.

Within the locality of the Project there are 10 LMUs. These are shown in **Table 5** and **Figure 9** and detailed below (Namoi CMA 2009).

Table 5
Land Management Units in Locality of Project

Land Management Unit	Comment
Basaltic Slopes and Hills (Generally 8-20%)	Not largely represented in locality. Limited areas occur within the Project area (but outside disturbance area) as well as in onsite biodiversity offset areas.
Black Earth Footslopes	In locality primarily associated with Project area and onsite biodiversity offset areas. Other areas located at extremities of locality.
Central Black Earth Plains	Major LMU of the locality located to the east and south of the Project area.
Central Mixed Soil Floodplain	Western portion of Project area. Situated to the north, east and south-east verge of locality.
Hard Sedimentary Footslopes (Generally 2- 8%)	Second most prominent LMU in the locality and most prominent in Project area.
Riparian Corridor	Associated with Mooki River and tributary to the south of the Project area.
Sandy Pilliga Footslopes	Of minor significance and located at southern edge of locality.
Sedimentary Hillslopes (Generally >8% - 15%)	Of medium significance in locality occurring in and adjacent to Project area.
Steep Basaltic Hills	Minor significance in locality.
Steep Sedimentary Hills (Generally >15%)	Associated with cliffs of Long Mountain in offsite offset areas and hills in north-west of Project area.

Basaltic Slopes and Hills

The Basaltic Slopes and Hills LMU encompass the Basalt Slopes (8-20% slope) which occur flanking the southern edge of the Liverpool Plains. This LMU has a land capability classification of IV, V or VI.

Red, Brown and Black Vertosols (red and brown clays with Black Earths) are most common with soil depth decreasing on steeper slopes.

Vegetation is usually scattered trees consisting of White and Yellow Box, Myall and Rough-barked Apple with some Red Gum in the watercourses and Stringybark in higher areas. Most of the grassy woodlands on the lower slopes have been cleared for grazing whereas the denser woodlands on the upper slopes have mostly been retained.

Grazing of native pastures is the dominant land use but there are some areas of improved pastures on the lower slopes associated with deeper soils. Native forest and dense woodlands are found on the upper slopes.

Black Earth Footslopes

The Black Earth Footslopes LMU encompasses the alluvial plains and slopes of between 2 - 8% slope that have been derived from volcanic parent materials.

The soils are predominately deep basaltic Black Vertosols (cracking clays) with some Red Ferrosols (stony red clays) and Red Vertosols (cracking clays). Soils may vary with slope position.

Land use is primarily dryland summer and winter annual cropping on the lower slopes with some localised irrigated cropping on the very low slope areas. Grazing is the predominant land use on slopes above 5%. LMU in locality has a land capability classification of III to IV.

The Central Black Earth Floodplains

The Central Black Earth Floodplains LMU encompasses the highly productive agricultural lands associated with the floodplains in the central part of the catchment. Land slopes within this LMU are generally less than 2% and this LMU occupies 8.3% of the Namoi Catchment.

Soils are mainly Black, Grey or Brown Vertosols (cracking clays) with some Rudosols (alluvial soils).

Native vegetation has been extensively cleared in many parts of this area, except for in the more frequently flooded areas. Some floodways are farmed, while others are managed as pasture and some retain native grasses. River Red Gum, Myall and Grey, Yellow or Bimble Box trees are common.

Land use in The Central Mixed Soil Floodplains LMU encompasses substantial plain areas within the central catchment (from the Liverpool Plains to Narrabri) of very low slope (0 - 2%). This LMU occupies 5.4% of the Namoi Catchment.

This part of the catchment is dominated by very extensive meander-plains (which are generally slightly higher in the plain landscape than other floodplain areas).

The soil types are highly variable but locally extensive and include Black Vertosols, (Black cracking clays), Brown and Grey Sodosols (grey and brown clays) and Brown Chromosols (Red brown earths).

Timber generally occurs as isolated or scattered trees, with occasional open woodlands. Native vegetation is mainly Bimble Box, White Box, Rough - barked Apple, River Red Gum and Myall with localised treeless plains dominated by Plains Grass.

Land use is mostly a mosaic of dryland and irrigated cropping and grazing on native or improved pastures, which is largely determined by the fertility of the soil and water availability. This LMU primarily has a land capability classification of II while some areas are VII or VIII.

This LMU corresponds primarily with the Conadilly and Yarraman soil landscapes and is the major LMU within the locality.

The Central Mixed Soil Floodplains

The Central Mixed Soil Floodplains LMU encompasses substantial plain areas within the central catchment (from the Liverpool Plains to Narrabri) of very low slope (0 - 2%). This LMU occupies 5.4% of the Namoi Catchment.

This part of the catchment is dominated by very extensive meander-plains (which are generally slightly higher in the plain landscape than other floodplain areas).

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Land use is mostly a mosaic of dryland and irrigated cropping and grazing on native or improved pastures, which is largely determined by the fertility of the soil and water availability. This LMU has a land capability classification ranging from II to VII.

This LMU corresponds primarily with the Dead Horse soil landscape and the Goran Lake and Lochaber landscapes. It is the second most prevalent LMU in the locality.

Hard Sedimentary Footslopes

The Sedimentary Footslopes LMU encompasses the gentler slopes (2-8% slope) and colluvial fans which are generally the transition area between sedimentary hills and the mixed soil floodplains.

Soil types include Red Kandosols (Red earths), Red Chromosols (Red brown earths), Red and Brown Sodosols (higher in sodium) and Yellow, Brown and Red Dermosols (stony red and chocolate soils).

Most common land use is grazing on native or improved pastures with significant areas of cropping which are slowly being converted to pastures for grazing. The land capability classification for this LMU ranges from IV to VI.

Riparian Corridor

The Riparian Corridor LMU is generally defined as a 20 m wide buffer from each streambank and has a land capability classification of VII. In the locality it is only located within the Central Black Earth Floodplains. Soil type varies depending on the base geology of the area and local sedimentation to include brown or grey clays, black earths, red – brown earths and sandy earths. The riparian corridor is dynamic with many geomorphological zones such as terraces and steep banks interacting with frequent flooding and water level changes. It can also be undulating, with unstable soils and predominance of River Red Gum communities, many of which are mature, and some Belah communities. Stability of this region is important for water quality and biodiversity.

Sandy Pilliga Footslopes

Sandy Pilliga Footslopes LMU and colluvial fans of generally 2 – 8% slope occur as the transition zone from the hills associated with the Jurassic and Cretaceous Pilliga Sandstones. This LMU has a land capability classification of V to VI and land use is predominantly pasture or improved pasture with minor portion of the unit still used for dryland cropping or specialty horticulture, with forestry and nature reserves occupying large amount.

The soils are predominantly deep Solodic Soils and Earthy Sands with very sandy to sandy loam topsoil. They are generally of low inherent fertility, low to moderate water holding capacity and are highly erodible. Shallow watertables (<5 m) can occur particularly in the Liverpool Plains, and there is often shallow water of varying quality associated where this landscape meets the plains below. Salinities vary with location.

Tree vegetation is mainly a mixture of White Cypress and Ironbark, with Bull Oak, and minor Box (Bimble, Yellow, White and Grey) Casuarina, Kurrajong and Hill Red Gum. There is also a shrub layer that is dominated by a huge variety of wattles, but can include Rosewood, Wilga, wild olives where this land has not been cleared.

The area of improved pasture is increasing as land is removed from poorly managed native pasture production or minor crop production.

Sedimentary Hillslopes

The Sedimentary Hillslopes LMU encompasses the mid-slope land (8-15% slope) fringing most of the foot-slopes of the Liverpool Plains.

Soils are moderately shallow (lithosols and skeletal red – brown earths) and rocky outcrops with minor steep slopes and low, cliff – like benches.

This LMU has a land capability classification of IV or V depending on soil and slope.

The most common use of the land is grazing of native pastures and some native forest management with limited dryland cropping.

Steep Basaltic Hills

The Steep Basaltic Hills LMU encompasses those areas with slope grades greater than 20% with soils derived from basalt geology.

Soil types do vary but are generally shallow and range from Black Vertosols (Black cracking clays), Brown Dermosols (Prairie soils) and Red and Brown Chromosols (Red and Brown earths) to Rudosols (shallow clays) and Tenosols (shallow sands) found more on upper slopes and shale lenses.

The steep slopes, variable soils and exposed rock have resulted in most of this area being retained as native forest and dense woodlands with some minor opportunity grazing on the lower slopes.

Steep Sedimentary Footslopes

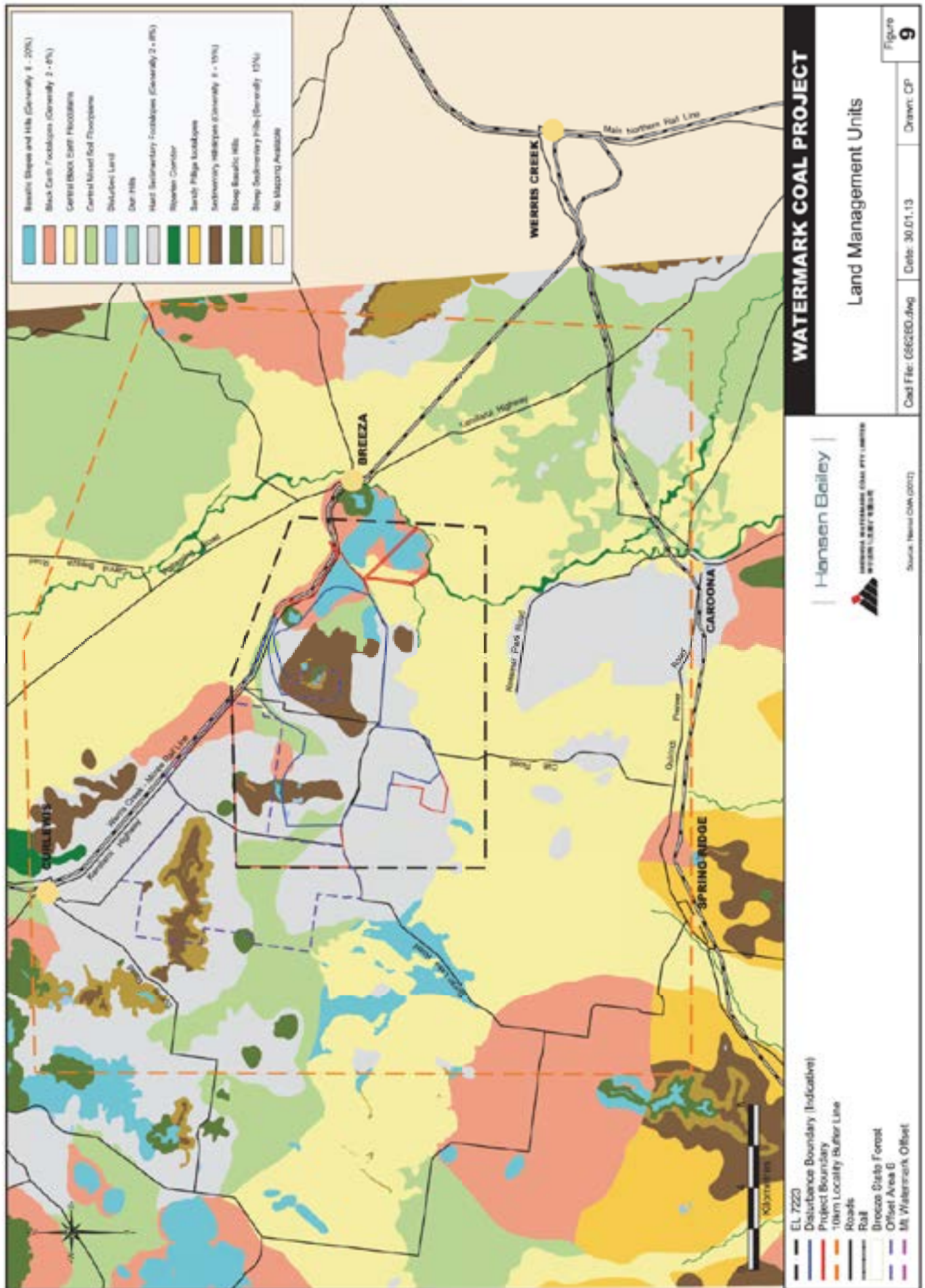
The Steep Sedimentary Hills LMU describes the sandstone and metamorphic rock outcrops found at the eastern edge and central parts of the Namoi Catchment. Land slopes are above 15%.

With typically steep sloped landforms, this LMU soils are usually shallow and range from Black Earths and Prairie Clays, Red – brown Earths to Lithosols on upper slopes and skeletal areas.

Land use is mostly native forest. Grazing is limited by the steepness of the slopes and lack of water. This LMU has a land capability classification of VI to VIII.

3.4.2 Offsite Biodiversity Offset Areas

The offsite biodiversity offset areas are located in the Boarder Rivers Gwydir Catchment Management Authority (BRGCMA). The BRGCMA have not classified its catchment into LMUs.



3.5 Agricultural History

The Breeza area was first settled by Europeans in the early 1800s. The lightly textured red soils associated with the Curlewis Hills were extensively cleared from the 1890s to the 1930s. The land was used for cereal crops and grazing being the typical wheat sheep country associated with the slopes and plains of NSW (Banks, 1995). However, soil structure deteriorated with constant cultivation and became subject to erosion, especially from high intensity summer storms.

The heavily textured self-mulching black clay soils were primarily used for grazing (sheep and cattle). From the 1950s with the advent of more appropriate equipment, cultivation and cropping of the black soils became more common. Over time the major cropping areas and grazing areas have reversed with the lighter red soils now being used primarily for grazing, though some fodder cropping with winter oats still occurs. Perennial tropical pasture species are also being sown in these soils.

Major agricultural crops grown in the locality include:

Winter crops	Summer crops
Wheat (bread and durum)	Cotton
Barley	Sorghum
Oats	Sunflower
Canola	Maize
Chickpeas	Mung beans
Safflower	Soybeans

Irrigation agriculture has been developed in the locality over the past 40 years. This has seen the expansion of the cotton industry on the Breeza Plain, though dryland cotton is also grown.

The Breeza area is at the south-east extremity of the cotton industry in Australia, though cotton is grown further west and south-west in the state. The first cotton in the Breeza area was planted in the 1983-84 season. Since then newer varieties and better management have resulted in a shorter cotton growing season so the crop is not at the limit of cumulated thermal units for maturation.

Gunnedah has developed into one of the major cattle livestock selling centres of New South Wales being New South Wales' third largest cattle saleyard in terms of number of cattle sold per annum (MLA 2011b).

The Breeza State Forest is one of a number of State Forests in the region (Banks, 1995). It is used for the production of white cypress pine (*Callitris glaucohylla*), white box (*Eucalyptus albens*) and iron bark logs (various *Eucalyptus spp.*).

Figure 10 to Figure 12 are historical aerial photographs of the Project area and the surrounding locality in 1954, 1989 and 2003. These photos illustrate agricultural land use at the time.





3.6 Regulated Water Sources

3.6.1 Project and Surrounding Locality

There are six water sources in the locality that are subject to the WM Act. These are detailed below in **Table 6**.

Table 6
Water Sharing Plans within Locality of the Project

Water Sharing Plan potentially Applicable to Project	Commencement Date	Licenses Held by Shenhua Watermark	Licences Held and Available Allocations
NSW Murray – Darling Basin Porous Rock Groundwater Source (Gunnedah – Oxley Basin)	16 January 2012	None	133 Water Access Licences (WALs) – share component 16,144 units
Upper and Lower Namoi Groundwater Sources (Zone 3)	1 November 2006	None	61 WALs – share component 17,101 units
Upper and Lower Namoi Groundwater Sources (Zone 7)	1 November 2006	WAL 12892 – 42 Units	16 WALs – share components 3,697 units
Upper and Lower Namoi Groundwater Sources (Zone 8)	1 November 2006	WAL 12896 – 164 units	66 WALs – share components 15,946 units
The Mooki River Water Source (part of the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources)	1 July 2004	None	28 WALs – share components 29,526.5 units
Namoi Unregulated and Alluvial Water Sources – Lake Goran	4 October 2012	1,223 (subject to issuance of certificate of title)	9 surface water licences – total entitlement 32,259 ML*

* At commencement of Water Sharing Plan the surface licences shall be converted to WALs and licensed entitlements shall be replaced by share units of equivalent proportions

Figure 13 shows the water management zones and existing users within the locality of the Project. Shenhua Watermark holds 1.24% of the total shares / licensed entitlements from these water sources. Water potentially removed from agriculture to be used in the Project is discussed in **Section 8** of this report.

3.6.2 Offsite Biodiversity Offset Areas

There are no regulated water sources in the locality of the offsite biodiversity offset areas. The properties are part of the northern watershed of the Nandewar Range which drains via the Horton River into the Gwydir River becoming part of the Gwydir Water Management Area.

The offsite biodiversity offset areas hold Basic Land Holder Rights as they have natural frontage to the water sources that form the tributaries of the Upper Horton River. The Project is not seeking approval to use Basic Land Holder Rights.

3.7 Breeza State Forest

The Breeza State Forest (the Forest) lies along the south-west corner of the Project area (**Figure 2**). The Forest is managed by Forests NSW, which is part of the Department of Primary Industries within the Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS).

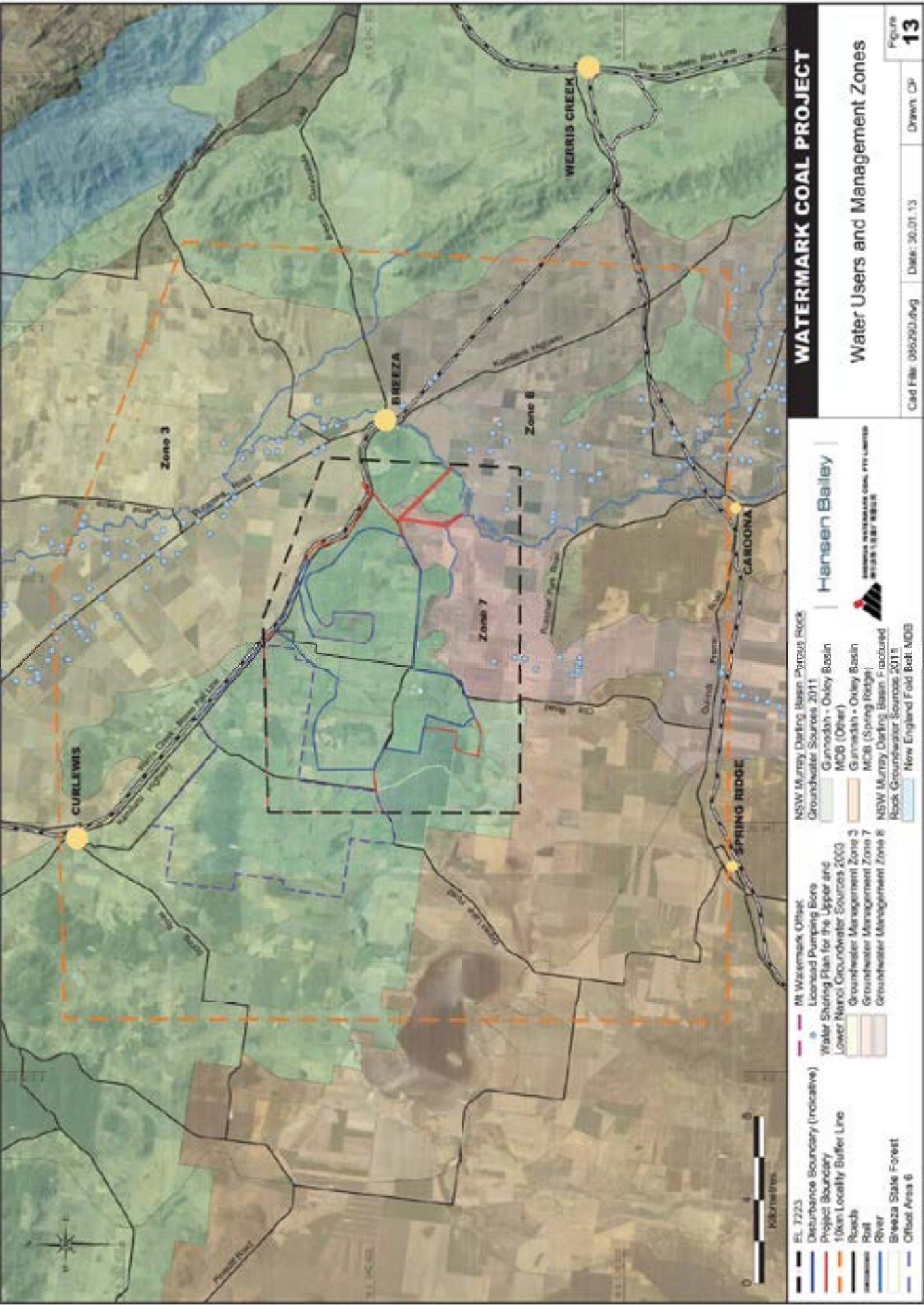
The Forest is managed for commercial timber harvesting under the Ecological Sustainable Forest Management Plan, Western Region. Within this plan the Forest is managed under Zone 4 – General Management Zone (Forests NSW, 2008).

The Forest is also identified as Zone 4 under the *Brigalow and Nandewar Community Conservation Act 2005*. Land dedicated as Zone 4 is State Forest under the *Forestry Act 1959* for the purposes of forestry, recreation and mineral extraction.

The strategic aim of Zone 4 land provides for commercial activities (in particular forestry and mining activities). The strategic aim relevant to mining included in the Brigalow and Nandewar Conservation Area Agreement includes:

‘Provide for exploration, mining, petroleum production and extractive industry in accordance with the Mining Act 1992 and the Petroleum (Onshore) Act 1991 and associated Regulations and guidelines.’

The Forest is outside the Project area and will not be impacted by the Project, nor will the management of the Forest be impacted.



4 Existing Agricultural Enterprises and Resources

This section identifies and describes the existing agricultural resources and enterprises within Shenhua Watermark owned land, residual onsite biodiversity offset area (portion of Offset Area 6) and offsite biodiversity offset areas and the surrounding locality. These agricultural resources and enterprises are shown on **Figure 14**.

4.1 Agricultural Enterprises

The information presented in this section is based on individual land manager interviews for agricultural enterprises on land owned by Shenhua Watermark or identified as potential biodiversity offset areas (residual onsite biodiversity offset area and offsite biodiversity offset area) and represents what is current agricultural practice on the land in question. It is noted that the existing land management practices do not always align fully with the land capability or agricultural suitability of the individual sections of the properties in question.

The agricultural enterprises identified are discussed in more detail in **Section 5** of this report.

4.1.1 Shenhua Watermark Owned Land

Land owned by Shenhua Watermark is managed as agricultural land and operated by a number of licensees (9) who occupy the land. These licensees also operate other land holdings or are engaged in other economic activities.

Currently licensees are operating extensive grazing operations and / or cropping operations on Shenhua Watermark owned land. The grazing operations include:

- Beef breeding enterprises producing weaners or domestic vealers;
- Growing out steers to finishing weights;
- Backgrounding steers for feedlot market;
- Self-replacing merino ewes; and
- Merino ewes crossed to terminal fat lamb sire.

These enterprises use a combination of native and naturalised pasture, improved tropical perennial based pastures and fodder crops which may or may not be also harvested for grain or conserved forage.

Cropping enterprises (in order of area used) include:

- Dryland wheat (Durum);
- Dry land wheat (bread);
- Grain sorghum;
- Barley (Malt);
- Canola;
- Sunflowers;
- Mung beans;
- Barley (feed grain)

- Irrigated wheat (Durum); and
- Cotton (irrigated).

Interviews with the current land managers did not identify any private forestry enterprises or activities on land owned by Shenhua Watermark.

4.1.2 Biodiversity Offset Areas

Residual Onsite Biodiversity Offset Area

The portion of land within Offset Area 6 not currently owned by Shenhua Watermark is utilised for extensive grazing of beef cattle and sheep and dryland winter cropping, as identified through individual land manager interviews.

Current grazing enterprises on privately owned land in Offset Area 6 include:

- Beef cattle breeding for weaner and vealer production;
- Cattle trading and fattening; and
- Cross bred ewes and fat tail sheep for fat lamb production.

Grazing was carried out on native and naturalised pasture and tropical based perennial improved pastures. Some fodder cropping using lucerne, grazing oats and forage sorghum is utilized by some land managers for these enterprises.

Cropping enterprises (in order of area used) are:

- Wheat (bread);
- Wheat (Durum);
- Canola;
- Barley (feed grain); and
- Barley (malting).

Interviews with the current land managers of these properties indicated that over the medium term (last five years plus) the amount of land annually cropped for cash crops and/or forage had decreased and more tropical based perennial improved pastures were utilised as this was considered more in line with the land and soil capability of the land.

Interviews with the current land managers did not identify any private forestry enterprises or activities.

Offsite Biodiversity Offset Areas

Two properties have been identified as offsite biodiversity offset areas. These are located near Barraba approximately 110 km north north-west of the Project. Discussions with land managers indicate that these properties are used for extensive grazing of breeding cows and sheep (merino ewes and wethers and first cross ewes). The land properties have no arable areas, with large areas covered by dense timber forest country.

Grazing is carried out on natural and naturalised pastures with a limited history of fertiliser use.

The land use within the offsite biodiversity offset areas is representative of their locality.

Interviews with the current land managers did not identify any private forestry enterprises or activities.

4.1.3 Surrounding Locality

Land use in the locality surrounding the Project Boundary is more diverse. The higher productivity of the agricultural soils associated with the Central Black Earth Floodplains and Black Earth Footslopes LMUs to the south, east and north-east of the Project area dominate the agricultural production within the locality. Primarily used for cropping, these lands also are used for beef grazing and some sheep grazing. Cropping is a mixture of dryland and irrigated cropping and winter and summer crops.

Major crops in the locality include:

- Cotton;
- Grain sorghum;
- Wheat (bread and Durum);
- Sunflowers;
- Canola;
- Barley (Malt and feed grain);
- Chickpeas;
- Safflower;
- Soyabeans;
- Maize; and
- Mung beans and other pulse crops.

Beef grazing is the predominant animal industry in the locality with sheep grazing for fat lamb and wool production also in operation.

Beef enterprises include:

- Weaner production;
- Vealer production;
- Yearling production;
- Feeder steer production;
- Jap ox production; and
- EU cattle production.

Baiada Poultry have breeder sheds located north of the Project area, towards Curlewis and north of the Werris Creek – Moree Rail Line.

To the south of the Project Boundary is the Caroona Feedlot. This is approximately 12.5 km south of the Project area. The feedlot utilizes some of the feed grain and forage crops grown in the locality. It is also a market for a portion of the feeder cattle in the locality. Neither the local feeder cattle industry nor the feedlot itself is dependent on the other for its viability.

4.2 Supporting Infrastructure and Services

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

The major beef cattle selling centre for the region is the Gunnedah saleyard, which are the third largest (in terms of number of cattle sold) in NSW (MLA 2011b). The Tamworth saleyard (ranked sixth) is of minor importance.

Sheep from the locality are sold mainly through the Tamworth saleyard (ranked ninth), with the Gunnedah saleyard of minor importance only selling 2,802 sheep in the year ending 30 June 2011 (MLA 2011a).

Stock agents from Gunnedah and Quirindi are utilised across the locality.

Grain Corp operates a number of grain receival silos in the locality (see **Figure 14**) (Grain Corp (2012). These are:

- Breeza (currently not operational) – capacity 3,500 tonne;
- Carroona – capacity 15,000 tonne;
- Curlewis – capacity 30,000 tonne;
- Nea Siding – capacity 17,500 tonne; and
- Spring Ridge – capacity 80,000 tonne.

Agricultural industries in the locality rely on a range of services provided in the Gunnedah and Quirindi LGAs. These include input supplies (fertilizer, seed, chemicals, animal health and agricultural hardware), agricultural equipment suppliers, irrigation suppliers and technicians, heavy and light engineering works, veterinary practices, grain marketers, and professional services (accountancy, financial, legal and agricultural consultancy).

Tamworth is a large regional centre, which also serves as a service centre to the locality.

The nearest cotton gin is the Carroll Cotton Gin, located between Breeza and Carroll. This privately owned cotton gin was established in 1995 and has a 1,900 module capacity (Anonymous, 2008).

Key transport routes and infrastructure utilised by agricultural enterprises to access supporting services within the local area and to access markets outside the locality are:

- Kamilaroi Highway;
- Nea Siding Spring Ridge Road;
- Quirindi Premier Road;
- Werris Creek – Moree Rail Line; and
- Werris Creek – Binnaway rail Line.

These are shown in **Figure 1**. The transport routes connect to the New England Highway and the Werris Creek – Newcastle Rail Line providing access to domestic and export markets via Newcastle, Sydney and Port Kembla. The New England Highway also provides transport linkages for major imported agricultural supplies (fertilizers, chemicals, farm machinery).

Two field stations are located in the locality (see **Figure 14**), both east of the Project area and associated with the Central Black Earth Floodplains LMU. These are:

- NSW Agriculture's Liverpool Plains Field Station; and
- Dow Agro Sciences' Breeza, NSW Field Station.

4.3 Agricultural Resources

4.3.1 Project and Surrounding Locality

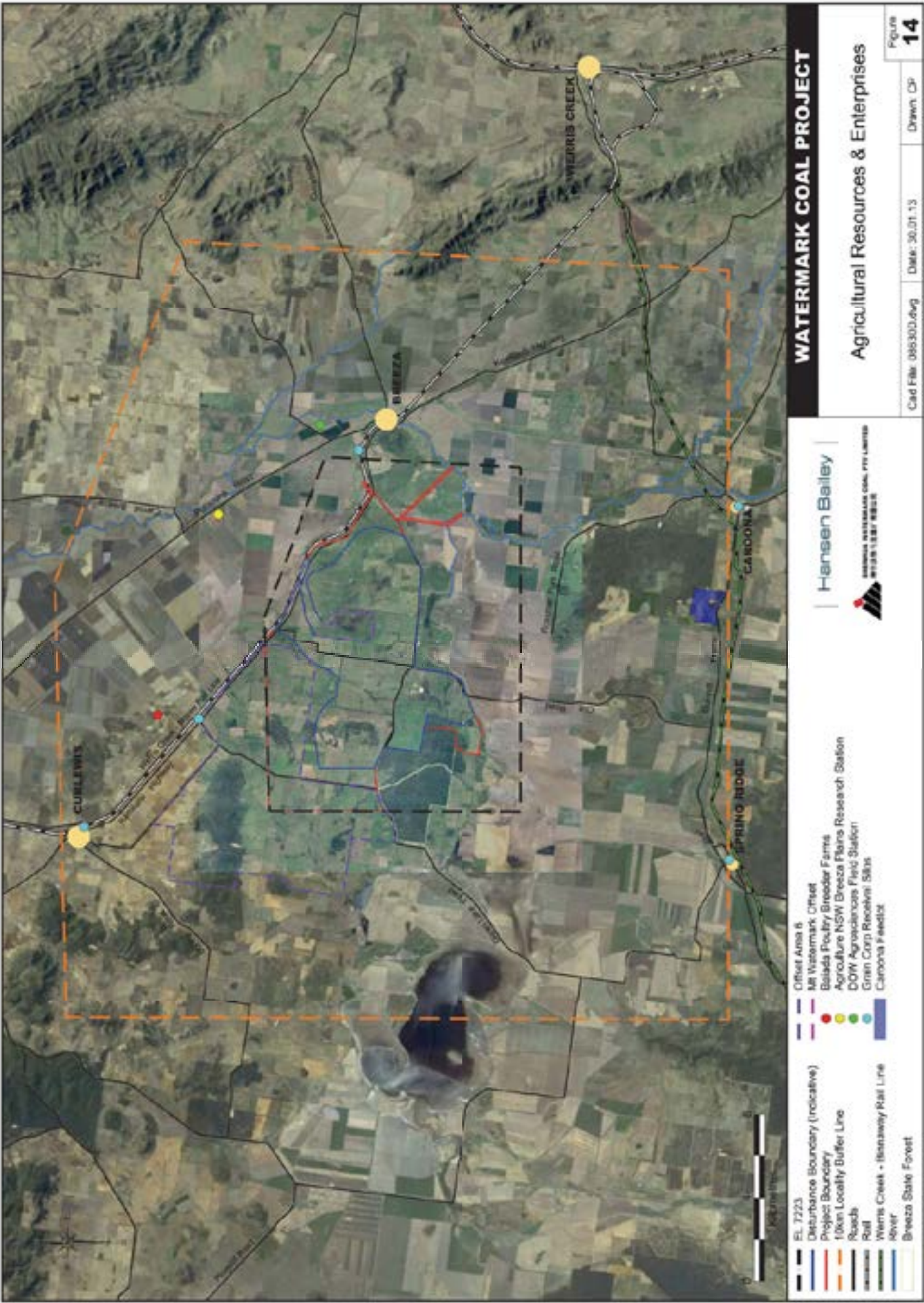
The significant agricultural resources in the locality of the Project include:

- The Mooki River Water Source (part of the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources);
- Lake Goran Water Source (part of the Namoi Unregulated and Alluvial Water Sources);
- Zone 3 of the Upper and Lower Namoi Groundwater Sources;
- Zone 7 of the Upper and Lower Namoi Groundwater Sources;
- Zone 8 of the Upper and Lower Namoi Groundwater Sources;
- NSW Murray – Darling Basin Porous Rock Groundwater Source (Gunnedah – Oxley Basin);
- Soils associated with the Black Earth Footslopes LMU;
- Soils associated with the Central Black Earth Floodplains LMU; and
- Soils associated with the Central Mixed Soil Floodplains.

The soil landscapes associated with these LMUs, high reliability rainfall and access to irrigation water make these soils highly prized for cropping. The Project is not situated on or anticipated to impact the black soil plains.

4.3.2 Offsite Biodiversity Offset Areas

Within the locality of the offsite biodiversity offset areas there is no significant agricultural resources, either natural or manmade (infrastructure). As noted in **Section 2.2**, the offsite biodiversity offset areas do not include BSAL.



4.4 Agricultural Value

The Project and locality lies within the Gunnedah LGA. The southern edge of the locality meets the Liverpool Plains LGA. The two LGAs are similar in their agricultural profile and together make up the area known as the Liverpool Plains region. The value of agricultural output for the two LGAs is \$232.1M. **Table 7** shows the contributions of the major agricultural enterprises.

Table 7
Value of Agricultural Production

Enterprise	Gunnedah LGA (\$M)	Liverpool Plains LGA (\$M)	Liverpool Plains region (* \$M)
Gross Value	125.5	156.6	282.1
Cereals for grain	54.9	51.8	106.7
Wheat	27.0	15.8	42.8
Sorghum	16.8	24.0	40.8
Barley	8.2	7.1	15.3
Maize	2.2	3.8	6.0
Oilseeds	4.7	3.6	8.3
Canola	2.2	0.3	2.5
Sunflowers	2.3	2.6	4.9
Soybeans	0.2	0.7	0.9
Cotton	31.1	1.1	32.2
Livestock Slaughterings	29.4	91.7	121.1
Beef Slaughterings	25.0	85.4	110.4
Sheep Slaughterings	1.4	2.3	3.7
Wool	1.3	3.5	4.8

* Combined figures for Gunnedah and Liverpool Plains LGAs.
Source: ABS 2008

The figures represent the greater emphasis on cropping in the Gunnedah LGA area and the greater reliance on the beef industry in the Liverpool Plains LGA, including the sorghum crop which is predominantly used for livestock feed (feedlots).

4.5 Employment

The agricultural industry in the Liverpool Plains region employs 1,659 people (ABS, 2007). This represents 24.4% of the workforce of the two LGAs. Employment break up is shown in **Table 8**.

Table 8
Liverpool Plains Region Agricultural Industry Employment

Occupation	Gunnedah LGA	Liverpool Plains LGA	Liverpool Plains Region
Managers	619	590	1,209
Professionals	21	3	24
Technicians & trade	17	26	43
Clerical & administration	29	30	59
Sales	3	0	3
Machinery operators & drivers	37	30	67
Labourers	103	138	241
Other	3	10	13
Total agriculture*	832	827	1,659
Total workforce	4,187	2,603	6,790

* Includes Agriculture, forestry and fishing
Source: ABS (2007)

5 Agricultural Assessment

This section provides an agricultural assessment of the Shenhua Watermark owned land, Project area, residual onsite biodiversity offset area (portion of Offset Area 6) and offsite biodiversity offset areas. It also provides alternative land uses for these areas and the suitability of those enterprises.

5.1 Methodology

The assessment methodology comprised:

- A review of the EIS Soil Survey and Land Capability Impact Assessment prepared by GSS Environmental (2013);
- A review of the EIS Groundwater Impact Assessment prepared by AGE Consultants (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 review of Namoi Catchment Management Authority (2009) *Land Management Units in the Namoi Catchment*;
- A site visit of the Shenhua Watermark owned land operated by licensees for agriculture, including individual land manager interviews, to ascertain current and potential agricultural production levels;
- A site visit of residual onsite and offsite biodiversity offset areas, including individual land manager interviews, to ascertain current and potential agricultural production levels;
- A site visit of the surrounding locality to ascertain agricultural industries and resources;
- Desktop assessment of the value of agricultural production associated with Shenhua Watermark owned land, residual onsite biodiversity offset area, offsite biodiversity offset areas and enterprises in locality;
- Desktop assessment of the agricultural value of water to be used by the Project;
- Desktop assessment 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 Critical Industry Clusters as defined by the SRLUP.

5.2 Agricultural Domains

Shenhua Watermark owned land, the Project area, residual onsite biodiversity offset area and offsite biodiversity offset areas were dissected into agricultural domains based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013), Namoi CMA LMUs (Namoi CMA, 2009), individual land manager interviews and SBA's own observations.

For each area of Shenhua Watermark owned land (the Project Area, Residual Onsite Biodiversity Offset Area and Offset Biodiversity Offset Area) the following information is presented:

- A physical description of the agricultural domains;
- The area of each domain (in hectares and as a percentage);
- The relevant soil type as per GSSE's (2013) soil survey;
- The relevant Land Capability classes as per Cunningham et. al. (1988);
- The relevant Agricultural Suitability classes as per Hulme et. al. (1988);
- The relevant LMU as per the Namoi CMA (2009);
- The quantum of agricultural production currently derived from each agricultural domain; and
- The value of agricultural production currently derived from each agricultural domain.

Agricultural domains were used to reflect the current land practices as they align to the various land classification systems within the limitations of individual land manager's management style and choices and the variance between individual land managers.

The agricultural domains (and therefore the agricultural enterprises) for the Shenhua Watermark owned land and properties identified as potential biodiversity offset areas are shown in **Figures 15 and 16**.

Section 8 of this report presents the same information for the land impacted by the Project, being the Disturbance Boundary, Onsite Biodiversity Offset Areas and the Offsite Biodiversity Offset areas.

5.2.1 Shenhua Watermark Owned Land

The agricultural domains within Shenhua Watermark owned lands are shown in **Figure 15**. **Table 9** provides an overview of each of the agricultural domains and their quantitative distribution within the disturbance area.

Table 9
Agricultural Domains within Shenhua Watermark Owned Land

Agricultural Domains	Description	Area (ha)	Area (%)
A	Irrigated cropping - Land suitable for irrigation though only a limited area has been irrigated. Land in this domain is owned by Shenhua Watermark but lies outside the Project boundary and will not be impacted by the Project.	2,226	15.0
B	Dryland cropping - Land highly suited to rotational dryland cropping with pasture phases included	1,674	11.2
C	Grazing with occasional cropping - Land suited to pasture and occasional cropping, potential for soil erosion during cropping phase without suitable precautions	7,612	51.3
D	Extensive grazing with potential for pasture improvement with limited soil disturbance, stoniness and slope prevent cropping	2,964	20.0
E	Timber and Hill grazing, low carrying capacity, slope and stoniness prevent pasture improvement, includes areas of no or limited agricultural value, includes timbered areas and cliffs of Long Mountain	367	2.5
Total		14,843	100.0

Table 9 shows that the majority of the Shenhua Watermark owned land (7,612 ha or 51.3%) is composed of land classed as Agricultural Domain C. This land is suited to grazing of beef cattle for breeding for weaner or vealer production, trade steers or sheep grazing (prime lamb and wool production).

It can also be used for dryland cropping (summer and winter) provided appropriate soil conservation techniques are used. These techniques include contour banks, minimal/ no till farming or pasture cropping. Previously this land may have been continually cropped. Based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013) and the LMUs (Namoi CMA, 2009), this land primarily coincides with the following:

- Soil types: Brown Sodosol, Red Chromosol Brown Vertosol Complex, and Red Chromosol;
- Land capability class III and IV;
- Agricultural suitability 2 and 3; and
- Hard Sedimentary Footslopes LMU.

Agricultural Domain A is high quality irrigable cropping land and is the least abundant, comprising an area of approximately 2,226 ha (15.0%) of Shenhua Watermark owned land. The land is suited to summer and winter crops grown in rotation or has the potential for grazing. Grazing intensity would be limited by the nature of the self-mulching soils becoming boggy after rain. Areas are subject to flooding which could result in crop loss. Based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013) and the LMUs (Namoi CMA, 2009), this land primarily coincides with the following:

- Soil types: Brown Vertosol;
- Land capability class II;
- Agricultural suitability class 1; and
- Central Black Earth Footslopes LMU.

Agricultural Domain B covers an area of approximately 1,674 ha (11.2%) of Shenhua Watermark owned land. The land is suited to dryland cropping capable of growing both summer and winter crops grown in rotation, which may or may not include a pasture phase. It is also utilised for vealer production and finishing off of weaned stock. Based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013) and the LMUs (Namoi CMA, 2009), this land primarily coincides with the following:

- Soil types: Red Chromosol Brown Vertosol Complex and Red Ferosol;
- Land capability class III and IV;
- Agricultural suitability 2; and
- Central Mixed Soil Floodplain LMU.

Agricultural Domain D covers an area of approximately 2,964 ha (20.0%) of Shenhua Watermark owned land. It is suited to extensive grazing by breeding stock or merino wethers. The agricultural value of the land is limited by its slope and erodability, limiting the level of pasture improvement. This land may have previously been cropped.

Based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013) and the LMUs (Namoï CMA, 2009), this land primarily coincides with the following:

- Soil types: Brown Verosol and Brown Sodosol Red Kandosol Complex;
- Land capability classes V and VI;
- Agricultural suitability 3 and 4; and
- Basaltic Slopes and Hills and Sedimentary Hillslopes LMUs.

Agricultural Domain E covers an area of approximately 367 ha (2.5%) of Shenhua Watermark owned land. It is suited to pasture improvement with limited soil disturbance. The land is capable of supporting moderate levels of pasture production and as such can be used for sheep production (breeding and wool) and beef cattle grazing (breeding). This area comprises higher hill slopes and plateaus which may have medium to heavy timber cover. The timbered areas are used for winter sheltering of pregnant and calving or lambing stock. Based on the Soil Survey and Land Capability Impact Assessment (GSS Environmental, 2013) and the LMUs (Namoï CMA, 2009), this land primarily coincides with the following:

- Soil types: Lithic Rudosol, Red Chromosol and Brown Dermosol;
- Land capability classes VI and VII;
- Agricultural suitability 4 and 5; and
- Steep Basaltic Hills, Steep Sedimentary Hills and Hard Sedimentary Footslopes LMUs.



5.2.2 Project Area

The agricultural domains within the Project area (situated on Shenhua Watermark owned land) are shown in **Figure 15**. **Table 10** provides an overview of each of the agricultural domains and their quantitative distribution within the Project area.

Table 10
Agricultural Domains within the Project Area

Agricultural Domain	Description	Area (ha)	Area %
A	Irrigated cropping - Land suitable for irrigation though only a limited area has been irrigated. Land in this domain is owned by Shenhua Watermark and lies within the Project Boundary along the pipeline easement but outside the disturbance area	47	0.5
B	Dryland cropping - Land highly suited to rotational dryland cropping with pasture phases included	1,614	17.0
C	Grazing with occasional cropping - Land suited to pasture and occasional cropping, potential for soil erosion during cropping phase without suitable precautions	5,151	54.2
D	Extensive grazing with potential for pasture improvement with limited soil disturbance, stoniness and slope prevent cropping	2,318	24.4
E	Timber and Hill grazing, low carrying capacity, slope and stoniness prevent pasture improvement, includes areas of no or limited agricultural value, includes timbered areas of Mt Watermark	370	3.9
Total		9,500	100.0

Table 10 shows that the majority of the land associated with the Project area (5,151 ha or 54.2%) is composed of land classed as Agricultural Domain C.

5.2.3 Residual Onsite Biodiversity Offset Area

The agricultural domains within the residual onsite biodiversity offset area (situated on land not owned by Shenhua Watermark) are shown in **Table 11**. **Figure 15** provides an overview of each of the agricultural domains and their quantitative distribution within the residual onsite biodiversity offset area.

Table 11
Agricultural Domains within the Residual Onsite Biodiversity Offset Area

Agricultural Domain	Description of Agricultural Enterprises	Area (ha)	Area %
A	Irrigated cropping - Land suitable for irrigation though only a limited area has been irrigated. Land in this domain is owned by Shenhua Watermark but lies outside the Project boundary and will not be impacted by the Project.	0	0.0
B	Dryland cropping - Land highly suited to rotational dryland cropping with pasture phases included	610	16.0
C	Grazing with occasional cropping - Land suited to pasture and occasional cropping, potential for soil erosion during cropping phase without suitable precautions	2,127	55.6
D	Extensive grazing with potential for pasture improvement with limited soil disturbance, stoniness and slope prevent cropping	0	0.0
E	Timber and Hill grazing, low carrying capacity, slope and stoniness prevent pasture improvement, includes areas of no or limited agricultural value, includes timbered areas and cliffs of Long Mountain	1,090	28.4
Total		3,827	100.0

Table 11 shows that the majority of the land associated with the residual onsite biodiversity offset areas (2,127 ha or 55.6%) is composed of land classed as Agricultural Domain C.

5.2.4 Offsite Biodiversity Offset Areas

The agricultural domains within offsite biodiversity offset areas are shown in **Figure 16**. **Table 12** provides an overview of each of the agricultural domains and their quantitative distribution within the offsite biodiversity offset areas.

Table 12
Agricultural Domains within the Offsite Biodiversity Offset Area

Agricultural Domain	Description of Agricultural Enterprises	Area (ha)	Area %
X	Extensive grazing on natural and naturalised pasture, potential for further development	394	13.7
Y	Extensive grazing on natural and naturalised pasture, limited potential further development	722	25.1
Z	Unclear heavily timbered land with steep terrain and gorges – no agriculture use	1,762	61.2
Total		2,878	100.0

Table 12 shows that the majority of the land associated with the residual offsite biodiversity offset areas (1,762 ha or 61.2%) is composed of land classed as Agricultural Domain Z.



5.3 Current Agriculture Production and Value

To examine the quantum and value of the agricultural production from Shenhua Watermark owned land, the Project area, residual onsite biodiversity offset area and offsite biodiversity offset areas an estimate was made based on the land manager interviews and reference to the agricultural domains. This information was used in conjunction with the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) (Primary Industry) gross margin budgets to calculate the quantum and value of current agricultural production for each of the areas.

5.3.1 Shenhua Watermark Owned Land

The enterprises operated within the agricultural domains of Shenhua Watermark owned land are shown in **Table 13**.

Table 13
Current Enterprises per Agricultural Domain of Shenhua Watermark Owned Land

Enterprise	Area* (ha)/Head	Market	Average Carrying Capacity/Yield*	Agricultural Domain
Cotton	40	Carroll Gin	10 bale/ha	A
Sorghum	838	Grain Traders, end users (feedlots, stockfeed manufacturers)	4.5 t/ha	A, B and C
Sunflowers	120	Processor Newcastle	1.6 t/ha	A and B
Mung Beans	120	Local agent	1.2 t/ha	A and B
Dryland wheat (Durum)	1,100	Grain Corp Silos, On farm storage then local agent, AWB	2.7 t/ha	A, B and C
Dryland wheat (bread)	1,001	On farm storage then local agent, Grain Corp Silos, AWB	2.5 t/ha	B and C
Irrigated wheat (Durum)	70	Grain Corp Silos	7.0 t/ha	A
Barley (feed)	87	Local Agent	3.7 t/ha	B and C
Barley (Malt)	689	Local Agent, Grain Corp,	2.9 t/ha	B and C
Canola	248	Processor Newcastle	2.5 t/ha	B
Beef breeders for local trade	740	Gunnedah saleyard	16.7 DSE	B, C and D
Beef breeders for heavy feeder steers	50	Gunnedah saleyard	16.9 DSE	B and C
Grow out steers 240-460 kg	440	Gunnedah saleyard, Direct to feedlot	8.6 DSE	C and D
Fatten steers 340 - 580 kg	500	Gunnedah saleyard	11.0 DSE	C, D and E
Grow out early weaned calves	900	Direct to feedlot or abattoir	7.1 DSE	C, D and E
Background feeder steers 280 – 350 kg	2,334	To feedlot	6.4 DSE	C and D
Merino with terminal sire replacing	200	Tamworth saleyard, Wool through agent at Tamworth	2.4 DSE	C, D and E
Merino ewes self replacing	2,575	Tamworth saleyard, Wool through agent at Tamworth	2.2 DSE	D and E

*Average per year, DSE = Dry Sheep Equivalent

The value of the agricultural production from the enterprises within Shenhua Watermark owned land is summarised in **Table 14**. Details are provided in **Appendix 1**.

Table 14
Quantum and Value of Agricultural Production from Shenhua Watermark Owned Land

Enterprise	Crop Production	Animals Sold*	Wool sold	Gross Value of Production (per annum)	Net Value of Production (per annum)
Cotton	400 bales			\$ 247,003	\$ 132,138
Sorghum	3,738 t			\$ 672,746	\$ 242,031
Sunflowers	192 t			\$ 108,096	\$ 50,892
Mung Beans	144 t			\$ 110,477	\$ 59,521
Wheat	5,923 t			\$1,628,263	\$ 644,471
Barley	2,349 t			\$ 452,097	\$ 186,977
Canola	615 t			\$ 307,520	\$ 181,720
Beef Breeding		848		\$ 560,837	\$ 270,749
Beef fattening/grow out		4,091		\$1,394,074	\$ 961,481
Sheep		253 head (hd)	1,560 kg	\$ 43,493	\$ 24,351
Total				\$5,524,606	\$2,754,330

* Not all sold through saleyards

Table 14 shows that the gross value of agricultural production from Shenhua Watermark owned land, based on current land use, is \$5.5M per annum. The net value of agricultural production is \$2.8M.

It is noted that the value of cattle sold from trading enterprises is net of the landed cost of cattle purchased or transferred on to the Shenhua Watermark owned land, which better represents the value of the beef production. This standard is followed throughout this assessment.

Not all cattle from the Shenhua Watermark owned land is sold through the Gunnedah saleyards. Of the 4,939 turned off the land only 1,426 were sold through the Gunnedah saleyards. The balance was sold direct to meatworks or feedlots.

All sheep sales from Shenhua Watermark owned land is sold through the Tamworth saleyard.

Cotton is processed at the Carroll Gin approximately 35 km north-west of Breeza.

Grain is delivered either to the surrounding Grain Corp receival silos or sold direct to end users such as feedlots or stock feed manufacturers. The estimate of the grain (wheat and barley) being delivered to Grain Corp is 6,857 tonnes.

Oils seeds are sold direct to Cargill processing plant in Newcastle.

Mung beans are sold to end users through local agents.

5.3.2 Project Area

Of the Shenhua Watermark owned land, the enterprises operated within the agricultural domains of the Project area are shown in **Table 15**.

Table 15
Current Enterprises per Agricultural Domain of the Project Area

Enterprise	Area* (ha)/Head	Market	Average Carrying Capacity/Yield*	Agricultural Domain
Sorghum	109	Grain Traders, end users (feedlots, stockfeed manufacturers)	2.3 t/ha	B and C
Dryland wheat (Durum)	722	Grain Corp Silos, On farm storage then local agent, AWB	2.5 t/ha	B and C
Dryland wheat (bread)	672	On farm storage then local agent, Grain Corp Silos, AWB	2.1 t/ha	B and C
Barley (feed)	35	Local Agent	3.8 t/ha	B and C
Barley (Malt)	413	Local Agent, Grain Corp,	2.5 t/ha	B and C
Canola	200	Processor Newcastle	2.5 t/ha	B
Beef breeders for local trade	467	Gunnedah saleyard	16.7 DSE	B, C and D
Beef breeders for heavy feeder steers	17	Gunnedah saleyard	16.9 DSE	B and C
Grow out steers 240-460 kg	230	Gunnedah saleyard, Direct to feedlot	8.6 DSE	C and D
Fatten steers 340 - 580 kg	200	Gunnedah saleyard	11.0 DSE	C, D and E
Grow out early weaned calves	900	Direct to feedlot or abattoir	7.1 DSE	C, D and E
Background feeder steers 280 – 350 kg	2,334	To feedlot	6.4 DSE	C and D
Merino with terminal sire replacing	134	Tamworth saleyard, Wool through agent at Tamworth	2.4 DSE	C, D and E
Merino ewes self replacing	2,575	Tamworth saleyard, Wool through agent at Tamworth	2.2 DSE	D and E

*Average per year, DSE = Dry Sheep Equivalent

The value of the agricultural production from the enterprises within the Project area is summarised in **Table 16**. Details are provided in **Appendix 2**.

Table 16
Quantum and Value of Agricultural Production from the Project Area

Enterprise	Crop Production	Animals Sold*	Wool sold	Gross Value of Production (per annum)	Net Value of Production (per annum)
Sorghum	251 t			\$ 87,505	\$ 31,481
Wheat	3,206 t			\$ 999,750	\$ 387,501
Barley	1,164 t			\$ 259,742	\$ 107,292
Canola	500 t			\$ 248,000	\$ 146,456
Beef Breeding		523 hd		\$ 345,290	\$ 163,626
Beef fattening/grow out		3,591 hd		\$ 1,217,511	\$ 885,516
Sheep		2,220 hd	19,928 kg	\$ 365,152	\$ 226,904
Total				\$ 3,522,950	\$ 1,948,868

* Not all sold through saleyards

Table 16 shows that the gross value of agricultural production from the Project area, based on current land use, is \$3.5M per annum. The net value of agricultural production is \$1.9M.

All sorghum is sold direct to end users, including feedlots or stock feed producers.

Winter cereals are sold direct to feed lots or through the Grain Corp grain receival silos. The tonnage estimated to pass through local Grain Corp silos is 3,300 tonnes which represents 3.2 % of the 142,500 tonnes capacity of the Grain Corp silos within 10 km of the Project (excluding the Breeza silo which is currently decommissioned – 3,500 tonne capacity).

Oils seeds are shipped to Newcastle for processing by Cargill.

The Gunnedah saleyard is the third largest regional cattle saleyards in NSW (MLA, 2011b) in terms of cattle sold through the yards per annum. It has weekly fat sales and monthly store cattle sales. The National Livestock Reporting Service NSW Cattle Saleyard Survey for the financial year ended 30 June 2011 (MLA, 2011b) shows that the Gunnedah saleyard had a throughput of 132,994 cattle. 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.

The cattle from the Project area sold through the auction system at the Gunnedah saleyard is 774 head per annum and represents 0.6% of the throughput, with the balance being sold direct to fatteners or feedlots, including operations owned by the land manager. This compares with the average variance from the mean of throughput for the three years 2008/09, 2009/10 and 2010/11 of 1.91%.

Based on the Gunnedah Shire Council's saleyard charges for financial year 2011/12 of \$5.61 per head, the 774 head sold from the Project area generated \$4,342 of income to the Gunnedah saleyard.

Cattle sold as fat animals are processed at various abattoirs across NSW and southern Queensland.

All sheep sold from the Project area are sold through the Tamworth saleyard, ranked ninth in NSW (Tamworth Regional Livestock Exchange (TRLX)). TRLX sold 173,555 fat sheep in 2010/11, selling 2.5% of sheep sold through saleyards in NSW (MLA 2011a). The sheep sold from the Project area represented 1.28% of the throughput of TRLX.

The 2011/12 income derived from sheep sales is \$0.70 per head (Manager TRLX, *pers. comm.* 2012). Sale of sheep from the Project area represents \$1,554 of income to the TRLX.

Fat sheep sold at the TRLX are processed at the two local abattoirs at Tamworth (Cargill and Country Fresh) and other works across northern and central NSW.

Wool from the Project area is sold through an agent at the Newcastle wool centre. Newcastle is the closest auction facility for wool to the Project followed by Yennora, Sydney. Newcastle sells approximately 70,000 bales per annum (Elders Newcastle, 2012 *pers. comm.*). Assuming an average bale weight of 176.8 kg (Australian Wool Exchange, 2012) the total wool clip from the Project area would be 113 bales or 0.16% of the Newcastle sale facility's annual throughput.

Table 17 shows that the gross value of agricultural production from the Project area is 2.8% of the agricultural production in the Gunnedah LGA, 1.5% of Liverpool Plains, 0.04% of NSW and 0.01% of Australia. The major contributor is beef cattle which represents 36.8% of the gross agricultural production of the Project area followed by wheat production (26.3%).

Table 17
Value Comparison of Agricultural Production

Enterprise	Project Area (\$M)	Gunnedah LGA (\$M)	Liverpool Plains (\$M)	NSW (\$M)	Australia (\$M)
Sorghum	0.1	16.8	40.8	117.8	286.1
Wheat	1.0	27.0	42.8	1,432.9	5,194.3
Barley	0.3	8.2	15.9	279.4	1,445.1
Canola	0.2	2.2	2.5	92.8	485.7
Beef Slaughtering*	1.5	25.0	110.4	1,603.3	6,550.5
Sheep Slaughterings & Wool	0.4	2.7	7.5	1,142.2	5,834.7
Total Agricultural Production	3.5	125.5	232.1	9,034.5	39,645.1

* Project area value is for cattle turned off net of purchase cost for non-breeding stock, be they sold for slaughter or to feedlots, traders, etc.

Source: ABS (2008)

5.3.3 Residual Onsite Biodiversity Offset Area

The enterprises operated within the agricultural domains of the residual onsite biodiversity offset area (situated on land not owned by Shenhua Watermark) are shown in **Table 18**.

Table 18
Current Enterprises per Agricultural Domain of the Residual Onsite Biodiversity Offset Area

Enterprise	Area* (ha)/Head	Market	Average Carrying Capacity/Yield*	Agricultural Domain
Sorghum	54	Grain trader	2.3 t/ha	C
Wheat (Durum)	352	Grain Corp silos, AWB	3.0 t/ha	B and C
Wheat (Bread)	307	Agent, Grain Corp silos	2.1 t/ha	B and C
Barley (feed)	100	Local Agent	3.2 t/ha	B
Barley (Malt)	60	Local Agent, Grain Corp silo	2.5 t/ha	C
Canola	70	Processor Newcastle	2.0 t/ha	C
Beef breeding (weaners)	78	Gunnedah saleyard	14.9 DSE	C
Beef Breeding (vealers)	724	Gunnedah Saleyard, Direct to Abattoir	16.7 DSE	B, C, D and E
Beef fattening (225-550 kg)	250	Gunnedah saleyard, Direct to feedlot	8.7 DSE	C and E
Beef fattening (300-550 kg)	180	Gunnedah saleyard	10.2 DSE	B and C
Beef fattening (340-580 kg)	363	Gunnedah saleyard	11.0 DSE	B and C
Dorper ewes	100	Tamworth	2.7 DSE	C and E
Merino ewes self replacing	66	Tamworth	2.1 DSE	C
XB ewes	300	Tamworth	2.7 DSE	C and E

*Average per year, DSE = Dry Sheep Equivalent

The value of the agricultural production from the enterprises within the residual onsite biodiversity offset area is summarised in **Table 19**. Details are provided in **Appendix 3**.

Table 19
Quantum and Value of Agricultural Production from the Residual Onsite Biodiversity Offset Area

Enterprise	Crop Production	Animals Sold*	Wool sold	Gross Value of Production (per annum)	Net Value of Production (per annum)
Sorghum	124			\$ 43,351	\$ 15,596
Wheat	1,709 t			\$ 471,688	\$ 182,045
Barley	466 t			\$ 100,023	\$ 42,072
Canola	140 t			\$ 86,800	\$ 51,260
Beef Breeding		854 hd		\$ 553,838	\$ 266,719
Beef fattening/grow out		777 hd		\$ 262,428	\$ 117,506
Sheep		546 hd	1,883 kg	\$ 78,653	\$ 40,427
Total				\$1,596,780	\$ 715,657

* Not all sold through saleyards

Table 19 shows that the gross value of agricultural production from the residual onsite biodiversity offset area, based on current land use, is \$1.6M per annum. The net value of agricultural production is \$0.7M.

Land managers reported that all cereals (2,299 t) are delivered into Grain Corp receival silos (Nea and Curlewis) and that canola is sold to Cargill. This represents 4.84% of the storage capacity of these two receival silos.

Land managers interviewed indicated that the majority cattle sold (1,424 head including cull cows and bulls) are sold through Gunnedah saleyard. This represents 1.07% of the annual throughput and \$7,988 (at \$5.61 per head) of the income to Gunnedah saleyard.

All sheep are sold through TRLX. The 546 head of sheep sold is 0.31% of TRLX sheep throughput for 2010/11 and represents \$382 income (at \$0.70 per head) for TRLX.

Wool is sold through agents selling at either Newcastle or Yenora wool centres depending on the agents reading of market conditions at the time. Assuming an average bale weight of 176.8 kg (Australian Wool Exchange, 2012) the total wool clip from the onsite biodiversity offset property would be 11 bales or 0.02% of the Newcastle sale facility's annual throughput.

5.3.4 Offsite Biodiversity Offset Areas

The enterprises operated within the agricultural domains of the offsite biodiversity offset areas are shown in **Table 20**.

Table 20
Current Enterprises per Agricultural Domain of the Offsite Biodiversity Offset Areas

Enterprise	Area* (ha)/Head	Market	Average Carrying Capacity/Yield*	Agricultural Domain
Beef Breeding	145	Gunnedah saleyards	14.9	X and Y
Merino ewes	1,000	Tamworth saleyard	2.1	X and Y
Merino Wethers	1,900	Tamworth saleyard	1.0	X and Y
XB ewes	100	Tamworth saleyard	2.7	X and Y

*Average per year, DSE = Dry Sheep Equivalent

The value of the agricultural production from the enterprises within the offsite biodiversity offset areas is summarised in **Table 21**. Details are provided in **Appendix 4**.

Table 21
Quantum and Value of Agricultural Production from the Offsite Biodiversity Offset Areas

Enterprise	Animals Sold*	Wool sold	Gross Value of Production (per annum)	Net Value of Production (per annum)
Beef Breeding	120 hd		\$ 63,888	\$ 48,111
Sheep	1,268 hd	16,155 kg	\$ 295,895	\$ 162,870
Total			\$ 359,783	\$ 210,981

* Not all sold through saleyards

Table 21 shows that the gross value of agricultural production from the offsite biodiversity offset areas, based on current land use, is \$0.4M per annum. The net value of agricultural production is \$0.2M.

Land managers interviewed indicated that the majority cattle sold (120 head including cull cows and bulls) are sold through Gunnedah saleyard. This represents 0.09% of the annual throughput (2010/11) and \$673 (at \$5.61 per head) of the income to Gunnedah saleyard.

All sheep are sold through TRLX. The 1,268 head of sheep sold is 0.73% of TRLX sheep throughput for 2010/11 and represents \$887 income (at \$0.70 per head) for TRLX.

Wool is sold through agents selling at Newcastle wool centres depending on the agents' reading of market conditions at the time. Assuming an average bale weight of 176.8 kg (Australian Wool Exchange, 2012) the total wool clip from the offsite biodiversity offset property would be 91 bales or 0.13% of the Newcastle sale facility's annual throughput.

5.3.5 Labour, Service Providers and Input Sources

During interviews with land managers full time labour equivalents (38 hours per week) required to operate the land, input sources and location of service providers was ascertained.

The following was reported:

- Shenhua Watermark owned land 18 Full Time Equivalent (FTE) personnel
- Residual onsite biodiversity offset areas 11 FTE
- Offsite biodiversity offset areas 1.25 FTE

Farm input services are mainly sourced from Gunnedah with Quirindi, Tamworth and Carroona being used by as alternate sources by five operators. One of the offsite biodiversity offset area operators sources farm supplies from Barraba.

Most professional services were sourced from Gunnedah. Most agronomic advice was sourced as part of input purchases with only two operators using fee for service contracts.

5.3.6 Quantum and Value of Agricultural Water

As stated in **Section 3.6**, Shenhua Watermark holds water licences for both groundwater (two WALs) and surface water (one surface water licence to be converted to a WAL when the Water Sharing Plan for the Lake Goran Water Source (part of the Namoi Unregulated and Alluvial Water Sources) commences.

Shenhua Watermark holds 206 share units of groundwater and 1,223 ML entitlement surface water. If it is assumed a 1 unit share is equivalent to 1 ML entitlement, Shenhua Watermark holds entitlements for a total of 1,329 ML of potential irrigation water. The amount of water required to operate the mine is discussed in the Surface Water Impact Assessment for the Project (see Appendix S of the EIS).

The agricultural value of this water is determined calculating the value (crop yield, gross value and net return) this water could gain by irrigating the highest value crop per megalitre of irrigation water for crops grown in the locality compared to the production and return from a similar area used for dryland cropping. DTIRIS (2011) farm budgets for summer irrigated crops and dryland crops for the Northern NSW irrigation region indicate that cotton provides the best economic agricultural use of irrigation water for established agricultural industries in the region. **Table 22** summarises the gross margin (per ML) of irrigation water for various summer crops grown in the locality.

Table 22
Gross Margin of Irrigation Water for Summer Crops

Crop	Gross Margin (per ha Irrigated)	Gross margin (per ha Dryland)	Irrigation Water (Max. required 4 years in 5) (ML)	Gross Margin (\$/ML)
Grain sorghum	\$ 501.93	\$ 293.58	3.8	\$ 57.20
Maize grain	\$ 1,123.35	\$ 387.95	7.2	\$ 102.14
Sunflowers (mono unsaturated)	\$ 827.01	\$ 424.10	3.9	\$ 103.31
Soybeans	\$ 621.97	\$ 347.24	6.0	\$ 45.79
Mung Beans	\$ 526.87	\$ 496.10	1.5	\$ 20.57
Cotton (Roundup Ready Flex©)	\$ 3,060.35	\$ 1,031.47	7.0	\$ 289.84

Table 23
Quantum and Value of Production of Irrigated and Dryland Cotton

Enterprise	Bales of cotton	Tonnes of cotton seed	Gross value of production* (per annum)	Net Value of Production (per annum)
203 ha irrigated cotton	1,827	658	\$ 1,240,789	\$ 621,251
203 ha dryland cotton	812	292	\$ 485,089	\$ 209,388
Difference	1,015	365	\$ 755,700	\$ 411,863

* DPI Gross margins assume a \$20 per discount for quality from dryland cotton relative to irrigated cotton

If it is assumed that 100% of entitlements is available then the water entitlements currently owned by Shenhua Watermark is enough to irrigate 203 ha of cotton. **Table 23** compares the quantum of production and the gross and net value of 203 ha of irrigated and dryland cotton.

The above shows that if this water is used for irrigated cotton production, the gross value of that cotton production is \$1.2M per annum while the marginal increase in cotton production due to the use of this water is \$0.8M per annum.

The potential cotton production from this water is 1,827 bales of cotton with the marginal increase in production over the same area growing dryland cotton are 1,015 bales. In the 2010/11 cotton season the Carroll cotton gin processed 67,000 bales and in 2011/12 is anticipating processing 90,000 bales (Carroll Cotton Gin, *pers. comm.* 2012).

The relative Water Sharing Plans for the individual WALs (including the proposed Water Sharing Plan for the Lake Goran Water Source) outline the rules under which Shenhua Watermark can license this water to other land managers to use for agricultural production, as currently occurs.

5.3.7 Total Combined Agricultural Production

Table 24 shows the combined agricultural production from Project Area, residual onsite biodiversity offset areas, offsite biodiversity offset areas and the water Shenhua Watermark is currently entitled to. This is compared to the agricultural production (quantum and value) from the Gunnedah LGA, the Liverpool Plains, NSW and Australia.

Table 24 also shows the relative small magnitude of agricultural output of the combined agricultural production when compared to local (5.3%), regional (2.9%), state (0.07%) and national (0.02%) agricultural production.

Table 24
Total Combined Agricultural Production

Enterprise	Project	Gunnedah LGA	Liverpool Plains**	NSW	Australia
Cotton [^]					
Bales	1,827				
\$ GV*	1.2 M	31.1 M	32.1 M	572.9 M	950.0 M
Sorghum					
Tonnes	375				
\$ GV*	0.1 M	16.8 M	40.8 M	117.9 M	286.1 M
Wheat					
Tonnes	4,915				
\$ GV*	1.5 M	27.0 M	42.8 M	1,432.9 M	5,194.3 M
Barley					
Tonnes	2,815				
\$ GV*	0.4 M	8.2 M	15.9 M	279.4 M	1,445.1 M
Canola					
Tonnes	755				
\$ GV*	0.3 M	2.2 M	2.5 M	92.8 M	4857 M
Beef					
Head	5,788				
\$ GV*	2.4 M^^	25.0 M	110.4 M	1,603.3 M	6,550.5 M
Sheep					
Head	4,034				
Kg wool	37,966				
\$ GV*	0.7 M	2.7 M	7.5 M	1,142.2 M	5,834.7 M
Total					
\$ GV*	6.7 M	125.5 M	232.1 M	9,034.5 M	39,645.1 M

* Gross Value of Production

** Liverpool Plains and Gunnedah LGAs combined

[^] Gross value of irrigated cotton

^{^^} Gross value is net of landed cost for non-breeding stock

Source: ABS 2008

5.4 Potential Agricultural Production

5.4.1 Project Area

The potential agricultural production of the Project area was examined assuming changes to management to represent superior management and or capital investment. It is noted that optimum enterprise mix changes with seasonal conditions, changes in markets, and individual managers' preferences and skills (cropping versus stock). The potential changes identified are shown in **Table 25**.

The estimates of carrying capacity are based on the growth potential of perennial tropical pasture systems and grazing management to harvest the relevant amount of pasture. It is noted that reliability of stock water is an issue within Agricultural Domains C, D and E as is the provision of the infrastructure of reticulated stock water, fencing and stock handling facilities.

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 26 shows that the potential agricultural production from the Project area has a gross value of \$7.6 M per annum and a net value of production of \$4.8 M per annum. Details are provided in **Appendix 2**. The value of the cattle trading enterprises is net of the landed cost of non-breeding stock.

Table 25
Changes to Models to Represent Potential Agricultural Production from Project Area

Agricultural Domain	Description of Agricultural Enterprises	Area (ha)	Yields t/ha Carrying capacities (DSE/ha)
A	Summer dryland cropping producing 3 year rotation	47	Sorghum: 6.0 Sunflowers: 2.1 Mung Beans: 1.6
B	Dryland cropping: Winter cropping program of 2 years wheat, 1 year Barley, 1 year canola	1,614	Wheat after canola: 5.0 Wheat after wheat: 4.5 Barley: 4.9 Canola: 2.0
C	Grazing with occasional cropping : Paddock subdivision, crop pasture rotations using tropical perennials and winter wheat two years in seven with 25% crop yield premium, grazing to grow out steers 240 to 460kg liveweight	5,151	Winter wheat: 3.1 Tropical pastures: 15 DSE/ha
D	Extensive grazing with paddock subdivision, perennial tropical pastures, Running breeders producing for the specialist local trade	2,318	Tropical pasture 10 DSE/ha
E	Timber and Hill grazing, Fencing and rotational grazing, used in conjunction with breeding enterprise	370	Native Pasture: 2 DSE/ha
Total		9,500	

Table 26
Maximum Potential of Agricultural Production from the Project Area

Enterprise	Quantum of Production	Gross Value of Production (per annum)	Net Value of Production (per annum)
Summer Cereals	153 tonnes	\$55,041	\$39,259
Winter Crops	13,023 tonnes	\$3,393,650	\$2,158,992
Canola	807 tonnes	\$371,335	\$233,699
Cattle	7,880 head	\$3,788,187	\$2,394,814
Total		\$7,608,214	\$4,826,764

5.4.2 Residual Onsite Biodiversity Offset Area

The potential agricultural production of the residual onsite biodiversity offset area was examined assuming changes to management to represent superior management and or capital investment. It is noted that optimum enterprise mix changes with seasonal conditions, changes in markets, and individual managers' preferences and skills (cropping versus stock). The potential changes identified are shown in Table 27.

Table 27
Changes to Models to Represent Potential Agricultural Production from the Residual Onsite Biodiversity Offset Area

Agricultural Domain	Description of Agricultural Enterprises	Area (ha)	Yields t/ha Carrying capacities (DSE/ha)
A	Summer dryland cropping producing 3 year rotation	0	
B	Dryland cropping: Winter cropping program of 2 years wheat, 1 year Barley, 1 year canola	610	Wheat after canola: 5.0 Wheat after wheat: 4.5 Barley: 4.9 Canola: 2.0
C	Grazing with occasional cropping : Paddock subdivision, crop pasture rotations using tropical perennials and winter wheat two years in seven with 25% crop yield premium, grazing to grow out steers 240 to 460kg liveweight	2,127	Winter wheat: 3.1 Tropical pastures: 15 DSE/ha
D	Extensive grazing with paddock subdivision, perennial tropical pastures, Running breeders producing for the specialist local trade	0	Tropical pasture 10 DSE/ha
E	Timber and Hill grazing, Fencing and rotational grazing, used in conjunction with breeding enterprise	1,090	Native Pasture: 2 DSE/ha
Total		3,827	

The estimates of carrying capacity are based on the growth potential of perennial tropical pasture systems and grazing management to harvest the relevant amount of pasture. It is noted that reliability of stock water is an issue within Agricultural Domains C, D and E as is the provision of the infrastructure of reticulated stock water, fencing and stock handling facilities.

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 28
Maximum Potential of Agricultural Production the Residual Onsite Biodiversity Offset Area

Enterprise	Quantum of Production	Gross Value of Production (per annum)	Net Value of Production (per annum)
Winter Crops	5,174 tonnes	\$1,351,883	\$860,821
Canola	305 tonnes	\$140,300	\$88,298
Cattle	2,751 head	\$1,270,430	\$882,957
Total		\$2,762,612	\$1,832,075

Table 28 shows that the potential agricultural production from the residual onsite biodiversity offset area has a gross value of \$2.8M per annum and a net value of production of \$1.8M per annum. Details are provided in **Appendix 5**.

The value of the cattle trading enterprises is net of the landed cost of non-breeding stock.

5.4.3 Offsite Biodiversity Offset Areas

The potential agricultural production of the offsite biodiversity offset areas was examined assuming changes to management to represent superior management and or capital investment. It is noted that optimum enterprise mix changes with seasonal conditions, changes in markets, and individual managers' preferences and skills (cropping versus stock). The potential changes identified are shown in **Table 29**.

Table 29
Changes to Models to Represent Potential Agricultural Production within Offsite Biodiversity Offset Areas

Agricultural Domain	Description of Agricultural Enterprises	Area (ha)	Yields t/ha Carrying capacities (DSE/ha)
X	Extensive grazing with aerial fertiliser and limited aerial pasture improvement lifting carrying capacity used for merino breeding enterprise	394	10.0 DSE
Y	Extensive grazing, native pasture with limited fertiliser input, marginal increase in production used for merino breeding enterprise	722	5.0 DSE/ha
Z	Not suited to agriculture	1,762	0 DSE/ha
Total		2,878	

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 30
Maximum Potential of Agricultural Production from Offsite Biodiversity Offset Areas

Enterprise	Quantum of Production	Gross Value of Production (per annum)	Net Value of Production (per annum)
Merino ewes 18u			
Sheep sold (hd)	2,804		
Wool sold (kg)	20,637	\$501,564	\$331,385
Total		\$501,564	\$331,385

Table 30 shows that the gross value of agricultural production could be increased to \$0.5 M per annum and the net value to \$0.3 M per annum. Details are provided in **Appendix 4**.

Merino breeding enterprise returns the most profitable return per hectare and per DSE unit however it is more labour intensive than beef breeding and is more susceptible to predation by wild dogs.

5.4.4 Potential Agricultural Production of Water

As stated in **Section 5.3.6**, cotton production provides the highest value use per ML of water of any irrigated agricultural industry currently operating in the region. Applying a 25% yield premium to represent superior management the 1,329 ML equivalents in entitlements (assuming 100% allocations) produces a gross value of production of \$1.6 M per annum, with a net value of production of \$0.9 M per annum. This is from the production of 2,284 bales of cotton including 882 kg of cotton seed. This is summarised in **Table 31**.

Table 31
Maximum Potential of Agricultural Production from Water

Enterprise	Bales	Cotton seed	Gross Value of Production (per annum)	Net Value of Production (per annum)
Cotton	2,284	882 Kg	\$1,550,986	\$892,806

5.4.5 Potential Total Combined Agricultural Production

The total potential agricultural production from the Project area, residual onsite biodiversity offset area, offsite biodiversity offset areas and Shenhua Watermark entitled water has a gross value of \$12.4 M per annum and a net value of production of \$7.9 M per annum. Details are provided in **Appendix 5**.

This would be from the sale of:

- 2,284 bales of cotton;
- 153 tonnes of summer crops;
- 19,309 tonnes of winter crops;
- 12,889 head of beef cattle;
- 2,804 head of sheep; and
- 20,637 kg of wool.

5.5 Alternative Agricultural Land Uses

The land within the disturbance area, buffer lands and onsite and offsite biodiversity offset areas are well suited to cropping, cattle and sheep grazing or a combination of both depending on slope and soil type.

Alternative agricultural land uses would aim to value add to the crop and forage production from the locality. These would include beef feedlots and freestall dairying. These activities are not inherently dependant on the production capability of the land which they occupy but proximity to surrounding reliable feed supplies and ability to handle and utilise appropriately manure accumulated at the site.

6 Stakeholder Consultation

6.1 Overview

The stakeholder engagement program for the Project and this Agricultural Impact Statement 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. A summary of the regulators and neighbouring landowners and industries consulted with regard to the Project and its potential impacts on agriculture are provided below:

Regulators:

- Department of Planning & Infrastructure;
- Department of Primary Industries;
- NSW Office of Water;
- Namoi Catchment Management Authority;
- Gunnedah Shire Council; and
- Liverpool Plains Shire Council.

Lessees, Neighbouring Landowners and Industries:

- Operators leasing Shenhua Watermark owned land;
- Owners of land within residual onsite biodiversity offset area;
- Owners of offsite biodiversity offset areas;
- NSW Farmers Association; and
- Watermark Community Consultative Committee.

Various consultation methods were adopted to identify stakeholder issues, including Project briefings, Community Newsletters, presentations, and the establishment of working groups.

6.2 Issues Identified

Table 32 outlines the regulatory stakeholder issues specific to this assessment and the section of the report which corresponds to each issue.

Table 32
Regulatory Stakeholder Issues

Ref.	Issue Raised	Section
1	Assess air quality impacts (including cumulative impacts)	Section 8.7 and Air Quality and Greenhouse Gas Impact Assessment (PAEHolmes, 2012)
2	Assess noise impacts (including cumulative impacts)	Section 8.8 and Acoustics Impact Assessment (Bridges Acoustics, 2013)
3	Identify and assess potential agricultural land use conflicts	Section 8
4	Assess impacts on agricultural resources and enterprises and proposed avoidance or mitigation strategies	Sections 8 and 9
5	Assess traffic impacts (including cumulative impacts) on the local road network	Section 8.10 and Traffic and Transport Impact Assessment (DC Engineering, 2013)
6	Impacts to the rail and road transport network, including competition and capacity	Section 8.10 and Traffic and Transport Impact Assessment (DC Engineering, 2013)
7	Impacts on surface water flow, pressure, recharge and quality, including impacts on existing users, Watermark Gully and the Mooki River	Section 8.3 and Surface Water Impact Assessment (WRM, 2013)
8	Impacts on ground water flow, pressure, recharge and quality, including impacts on existing users	Section 8.2 and Groundwater Impact Assessment (AGE, 2013)
9	Impact on rural labour and communities	Section 8.11 and Social Impact Assessment (Hansen Bailey, 2013)
10	Biodiversity offsets and impacts on current and future productive agricultural land	Section 8.1.1 to 8.1.3 and Ecology Impact Assessment (Cumberland Ecology, 2013)
11	Weed and feral animal impacts	Section 9
12	Post mining land use and land capability and agricultural suitability	Section 8.1.1 and Soil Survey and Land Capability Impact Assessment (GSSE, 2013)
13	Mine rehabilitation and final voids	Section 8.1.1 and mine plan (see main volume of EIS), Rehabilitation and Mine Closure Strategy (GSSE, 2013)

Table 33 outlines the community stakeholder issues specific to this assessment and the section of the report which corresponds to each issue.

Table 33
Community Stakeholder Issues

Ref.	Issue Raised	Section
1	Air quality impacts (including cumulative impacts) on residences and livestock	Section 8.7 and Air Quality and Greenhouse Gas Impact Assessment (PAEHolmes, 2012)
2	Noise impacts (including cumulative impacts) on residences and livestock	Section 8.8 and Acoustics Impact Assessment (Bridges Acoustics, 2013)
3	Impacts on surface water quality	Section 8.3 and Surface Water Impact Assessment (WRM, 2013)
4	Extraction of water from the Mooki River	Section 8.1.4 and 8.2.6
5	Discharges into watercourses	Surface Water Impact Assessment (WRM, 2013)
6	Impacts on groundwater aquifers, including impacts on water quality, quantity and loss of water for agricultural activities	Section 8.2 and Groundwater Impact Assessment (AGE, 2013)
7	Competition for labour	Section 8.11 and Social Impact Assessment (Hansen Bailey, 2013)
8	Impacts to the visual amenity of the surrounding landscape and sensitive receptors	Section 8.9 and Visual Impact Assessment (JVP, 2012)
9	Onsite screening to conceal construction and operation activities	Section 8.9 and Visual Impact Assessment (JVP, 2012)
10	Increases in traffic volumes	Section 8.10 and Traffic and Transport Impact Assessment (DC Engineering, 2013)
13	Suitability of the land for agriculture	Section 5.2 and Soil Survey and Land Capability Impact Assessment (GSSE, 2013)
14	Impacts on short and long term agricultural productivity	Section 8.1
15	Buffer distances to Alluvial soils and groundwater aquifers	Section 4.3 and Groundwater Impact Assessment (AGE, 2013)
16	Flooding impacts, including potential contact with mining areas	Surface Water Impact Assessment (WRM, 2013)
17	Water licensing requirements and strategy	Section 3.6, 8.1.4, 8.2.6, Surface Water Impact Assessment (WRM, 2013) and Groundwater Impact Assessment (AGE, 2013)
18	Integration of Namoi Water Study findings	Section 8.3, 8.2, Surface Water Impact Assessment (WRM, 2013) and Groundwater Impact Assessment (AGE, 2013)

6.3 Ongoing Stakeholder Engagement

Shenhua Watermark is committed to the continuation of the stakeholder engagement plan developed for the Project and is seeking to achieve the best possible outcomes for all Project stakeholders.

Various mechanisms will be implemented to ensure the effective ongoing engagement with Project stakeholders, including:

- Regular consultation with neighbouring land owners;
- Regular consultation with the relevant State and Commonwealth government agencies, service and infrastructure providers, local government representatives and local members of parliament;
- Regular consultation with non-government organisations, business groups, community groups, cultural and heritage groups;
- Regular meetings with the Environment, Water and Koala Community Reference Groups;
- Project updates to the Watermark Community Consultative Committee;
- Distribution of regular Community Information Sheets to residents in Quirindi and Gunnedah and on the website;
- Regular Community Information Sessions; and
- Provision of management plans and monitoring data via the Shenhua Watermark website.

An Annual Review will continue to be prepared for the Project. This document will summarise company activities and performance in the areas of health, safety, environment and community. A copy of the Annual Review will be made available to the public in hard copy upon request or via the Shenhua Watermark website.

7 Risk Assessment

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. This risk assessment is presented in **Appendix 6**. Each of the potential environmental issues was ranked in accordance with the Risk Matrix as either being of low, medium or significant risk as shown in **Table 34**.

Table 34
Risk Assessment

Issue	Category (without mitigation measures)
Availability and productivity of agricultural land	Significant
Surface and ground water	Medium to Significant
Air quality	Low
Noise	Low
Visual	Low
Traffic and transport	Low
Business and Infrastructure	Low
Labour	Low
Weed management	Low
Rehabilitation	Medium

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.

8 Impact Assessment

This section assesses the potential impacts on agricultural land within the disturbance area, onsite and offsite biodiversity offset areas and water resources removed from agriculture as a result of the Project. As part of the Agricultural Impact Statement Gillespie Economics were 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 7**.

8.1 Availability and Productivity of Agricultural Land

8.1.1 Disturbance Area

Any agricultural land that is situated within the disturbance area (5,630 ha) will be removed from production as a result of the Project. The mining areas include approximately 3,348 ha within the disturbance area. Sustainable farming practices will, however, continue during the life of the Project in available areas outside the disturbance boundary.

Post mining, at least 1,000 ha of agricultural land with Class III rural land capability will be re-established within the rehabilitated disturbance area and will be available for agricultural purposes (see **Figure 17**). The remaining areas will be used for ecological conservation via the re-establishment of native woodland and grassland in perpetuity. This is discussed further in the Ecology Impact Assessment for the Project (see Appendix K of the EIS).

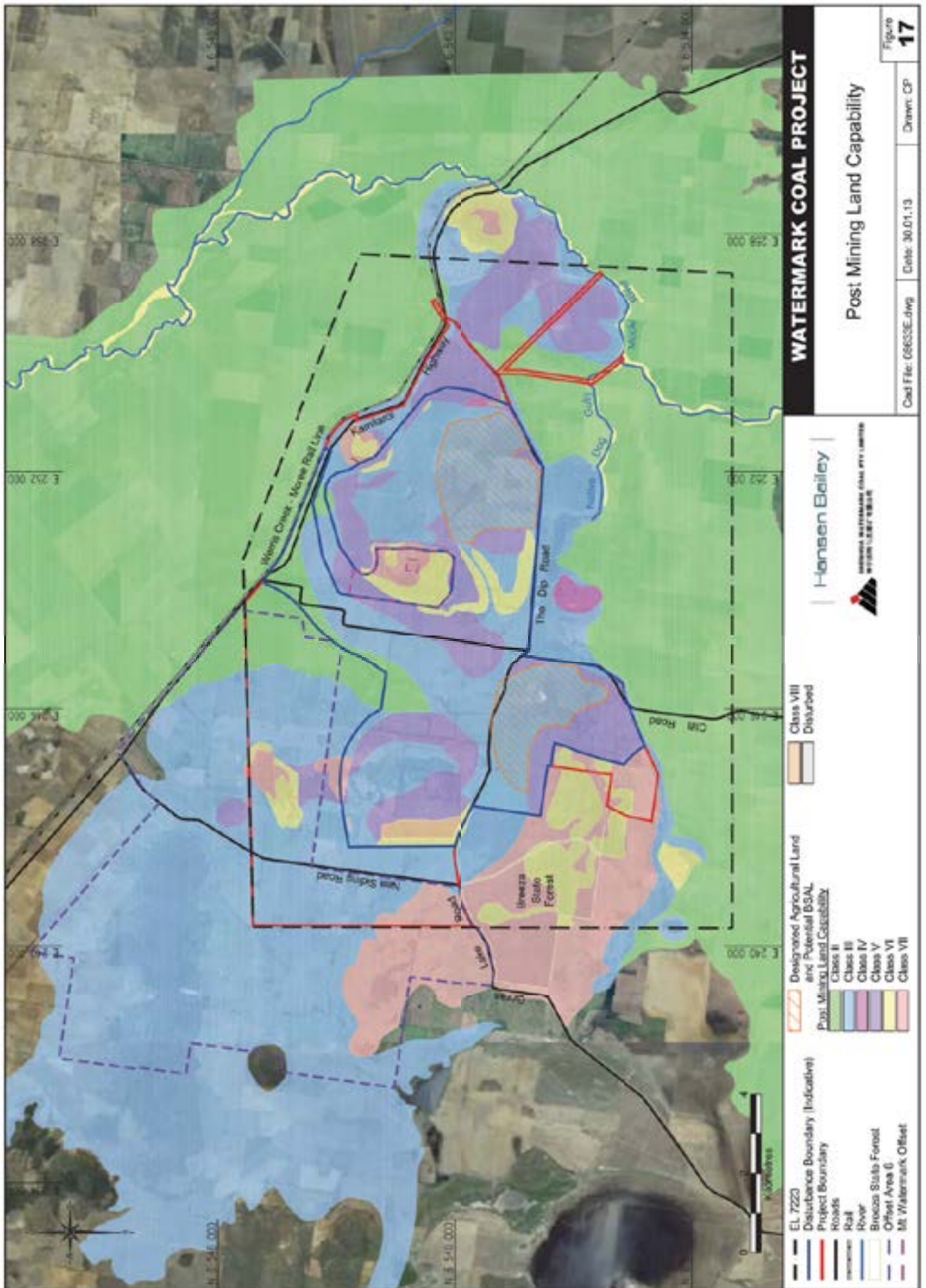
It is estimated that the following areas of the identified agricultural domains will be affected within the disturbance area:

- Domain A 3 ha (within pipeline easement and will not be directly impacted);
- Domain B 756 ha;
- Domain C 3,214 ha;
- Domain D 1,570 ha; and
- Domain E 87 ha.

Table 35 shows the quantum of agricultural production impacted by the Project within the disturbance area. This is based on the information provided for each agricultural domain in **Section 5**.

Table 35
Quantum and Value of Agricultural Production Affected within the Disturbance Area

Enterprise	Disturbance Area
Sorghum (tonnes) per annum	44
Wheat (tonnes) per annum	1,809
Barley (tonnes) per annum	898
Canola (tonne) per annum	332
Wool sold (kg) per annum	19,928
Sheep sold per annum	2,220
Beef cattle sold per annum	4,506
Gross value of production per annum	\$2.69 M
Net value of production per annum	\$1.56 M



Conservatively assuming that agricultural production from the entire disturbance area ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$45.2 M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$26.9 M (using a 7% discount rate) (Gillespie Economics, 2012) (see **Appendix 7**).

This impact will partly be offset by the 1,000 ha of Class III land within the disturbance area to be returned to agriculture at the end of the Project (30 years) (see **Figure 17**). If it is assumed that similar farming practices to the existing land use are applied, 50% of the land would be used for grazing beef breeders and the balance is cropped annually in rotation with a pasture phase. The cropping breakdown is 67% wheat and 33% canola. The expected annual production when the land is returned to full production would be expected:

- Wheat 1,005 tonnes
- Canola 264 tonnes
- Beef cattle 323 head sold

This will result in a gross value of production of \$ 0.7M per annum and a net value of production of \$ 0.3M per annum following the cessation of mining (Year 30).

8.1.2 Onsite Biodiversity Offset Areas

Pending further land management arrangements, the properties selected as onsite biodiversity offset areas for the Project may:

- No longer be available for agricultural purposes and be reserved in perpetuity for the conservation of ecological values; or
- Managed in part for agricultural purposes, where current land practices apply, in conjunction with the conservation of ecological values in perpetuity.

It is estimated that the following areas, totalling 7,797 ha, of the identified agricultural domains will potentially be affected within the onsite offset areas:

- Domain A 0 ha;
- Domain B 1,274 ha;
- Domain C 4,844 ha
- Domain D 414 ha; and
- Domain E 1,265 ha.

Table 36 shows the total quantum of production impacted by the Project on agricultural land within the onsite biodiversity offset areas should that land become unavailable for agricultural purposes. This is based on the information provided for each agricultural domain in **Section 5**.

Table 36
Quantum and Value of Agricultural Production Affected within the Onsite Biodiversity Offset Areas

Enterprise	Onsite Biodiversity Offset Areas
Sorghum (tonnes) per annum	124
Wheat (tonnes) per annum	1,708
Barley (tonnes) per annum	466
Canola (tonne) per annum	140
Wool sold (kg) per annum	1,883
Sheep sold per annum	546
Beef cattle sold per annum	1,554
Gross value of production per annum	\$1.6 M
Net value of production per annum	\$0.7 M

Conservatively assuming that agricultural production from the onsite biodiversity offset areas ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$24 M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$10.7 M (using a 7% discount rate) (Gillespie Economics, 2012).

The quantum and value of agricultural production for the onsite biodiversity offset areas if it was managed in part for agricultural purpose cannot be assessed until further arrangements have been finalised.

8.1.3 Offsite Biodiversity Offset Areas

Pending further land management arrangements, the properties selected as offsite biodiversity offset areas for the Project will no longer be available for agricultural purposes and reserved in perpetuity for the conservation of ecological values.

Table 37 shows the total quantum of production impacted by the Project on agricultural land within the offsite biodiversity offset areas should that land become unavailable for agricultural purposes. This is based on the information provided for each agricultural domain in **Section 5**.

Table 37
Quantum and Value of Agricultural Production Affected within the Offsite Biodiversity Offset Areas

Enterprise	Offsite Biodiversity Offset Areas
Wool sold (kg) per annum	16,155
Sheep sold per annum	1,268
Beef cattle sold per annum	120
Gross value of production per annum	\$ 359,782
Net value of production per annum	\$ 148,809

Conservatively assuming that agricultural production from the offsite offset area ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$5.6M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$2.3 M (using a 7% discount rate) (Gillespie Economics, 2012).

8.1.4 Water Required for the Project

Groundwater Impact Assessment (AGE Consultants, 2013) and the Surface Water Impact Assessment (WRM Water & Environment, 2013) prepared for the Project has identified the impact of the Project on groundwater and surface water. These are summarised in Sections 8.2 and 8.3 of this report.

It is predicted that 194 ML of water will be diverted from agricultural activities to mining. The level of annual water requirement implies that potentially 28 ha of cotton would be converted from irrigated to dryland production. This represents a loss in cotton production of 140 bales of cotton with a gross value loss of \$104,234 per annum and a net value loss of \$56,809. Over the life of the Project, the present value of the gross value of production foregone is \$1.4 M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$0.9 M (using a 7% discount rate) (Gillespie Economics, 2012).

8.1.5 Total Combined Agricultural Production

The combined gross value of production from the impacted agricultural land is \$4.8M per annum. As shown in **Table 38**, this value is 3.8% of the total agricultural production of the Gunnedah LGA, 2.1% in the Liverpool Plains region, 0.05% of NSW, and 0.01% of Australia.

Table 38
Value of Total Agricultural Production Impacted and Outputs

Enterprise	Project	Gunnedah LGA	Liverpool Plains	NSW	Australia
Sorghum	\$ 0.1 M	\$ 16.8 M	\$ 40.8 M	\$ 117.9 M	\$ 286.1 M
Wheat	\$ 1.1 M	\$ 27.0M	\$ 42.8 M	\$ 1,432.9 M	\$ 5,194.3 M
Barley	\$ 0.3M	\$ 8.2 M	\$ 15.9 M	\$ 279.4 M	\$ 1,445.1 M
Canola	\$ 0.2 M	\$ 2.2 M	\$ 2.5 M	\$ 92.8 M	\$ 4857.0 M
Cotton	\$ 0.1 M	\$ 31.1M	\$ 32.1M	\$ 572.9 M	\$ 950.0M
Sheep meat and wool	\$ 0.7 M	\$ 2.7 M	\$ 7.5 M	\$ 1,142.2 M	\$ 5,834.7 M
Beef production	\$ 2.2 M	\$ 25 0 M	\$ 110.4 M	\$ 1,603.3 M	\$ 6,550.5M
Total*	\$ 4.8M	\$ 125.5 M	\$ 232.1 M	\$ 9,034.5 M	\$ 39,654.1 M

* Totals may not added up due to rounding errors
Source: ABS 2008

In total, foregone gross value and net value of agricultural production from land resources required for the Project is estimated at a present value of \$73.4M and \$39.3M, respectively (using a 7% discount rate).

As the overall agricultural contribution of the land within the disturbance boundary and the onsite and offsite biodiversity offset areas 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.

8.1.6 Surrounding Locality

The Project will reduce the availability of 3,827ha (i.e. the residual onsite offset area) of land for agricultural through acquisition of land for onsite biodiversity offset areas.

8.1.7 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 local regional input-output table by Gillespie Economics (see **Appendix 7**).

Table 39 summarises the estimated direct and indirect regional impacts of foregone agricultural land and water resources required for the Project and compares this to the impacts of the Project on the local region. Further details are provided within **Appendix 7**.

Table 39
Annual Regional Production, Economics Impacts of the Foregone Agriculture and the Project

Production Type	Agricultural Land			Water	Total Agricultural Land and Water	Project
	Disturbance Area	Onsite Offset	Offsite Offset			
	Beef, Grains, Sheep	Beef, Grains, Sheep	Beef, Sheep	Coal		
Direct Impacts						
Output (\$M)	3	2	0	0	5	744
Value-added (\$M)	2	1	0	0	3	424
Household income (\$M)	1	0	0	0	1	45
Employment (No.)	18	9	4	1	31	369
Direct and indirect Impacts						
Output (\$M)	4	2	1	0	8	902
Value-added (\$M)	2	1	0	0	4	493
Household income (\$M)	1	1	0	0	2	80
Employment (No.)	24	12	4	1	41	908

The direct annual output of the Project (at 10 Mtpa of ROM coal) is estimated at \$744 M. In contrast, the direct annual output of future use of agricultural lands and water resources that would be potentially impacted by the Project is estimated at \$5 M.

Gillespie Economics (2012) also undertook a benefit cost analysis which included an estimation of the present value of production costs and benefits of the Project over a 30 year period. The present value of net production benefits of the Project to Australia are estimated at \$1,310 M. In contrast, the present value of future use of agricultural lands and water resources that would be utilised by the Project is estimated at \$39 M and \$1 M, respectively. Gillespie Economics concluded that based on these comparative values, the Project is considered to be significantly more efficient than continued agricultural production.

8.2 Groundwater

8.2.1 Background

In order to assess the potential impacts of the Project on the existing groundwater regime, a Groundwater Impact Assessment was completed by Australasian Groundwater & Environmental (AGE) Consultants (2013). As part of this assessment a predictive numerical model was constructed to simulate the historical and predicted hydrogeological environment. This model was used to estimate the inflows of groundwater into the proposed open cut mining areas 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 flow transfer disruption from the Upper and Lower Namoi alluvial groundwater source.

The section below provides a summary of the Groundwater Impact Assessment conducted for the Project so as to identify and account for any impact on the availability of water for agricultural purposes relevant to this assessment only. For further details, please refer to the full assessment (Appendix T of the EIS).

8.2.2 Change in Potentiometric Surface / Water Table Levels

Permian Drawdown

The depressurisation induced by mining in the Eastern Mining Area extends to a maximum of 1.8 km from the mining area in year 21. Groundwater levels are predicted to reduce by 3 m or less in the Permian underlying the Narrabri Formation, laterally extending up to 0.7 km. The model does not predict drawdown of greater than 1 m in the Permian underlying the Gunnedah Formation due to mining in the Eastern Mining Area.

The depressurisation induced by mining in the Southern Mining Area is more extensive and extends to a maximum of 3.2 km from the mining area in year 25. The model predicts a drawdown of 25 m or less in the Permian underlying the Narrabri Formation. The depressurisation in the Permian extends to the south where the overlying Gunnedah Formation is present. At this distance, drawdown in the Permian is predicted to be less than 2 m.

The depressurisation induced by the Western Mining Area is less significant than the Southern Mining Area and Eastern Mining Area because it is located in an elevated area where groundwater levels are deeper and the operating life is short at 6 years. The zone of depressurisation extends to a maximum of 1 km from the mining area in year 30. Depressurisation due to the Western Mining Area does not extend in the Permian under the alluvial aquifers.

The model indicates groundwater levels begin to recover after the backfilling of the Eastern Mining Area and Southern Mining Area. This is due to seepage into the Overburden Emplacement Areas from the mining area walls and from rainfall recharge. In the Southern and Eastern Mining Area, this results in groundwater levels recovering to higher than pre-mining levels which prevents a water deficit occurring post mining.

Alluvial Drawdown

The proposed open cut mining areas do not directly intersect the alluvial aquifers of the Narrabri and Gunnedah Formations. The groundwater model indicates depressurisation in the underlying Permian strata will reduce upward water pressure from the Permian, and close to the mining areas will induce downward vertical flow from the overlying alluvial aquifers into the underlying Permian. This change in Permian water pressures therefore induces changes in groundwater levels in the alluvial aquifers.

The groundwater model predicts a zone of depressurisation that extends into the Narrabri Formation adjacent to the Eastern Mining Area and Southern Mining Area.

The zone of drawdown around the Southern Mining Area is more extensive and extends towards the south and into the underlying Gunnedah Formation. The groundwater model predicts drawdown in the Gunnedah Formation to be 1 m – 2 m at Year 21. Depressurisation in the alluvium extends to a maximum of 3.9 km from the Southern Mining Area in Year 25 (based on 1m drawdown contour).

As seasonal variation is typically ± 1 m to 2 m it is possible the groundwater drawdowns could be masked during periods of significant sustained recharge.

8.2.3 Interaction with Alluvial Aquifers and Groundwater Management Zones

Porous Bedrock Aquifers

The groundwater model predicts an average groundwater seepage rate into the mining areas of 0.5 ML/day (180 ML/yr) with a peak of up to 756 ML/yr. The groundwater seepage to the mining areas is largely sourced from the Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources. As the zone of depressurisation increases, there is a net transfer of water from the 'Spring Ridge' management zone of this WSP into the 'Other' management zone which peaks at 32.7 ML/year in Year 25. Groundwater seepage into the mining areas represents less than 0.1% of the extraction limits for this groundwater source.

Upper Namoi Alluvium

A 150 m buffer zone of bedrock will remain in place between the mining areas and the black soil plains, and the mining areas do not directly intersect the alluvial aquifers of the Narrabri and Gunnedah Formations, therefore any impacts to the alluvial aquifer systems will result from a reduction in pressure in the Permian which reduces the rate of water transfer from the Permian to the alluvial aquifer system.

Table 40 summarises the cumulative reduction in flow from the Permian to the alluvium for each Water Management Zone identified under the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*. The change in upward flow from the Permian to the alluvium due of mining is negligible beyond the immediately adjacent Zone 7. Zones 3 and Zone 8 report only a very small change. No change in flow rates is predicted for Zones 1, 6 and 10, which are relatively distant from the Project.

The groundwater flow from the underlying Permian formations to the alluvium reduces by a maximum rate of 0.3 ML/day in Zone 7, with the maximum annual loss at 101.8 ML/year. The rate of transfer of water from the Permian to the alluvium reduces as the zone of depressurisation increases and reaches a peak when mining in the Southern Mining Area is most extensive in Year 24.

The average pumping rate from a single licensed agricultural bore in the Upper Namoi alluvium (within 10 km of the Project Boundary) is 142 ML/yr. The groundwater model predicts that the volume of water removed from the Zones 3, 7 and 8 is a very small quantity of water, peaking at 98.1 ML/year, which is equivalent to no more than the usage from a single bore in the peak years of mining.

Under post-mining conditions, the water levels in these areas recover and the surrounding Permian regains pressure. The emplacement of overburden in the mining areas and the associated enhanced recharge rapidly reverses the effects of groundwater depressurisation on the alluvial aquifer system. The model indicates that 15 years after mining ceases, upward flow to the alluvium will be returned to pre-mining rates.

Beyond 15 years of recovery, the enhanced OEA recharge causes a net gain of 0.1 ML/day to the alluvial groundwater management areas, which means there is no long term deficit of water post mining.

Table 40
Reduction in Transfer Rate from Permian to Alluvium

Zone	Reduction in Transfer Rate from Permian to Alluvium over 30 Years		
	Cumulative over Project life (ML)	Average (ML/year)	Peak (ML/year)
3	14.0	0.5	1.1
7	1020.8	34.0	101.8
8	35.5	-1.2	0.4

Note - negative numbers indicate an increase in transfer rate from Permian to alluvium above pre-mining conditions

It is important to note that **Table 40** presents the predicted change in the groundwater transfer rate from the Permian bedrock to the alluvium due to the Project. The majority of this water does not flow into the proposed open cut mining areas, but it simply remains in the underlying Permian bedrock and is therefore is not lost from the larger groundwater system. When mining is complete in the Southern Mining Area and Eastern Mining Areas, the Triassic/ Permian basement starts to repressurise and the predicted flow rate from the Permian basement to the overlying alluvium increases to pre-mining rates within 15 years. Beyond 15 years, there is a net increase in the transfer from the Permian to the alluvium due to the mounding of groundwater within the backfilled Southern and Eastern Mining Areas caused by enhanced increased recharge.

The change in upward flow from the Permian to the individual alluvial units (i.e. Narrabri and Gunnedah Formations) is dependent on the proximity of the units to the mining areas. Ninety percent of the alluvial transfer loss occurs from the Permian to the Narrabri Formation Aquifer, while just 10% of transfer loss occurs from the Permian to the Gunnedah Formation Aquifer. This is an important point to note because although the Narrabri and Gunnedah Formations are managed as a single aquifer unit under the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*, the Narrabri Formation contains poor quality water and is not targeted by surrounding users to supply agriculture. The modelling indicates the impact will be largely limited to the Narrabri Formation where the yields and water quality are poorer.

Reduction in Flow to Upper Namoi Alluvium

The highly productive Gunnedah Formation aquifer does not exist within the proposed mining area. The closest occurrence of the aquifer is 900 m from the north-eastern corner of the Eastern Mining Area and 1.3 km in the south. The centre of the main channel within the Gunnedah Formation where the most productive bores are located is between 3.8 km and 5.7 km from the proposed mining areas.

The groundwater model indicates that the Project will create a zone of depressurisation induced by mining in the Permian formations underlying the Upper Namoi alluvium. Groundwater flow from the underlying Permian to the Upper Namoi alluvium will be reduced by a maximum rate of 0.3 ML/day.

8.2.4 Changes to Surface Water Flow

In the absence of mining, the Mooki River and Quirindi Creek network have both losing and gaining characteristics (i.e. lose water to the underlying groundwater formations along some reaches, or gain water via groundwater flow on other reaches depending on the depth to the water table). Once mining commences the Permian becomes depressurised, and within the zone of influence, upward flow from the Permian to the alluvium is predicted to reduce. The resultant lowering of groundwater levels in the Narrabri Formation, although very small, does increase the hydraulic gradient between the bed of the Mooki River and the underlying aquifer. The higher gradient potentially increases the rate of surface water flow from the river to the aquifer.

The groundwater model found a small increase (0.13 ML/day in year 24) in the net flow from the Mooki River to the underlying aquifer (i.e. an increase in 'losing' conditions). The other surface water features do not show any significant response to mining. The increase in seepage from the Mooki River to the underlying alluvium of 0.13 ML/day represents an undetectable proportion of the total river leakage along the Mooki River of 0.4%.

There is no significant impact on Lake Goran as the groundwater level drawdown is not predicted to exceed 0.01 m. Lake Goran is an ephemeral lake and does not receive a significant contribution from groundwater and therefore will not be impacted by the Project.

The total additional flow from the Mooki River to the underlying aquifer totals 323 ML at the end of the Project life.

The model demonstrates that as the zone of depressurisation reduces post-mining, predicted flow from the river to the underlying aquifer also reduces. By approximately Year 60, the zone of depressurisation has fully retracted and there is no further cumulative transfer from the Mooki River to the underlying aquifer. When the post-mining loss is considered the total additional flow through the Mooki River to the underlying aquifer due to the Project is 489 ML. This is equivalent to an average of 16.3 ML/yr over the Project life or less than 0.02% of the mean flow along the river at Breeza.

8.2.5 Impact on Groundwater Users

There are 508 registered groundwater monitoring and pumping bores within a 10 km radius of the Project. Seventy-one of these bores are licensed and metered by NOW for water allocation. The majority of these bores abstract groundwater from the Gunnedah Formation.

Within 10 km of the Project Boundary, 35 bores are predicted to experience maximum groundwater level reductions of greater than or equal to 0.1 m. Of these, four bores adjacent to the Southern Mining Area have a maximum predicted drawdown between 1 m and 2 m.

The largest predicted reduction in water level of 1.4 m is limited to bore GW15505, which is the closest bore to the Southern Mining Area. When operations in the Southern Mining Area and Eastern Mining Area cease, the model predicts that groundwater levels in the depressurised zone recover relatively rapidly within approximately five years.

As described previously, groundwater flow from the underlying Permian to the alluvium will be reduced by a maximum rate of 0.3 ML/day. This represents less than 0.5% of the flow from registered bores within 10 km of the Project Boundary and is due to predicted pressure transmission between the fractured rock and alluvial systems. If this occurs, it represents a negligible change in groundwater availability to adjacent groundwater users.

8.2.6 Water Licensing Requirements

Table 41 summarises the share components available under the Water Sharing Plans for the Upper and Lower Namoi Groundwater Sources and Murray-Darling Basin Porous Rock Groundwater Sources. Predicted water take attributable to the Project is described in AGE (2013).

Table 41
Water Allocations

Source	Predicted Peak Annual Water Take (During Mining)	Predicted Peak Annual Water Take (After Mining)	Total Share Component Requirement for Project (Units)	Share Component Already held by Shenhua (Units)
Namoi Groundwater Zone 3	1.1	0*	1.2	Nil
Namoi Groundwater Zone 7	101.8	0*	112	42
Namoi Groundwater Zone 8	0.4	0*	0.4	164
Porous Rock (Gunnedah-Oxley Basin - Other)	756	0*	940	Nil
Porous Rock (Gunnedah-Oxley Basin – Spring Ridge)	33	0*	42	Nil
Mooki River	47.5	0*	53	Nil
Lake Goran	0	0*	0	1,223 (subject to issuance of certificate of title)
3, 7 or 8 or Mooki River^	600	0	660	Nil

Source: AGE (2013) and WRM (2013)

The losses to agriculture from the reallocation of water from agricultural purposes to coal mining purposes will be mitigated by obtaining appropriate water licences. There is sufficient water available on the open market for Shenhua Watermark Coal Pty Limited to obtain the additional water licences required without impacting on the water market.

8.2.7 Biophysical Strategic Agricultural Land and Aquifer Interference Policy

As discussed in **Section 2.2**, a small area of BSAL (96.1 ha) has been identified within the Project area as it is considered to fulfil the criteria for soil fertility and land capability. As such, this agricultural impact statement must address the gateway criteria for BSAL as outlined in the SRLUP and also consider the AIP.

The gateway criteria for BSAL require a consideration of the Project's impacts on 'Highly Productive Groundwater'. The term 'Highly Productive Groundwater' is not defined in the SRLUP; however the term is defined in the AIP as:

“A groundwater source that is declared in the Regulations and will be based on the following criteria:

- a) has total dissolved solids of less than 1,500 mg/L, and*
- b) contains water supply works that can yield water at a rate greater than 5 L/sec.”*

Gunnedah Formation

The closest occurrence of the Gunnedah Formation is 900 m to the north-eastern corner of the Eastern Mining Area (see **Figure 18**). The centre of the main channel within the Gunnedah Formation where the most productive bores are located is between 3.8 km and 5.7 km from the proposed mining areas.

The Gunnedah Formation consists of sand and gravel dominant with minor clay bands and typically has high permeability and yield. A review of the NOW groundwater data (GHD, 2011) indicates a substantial variation in yield, and hence hydraulic conductivity for the Gunnedah Formation around the Project area. The highest yielding bores are located in the thick gravel sediments located to the east of the Mooki River, which is consistent with historical mapping. Broughton (1994) identified a high yield (greater than 50 L/s) zone that is located to the east of the Project Boundary.

The yields decrease down to between 5 – 50 L/s in the south-east corner of the Project Boundary and further reduce to 0.5 L/s – 5 L/s in the southern and north-eastern portions of the Project Boundary

Water quality records from NOW indicate groundwater within the Gunnedah Formation to the west of the Mooki River (i.e. towards the Project Boundary) is typically slightly brackish at between 1,200 mg/L to 3,000 mg/L TDS. To the east of the Mooki River, groundwater is much fresher with TDS less than 500 mg/L. All samples from the Gunnedah Formation indicate the water is suitable for stock watering. In summary, the Gunnedah Formation is considered to satisfy the ‘highly productive groundwater’ criteria for yield and salinity, however does not occur within the Project Boundary.

Narrabri Formation

The closest occurrence of the Narrabri Formation is 150 m to the Eastern and Southern Mining Areas.

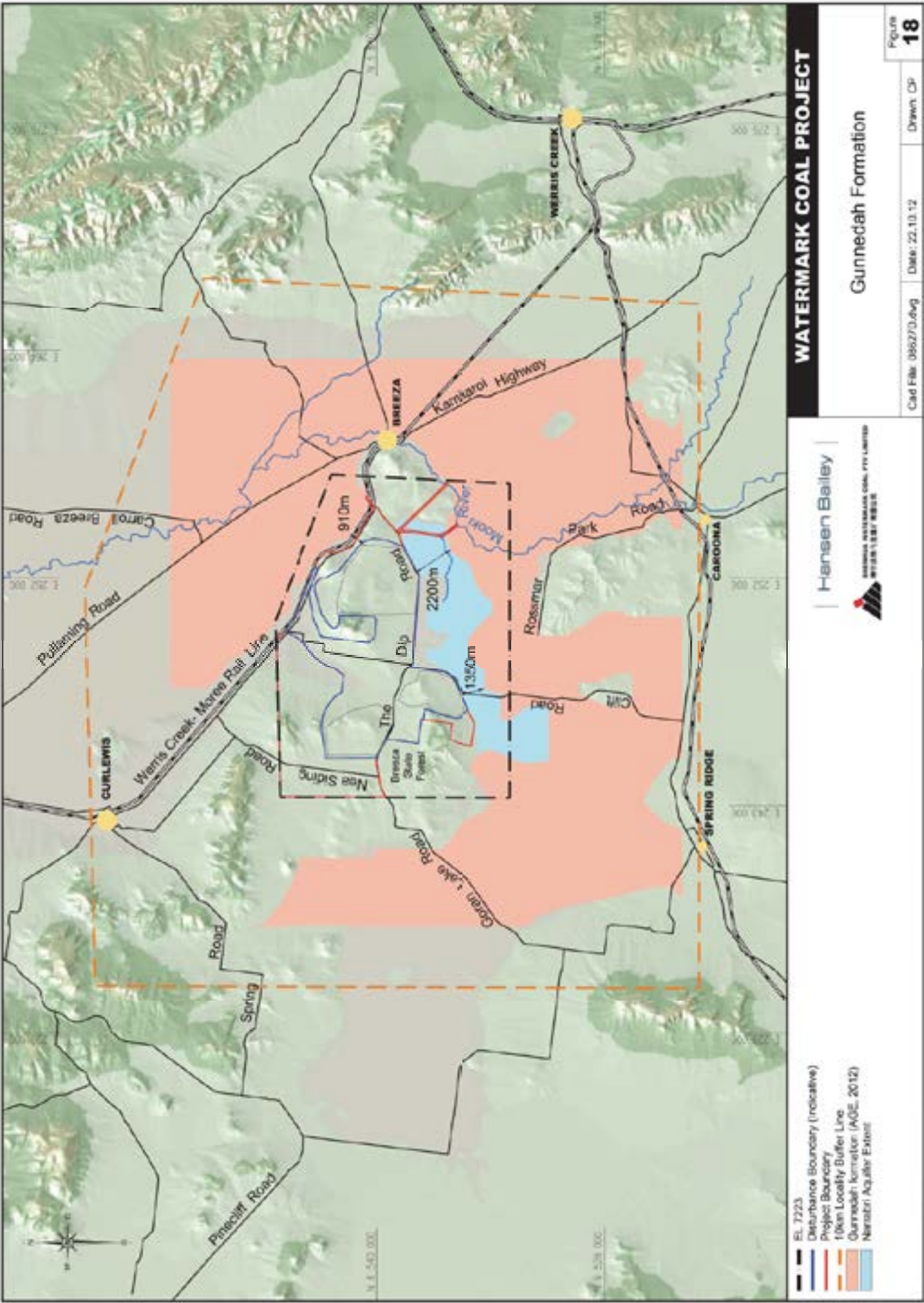
The average yield from the Narrabri Formation is approximately 50 litres per second (L/s). Groundwater in the Narrabri Formation to the south of the Project Boundary is brackish to saline, with TDS concentrations greater than 10,000 milligrams per litre (mg/L), which is not suitable for beef cattle. Sheep can tolerate salinity up to 13,000 mg/L indicating a small proportion of groundwater from the Narrabri Formation is suitable for livestock consumption.

In summary, the Narrabri Formation is not considered to satisfy the ‘highly productive groundwater’ criteria for salinity.

Impacts to Highly Productive Groundwater

The Gunnedah Formation is considered to satisfy the highly productive groundwater criteria of the SRLUP and AIP for yield and salinity; however, it does not occur beneath BSAL impacted by the Project nor elsewhere within the Project Boundary. The Narrabri Formation is not considered to satisfy the highly productive groundwater criteria and does not occur beneath land impacted by the Project. The Permian formations are also not considered to satisfy the highly productive groundwater criteria.

As noted above, the groundwater model indicates that the Project will create a zone of depressurisation induced by mining in the Permian formations underlying the Upper Namoi alluvium. Groundwater flow from the underlying Permian to the Upper Namoi alluvium will be reduced by a maximum rate of 0.3 ML/day.



The average pumping rate from a single licensed agricultural bore in the Upper Namoi alluvium (within 10 km of the Project Boundary) is 142 ML/yr. The groundwater model predicts that the volume of water removed from the Zones 3, 7 and 8 is a very small quantity of water, peaking at 98.1 ML/year, which is equivalent to no more than the usage from a single bore in the peak years of mining.

The groundwater model also predicts drawdown in the Gunnedah Formation to be 1 m - 2 m at Year 21. Depressurisation in the alluvium extends to a maximum of 3.9 km from the Southern Mining Area in Year 25 (based on 1 m drawdown contour). As seasonal variation is typically ± 1 m to 2 m it is possible the groundwater drawdowns could be masked during periods of significant sustained recharge.

Therefore, considering the above, the Project is not considered to reduce the agricultural productivity of BSAL within the Project area and surrounds through impacts to highly productive groundwater.

8.3 Surface water

In order to assess the potential impacts of the Project on the existing surface water regime, a Surface Water Impact Assessment was completed by WRM Water & Environment (WRM, 2013) (Appendix S of the EIS). The assessment includes a simulation of the water balance for the proposed mine water management system, as well as flood studies of Watermark Gully and the Mooki River which are the two primary watercourses draining the Project area.

The section below provides a summary of the Surface Water Impact Assessment conducted for the Project so as to identify and account for any impact on the availability of water for agricultural purposes. For further details, please refer to the full assessment (Appendix S of the EIS).

Impacts associated with the Project will include a temporary reduction in the catchment area draining to receiving watercourses due to capture of runoff from disturbed catchment areas within the mine water management system. This reduction in catchment area will temporarily reduce the volume and peak of stormwater runoff resulting in a reduction in flood discharges. The maximum captured catchment areas at any one time represent:

- Less than 1% of the Mooki River catchment to the confluence with Watermark Gully.
- Approximately 25% of the catchment area of Watermark Gully to the Kamilaroi Highway.
- Approximately 27% of the catchment of Native Dog Gully.
- Less than 0.4% of the catchment to Lake Goran.

At the completion of mining, surface runoff from rehabilitated overburden emplacement areas will be released from the site. An area of approximately 108 ha, which originally drained to Lake Goran, will continue to drain to the mine final void. The changed topography following completion of the Project will have the following impacts on catchment areas:

- The catchment draining north via Watermark Gully will increase by 5.2 km², an increase of approximately 13%.
- The catchment draining to Lake Goran will be reduced by 6.0 km². This represents a reduction in catchment area of less than 0.5% and, in practical terms, will have no measureable impact on inflows to the lake.
- The catchment draining north to the Mooki River floodplain will be increased by 1.4 km².

- The catchment draining south to Native Dog Gully and the Mooki River floodplain will be reduced by 1.6 km² (2%).

The water requirements of the Project have been investigated using a detailed site water balance model.

The model results are summarised as follows:

- On average, different stages of mining will operate with a net water deficit of the order of 20 to 160 ML/year (in reality, the site water balance will vary significantly from year to year, depending upon climatic conditions);
- On average, water collected onsite, such as groundwater inflow and surface runoff to mining areas and storages should be able to meet all mine water demands about 90% of the time;
- There is a 10% chance that the volume of external water supply required in any year from Year 4 to Year 19 will be of the order of 300 to 600 ML/year; and
- Under extreme drought conditions (1% chance), the annual volume of external water supply could potentially be 900 ML/ year.

Water required from external sources (approximately 600 ML) will be obtained under appropriate Water Access Licences. The surface water model for the Project predicts that there is a less than 10% chance that offsite supplies required for the Project would exceed this volume.

The mine water management system will be operated to fully contain mine water and to preferentially reuse this water to meet mine site demands. The results of the mine water balance modelling show that under the full range of historical rainfall conditions, the proposed mine water management system will have sufficient capacity to contain all mine water on the site without the need for offsite releases.

The proposed mine site water management strategy and infrastructure will ensure that the Project has a negligible impact on the quality of surface runoff and receiving waters.

8.4 Movement of Water from Agriculture

As described in **Section 8.2** and **8.3**, the Project is predicted to result in the following impacts to water sources utilized by agricultural activities in the area:

- Average reduction in the rate of groundwater flow from the Permian into the overlying Narrabri and Gunnedah Formation of 33.3 ML/yr; - zone 3, 7 and 8
- Average annual additional transfer of water from the Mooki River to the underlying alluvium of 10.7 ML/yr; and
- Average of approximately 150 ML/yr of external water supply.

The water take from the Porous Bedrock Aquifer due to the Project has not been included in the above, as the aquifer is very deep, poor quality and yielding and is not commonly used for intensive agricultural purposes.

The groundwater impacts directly associated to the Project are limited to the 30-year mine life and approximately 15 years thereafter. At this time, groundwater take from the alluvial aquifer sources is reversed and the alluvial groundwater source is directly replenished by the Project.

The external make-up water supply for the Project (average of approximately 150 ML/year, up to 600 ML/year with less than 10% probability) has conservatively been assumed to be water which is currently utilised for agricultural purposes.

Therefore, the Project is predicted to result in the annual average relocation of approximately 194 ML/year of water from agricultural purposes to coal mining purposes.

As outlined in **Section 8.1.4**, assuming the annual water requirement of 194 ML per annum implies that potentially 28 ha of cotton would be converted from irrigated to dryland production. This represents a loss in cotton production of 140 bales of cotton with a gross value loss of \$104,234 per annum and a net value loss of \$56,809. Over the life of the Project, the present value of the gross value of production foregone is \$1.4 M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$0.9 M (using a 7% discount rate) (Gillespie Economics, 2012).

8.5 Soils and Land Capability

A Soil Survey and Land Capability Impact Assessment was undertaken by GSS Environmental (GSSE) for the Project Boundary and is provided in Appendix Y of the EIS. **Section 3.3** of this report outlines the soil survey methodology and subsequent soil types identified within the Project Boundary.

This section outlines the potential impacts to soil resources and land capability within the Project Boundary, as a result of the Project.

8.5.1 Alluvial Black Soil

As part of the Project, Shenhua Watermark has maintained a 150 m buffer from the open cut mining areas to the Alluvial Black Soils and thus, no disturbance of this soil type is anticipated. Further, no impact to surrounding Alluvial Black Soils (or the blacksoil plains) is anticipated due to the Project.

8.5.2 Topsoil and Subsoil Balance

Disturbance of the topsoil and intermediate soil layers will be confined within the Eastern, Southern and Western Mining Areas. The recommended stripping depth for each of the soil types within the mining areas and the soil balance for the Project has been developed and is presented in Appendix Y of the EIS.

To achieve the desired post-mining land capability, the total volume of material required for rehabilitation of the Project (topsoil and subsoil) is 24,578,000 m³. The total volume of suitable material available for reuse in rehabilitation is 28,279,800 m³, which results in a surplus of 3,701,800 m³.

8.5.3 Land Capability

Impacts to the land as a result of the Project will remain within the Disturbance Boundary. Areas outside this are expected to maintain its existing pre-mining class, including all Class II land. The current land capability classification within the Disturbance Boundary ranges from Class II to Class VII, with Class VII dominating the existing environment. No Class II land will be disturbed as a result of the Project.

Following the completion of mining, land capability classes within the Disturbance Boundary are predicted to range from Class II to Class VIII. It is proposed that at least 1,000 ha of rehabilitated land with Class III characteristics within the Disturbance Boundary will be dedicated for agricultural purposes. The remaining 4,630 ha will be used for ecological conservation through the restoration of native woodland and grassland.

The targeted 3,233 ha of post mining land capability Class III is achievable due to the creation of relatively gentle topography, excess topsoil and subsoil resources available and previous examples of high quality mine rehabilitation of agricultural land (see **Section 9.4** for further details).

The post mining landform contains relatively gentle slopes compared to the majority of mines within NSW and QLD, which allows for the potential establishment of land capability Class III on the rehabilitated landform. Furthermore these relatively gentle slopes will contain slope lengths and suitable soil depth designed to minimise erosion risk and ensure the land meets criteria for land capability Class III.

A comparison of the pre-mining and post-mining rural land capability classifications of the Disturbance Boundary are provided in **Table 42** and **Figure 17**.

Table 42
Pre and Post Mining Land Capability

Land Class	Pre-mining		Post-mining	
	ha	%	ha	%
Class II Regular Cultivation	351.3	6.2	351.3	6.2
Class III Regular Cultivation	2,948.4	52.4	3,233.0	57.4
Class IV Grazing, occasional cultivation	80.5	1.4	22.7	0.4
Class V Grazing, occasional cultivation	1,751.0	31.1	1,649.5	29.3
Class VI Grazing only	426.8	7.6	273.0	4.9
Class VII Unsuitable for rural production	55.4	1.0	9.7	0.2
Class VIII Unsuitable for rural production	0.0	0.0	86.8	1.5
Disturbed Land	16.6	0.3	4.0	0.1
Total	5,630.0	100	5,630.0	100

8.5.4 Agricultural Suitability

Impacts to the land as a result of the Project will remain within the Disturbance Boundary. Areas outside this are expected to maintain its existing pre-mining class. The current agricultural suitability classification within the Disturbance Boundary ranges from Class 1 to Class 5, with Class 2 dominating the existing environment.

Following the completion of mining, agricultural suitability classes within the Disturbance Boundary will remain similar to pre-mining conditions ranging from Class 1 to Class 5. No Class 1 land will be disturbed as a result of the Project.

A comparison of the pre-mining and post-mining agricultural suitability classifications of the Disturbance Boundary are provided in **Table 43**.

Table 43
Pre and Post Mining Agricultural Suitability

Land Class	Pre-mining		Post-mining	
	ha	%	ha	%
Class 1 Highly productive land suited to both row and field crops.	351.3	6.2	351.3	6.2%
Class 2 Highly productive land suited to both row and field crops.	2,948.4	52.4	3,233.0	57.4%
Class 3 Moderately productive lands suited to improved pasture and to cropping within a pasture rotation.	1,831.5	32.5	1,672.2	29.7%
Class 4 Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	426.8	7.6	273.0	4.8%
Class 5 Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	55.4	1.0	96.5	1.7%
Disturbed Land	16.6	0.3	4.0	0.1%
Total	5,630	-	5,630	-

8.5.5 Biophysical Strategic Agricultural Land

The SRLUP mapping indicates approximately 96 ha of BSAL is potentially present in the Disturbance Boundary. Site verification of this area in consideration of the SRLUP criteria, found that the soil landscape within the Project Boundary considered most likely to fulfil the criteria for fertility and land capability was Ponderosa (soil type 7). Details of soil fertility are discussed in detail in Appendix Y of the EIS. The area of this soil landscape within the mining areas was calculated to be 96.1 ha.

As part of the Biodiversity Offset Strategy for the Project, Shenhua Watermark has and continues to acquire land holdings (Onsite and Offsite biodiversity Offset Areas) containing substantial amounts of vegetation to compensate for any potential ecological impacts from the Project. The SRLUP mapping indicates approximately 375 ha BSAL may occur within the Onsite Offset Areas. Site verification of this area in consideration of the SRLUP criteria, found that a further 321 ha was identified, thereby increasing the total area of BSAL in the Onsite Offset Areas to 696 ha.

There is no BSAL situated within the Offsite Offset Areas.

Section 8.6 below provides an assessment of impacts on BSAL as a result of the Project.

8.6 Impact on Biophysical Strategic Agricultural Land

As noted in **Section 2.2**, this agricultural impact statement must address the gateway criteria for BSAL as outlined in the SRLUP. This section outlines the gateway criteria from the SRLUP and how the Project area, onsite and onsite biodiversity offset areas interact with the criteria.

8.6.1 Site Verification

Project Area

The mapping of the SRLUP has indicated that BSAL may occur within the Project area. The Project area was therefore ground-truthed and assessed for BSAL according to the values and criteria from the SRLUP, as listed in **Table 44**.

A small area of BSAL (96.1 ha) has been confirmed to occur within the Project area as it is considered to fulfil the criteria for BSAL (see **Figure 19**).

Table 44
BSAL Site Verification

Value	Criteria	Site Verification
Biophysical Strategic Agricultural Land	Land that falls under soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH), and	GSSE (2013) determined that soils within the Ponderosa and Carinya soil landscapes are expected to fulfil the criteria of 'high' to 'moderately high' fertility, whilst the soils within the Booloocooroo soil landscape is considered marginal.
	Land capability classes I, II or III under the Land and Soil Capability Mapping of NSW (OEH), and	GSSE (2013) determined that the soil landscapes which were considered to fulfil the land capability criteria were Fullwoods Road, Goscombes Road, Booloocooroo and Ponderosa. The soil landscape within the Project area considered fulfils the first two BSAL criteria for fertility and land capability was Ponderosa. The area of this soil landscape within the Disturbance Boundary was calculated to be 96.1 ha.
	Reliable water of suitable quality, characterised by land having rainfall of 350mm or more per annum (9 out of 10 years); or properties within 150 m of a regulated river, or unregulated rivers where there are flows for at least 95% of the time (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 or less than 1,500 mg/L	The Project Area receives rainfall of 407.7mm or more per annum 9 years in 10 and therefore is characterised as having reliable water of suitable quality. The small area of BSAL identified within the Project area identified to fulfil the criteria for soil fertility and land capability is not located within 150 m of a regulated river or unregulated river. The Gunnedah Formation is considered to satisfy the BSAL criteria for yield and total dissolved solids. However, the Gunnedah Formation does not occur within the Project area. The closest occurrence of the Gunnedah Formation to the Project area is approximately 900m.

Value	Criteria	Site Verification
		The Narrabri Formation is not considered to satisfy the BSAL criteria for TDS.
	OR	
	Land that falls under soil fertility classes 'moderate' under the Draft Inherent General Fertility of NSW (OEH), and	No Class I or II land will be disturbed due to the Project and therefore, this criterion does not apply.
	Land Capability classes I or II under the Land and Soil Capability Mapping of NSW (OEH), and	As above.
	Reliable water of suitable quality, characterised by land having rainfall of 350mm or more per annum (9 out of 10 years); or properties within 150 m of a regulated river, or unregulated rivers where there are flows for at least 95% of the time (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 or less than 1,500 mg/L	As above.

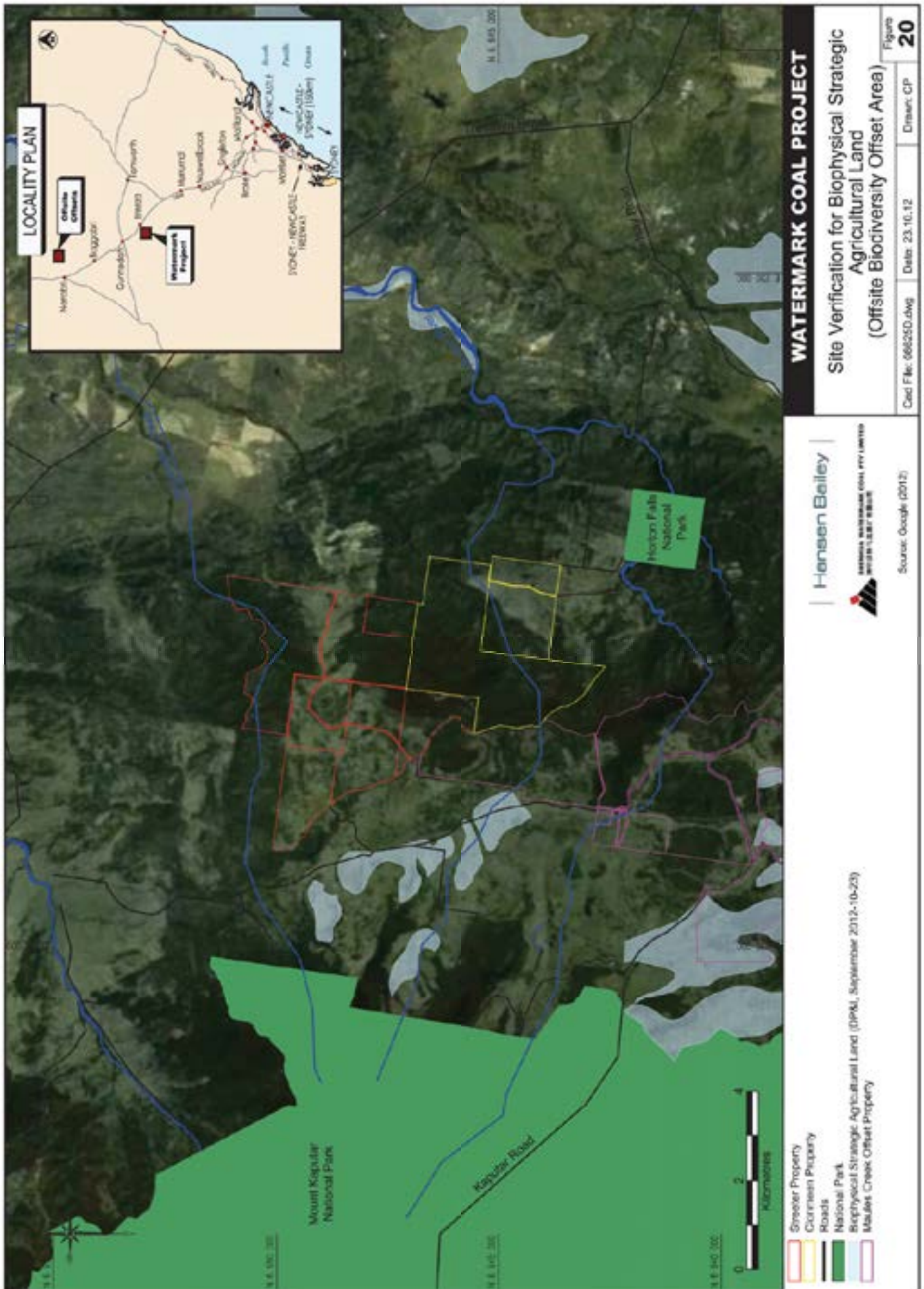
Onsite Biodiversity Offset Areas

The mapping of the SRLUP indicates that approximately 375 ha of BSAL may occur within the proposed onsite biodiversity offset areas (**Figure 19**). These areas are characterised by the Ponderosa and Conadilly soil landscapes which GSSE (2013) identified are expected to fulfil the BSAL criteria of 'high' to 'moderately high' fertility and land capability. Following site validation of the onsite biodiversity offset areas (GSSE, 2013) (see Appendix Y of the EIS), a further 321 ha of BSAL was identified, thereby increasing the total area to 696 ha. These areas will be set aside as ecological offsets for the Project in perpetuity.

Offsite Biodiversity Offset Areas

The mapping of the SRLUP indicates that no BSAL is identified to likely occur within the offsite biodiversity offset areas (**Figure 20**) and site validation confirms this (GSSE, 2013) (see Appendix Y of the EIS).





8.6.2 Agricultural Productivity

The gateway criteria require an assessment on the potential impacts of the Project to BSAL. Specifically, the gateway criteria require an assessment of the following:

“Whether the proposal would significantly reduce the agricultural productivity of the land based on a consideration of:

(a) Impacts on the land through surface area disturbance and subsidence;

(b) Impacts on:

(i) soil fertility

(ii) rooting depth, or

(iii) soil profile materials and thicknesses;

(c) Increases in land surface microrelief or soil salinity, or significant changes to soil pH, and

(d) Impacts on Highly Productive Groundwater, including the provisions of the Aquifer Interference Policy”

This section describes the potential impacts of the Project in regard to the above gateway criteria.

Project Area

As described in **Section 8.6.1**, a small area of BSAL (96.1 ha) has been identified within the Project area. This area of BSAL is located within the proposed disturbance area, and thus, the proposed open cut mining areas of the Project.

As such, the Project will impact on 96.1 ha of BSAL through surface disturbance associated with open cut mining. Further, the Project will impact on the soil fertility, rooting depth, soil profile materials, soil thickness and surface microrelief of the 96.1 ha of BSAL identified to be impacted by the Project due to disturbances by open cut mining.

As discussed in **Section 8.2.7**, the Project is not predicted to significantly impact on Highly Productive Groundwater within the Project area and surrounds.

Therefore, the Project is only predicted to significantly reduce the agricultural productivity of 96.1 ha of BSAL within the Project area.

Based on current land use, the BSAL within the Project area is used for winter cropping. Based on a crop rotation of two years wheat and one year canola, the gross value of agricultural production from this area is \$51,524 per annum and the net value of production is \$22,906 per annum. This is from 193 tonnes of wheat and 52 tonnes of canola.

The gross value of agricultural production foregone as a result of the loss of BSAL amounts to \$0.7M (at 7% discount rate). This present value assumes that the BSAL is removed from agricultural production in perpetuity. The net value of future agricultural foregone as a result of this BSAL is \$0.3M present value at 7% discount rate (Gillespie Economics, 2012).

Onsite Biodiversity Offset Areas

As noted in **Section 8.6.1**, the mapping of the SRLUP indicates that approximately 375 ha of BSAL may occur within the onsite biodiversity offset areas (**Figure 19**). Following soil validation of the onsite biodiversity offset areas (GSSE, 2013) (see Appendix Y of the EIS), a further 321 ha of BSAL was identified, thereby increasing the total area to 696 ha.

The Project is proposing to utilise the onsite biodiversity offset areas for ecological conservation purposes by excluding agricultural activities and actively regenerating the land to native woodland and grassland. The good quality soils also allow koala friendly tree species to be regenerated to support Koala populations.

As such, the onsite biodiversity offset areas will experience a change in land use as a result of the Project; however the inherent agricultural productivity of the land will not be affected or reduced. No land within the onsite biodiversity offset areas will be subject to surface disturbance or will experience impacts to soil fertility, rooting depth, soil profile materials, soil thickness, surface microrelief and soil salinity. Further, as discussed in **Section 8.2.7**, the Project is not predicted to significantly impact on Highly Productive Groundwater within the Project area and surrounds.

Therefore, the Project will not significantly reduce the agricultural productivity of potential BSAL within the onsite biodiversity offset areas, but rather change the land use. As discussed in **Section 8.1.2**, conservatively assuming that agricultural production from the onsite biodiversity offset areas ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$24.0 M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$10.7 M (using a 7% discount rate) (Gillespie Economics, 2012).

Offsite Biodiversity Offset Areas

As noted in **Section 8.6.1**, the mapping of the SRLUP indicates that no BSAL is identified to likely occur within the offsite biodiversity offset areas (**Figure 20**).

The Project is proposing to utilise the offsite biodiversity offset areas for ecological conservation purposes by excluding agricultural activities and actively regenerating the land to native woodland and grassland.

As such, the offsite biodiversity offset areas will experience a change in land use as a result of the Project; however the inherent agricultural productivity of the land will not be affected or reduced. No land within the offsite biodiversity offset areas will be subject to surface disturbance or will experience impacts to soil fertility, rooting depth, soil profile materials, soil thickness, surface microrelief and soil salinity. Further, as discussed in **Section 8.2.7**, the Project is not predicted to significantly impact on Highly Productive Groundwater within the Project area and surrounds.

Therefore, the Project will not significantly reduce the agricultural productivity of potential BSAL within the onsite biodiversity offset areas, but rather change the land use. As discussed in **Section 8.1.3**, conservatively assuming that agricultural production from the offsite biodiversity offset areas ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$5.6M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$2.3 M (using a 7% discount rate) (Gillespie Economics, 2012).

8.6.3 Critical Industry Clusters

Under the SRLUP, no Critical Industry Clusters have been identified in the New England North West region. As such, this gateway criterion does not apply to the Project.

8.6.4 Cost Benefit Consideration

The gateway criteria require an assessment of “*whether the proposal would be in the public interest through a cost benefit analysis in accordance with the Government’s published cost benefit methodology.*”

As discussed in **Section 8.1.7**, Gillespie Economics (2012) undertook a benefit cost analysis which included an estimation of the present value of production costs and benefits of the Project over a 30 year period. The present value of net production benefits of the Project to Australia are estimated at \$1,310 M. In contrast, the present value of future use of agricultural lands and water resources that would be utilised by the Project is estimated at \$39 M and \$1 M, respectively. Gillespie Economics concluded that based on these comparative values, the Project is considered to be significantly more efficient than continued agricultural production and therefore is in the public interest.

8.6.5 Consultation

The gateway criteria require a consideration of “*any submissions received from relevant agencies, council(s) and the community, and any advice received from the Commonwealth Independent Expert Scientific Committee*”.

Section 6 of this report outlines the relevant issues raised by regulatory authorities, local councils and the community. No advice has been received to date from the Commonwealth Independent Expert Scientific Committee.

8.6.6 Summary

In summary, the Project will impact and significantly reduce the agricultural productivity of 96.1 ha of BSAL by open cut mining disturbance.

The Project is proposing to utilise the onsite and offsite biodiversity offset areas for ecological conservation purposes by excluding agricultural activities and actively regenerating the land to native woodland and grassland. As such, the onsite and offsite biodiversity offset areas will experience a change in land use as a result of the Project; however the inherent agricultural productivity of the land will not be affected or reduced. Therefore, the Project is not considered to significantly reduce the agricultural productivity of potential BSAL within the onsite and offsite biodiversity offset areas.

Gillespie Economics (2012) concluded that based on these comparative values, the Project is considered to be significantly more efficient than continued agricultural production and therefore is in the public interest.

8.7 Air Quality

In most cases the impacts of dust deposition 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, use of water carts and dust suppressants, and implementation of blast management techniques will also ensure that dust deposition concentration 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 deposition concentrations.

Modelling by PAE Holmes (2012) (Appendix G of the EIS) predicts that the cumulative annual average dust deposition concentration predicted for privately owned properties is below 4g/m²/month in all modelled years. When considering the Project's emissions alone the dust deposition concentration predicted for privately owned properties are less than 2g/m²/month in all modelled years.

8.7.1 Dust impacts 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".

The implementation of real time monitoring systems within the vicinity of the Project will also ensure that dust deposition concentration 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 deposition concentrations.

8.7.2 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 PAE Holmes (2012) (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 deposition concentrations and emissions in further detail (see Appendix G of the EIS).

8.7.3 Dust impacts on Cotton

Due to stakeholder concerns regarding potential impacts of dust on cotton as a result of the Project, a study has been completed by SBA as part of this assessment to investigate the issue (see **Appendix 8**).

This study stated that:

- A CSIRO study found that Australia had the lowest levels of contaminants of all cotton crops (2006/2007) imported by an international spinning mill with no mention of dust, dirt or sand;
- Discussions with Australian cotton industry professionals (including Australian Cotton Ginners Association, Queensland Cotton's Moura Gin, Cotton Seed Distributer Wee Waa, Auscot Warren and CSIRO Geelong) largely indicated that dust impacts on cotton was not a known issue. Where there had been incidental cases of road dust on crops, it was concluded that dust was easily and effectively removed at the pre-cleaning phase of the ginning process and did not affect cotton quality; and
- Significant dust loads for extended periods of time are required for a plant to experience any adverse impacts.

As such, the predicted dust deposition rates generated by the Project will have minimal impact on the productivity of vegetation, including cotton, outside the Project Boundary.

The implementation of real time air quality monitoring systems within the vicinity of the Project will also ensure that dust deposition concentration 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 deposition concentrations.

The Air Quality and Greenhouse Gas Impact Assessment address the extent of dust deposition concentrations and emissions in further detail (see Appendix G of the EIS).

8.8 Noise

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 owned by Shenhua Watermark and some neighbouring private land owners.

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.

Mining operations within the region and abroad have for many years used company-owned land within close proximity to open cut mining to raise beef cattle and operate dairy farms. 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.

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, and establishment of acoustic shields, such as noise bunds, will assist in reducing noise and blasting impacts.

Based on the findings of the Acoustic Impact Assessment, noise and blasting impacts on agricultural resources and enterprises in the locality is assessed as minimal. The Acoustic Impact Assessment addresses the extent of noise and blasting in further detail (see Appendix H of the EIS).

8.9 Visual

A visual impact assessment was undertaken by JVP Visual Planning and Design (JVP) and is provided in Appendix J 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.

The visual impacts associated with the Project will affect viewing locations to the north, south, east and west of the Project Boundary; however, such impacts vary in significance and in time during the life of the Project until rehabilitation is completed.

Due to the high to moderate sensitivity of nearby receivers, the visual effect of each mining area typically creates high and moderate visual impacts. This will typically be reduced to moderate and low following completion and rehabilitation of Overburden Emplacement Areas and backfilling of the Eastern and Southern Mining Areas. These impacts will further be reduced to very low as rehabilitation matures. By Year 30, the final landform will be integrated with the existing landscape.

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 visual impacts as a result of the Project.

Further, the productivity or the marketability of products from surrounding enterprises will not be affected by the visual impact 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 J of the EIS).

Numerous mitigation measures have been incorporated into the design and operating plans for the Project that will reduce the visual effect and mitigate the visual impact of the Project on viewing locations. A Visual and Lighting Management Plan will also be developed for the Project and will include onsite mitigation and management measures to reduce visual impacts further. Where deemed necessary through consultation within relevant stakeholders, offsite mitigation and management measures will be implemented.

8.10 Traffic and Support Infrastructure and Services

A Traffic and Transport Impact Assessment undertaken for the Project (DC Engineering, 2013) (see Appendix AB of the EIS) assessed the impacts on the road and rail network as a result of the Project.

During the construction and operations phase, the Project will utilise key road access routes, including the Kamlaroi Highway, Mine Access Road (once constructed) and Court Lane (construction phase only). The Mine Access Road will be the main access point for all Project traffic.

Modelling undertaken by DC Engineering strongly indicates that the traffic generated by the construction and operation (peak) phase 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 1.9% per annum growth in background traffic.

Permanent road closures will be required to allow for the Project, including all roads within the disturbance boundary, Court Lane and the section of The Dip Road between Clift Road and Cull Road. These roads currently service rural properties. An alternative route will be provided for the Dip Road closure via an upgraded Cull Road, upgraded and new Werner Road, and Clift Road.

The modelled increase in travel time (average of five minute per vehicle) associated with this alternative route is regarded as acceptable.

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 and therefore no adverse impacts are predicted.

The Project will transport coal to the Port of Newcastle Port by rail on the Werris Creek - Moree Railway Line. The Traffic and Transport Impact Assessment indicated that up to eight train movements (four laden and four non-laden) will be generated each haul day by the Project. This rail line is also used for the transport of agricultural commodities, primarily grain, for export also to Newcastle.

ARTC (2011) have already conducted extensive capacity demand forecasting along this line and have identified potential weak points along the network. Their strategy document (ARTC, 2011) identifies a range of network upgrades that would be required to facilitate the existing and forecast demand increases. As these have already been recommended by the ARTC, they are not raised as mitigation measures in this assessment.

8.11 Labour Supply

A Social Impact Assessment was undertaken for the Project (Hansen Bailey, 2013) (See Appendix AE of EIS).

The Gunnedah, Liverpool Plains and Tamworth Regional LGAs have an economy that is dominated by the agricultural sector. Close to 50% of the regional economy in the Namoi Valley is directly or indirectly dependent on agriculture (Parsons Brinckerhoff, 2010).

Coal mining activities previously operating in the region had mostly closed in the 1990s due to low profits. However, the mining and resources industry has recently resumed within the area, particularly in the last several years. Local government development statistics from 2007 to 2011 reflect this growth in Gunnedah, while developments in the same period in the Liverpool Plains LGA decreased and fluctuated in the Tamworth LGA (DP&I, 2008b; 2009; 2010).

In June 2012, the rates of unemployment within the Gunnedah (6.7%), Liverpool Plains (6.6%) and Tamworth Regional (6.3%) LGAs were higher than neighbouring LGAs, including the Upper Hunter LGA (1.7%) and Narrabri LGA (5.2%). Rates were also higher than NSW (5.2%) (DEEWR, 2012b).

The 'agriculture, fishing and forestry' sector accounted for 17% of total employment of people over 15 within the Gunnedah LGA in 2011, 24% in the Liverpool Plains LGA and 7% in the Tamworth Regional LGA. These were the highest proportions of industry sector employment for the Gunnedah and Liverpool Plains LGAs, while the highest proportion for the Tamworth Regional LGA was the 'health care and social assistance' sector at 14% (ABS, 2012g).

The 'mining' sector more than doubled in employment in the Liverpool Plains LGA between 2006 and 2011 and more than tripled in the Gunnedah LGA in that period. In 2011, this equated to 3% and 7% of the total employed people in those LGAs respectively.

The number of people employed in the 'mining' sector in Tamworth Regional LGA almost tripled between 2006 and 2011, representing 0.8% of the total employed people in the LGA in 2011.

The Social Impact Assessment undertaken for the Project (Hansen Bailey, 2013) (see Appendix AE of the EIS) showed that in 2012 there is a labour supply surplus within the regional area of the Project, including:

- 2,595 unemployed people living in the Sub Regional Study Area;
- An available labour supply of 1,010 people in the Gunnedah LGA (up from 921 in 2006), including a labour surplus of 591 (427 in 2006);
- An available labour supply of 734 people in the Liverpool Plains LGA (up from 612 in 2006), including a labour surplus of 477 (422 in 2006); and
- An available labour supply of 4,674 people in the Tamworth Regional LGA (up substantially from 2,575 in 2006), including a labour surplus of 2,755 (1,634 in 2006).

As there is more than adequate labour supply within the regional area to source workforce personnel (600 personnel for construction phase and 600 personnel for operation phase), the Project is not anticipated to impact on the labour supply available for the operation of agricultural enterprises (Hansen Bailey, 2013) (See Appendix AE of EIS).

Caution must be taken when applying this data to the Project, particularly as the skills and working intentions of the available labour force is not known. However, it appears that the Sub Regional Study Area will be able to absorb a substantial proportion of the jobs created by the Project.

Shenhua Watermark would strongly prefer that non-local hires eventually settle locally in the Sub Regional Study Area, therefore avoiding a 'fly-in / fly-out' (FIFO) or 'drive-in / drive-out' (DIDO) workforce.

There is anecdotal evidence in the Upper Hunter 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 their 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).

In addition to increasing employment opportunities generally, it is also expected that the Project will assist in improving the current high rates of youth and Indigenous unemployment in the study area. The Project also has the potential to assist in improving women's labour force participation rates.

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

9 Mitigation and Management Measures

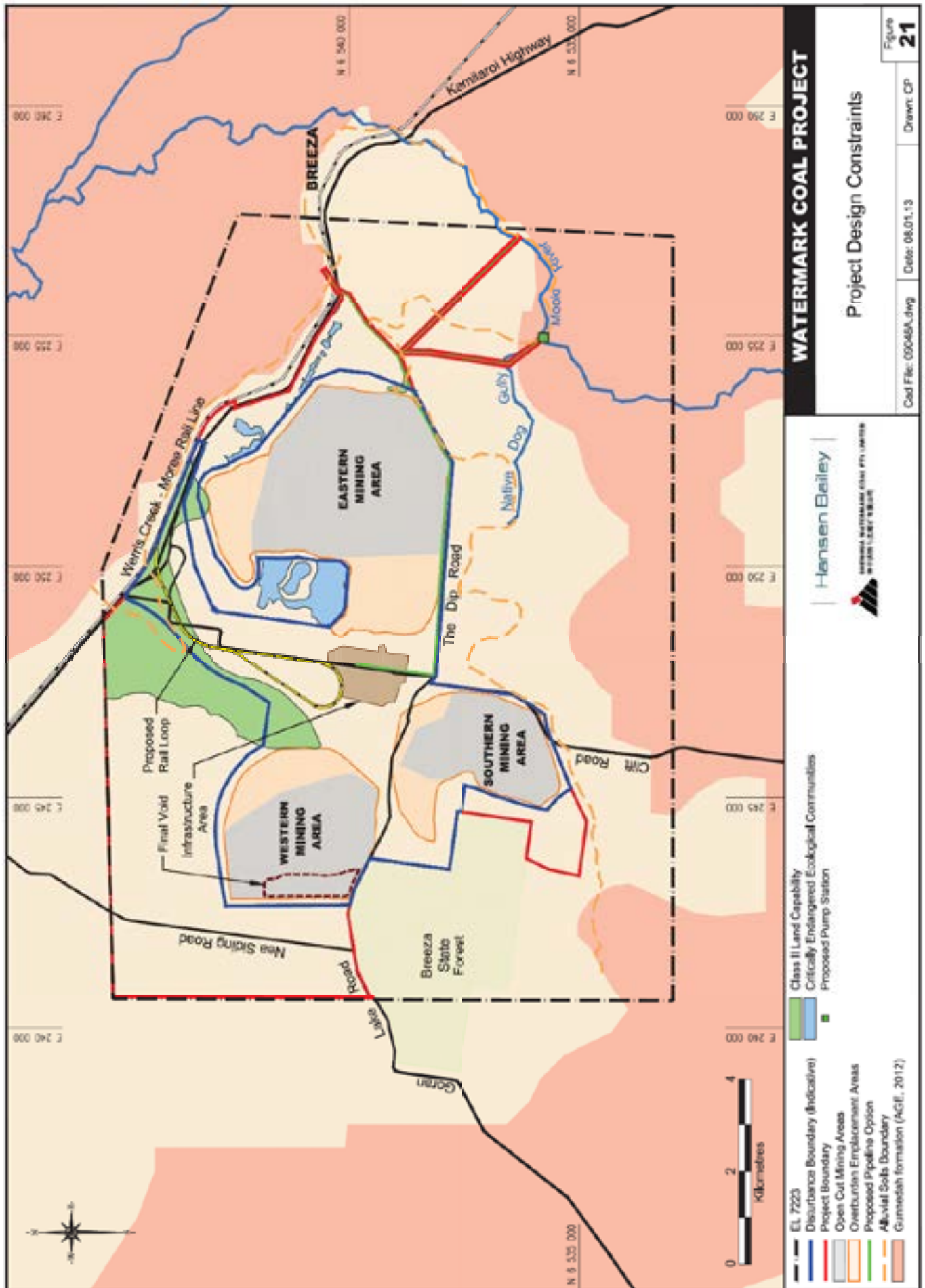
This section describes the alternatives which were considered during the design of the Project to minimise impacts to agricultural resources. This section also outlines the recommended mitigation, monitoring and management measures to be implemented during the Project to minimise impacts to agricultural resources.

9.1 Project Design Review

The development of the Project included the consideration and refinement of a number of mine plans and operational alternatives. A key focus of these Project design refinements was to minimise impacts to agricultural resources. Appendix C (*Mine Plan Justification Report* by Hansen Bailey and GHD, 2012) of the EIS provides a summary of the work that was undertaken in order to arrive at the proposed Project design.

The mine plan as proposed incorporates the following so as to reduce impacts to agricultural resources (see **Figure 21**):

- The protection of the groundwater regime of the black soil plains with a minimum 900 m horizontal barrier of natural material between active mining areas and the highly productive Gunnedah Formation aquifer;
- A minimum 150 m buffer to alluvial black soils and black soil plains;
- Disturbance of only land owned by Shenhua Watermark;
- No disturbance of Mt Watermark;
- No disturbance of Breeza State Forest;
- There is only one final void which is distant from the black soil plains and Gunnedah Formation;
- The OEA merges into the natural topography (such as Mt Watermark and Black Mountain);
- Reduced slopes of the OEA to facilitate the re-establishment of Box Gum Woodland on the mine rehabilitation and to achieve the maximum post-mining land capability classification practicable;
- Early and progressive rehabilitation of the OEA;
- Early development and rehabilitation of the northern OEA in the Eastern Mining Area to assist as a visual screen;
- Allocating night mining activities to locations deeper in the open cut mining area to enhance shielding effects where practicable;
- Haul routes designed to reduce exposure in elevated areas and to reduce the overall haul distance;
- Utilising large equipment to reduce the number of mobile equipment operating at any one time;
- Implementation of best-practice sound power levels on all of the equipment fleet to reduce noise impacts;
- The CHPP, ROM bins and conveyors include shielding, where practicable, to reduce air and noise impacts;



- Rail loop with minimum grade to reduce the grade and thus locomotive power and noise while loading;
- Minimal drop height to/from equipment during loading/unloading activities where practicable;
- Haul routes and active exposed mining areas are to be suppressed with chemical agents and surface crusting agents;
- The train load out water spray system will have the ability to apply a dust suppressant to the loaded coal wagons if deemed necessary;
- Avoidance of disturbance of 351 ha of Class II land capability;
- A rehabilitation strategy to reinstate approximately 3,233 ha of Class III rural land capability, of which approximately 1,000 ha is to be used for agriculture; and
- Situating the MIA to avoid CEEC where possible and to obtain maximum natural shielding from private receivers.

9.2 Environmental Management System

Shenhua Watermark will develop and implement an Environmental Management System (EMS) for the Project, consistent with the principles of AS/NZS ISO 14001:2004. The EMS will be a key tool in assisting Shenhua Watermark to reduce any impacts to agricultural resources. The EMS will comprise a number of Environmental Management Plans, an Environmental Monitoring Program (EMP), associated operating procedures and standards, and requirements to report on the Project's performance.

The EMS will be subject to regular reviews and audits, recording of incidents and non-conformances and the maintenance of a Corrective Action Register. All Management Plans will also have measurable Key Performance Indicators. All of these tools will assist in regular feedback and improvement of the EMS, which in turn assesses its effectiveness.

9.2.1 Monitoring and Measurement

Since 2009, Shenhua Watermark has operated an Environmental Monitoring Program (EMP) for the purposes of obtaining relevant background monitoring data. The environmental monitoring network comprises of:

- Two meteorological monitoring stations;
- 17 air quality monitoring stations;
 - 13 dust deposition gauges; and
 - Four High Volume Air Samplers (HVAS) (including provisions for Particulate matter less than 10 µm (PM10), Particulate matter less than 2.5 µm (PM2.5) and Total Suspended Particulate (TSP) measurements)
- Five noise monitoring stations;
- 13 surface water monitoring stations; and
- 103 groundwater monitoring stations.

The existing EMP is described further in the EIS Main Volume. The existing EMP will be expanded for the Project, as indicatively shown in **Table 45**.

Further refinement of monitoring programs and management plans will be undertaken during the development approval process. A key component of the management plans will be the development of trigger levels and Trigger Response Action Plans, in consultation with stakeholders. The environmental monitoring program and data collected as listed in **Table 45** will form the basis in this regard.

Table 45
Proposed Monitoring Programs and Management Plans

Parameter Monitored	Management Plan	Parameters monitored	Frequency
Rehabilitation / Biodiversity Offset	Rehabilitation Management Plan Biodiversity Management Plan Biodiversity Offset Management Plan	Pasture Monitoring: • Ground cover (%); • Frequency of all plant species present (%); • Presence of weeds; • Estimated pasture yield (kg/ha); • Visual assessment of general health. • Soil Monitoring • Photo Monitoring • Weed monitoring • Geotechnical stability • Surface and groundwater monitoring	• Six Monthly
Surface Water	Water Management Plan	• Downstream and upstream surface water quality • Sediment dam water quality • Surface water flows	• Monthly
Groundwater	Water Management Plan	• Seepage/leachate • Groundwater levels • Water quality	• Monthly • Monthly • Quarterly
Air Quality	Air Quality and Greenhouse Gas	• Predictive meteorological forecasting • PM10 and PM2.5 Monitoring (including real time monitoring) • Dust Deposition • Total Suspended Particulate (TSP) • Regional Monitoring (control site)	• Daily • Daily • Monthly • Monthly • Monthly
Blasting	Noise and Blasting Management Plan	• Filming • Air blast overpressure (dB[Linear peak]); and • Peak particle velocity (mm/s).	• Daily
Noise	Noise and Blasting Management Plan	• Predictive meteorological forecasting • Real – time noise monitoring for day to day planning • Supplementary attended monitoring	• Daily • Daily • Quarterly
Meteorological Conditions	Air Quality Monitoring Plan	• Rainfall • Temperature @ 2m • Temperature @ 10m • Wind Speed @ 10 m • Wind Direction @ 10 m • Sigma Theta • Solar Radiation	• Daily
Traffic	Traffic Management Plan	• Traffic volume surveys • Amount of coal transported from site • Date and time of each train movement	• Annual • Daily • Daily
Waste	Waste Management Plan	• Quantities of waste • Waste streams	• Six Monthly

An Annual Review will continue to be prepared for the Project. This document will summarise company activities and performance in the areas of health, safety, environment and community. A copy of the Annual Review will be made available to the public in hard copy upon request or via the Shenhua Watermark website.

Further, all management plans and monitoring data will be made publicly available on the Shenhua Watermark website.

9.3 Proposed Agricultural Management Measures

This section describes the proposed management measures and monitoring plans recommended to be implemented for the Project to minimise potential agricultural impacts. The proposed management and monitoring plans should include trigger points and plans for predicted and unforeseen impacts of the Project. It should also include appropriate operational responses and remedial action, including the basis for each trigger response.

9.3.1 *Minimisation of Disturbance to Agricultural Lands*

The area of agricultural land disturbed by the Project at any one time should be minimised so that agricultural uses can continue where practicable. Detailed mine planning should minimise land disturbance in advance of operations and include provisions for progressive rehabilitation. This will assist in reducing impacts to agricultural lands.

9.3.2 *Continued Use of Existing Agricultural Lands*

It is recommended that Shenhua Watermark continue to work with land managers on Shenhua Watermark owned land where practicable. This will ensure the continued productivity of agricultural land not directly impacted by the Project.

A Land Management Plan should be prepared to guide the management of Shenhua Watermark owned land, including provisions for grazing and cropping management, erosion and sediment controls and weed and pest controls. This should be communicated and enforced with land managers to ensure the ongoing agricultural productivity of Shenhua Watermark owned land.

9.3.3 *Sustainable Farming Practices*

Project Area

Sustainable farming practices, including reduced till farming and rotational grazing techniques should be implemented in available areas outside of the Project disturbance boundary within the Project area, including implementation of measures as proposed by the Namoi CMA for Best Management Practices of the appropriate LMU. Shenhua Watermark should ensure that as part of the Licences to Occupy, land managers will be required to commit to the implementation of the program as outlined in any collaboration agreement that Shenhua Watermark and the CMA may develop to manage the natural resources while managing the land to its full potential.

Onsite Biodiversity Offset Areas

In the event that the onsite biodiversity offset areas are managed in part for agricultural purposes, sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate LMU as set out by the Namoi CMA.

Offsite Biodiversity Offset Areas

In the event that the offsite biodiversity offset areas are managed in part for agricultural purposes, sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate Land Capability and Agricultural Suitability Class as set out by the Boarder Rivers Gwydir CMA.

9.3.4 Soil Management

In order to reduce the potential for soil degradation within the Project Boundary, the following strategies will be implemented during operations and rehabilitation to achieve the desired post-mining land capability and agricultural suitability:

Subsoil and topdressing will be spread to depths and layers dependent on target land capability;

Materials will be stripped to indicated levels in a slightly moist condition and placed directly onto reshaped areas (i.e. to avoid the requirement for stockpiling), where practical;

Where topsoil resources allow, topsoil will be spread to a minimum depth of 100 mm on all re-graded OEA or disturbance areas. Topsoil will be spread, treated with fertiliser and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion;

Where materials must be stockpiled, efforts will be made to reduce compaction by keeping soil in as coarsely textured a condition as possible;

Stockpiles will be a maximum of 3 m in height and if stored for greater than 12 months, seeded and fertilised and treated for weeds prior to respreading;

An inventory of designated areas and available soil will be maintained to ensure adequate topsoil and subsoil materials are available for planned rehabilitation activities;

Thorough seedbed preparation will be undertaken to ensure optimum establishment and growth of vegetation with all topsoiled areas lightly contour ripped to create a “key” between the soil and the overburden. Ripping will be undertaken on the contour, preferably when soil is moist. The respread topsoil surface will be scarified prior to, or during seeding, to reduce runoff and increase infiltration;

Regrading will be undertaken where required to produce slope angles, lengths and shapes that are compatible with the land use and not prone to an unacceptable rate of erosion. This will be done in integration with drainage structures and dams capable of conveying runoff from the newly created catchments whilst minimising the risk of erosion and sedimentation (including contour furrows or contour banks at intervals down the slope, contour ripping across the grade, and graded banks where required); and

Engineered waterways, spillways and sediment control dams (using erosion blankets, ground cover vegetation and/or rip rap) will also be implemented to capture sediment laden runoff.

9.3.5 Dust Management

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 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.

9.3.6 Noise Management

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, installation of noise reduction technology on mobile equipment and infrastructure, implementation of blast management techniques, and establishment of acoustic shields, such as noise bunds, will assist in reducing noise and blasting impacts.

9.3.7 Water Management

The Project is predicted to result in the annual average relocation of approximately 257 ML/year of water from agricultural purposes to coal mining purposes. Shenhua Watermark will hold the necessary WALs under the relevant Water Sharing Plans prior to extraction.

A Water Management Plan should be developed for the Project, which includes the monitoring of surface water and groundwater. The Water Management Plan will minimise offsite water quality impacts and describe the water management protocols of the site and any required response procedures or remedial actions.

9.3.8 Weed and Pest Management

Shenhua Watermark should develop and implement a weed and pest management plan to control the distribution of invasive species and feral animals within the Project area, other Shenhua Watermark owned land and the offset properties. This plan should include the commitment of appropriate resources (physical, financial and labour) to ensure it is implemented in an effective manner.

Shenhua Watermark should consult with the Central North Livestock Health and Pest Authority as to the appropriateness of the plan. A monitoring and reporting system will be an integral part of the management plan.

9.3.9 Re-establishment of Agricultural Land

To compensate for the loss in available agricultural land as a result of the Project, at least 1,000 ha of the post-mining landform (rehabilitated disturbance area) will be returned to a Class III rural land capability. The area of Class III rural land capability that will be returned to agricultural production is shown in **Figure 17** and **Figure 29**. This area will be dedicated to agricultural purposes following cessation of mining and completion of rehabilitation works, in accordance with the management measures included in the Rehabilitation and Mine Closure Strategy for the Project (see Appendix AA of the EIS).

The targeted 3,233 ha of post mining land capability Class III is achievable due to the creation of relatively gentle topography (see **Figure 30**), excess topsoil and subsoil resources available and previous examples of high quality mine rehabilitation of agricultural land.

The post mining landform contains relatively gentle slopes compared to the majority of mines within NSW and QLD, which allows for the potential establishment of land capability Class III on the rehabilitated landform. Furthermore these relatively gentle slopes will contain slope lengths and suitable soil depth designed to minimise erosion risk and ensure the land meets criteria for land capability Class III.

In order to ensure that at least 1,000 ha of land is returned to Class III rural land capability, the Rehabilitation Management Plan will include specific strategies and management measures for agricultural lands.

Key strategies that will be included in the document to assist in the rehabilitation of agricultural lands include:

- Measures to minimise impacts to agricultural lands located outside of the areas proposed to be disturbed for the Project);
- Minimisation of the total areas disturbed by mining activities at any one time;
- Procedures for the stripping, stockpiling and reuse of soil resources in landform development and rehabilitation activities;
- Progressive rehabilitation of disturbed areas following the completion of mining; and
- A staged rehabilitation strategy for the Project (for disturbance areas and biodiversity offset areas), including both short term and long term development objectives and targets, initial completion criteria and mine closure;
- Rehabilitation and agricultural land use monitoring to assess the development and effectiveness of Project rehabilitation areas; and
- Continued utilisation of Shenhua Watermark owned lands located outside of the Project disturbance and Biodiversity Offset Areas for sustainable agricultural enterprises.

The soil profile of this area shall be reconstructed as per the procedures and management measures included the Rehabilitation and Mine Closure Strategy for the Project (see Appendix AA of EIS). The soil profile of the lands rehabilitated to Class III land capability will be developed to be suitable for occasional cultivation and for the establishment of crops and pasture (both native and introduced).

It is difficult to prescribe the style of agricultural enterprise to be carried on this land in the future due to the ongoing evolution of farming systems with increased knowledge, changing agricultural technology (machinery, crop monitoring) and changing market returns over the medium to longer term. However farming systems that incorporate aspects of minimal tillage farming, pasture cropping, permanent pasture and combined cropping/grazing practices are anticipated to be most likely to be used.

As such, issues relating to paddock size and workability will be determined relevant to technology and knowledge applicable to agricultural enterprises at the post mining and rehabilitation phase.

Introduction of agriculture onto rehabilitated mine land shall be undertaken as soon as practicable having consideration of the relevant safety and legislative requirements relating to mine operations.

This rehabilitated land shall be returned to private ownership by Shenhua Watermark at the end of the Project as per any conditions of approval given to Shenhua Watermark when the land was initially purchased.

9.4 Demonstrated Capacity of Rehabilitation

The success of rehabilitation for the Project is dependent on a variety of factors, as listed below, which will be monitored in order to assess the effectiveness of rehabilitation, desired post-mining land capability and reinstatement of agricultural land.

9.4.1 Soil Balance

As discussed in **Section 12.5**, the topsoil and subsoil balance indicates that adequate soil resources will be available for reinstatement during rehabilitation to achieve the desired post-mining land capability and reinstatement of agricultural land. This will facilitate the reinstatement of the required soil layers and depths to ensure successful rehabilitation in line with the desired post-mining land capability.

9.4.2 Rehabilitation Monitoring

Regular monitoring of the rehabilitated areas should be undertaken during the initial vegetation establishment period and beyond to demonstrate whether the objectives of the Rehabilitation and Mine Closure Strategy are being achieved and whether a sustainable and stable landform has been provided.

Monitoring should be conducted periodically by independent, suitably skilled and qualified persons in at representative locations (one in every 100 ha of rehabilitation). Annual reviews of monitoring data to assess trends and monitoring program effectiveness should be conducted. The outcome of these reviews should be included in the Annual Review. Further details on the proposed Rehabilitation Monitoring Program are presented in Appendix AA of the EIS (Rehabilitation and Mine Closure Strategy prepared by GSSE, 2013).

9.4.3 Rehabilitation Success Criteria

Preliminary success criteria (or completion criteria) for the rehabilitation areas are presented in Appendix AA of the EIS (Rehabilitation and Mine Closure Strategy prepared by GSSE, 2013). The success criteria are performance objectives or standards against which rehabilitation success is demonstrated. The success criteria comprise indicators that reflect the nominated post-mine land uses, being native woodland and land capability Class III agricultural land.

Ongoing achievement of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated landscape is in a productive and sustainable condition.

The final success criteria will be developed and agreed in consultation with the relevant government agencies and community. These criteria should be reviewed every five years with stakeholder participation to ensure the nominated success criteria achieve the desired rehabilitation outcomes. Progress against the rehabilitation success criteria should be regularly monitored and reported annually to all relevant stakeholders by way of the Annual Review.

9.4.4 Rehabilitation Trials

A key component of successful rehabilitation is to regularly review performance and to identify areas for continuous improvement. In this regard, Shenhua Watermark should contribute to and actively participate in trials and research to improve mine site rehabilitation techniques and enhance performance outcomes. This may include trials and research into the re-establishment of native woodland, native grasses, Box Gum Woodland CEEC, riparian corridors and preferred Koala habitat. Consideration should also be applied to any trials and research into agricultural activities and performance indicators post-mining.

9.4.5 Previous Examples

The 'Alluvial Lands Project', carried out by Coal & Allied in 1994, was performed to validate recommended soil rehabilitation techniques to reinstate Class I and II land within a mining disturbance footprint, compared to nearby undisturbed control land. In order to measure the success of the Project, productivity yield monitoring and soil chemical attribute analysis was conducted from 2003 to 2007 and soil structure and fertility monitoring was conducted from 2003 to 2006 (Nelson & Stewart, 2007).

The study reported that the rehabilitated land contained optimal nutrient levels for lucerne crops, and exhibited higher than average yield for the district. The observed rehabilitated soil showed no significant difference in physical and chemical structure compared to control land, with a minor reduction in organic carbon that would naturally increase following correct pasture management techniques.

9.5 Progressive Rehabilitation

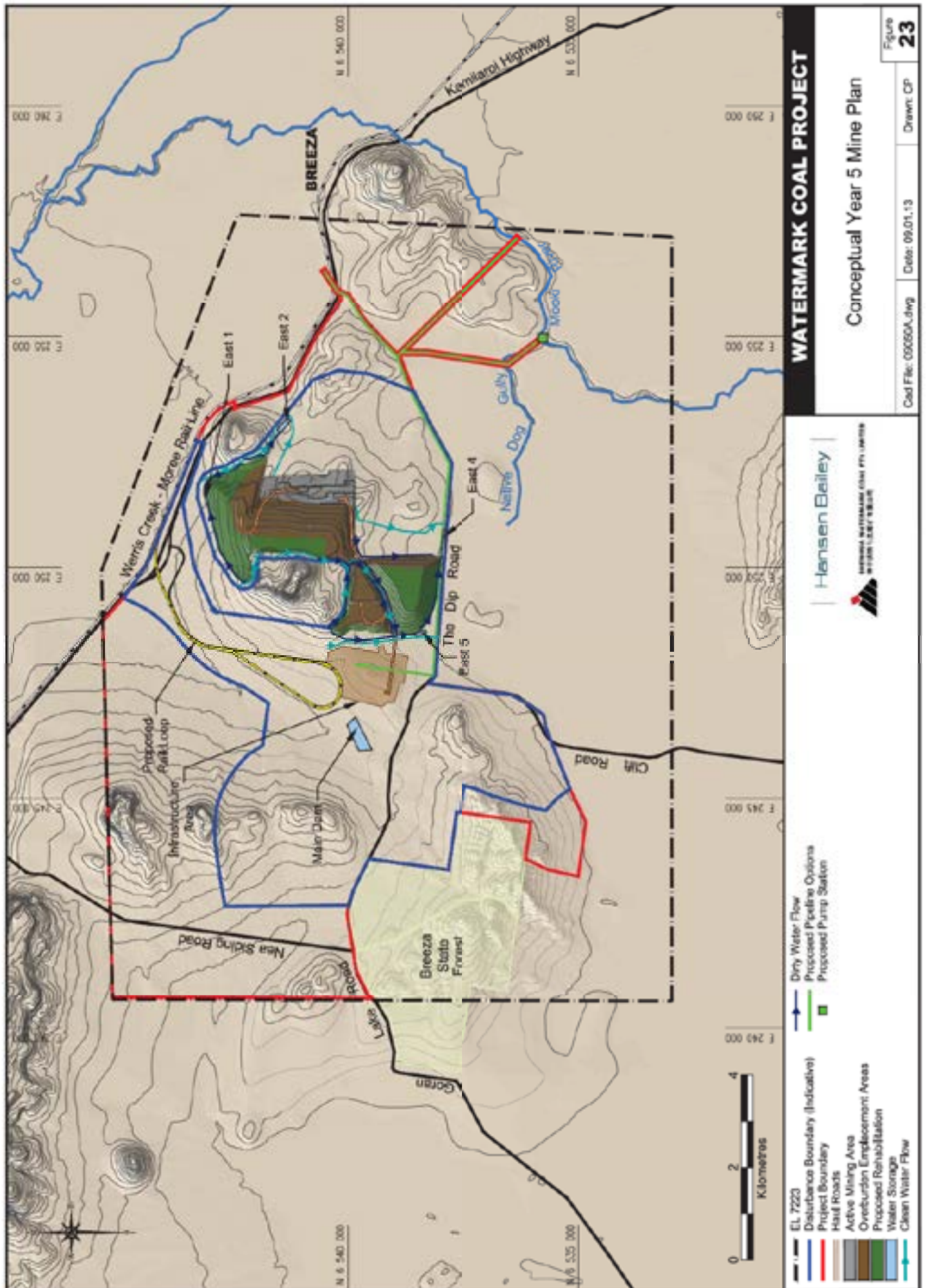
Progressive rehabilitation is an integral component of the Project. As mining advances, progressive rehabilitation will be scheduled as shown in **Figure 22** to **Figure 29**.

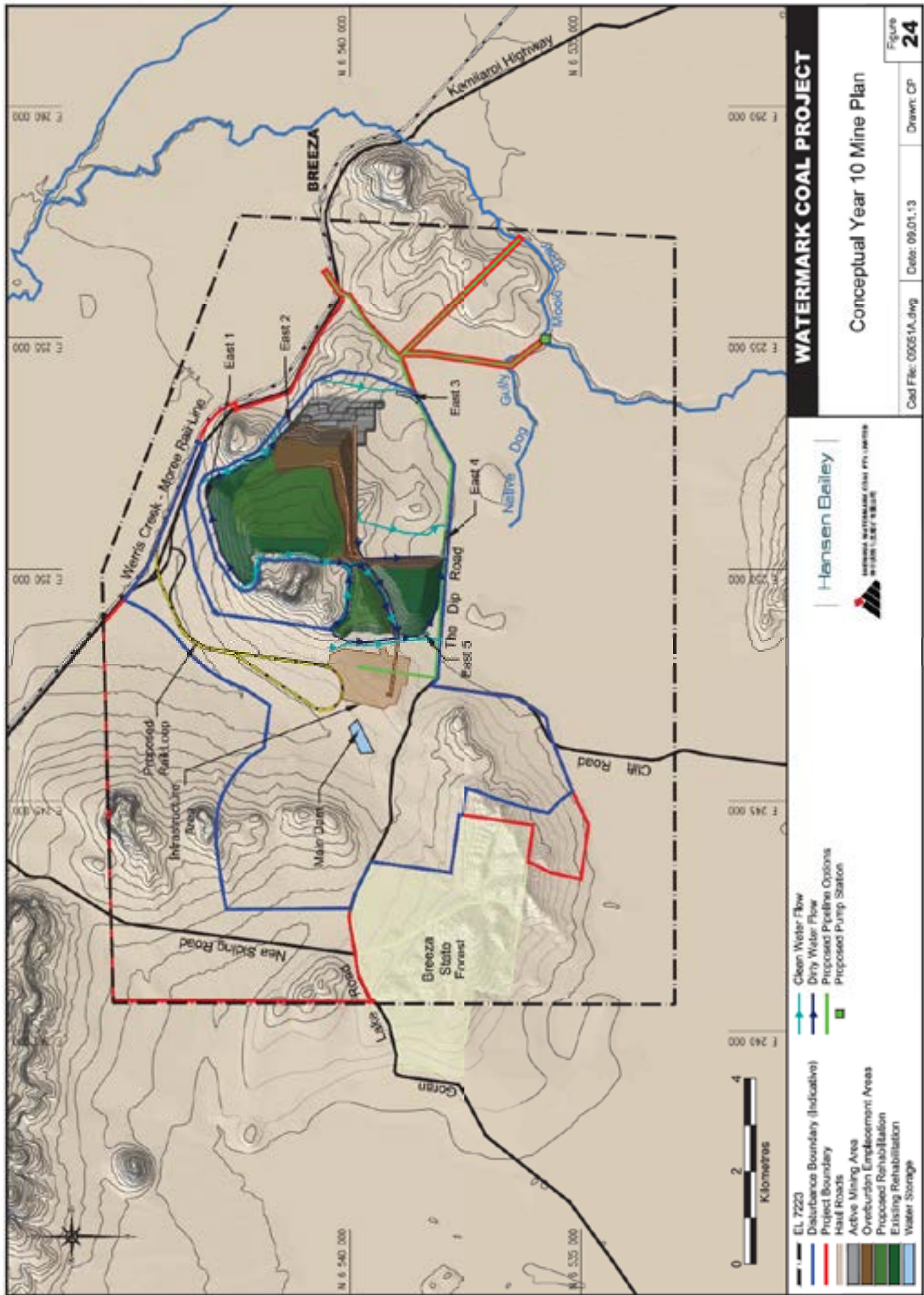
The rehabilitation program for the Project involves the infilling of the Eastern and Southern Mining Area voids, the establishment of a stable conceptual final landform, soil management and translocation, implementation of erosion and sediment controls, revegetation and relevant maintenance and monitoring to achieve a successful and self-sustaining landscape. The final landform will be developed to create slopes with gradients up to approximately 10 degrees (and generally less than this) and to allow competent material to be placed below the subsoil and topsoil layers ensuring that the exposure of large rocks on the final surface will be avoided. This is illustrated in the slope analysis of the conceptual final landform as shown on **Figure 30**.

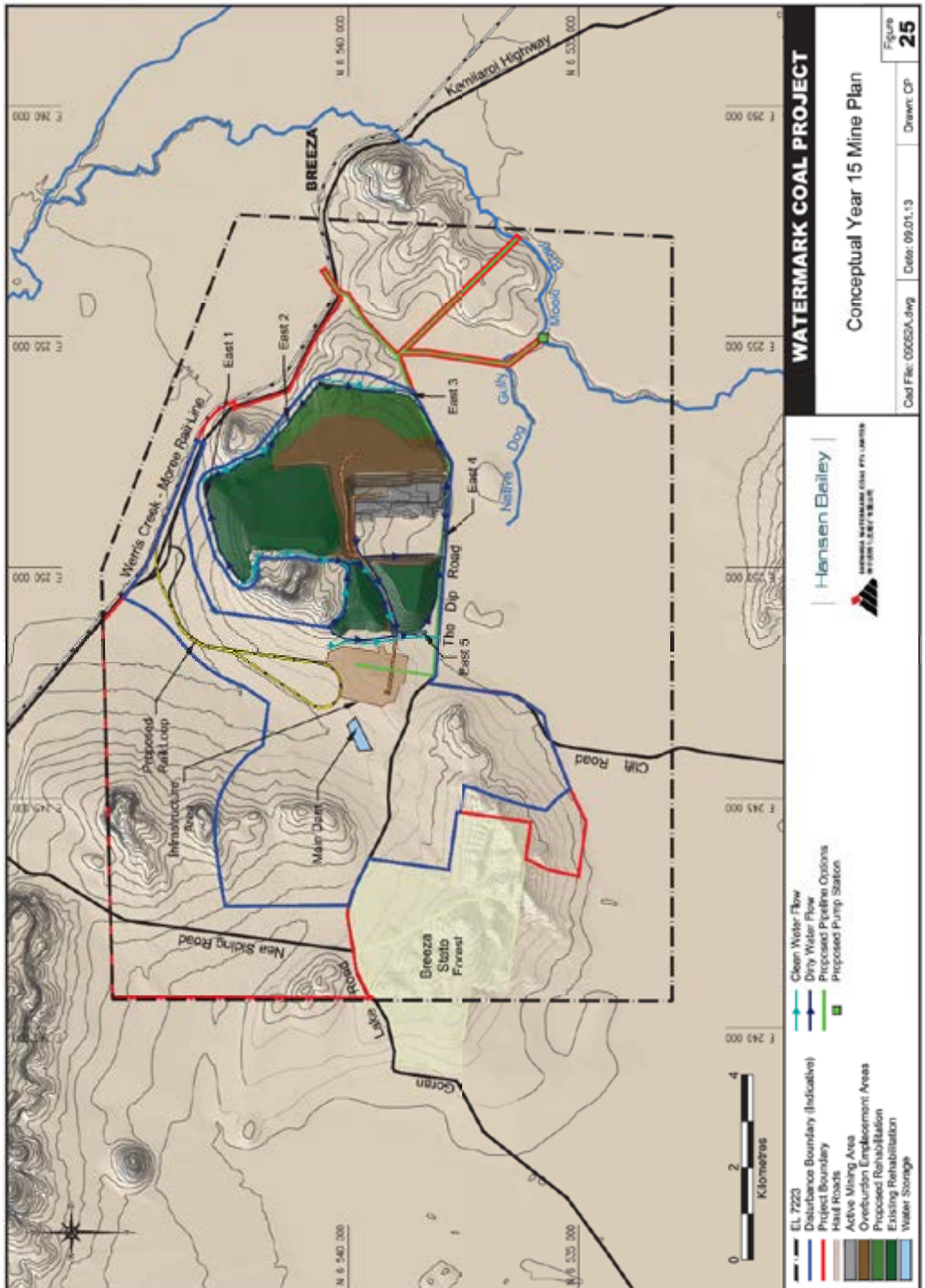
The targeted 3,233 ha of post mining land capability Class III is achievable due to the creation of relatively gentle topography, excess topsoil and subsoil resources available and previous examples of high quality mine rehabilitation of agricultural land.

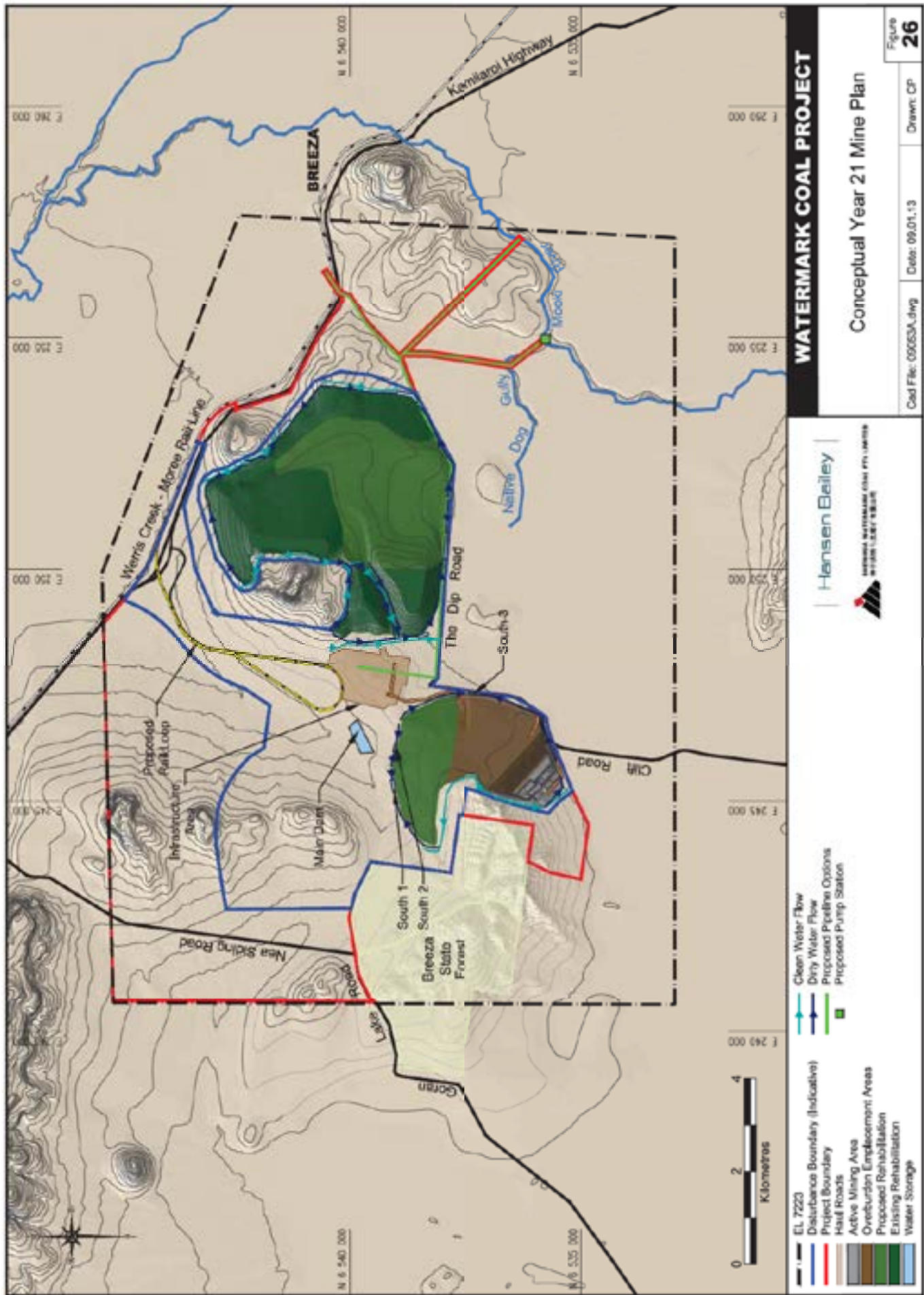
The OEAs will be progressively rehabilitated over the life of the mine as soon as practical. This staged approach will minimise the open cut mining disturbance area at any one time and reduce the environmental impacts from the open cut operations and on agricultural resources. The Rehabilitation and Mine Closure Strategy should be reviewed on a regular basis to ensure disturbed areas are kept to a minimum.

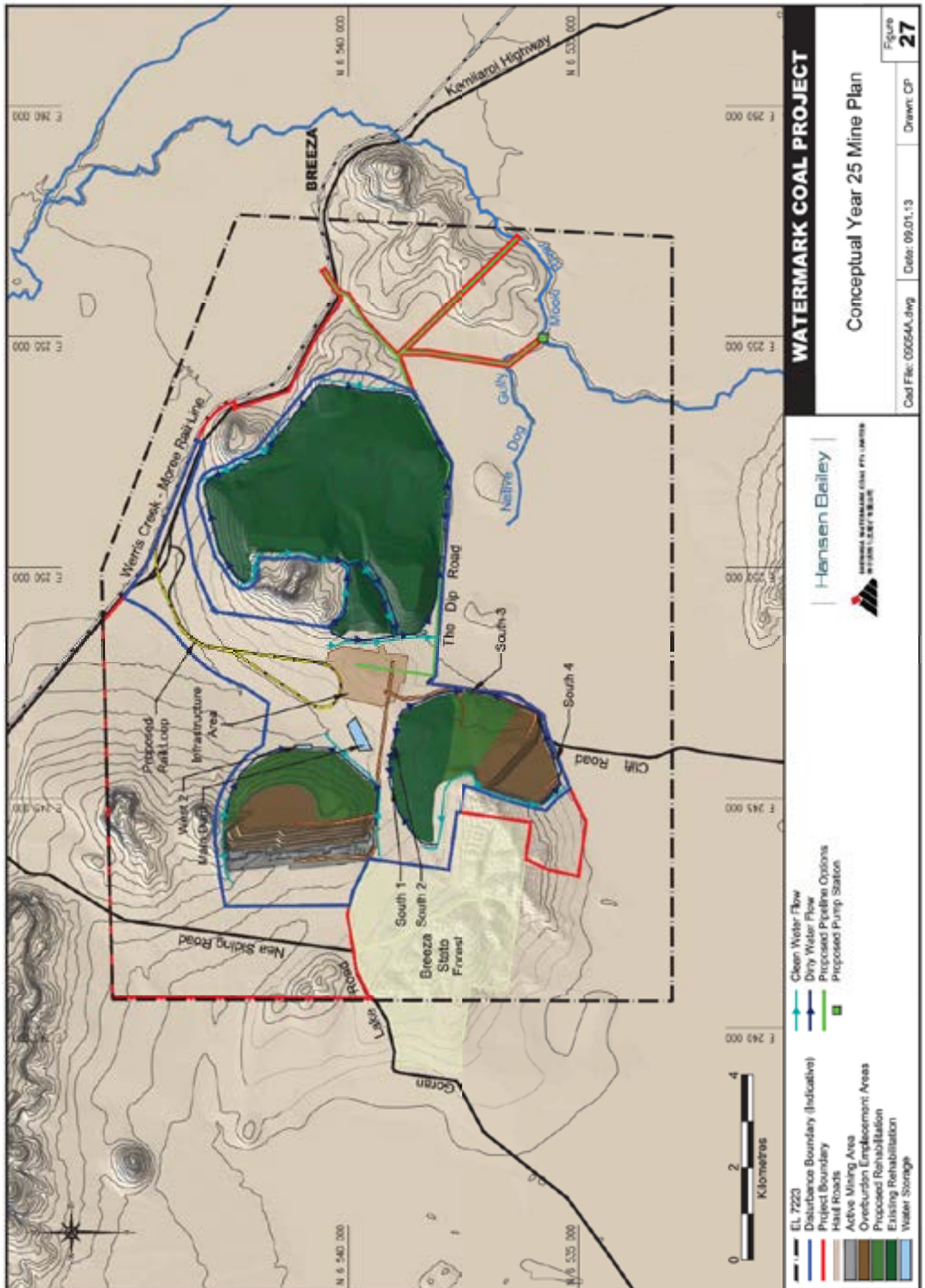


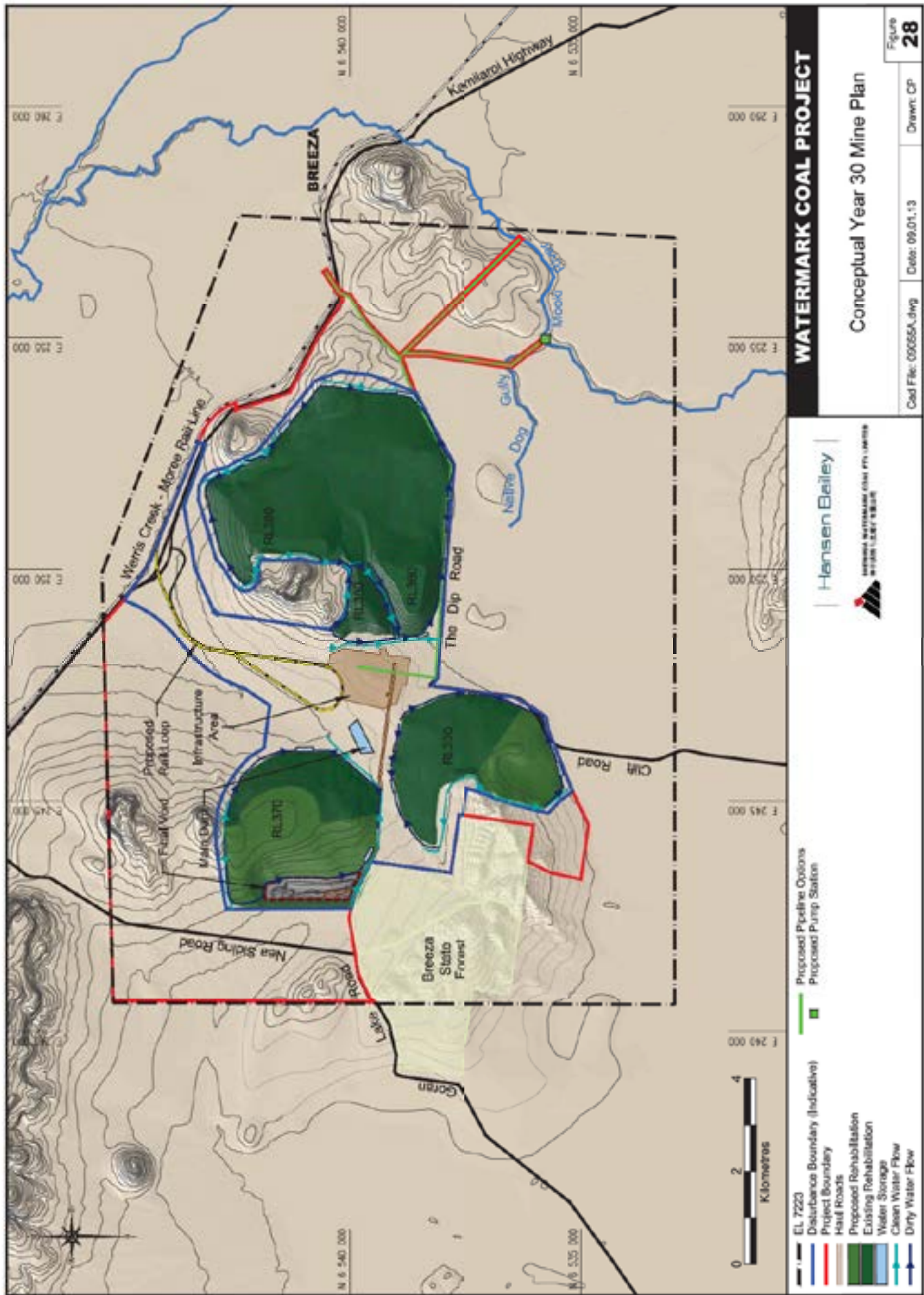




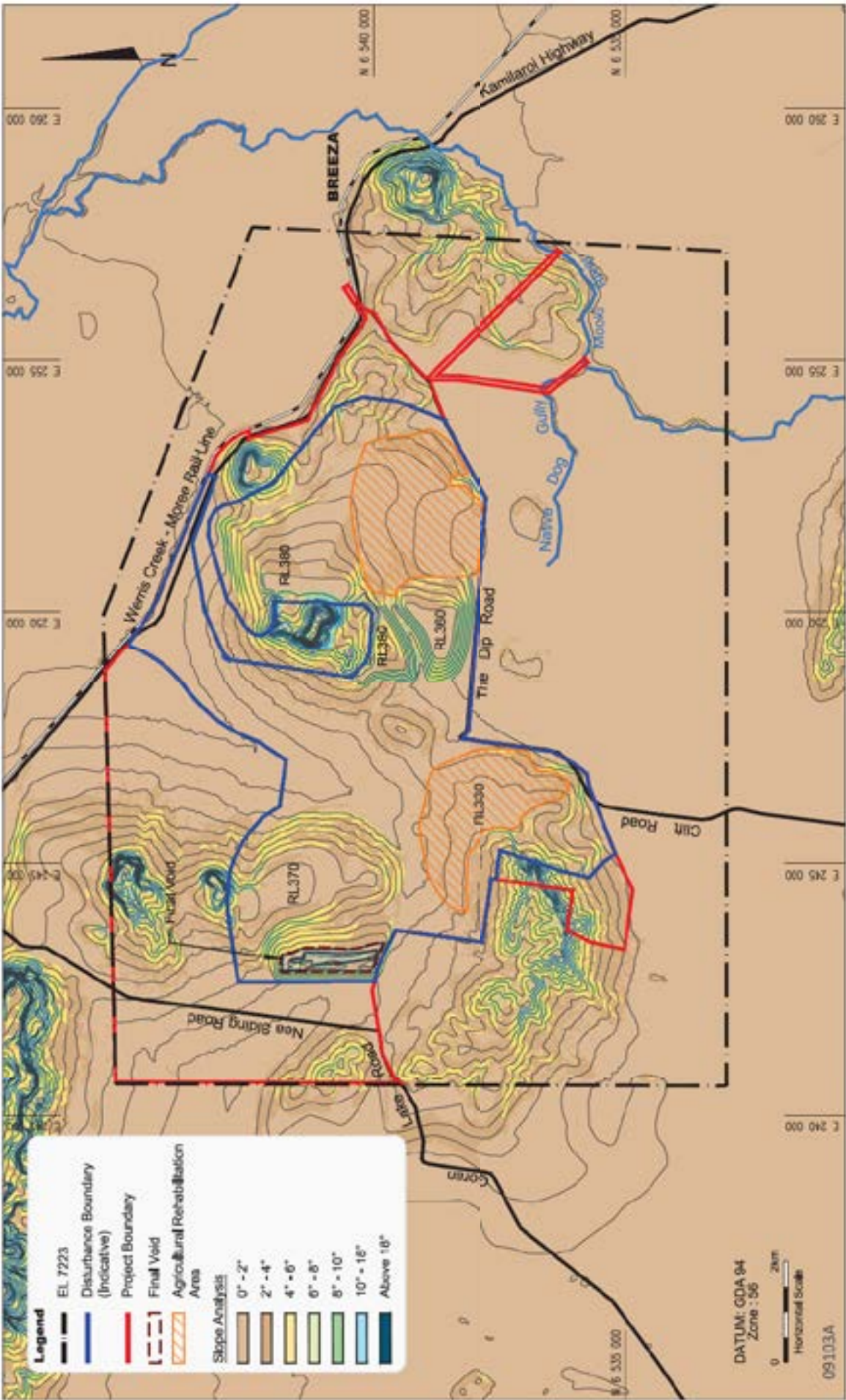












WATERMARK COAL PROJECT

Conceptual Final Landform Slope Analysis

FIGURE 30

10 Conclusion

The land that comprises the Project (9,500 ha) is owned by Shenhua Watermark. All of this land is licensed to previous land holders who use the land for beef cattle and sheep grazing, and winter as well as dry land winter cropping and summer dryland and irrigated cropping. The current gross value of agricultural production from Shenhua Watermark owned land, based on current land use, is \$5.5M per annum. The net value of agricultural production is \$2.8M.

An area of approximately 5,630 ha will be lost from agricultural production including 96.1 ha of land mapped as BSAL in the SRLUP. The current gross value of agricultural production from the disturbance area is \$2.7M per annum and the net value is \$1.6M.

The Project's Biodiversity Offset Package consists of two components: onsite biodiversity offset areas (7,797 ha) and offsite biodiversity offset areas (2,878 ha) to be conserved in perpetuity.

The onsite biodiversity offset areas include some land owned by Shenhua Watermark to the north-west of the Project area. Agricultural enterprises carried out on this land include summer and winter cereal cropping, oilseed production and grazing of beef cattle and sheep. The current gross value of agricultural production from the onsite biodiversity offset areas is \$1.6M per annum and the net value is \$0.7M.

The offsite biodiversity offset areas includes land located near Barraba in the Tamworth LGA, approximately 110 km north north-west of the Project. The current gross value of agricultural production from the offsite biodiversity offset areas, based on current land use, is \$0.4M per annum and the net value is \$0.1M.

The Project area has been assessed in relation to the impacts of the Project on strategic agricultural land having regards to the 'gateway criteria' in the SRLUP. A relatively small area of BSAL (96.1 ha) is considered to satisfy the criteria for BSAL on the basis of soil fertility and land capability. This land is situated within the disturbance area and will be removed for the life of the Project.

The 'gateway criteria' requires a 'cost benefit consideration' as to whether the Project 'would be in the public interest' through a 'cost benefits analysis'. In this context it is relevant to note that the gross value of agricultural production from the identified 96.1 ha of BSAL is estimated to be \$0.05M which would have a net value is \$0.02M.

Part of the onsite biodiversity offset areas required for the Project is situated on 375 ha of BSAL as mapped in the SRLUP. Following soil validation of the onsite biodiversity offset areas (GSSE, 2013) (see Appendix Y of the EIS), a further 321 ha of BSAL was identified, thereby increasing the total area to 696 ha. These areas will be set aside as ecological offsets for the Project in perpetuity.

The mapping of the SRLUP indicates that no BSAL is identified to likely occur within the offsite biodiversity offset areas and soil validation (GSSE, 2013) (see Appendix Y of the EIS) confirms this.

AG&E (2013) advises that the Project is predicted to result in the annual average reallocation of approximately 194 ML/year of water from agricultural purposes to coal mining purposes. The Project is not considered to reduce the agricultural productivity of BSAL within the Project area and surrounds through impacts to highly productive groundwater.

The impact of removing 194 ML from agricultural use results in a gross value loss of \$0.1 M per annum. The net value lost is \$0.06 M per annum.

The gross value of agricultural production lost as a result of the Project is predicted to be \$4.8 M per annum. This value is 3.8% of the total agricultural production of the Gunnedah LGA, 2.1% in the Liverpool Plains region, 0.05% of NSW and 0.01% of Australia.

The losses to agriculture will be mitigated by the commitment from Shenhua Watermark to reinstate at least 1,000 ha of agricultural capability Class III land as part of the mine rehabilitation process. Based on current agricultural practices and returns, this would have an annual gross value of production of \$0.7M and a net value of production of \$ 0.3M per annum.

The targeted 3,233 ha of post mining land capability Class III is achievable due to the creation of relatively gentle topography, excess topsoil and subsoil resources available and previous examples of high quality mine rehabilitation of agricultural land.

The losses to agriculture from the relocation of water from agricultural purposes to coal mining purposes will be mitigated by ensuring all appropriate water licences are obtained. There is sufficient water available on the open market for Shenhua Watermark to obtain the additional water licences required without significantly affecting agricultural activities in the region.

The loss of agricultural production from the area within of the disturbance footprint, the onsite biodiversity offset areas; the offsite biodiversity offset area resulting from the Project is small. The reduction of rural production will be minimal and of no materiality to local regional and state agricultural capacity or production during the Project life.

The Project will not have any impact on the alluvial soils or agricultural productivity of land outside the Project Area and the Biodiversity Offset Areas.

Other potential impacts on agricultural resources and enterprises within the locality, including air quality, noise, traffic and transport, visual, labour supply, have been assessed as having a minimal effect.

To maintain and where possible enhance the agricultural productivity of the land outside the Project area, it is recommended that Shenhua Watermark Coal Pty Limited:

- Minimise the disturbance of agricultural land at any one time;
- Continue to work with land managers to utilise agricultural land owned by Shenhua Watermark Coal Pty Limited;
- Develop and implement a weed and pest management plan to control the distribution of invasive species and feral animals at the Project and Biodiversity Offset Areas;
- Consult with the Central North Livestock Health and Pest Authority as to the appropriateness of the weed and pest management plan;
- Implement sustainable farming practices, including reduced till farming and rotational grazing techniques in available areas outside of the Disturbance Boundary. Further, consider the implementation of measures as proposed by the Namoi Catchment Management Authority for Best Management Practices of the relevant Land Management Units;
- Ensure that as part of the Licences to Occupy, land managers will be required to commit to the implementation of the program as outlined in any collaboration agreement that Shenhua Watermark Coal Pty Limited and the Catchment Management Authority may develop to manage the natural resources while managing the land to its full potential;

- In the event that the onsite biodiversity offset areas are managed in part for agricultural purposes, ensure sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate Land Management Units as set out by the Namoi Catchment Management Authority land;
- In the event that the offsite biodiversity offset areas are managed in part for agricultural purposes, ensure sustainable farming practices should be implemented that are in line with the Best Management Practices for the appropriate Land Capability and Agricultural Suitability Class as set out by the relevant Catchment Management Authority; and
- Reinstate agricultural production on rehabilitated land as soon as practicable having consideration of safety and legislative requirements relating to mine operations.

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Appendix 1

Value and Quantum of Agricultural Production from Shenhua Watermark Owned Land

Appendix 1 Value and quantum of agricultural production from Shenhua Watermarked owned land

Crop	Area Ha	Gross Value \$/ha	VC \$/ha	Gross Margin \$/ha	Yield t or bale	Gross Value \$	VC \$	GM \$	Prodn	Unit
Cotton	40	6,175.08	2,871.64	3,303.44	400	247,003	114,866	132,138	400	Bales
Sorghum	838	802.80	513.98	288.82	3,738	672,746	430,715	242,031	3,738	T
Sunflowers	120	900.80	476.70	424.10	192	108,096	57,204	50,892	192	T
Mung Beans	120	920.64	424.63	496.01	144	110,477	50,956	59,521	144	T
Wheat (Durum)	1,100	675.00	448.56	226.44	2,963	742,500	493,416	249,084	2,963	T
Wheat Irrg Durum	70	1,750.00	868.52	881.48	490	122,500	60,796	61,704	490	T
Wheat (Bread)	1,001	762.50	429.15	333.35	2,470	763,263	429,579	333,683	2,470	T
Barley (feed)	87	656.25	377.21	279.04	326	57,120	32,832	24,288	326	T
Barley (Malt)	689	573.30	337.16	236.14	2,023	395,004	232,303	162,700	2,023	T
Oats	-	-	-	-	-	-	-	-	-	T
Canola	248	1,240.00	507.26	732.28	615	307,520	125,800	181,605	615	T
Total cropping as is						3,526,229	2,028,468	1,497,646		
Livestock	DSE/ha	Gross Value \$/hd	VC \$/hd	Gross Margin \$/hd	Number	Gross Value \$	VC \$	GM \$	Cattle Sold Kg Wool Sold	Sheep sold
Beef		709.92	367.20	342.71	790	560,834	290,091	270,743	848	0
Fattened steers										0
Breeders										0
Grow out steers		333.99	103.64	230.36	4,174	1,394,087	432,579	961,508	4,091	0
Sheep										
Merinos self replacing		184.41	83.37	101.04	200	36,882	16,674	20,208	0	1,188
Merino X Terminal sire		132.21	49.35	82.86	50	6,611	2,468	4,143	0	372
Total Livestock as is						\$ 1,998,413	\$ 741,812	\$ 1,256,602	4,939	1,560
Total Agriculture as is						\$ 5,524,642	\$ 2,770,280	\$ 2,754,248		253

Appendix 2

Value and Quantum of Agricultural Production from the Project Area

Appendix 2 Quantum and Value of Agricultural Production from Project Boundary

Crop	Area Ha	Gross Value \$/ha	VC \$/ha	Gross Margin \$/ha	Yield t or bale	Gross Value \$	VC \$	GM \$	Prodn	Unit	
Sorghum	109	802.80	513.98	288.82	2.3	87,674	56,132	31,542	251	T	
Wheat (Durum)	722	675.00	448.56	226.44	2.5	487,472	323,941	163,530	1,826	T	
Wheat (Bread)	672	762.50	429.15	333.35	2.1	512,537	288,466	224,071	1,380	T	
Barley (feed)	35	656.25	377.21	279.04	3.8	22,848	13,133	9,715	131	T	
Barley (Malt)	413	573.30	337.16	236.14	2.5	236,790	139,257	97,533	1,033	T	
Canola	200	1,240.00	507.26	732.28	2.5	248,000	101,452	146,456	500	T	
Total cropping as is						1,595,321	922,381	672,848			
Livestock	DSE/ha	Gross Value \$/hd	VC \$/hd	Gross Margin \$/hd	Number	Gross Value \$	VC \$	GM \$	Cattle Sold	Kg Wool Sold	Sheep sold
Beef		713.41	375.34	338.08	484	344,934	181,475	163,460	523	0	0
Fattened steers		332.29	90.61	241.68	3,664	1,217,496	331,992	885,504	3,591	0	0
Grow out steers											
Sheep		184.41	83.37	101.04	134	24,711	11,172	13,539	0	796	142
Merinos self replacing		132.21	49.35	82.86	2,575	340,441	127,076	213,365	0	19,132	2,078
Merino X Terminal sire											
Total Livestock as is						\$ 1,927,582	\$ 651,714	\$ 1,275,868	4,113	19,928	2,220
Total Agriculture as is						\$ 3,522,902	\$ 1,574,095	\$ 1,948,715			

Appendix 3

Value and Quantum of Agricultural Production from the Residual Onsite Biodiversity Offset Areas

Appendix 3 Value and quantum of agricultural production from onsite offset area outside project area

Crop	Area Ha	Gross Value \$/ha	VC \$/ha	Gross Margin \$/ha	Yield t or bale	Gross Value \$	VC \$	GM \$		
Sorghum	54	802.80	513.98	288.82	124	43,183	27,647	15,536		
Wheat (Durum)	352	675.00	448.56	226.44	1,055	237,479	157,812	79,666		
Wheat (Bread)	307	762.50	429.15	333.35	654	233,950	131,672	102,278		
Barley (feed)	100	656.25	377.21	279.04	316	65,772	37,805	27,967		
Barley (Malt)	60	573.30	337.16	236.14	150	34,381	20,219	14,161		
Canola	70	1,240.00	507.26	732.28	140	86,800	35,508	51,260		
Total cropping as is						701,564	410,664	290,868		
Livestock	DSE DSE/ha	Gross Value \$/hd	VC \$/hd	Gross Margin \$/hd	Number	Gross Value \$	VC \$	GM \$	Hd Sold	Kg Wool Sold
Beef										
Breeders weaners		440.61	108.81	331.80	78	34,368	8,487	25,880	65	
Breeders Vealers		717.50	384.85	332.65	724	519,111	278,439	240,672	789	
Fattened steers										
Steers (225-500kg)		446.00	131.95	314.05	250	111,500	32,988	78,513	245	
Steers (300-500kg)		281.00	131.95	149.05	180	50,580	23,751	26,829	176	
Steers 340-580kg		276.44	242.93	33.51	363	100,346	88,182	12,164	356	
Total Cattle					1,595	815,905	431,847	384,058	1,630	
Sheep										
Dorper Ewes		138.83	44.37	94.46	100	13,883	4,437	9,446	74	0
Merino ewes self replacing 20 micron		184.41	83.37	101.04	66	12,171	5,502	6,669	70	392
XB bred ewes		175.33	94.29	81.04	300	52,599	28,287	24,312	401	1,491
Total sheep					466	78,653	38,226	40,427	546	1,883
Total Livestock as is						\$ 894,558	\$ 470,074	\$ 424,485		
Total Agriculture as is						\$ 1,596,122	\$ 880,738	\$ 715,352		

Appendix 4

Value and Quantum of Agricultural Production from the Offsite Biodiversity Offset Areas

Appendix 4 Quantum and value of agricultural production from offsite offset areas

	HA			
	Maynes	Streeter	Total	
Cropping only	0	0	0	
Mixed	0	0	0	
Grazing only	239	921	1,160	
Unused	954	819	1,773	
Total	1,193	1,740	2,933	

Livestock			
Beef			
Breeders Weaners	100	45	145
Sheep			
Merino ewes 18 micron		1,000	1,000
Merino wethers 18 micron		1,900	1,900
XB bred ewes		100	100
Total sheep			3,000

	Gross Income per head	Variable costs per head	GM per head	Head sold per unit	Kg wool sold per unit	Sheep sold per unit	Total	Gross Income	Variable costs	GM	Cattle sold	Kg wool sold	Sheep sold
Beef													
Breeders Weaners	440.61	108.81	331.8	0.83			145	\$ 63,888	\$ 15,777	\$ 48,111	120	0	0
Sheep													
Merino ewes 18 micron	139.51	47.33	92.17		5.74	0.777	1,000	\$ 139,508	\$ 47,335	\$ 92,173	0	5,740	777
Merino wethers 18 micron	73.08	40.14	32.94		5.22	0.188	1,900	\$ 138,853	\$ 76,268	\$ 62,585	0	9,918	357
XB bred ewes	175.33	94.29	81.04		4.97	1.337	100	\$ 17,533	\$ 9,429	\$ 8,104	0	497	134
Total sheep							3,000	\$ 295,894	\$ 133,031	\$ 162,863	-	16,155	1,268
TOTAL								\$ 359,782	\$ 148,809	\$ 210,974	120	16,155	1,268

Appendix 5

Potential Value and Quantum of Total Combined Agricultural Production

Appendix 5: Potential Quantum and Value of Agricultural Production from Project Area, Offset Areas and Water Resource
Shenhua Watermark Project Area and water resource owned

Potential Production													
Agricultural Domain	Area	Enterprise	Proportion allocated	Quantum of prdn Tonnees/ha DSE/ha	Unit of production	Ha or Head	Animals sold per hd	Gross income/ha or Gross Income/hd	VC/ha or VC/hd	GM/ha or GM/hd	Total quantum of production (Tonnes or Hd sold)	Gross value of Production	Net value of production
Project Area													
A	47	Sorghum	33%	6.0	Tonnes	15.8		\$1,080	\$536	\$544	95	\$17,028	\$8,577
		Sunflowers	33%	2.1	Tonnes	15.8		\$1,182	\$479	\$703	33	\$18,636	\$18,636
		Mung Beans	33%	1.6	Tonnes	15.8		\$1,229	\$465	\$764	25	\$19,377	\$12,046
											153	\$55,041	\$39,259
B	1,615	Wheat after wheat	25%	4.5	Tonnes	403.6		\$1,238	\$475	\$763	1,816	\$499,688	\$307,966
		What after canola	25%	5.0	Tonnes	403.6		\$1,375	\$485	\$890	2,018	\$554,984	\$359,226
		Canola	25%	2.0	Tonnes	403.6		\$920	\$341	\$579	807	\$371,335	\$233,699
		Barley	25%	4.9	Tonnes	403.6		\$882	\$366	\$516	1,978	\$355,997	\$208,271
												\$1,782,004	\$1,109,162
C	5,151	Wheat	28%	5	Tonnes	1442		\$1,375	\$485	\$890	7,211	\$1,982,981	\$1,283,530
		Grow out steers	72%	15.0	DSE	6446	0.98	\$446	\$132	\$314	6,317	\$2,874,787	\$2,024,275
												\$4,857,768	\$3,307,805
D	2,318	Breeding for specialist local trade (16.68 DSE)	100%	10.0	DSE	1390	1.09	\$637	\$382	\$255	1,515	\$885,155	\$354,590
												885,155	354,590
E	370	Breeding enterprise in conjunction with Domain D (16.68 DSE)	100%	2.0	DSE	44	1.09	\$637	\$277	\$360	48	\$28,245	\$15,948
													28,245
Proeject area	9,500	Summer Crops									153	55,041	39,259
		Winter cereals									13,023	3,393,650	2,158,992
		Canola									807	371,335	233,699
		Beef Cattle									7,880	3,788,187	2,394,814
												\$ 7,608,214	\$ 4,826,764

Appendix 5: Potential Quantum and Value of Agricultural Production from Project Area, Offset Areas and Water Resource
Shenhua Watermark Project Area and water resource owned

Potential Production													
Agricultural Domain	Area	Enterprise	Proportion allocated	Quantum of prdn Tonnees/ha DSE/ha	Unit of production	Ha or Head	Animals sold per hd	Gross income/ha or Gross Income/hd	VC/ha or VC/hd	GM/ha or GM/hd	Total quantum of production (Tonnes or Hd sold)	Gross value of Production	Net value of production
Residual Onsite Biodiversity Offset Area													
A	0	Sorghum	33%	6.0	Tonnes	15.8		\$1,080	\$536	\$544	0	\$0	\$0
		Sunflowers	33%	2.1	Tonnes	15.8		\$1,182	\$479	\$703	0	\$0	\$0
		Mung Beans	33%	1.6	Tonnes	15.8		\$1,229	\$465	\$764	0	\$0	\$0
B	610	Wheat after wheat	25%	4.5	Tonnes	403.6		\$1,238	\$475	\$763	686	\$188,795	\$116,358
		What after canola	25%	5.0	Tonnes	403.6		\$1,375	\$485	\$890	763	\$209,688	\$135,725
		Canola	25%	2.0	Tonnes	403.6		\$920	\$341	\$579	305	\$140,300	\$88,298
		Barley	25%	4.9	Tonnes	403.6		\$882	\$366	\$516	747	\$134,505	\$78,690
C	2,127	Wheat	28%	5	Tonnes	595.56		\$1,375	\$485	\$890	2,978	\$818,895	\$530,048
		Grow out steers 240-460 Kg (8.63 DSE)	72%	15.0	DSE	2662	0.98	\$446	\$132	\$314	2,609	\$1,187,177	\$835,948
D	0	Breeding for specialist local trade (16.68 DSE)	100%	10.0	DSE	0	1.09	\$637	\$382	\$255	0	\$0	\$0
		Breeding enterprise in conjunction with Domain D (16.68 DSE)	100%	2.0	DSE	131	1.09	\$637	\$277	\$360	142	\$83,253	\$47,009
Proejct area	3,827	Summer Crops									0	0	0
		Winter cereals									5,174	1,351,883	860,821
		Canola									305	140,300	88,298
		Beef Cattle									2,751	1,270,430	882,957
Total										\$ 2,762,612	\$ 1,832,075		

Appendix 5: Potential Quantum and Value of Agricultural Production from Project Area, Offset Areas and Water Resource
Shenhua Watermark Project Area and water resource owned

Potential Production													
Agricultural Domain	Area	Enterprise	Proportion allocated	Quantum of prdn Tonnees/ha DSE/ha	Unit of production	Ha or Head	Animals sold per hd	Gross income/ha or Gross Income/hd	VC/ha or VC/hd	GM/ha or GM/hd	Total quantum of production (Tonnes or Hd sold)	Gross value of Production	Net value of production
Offsite Offset Area													
X	394	Merino Ewes 18"	100%	10.0	DSE	1876	0.78	\$140	\$47	\$92	1,463	\$261,743	\$172,934
Y	722	Merino Ewes 18"	100%	5.0	DSE	1719	0.78	\$140	\$47	\$92	1,341	\$239,821	\$158,450
Z	1,761		100%	0.0	DSE	0	0	\$0	\$0	\$0	0	\$0	\$0
											2,804	\$501,564	\$331,385
											20,637		
												Wool Kg	
Water	1,423	Cotton	100%	11.25	bales	203		\$7,640	\$3,242	\$4,398	2,284	\$1,550,986	\$892,806
Combined		Cotton									2,284	1,550,986	892,806
		Summer Crops									153	55,041	39,259
		Winter cereals									18,197	4,745,533	3,019,813
		Canola									1,112	511,635	321,996
		Beef Cattle									10,631	5,058,616	3,277,770
		Sheep									2,804	501,564	331,385
		Wool									20,637		
TOTAL												\$12,423,376	\$7,883,030

Appendix 6

Risk Assessment Matrix

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 4360:1999), Joint Australian / New Zealand Standard, p.34

Risk Assessment Information

Appendix 6

Watermark Coal Project Agricultural Impact Statement Risk Assessment

Risk Quantification

Risk type	Description	Likelihood	Consequences	Overall rating (<u>without mitigation measures</u>)
Availability and productivity of agricultural land	Project will result in large areas of productive land being removed from agriculture over 30 years	5	2	Significant
	Biodiversity offsets will result in large areas of productive land being removed from agriculture	5	2	Significant
	Project will impact on highly productive alluvial soils	2	4	Significant
Surface and ground water	Project affects downstream surface water quality	2	3	Medium
	Project affects downstream groundwater water quality	2	4	Significant
	Project affects groundwater availability (depth) increasing cost of stock and irrigation water pumping	3	3	Significant
	Project affects the highly productive Gunnedah formation alluvial aquifer	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 afflux in flood events	1	3	Medium
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
	Increase in coal rail movements affects	3	1	Low

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- 2 -

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Appendix 6

Watermark Coal Project Agricultural Impact Statement Risk Assessment

Risk type	Description	Likelihood	Consequences	Overall rating (<u>without mitigation measures</u>)
	agricultural rail movements			
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	3	1	Low
	Increased competition and cost for agricultural labour resources	3	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 7

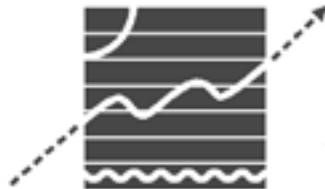
Economic Review of Potential Agricultural Impacts

Watermark Coal Project
Economic Review of Potential Agricultural Impacts

Prepared for

Shenhua Watermark Coal Pty Ltd
C/- Hansen Bailey Pty Limited

By



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October 2012

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	AGRICULTURAL AND MINING INDUSTRIES IN NEW SOUTH WALES.....	3
	2.1 LAND USE.....	3
	2.2 ECONOMIC GROWTH IN REGIONAL AREAS.....	4
	2.3 PRIME AGRICULTURAL LAND AND OTHER LAND USES.....	4
	2.4 FOOD SECURITY.....	5
	2.5 WATER SUPPLIES AND MINING.....	6
3	AGRICULTURAL AND MINING INDUSTRIES IN THE REGION.....	8
	3.1 AGRICULTURE.....	8
	3.2 COAL MINING.....	10
4	ECONOMIC FRAMEWORKS FOR THE ASSESSMENT OF PROPOSALS THAT IMPACT AGRICULTURAL LAND AND WATER.....	12
	4.1 ECONOMIC EFFICIENCY.....	12
	4.2 REGIONAL ECONOMIC IMPACT ASSESSMENT.....	13
5	PROJECT IMPACTS ON AGRICULTURAL RESOURCES.....	14
	5.1 OPPORTUNITY COST OF AGRICULTURE AND WATER RESOURCES.....	14
	5.2 REGIONAL IMPACTS.....	16
	5.3 ECONOMIC EFFICIENCY OF REALLOCATION OF AGRICULTURAL RESOURCES TO THE PROJECT.....	17
6	CONCLUSION.....	18
7	REFERENCES.....	19

LIST OF TABLES

Table 2.1	NSW Agricultural Land Area
Table 2.2	NSW Land Uses
Table 2.3	NSW Water Consumption 20010-11
Table 2.4	Industry Gross Value Added for Water Using Industries – 2009-10 (Australia)
Table 3.1	Existing Agricultural Land Use and Value of Production in the Local Region (2006)
Table 3.2	Employment by Agricultural Sectors in the Local Region
Table 3.3	Existing Coal Mining Production, Gross Value and Direct Employment in the Gunnedah Coalfield
Table 4.1	Potential Costs and Benefits of a Mining Proposal that Impacts Agricultural Land
Table 5.1	Quantum and Value of Agricultural Production Affected within the Disturbance Footprint
Table 5.2	Quantum and Value of Agricultural Production Affected within the Onsite Biodiversity Offset Areas
Table 5.3	Quantum and Value of Agricultural Production Affected within the Offsite Biodiversity Offset Areas
Table 5.4	Annual Impacts of the Foregone Agriculture and the Project on the Local Economy
Table 5.5	Net Production Benefits of Agricultural Resources Compared to the Project

LIST OF FIGURES

Figure 2.1	NSW Land Area Allocated to Wheat and Barley
Figure 3.1	Agricultural Sectors in the Local Region

1 INTRODUCTION

Gillespie Economics was commissioned by Hansen Bailey Environmental Consultants, on behalf of Shenhua Watermark Coal Pty Ltd to complete an economic review of potential agricultural impacts for the Watermark Coal Project. The purpose of the assessment is to form part of an Environmental Impact Statement (EIS) being prepared to support an application for State Significant Development Consent for the Project under Division 4.1 of Part 4 the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project seeks approval to extract up to 10 million tonnes per annum (Mtpa) of Run-Of-Mine (ROM) coal over a period of 30 years.

This report is associated with the Economics Impact Assessment completed for the Project (Gillespie Economics, 2012), as presented in Appendix AE of the EIS.

In October 2008, following a competitive tender process, Shenhua Watermark was successfully granted EL 7223 by the Minister for Mineral Resources. The Project is located within EL 7223, approximately 25 km south south-east of the township of Gunnedah and to the immediate west of the village of Breeza, within the Gunnedah Local Government Area (LGA). The Project is approximately 282 km by rail from the export Port of Newcastle.

The Project generally comprises:

- The construction and operation of an open cut mining operation extracting up to 10 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal for a 30 year period;
- An open cut mining fleet of excavators and shovels, supported by haul trucks, dozers, graders, drill rigs and water carts;
- Progressive rehabilitation of all disturbed areas;
- The construction and operation of a Coal Handling and Preparation Plant (CHPP) with a throughput of 10 Mtpa ROM coal;
- The co-disposal of tailings and coarse reject within the Overburden Emplacement Areas (OEA);
- The construction and operation of a rail spur, rail loop, Kamilaroi Highway rail overpass, associated load out facility and connection to the Werris Creek - Moree Railway Line;
- The construction and operation of a Mine Access Road;
- The construction and operation of administration, workshop and related facilities;
- The construction and operation of ground and surface water management and reticulation infrastructure including pipelines, pumping stations and associated infrastructure for access to water from groundwater aquifers, the Mooki River and private dams to the north-east of the Project Boundary;
- The installation of communications and electricity reticulation infrastructure; and
- A workforce of up to approximately 600 full-time equivalent employees during construction and up to 600 full-time equivalent employees during the operation of the Project.

Scott Barnett & Associates Pty Ltd (2012) undertook an Agricultural Impact Assessment for the Project. This report relies upon 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 region. The economic efficiency and

regional economic impact assessment frameworks for the consideration of economic impacts of the Project on 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 barley¹) has actually increased (Figure 2.1).

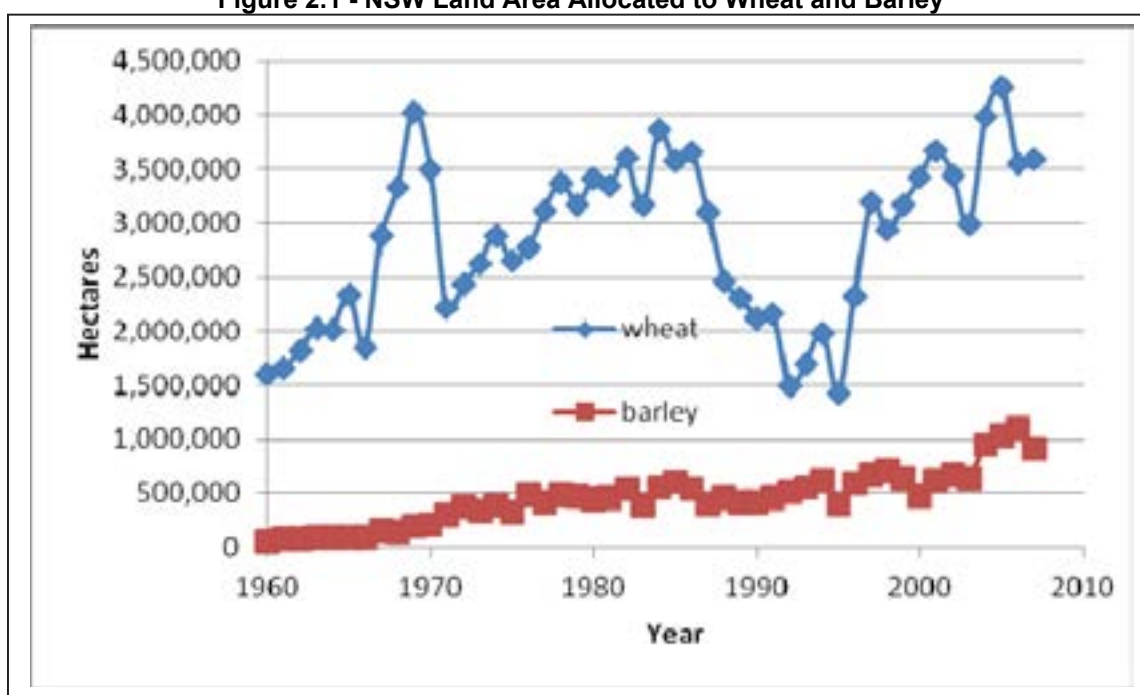
Table 2.1 - NSW Agricultural Land Area

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 2010-11 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).

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, 2011b). 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 2,896 GL, or 57% of NSW water consumption in 20010-11. Mining is a relatively small consumer of water, using 78 GL or 2% of NSW water consumption in 20010-11 (Table 2.3).

Table 2.3 – NSW Water Consumption 2010-2011

Sector	GL	%
Agriculture, forestry and fishing	2,896	57%
Mining	78	2%
Manufacturing	144	3%
Electricity, gas, water and waste services	995	20%
Other industries	400	8%
Household	527	10%
Total	5,040	100%

Source: ABS (2012c)

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 value 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 (2011c)

3 AGRICULTURAL AND MINING INDUSTRIES IN THE REGION

3.1 Agriculture

The local region (i.e. the Gunnedah, Liverpool Plains and Tamworth local government areas [LGAs]) has a combined land area of 1.7M ha, of which 68% is agricultural land (Table 3.1). Of this agricultural land, 2.1% is irrigated with annual irrigation volumes of approximately 119,360 million litres (ML) (Table 3.1). The total value of agricultural production in this local region in 2006 is estimated at \$462M (Table 3.1).

Table 3.1 - Existing Agricultural Land Use and Value of Production in the Local Region (2006)

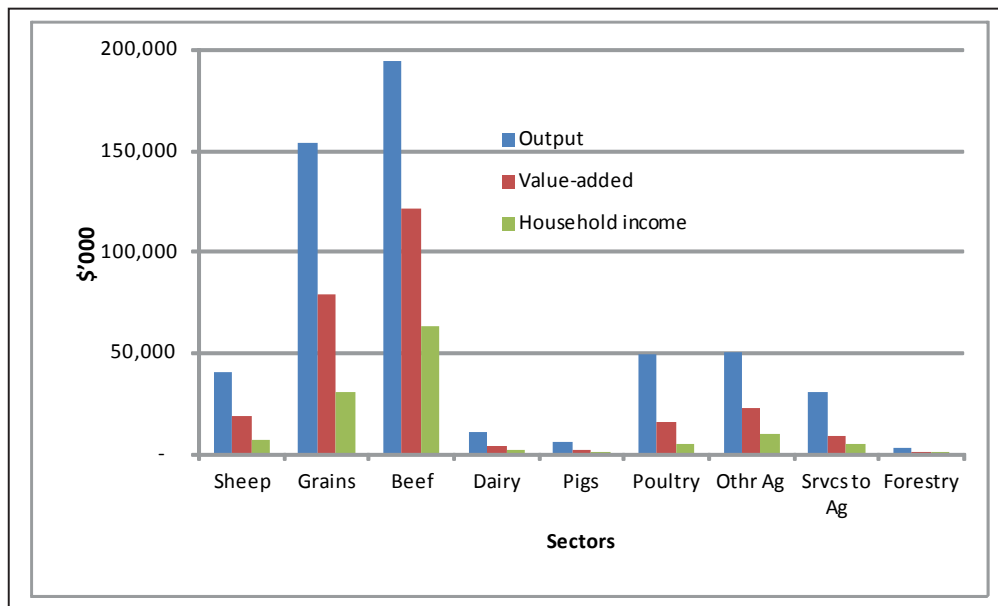
	Units	Gunnedah LGA	Liverpool Plains LGA	Tamworth LGA	Total - Local Region
Area					
Land Area	ha '000	499	509	989	1,997
Area of Agricultural Land	ha '000	434	502	777	1,713
Irrigation					
Area Irrigated	ha '000	18	8	10	36
Irrigation Volume Applied	ML	62,907	23,347	33,106	119,360
Other Agricultural Uses	ML	2,068	3,580	8,487	14,135
Total Water Use	ML	64,974	26,927	41,593	133,494
Area Irrigated as Proportion of Agricultural Land	%	4.1	1.6	1.3	2.1%
Value					
Gross Value of Crops	\$M	95	61	24	181
Gross Value of Livestock Slaughterings	\$M	29	92	124	245
Gross Value of Livestock Products	\$M	1	4	31	35
Total Gross Value of Agricultural Production	\$M	126	157	179	462
Employment in Agriculture	No.	779	794	1,724	3,297

Source: ABS (2012a)

Note: Totals may have minor discrepancies due to rounding.

The input-output table developed for the local region (Gillespie Economics, 2012) provides an indication of the direct relative significance of the different agricultural sectors, affirming beef cattle and grains as the main agricultural sectors (Figure 3.1).

Figure 3.1
Agricultural Sectors in the Local Region



Source: Gillespie Economics (2012).

Total employment in the agricultural industry in the local region in 2006 was 3,307 (ABS, 2012b). Table 3.2 provides a more detailed employment by industry breakdown which indicates that the main agricultural employment is in beef cattle farming and the grains sectors.

Table 3.2 - Employment by Agricultural Sectors in the Local Region

Sector	No.
0100 Agriculture, nfd	113
0112 Nursery Production (Outdoors)	5
0113 Turf Growing	3
0123 Vegetable Growing (Outdoors)	21
0130 Fruit and Tree Nut Growing, nfd	3
0131 Grape Growing	4
0135 Stone Fruit Growing	3
0137 Olive Growing	7
0140 Sheep, Beef Cattle and Grain Farming, nfd	14
0141 Sheep Farming (Specialised)	186
0142 Beef Cattle Farming (Specialised)	1,152
0143 Beef Cattle Feedlots (Specialised)	26
0144 Sheep-Beef Cattle Farming	364
0145 Grain-Sheep or Grain-Beef Cattle Farming	478
0149 Other Grain Growing	358
0152 Cotton Growing	78
0159 Other Crop Growing, nec	73
0160 Dairy Cattle Farming	73
0170 Poultry Farming, nfd	80
0171 Poultry Farming (Meat)	21
0172 Poultry Farming (Eggs)	102
0191 Horse Farming	61
0192 Pig Farming	25
0193 Beekeeping	24
0199 Other Livestock Farming, nec	12
0200 Aquaculture, nfd	4
0203 Onshore Aquaculture	3
0300 Forestry and Logging, nfd	4
0301 Forestry	4
0302 Logging	6
Total	3,307

Source: ABS (2012b)

3.2 Coal Mining

NSW DPI (2011) identifies 6 coal mines in the Gunnedah Coalfield producing 4.80 Mt of saleable coal in 2008/09. Conservatively assuming all of this production is steaming coal with a value of AUD\$100 per tonne, this level of saleable coal production is estimated to have a value of around \$480 (M) (Table 3.3) which is greater than the value of all agricultural production in the local region in 2006 (reported as \$462M in Table 3.1). Direct employment in mining in the Gunnedah Coalfield as reported by NSW DPI (2011) was 356.

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

Coal Mining	Units	Total
Coal Saleable Production (2007/2008)	Mt	4.80*
Gross Value of Coal Production (2007/8)	\$M	480**
Direct Mining Employment (2008)	No.	356*

Source: * NSW Department of Primary Industries (DPI) (2011)

** Conservatively assuming only steaming coal production and a value of AUD\$100/t
Free on Board (FOB) in December 2007 (DPI, 2010)

Note: Mt = million tonnes.

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 occurrence 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 mitigation	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.

Similarly, 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 ultimate 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 impact agricultural land resources through the Project disturbance footprint, the onsite biodiversity offset areas, the offsite biodiversity offset areas and the utilisation of groundwater and surface water that could otherwise be use for agricultural production.

Project Disturbance Footprint

Scott Barnett & Associates (2012) identifies the following annual agricultural production impacted by the Project disturbance footprint.

Table 5.1
Quantum and Value of Agricultural Production Affected within the Disturbance Footprint

Enterprise	Disturbance Footprint
Sorghum (tonnes) per annum	44
Wheat (tonnes) per annum	4,034
Barley (tonnes) per annum	183
Canola (tonne) per annum	32
Wool sold (kg) per annum	19,928
Sheep sold per annum	2,220
Beef cattle sold per annum	4,506
Gross value of production per annum	\$2.92 M
Net value of production per annum	\$1.74 M

Conservatively assuming that agricultural production from the entire disturbance footprint ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$45.2M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$26.9M (using a 7% discount rate).

The impact will partly be offset by the rehabilitation of 1,000 ha of Class III land within the disturbance footprint to be returned to wheat, canola and beef cattle production at the end of the Project (30 years). This will result in a gross value of production of \$0.7M per annum and a net value of production of \$0.3M per annum following the cessation of mining (Year 30).

Including these offsetting agricultural impacts, the present value of the gross value of production foregone is \$43.0M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$26.0M (using a 7% discount rate).

Onsite Offset Area

Scott Barnet & Associates Pty Ltd (2012) identifies the following annual agricultural production impacted by the onsite offset areas.

Table 5.2
Quantum and Value of Agricultural Production Affected within the Onsite Biodiversity Offset Areas

Enterprise	Onsite Biodiversity Offset Areas
Sorghum (tonnes) per annum	124
Wheat (tonnes) per annum	1,709
Barley (tonnes) per annum	466
Canola (tonne) per annum	140
Wool sold (kg) per annum	1,883
Sheep sold per annum	546
Beef cattle sold per annum	1,554
Gross value of production per annum	\$1.55 M
Net value of production per annum	\$0.69 M

Conservatively assuming that agricultural production from the onsite biodiversity offset areas ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$24.0M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$10.7M (using a 7% discount rate).

Offsite Offset Area

Scott Barnet & Associates Pty Ltd (2012) identify the following annual agricultural production impacted by the offsite offset areas.

Table 5.3
Quantum and Value of Agricultural Production Affected within the Offsite Biodiversity Offset Areas

Enterprise	Offsite Biodiversity Offset Areas
Wool sold (kg) per annum	16,155
Sheep sold per annum	1,268
Beef cattle sold per annum	120
Gross value of production per annum	\$ 359,782
Net value of production per annum	\$ 148,809

Conservatively assuming that agricultural production from the onsite biodiversity offset areas ceases at the commencement of the Project for perpetuity, the present value of the gross value of production foregone is \$5.6M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$2.3M (using a 7% discount rate).

Total Land Resources

In total, foregone gross value and net value of agricultural production from land resources required for the Project is estimated at a present value of \$72.6M and \$39.0M, respectively (using a 7% discount rate).

5.1.2 Water Resources

If the Project diverts water resources that could otherwise potentially be used for agricultural purposes there may also be an additional impact on agriculture.

Australasian Groundwater and Environmental Consultants Pty Ltd (2012) identify that the Project is predicted to result in the annual average relocation of approximately 257 ML/year of water from agricultural purposes to coal mining purposes.

This level of annual water requirement implies that potentially 37 ha of cotton would be converted from irrigated to dryland production. This represents a loss in cotton production of 185 bales of cotton with a gross value loss of \$113,233 per annum and a net value loss of \$75,069. Over the life of the Project, the present value of the gross value of production foregone is \$1.4M (using a 7% discount rate) and the present value of the net value of agricultural production foregone is \$0.9M (using a 7% discount rate) (Gillespie Economics, 2012).

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 local region input-output table (Gillespie Economics, 2012) within which foregone production is located (i.e. the beef sector, sheep sector, grains sector and other agriculture sector (cotton)). Table 5.4 summarises the estimated direct and indirect regional impacts of foregone agricultural land and water resources required for the Project and compares this to the impacts of the Project on the local region.

Table 5.4 - Annual Impacts of the Foregone Agriculture and the Project on the Local Economy

	Agricultural Land			Water	Total Agricultural Land and Water	Project
	Disturbance Footprint	Onsite Offset	Offsite Offset			
Production Type	Beef, Grains, Sheep	Beef, Grains, Sheep	Beef, Grains, Sheep	Cotton		Coal
Direct Impacts						
Output (\$M)	3	2	0	0	5	744
Value-added (\$M)	2	1	0	0	3	424
Household income (\$M)	1	0	0	0	1	45
Employment (No.)	18	9	4	1	31	369
Direct and indirect impacts					-	
Output (\$M)	4	2	1	0	8	902
Value-added (\$M)	2	1	0	0	4	493
Household income (\$M)	1	1	0	0	2	80
Employment (No.)	24	12	4	1	41	908

The Project is estimated to provide considerable activity to the local 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 5.4).

The direct annual output of the Project (at 10 Mtpa of ROM coal production) is estimated at \$744M. This is greater than the annual value of agriculture production in the local region in 2006 (i.e. \$462M) (Table 3.1). The direct annual agricultural production from the land and water resources that would potentially be impacted by the Project is estimated at \$5M (Table 5.4).

The direct and indirect regional employment provided by the Project would be up to 908 compared to up to 41 agricultural-related jobs that would be forgone as a result of the Project impacts on agricultural land and use of Project water (Table 5.4).

This stimulus provided by the Project would continue for approximately 30 years, with reduced stimulus as the Project ramps up and ramps down.

5.3 Economic Efficiency of Reallocation of Agricultural Resources to the Project

The BCA included estimation of the present value of production costs and benefits of the Project over a 30 year period. The present value of net production benefits of the Project to Australia are estimated at \$1,310M (Table 5.5) (Gillespie Economics, 2012)³. In contrast, the present value of future use of agricultural lands that would be utilised by the Project is estimated at \$39M and the present value of future use of the water resources that would be potentially diverted from agricultural uses by the Project is estimated at \$1M (Table 5.5).

Table 5.5 - Net Production Benefits of Agricultural Resources Compared to the Project

	Agricultural Land			Water	Total Agricultural Land and Water	Project
	Disturbance Footprint	Onsite Offset	Offsite Offset			
Net Production Benefits ¹	\$26M	\$11M	\$2M	\$1M	\$40M	\$1,310M

Source: Gillespie Economics (2012).

¹ Discounting is at 7%.

Based on the comparative values provided in Table 5.5, excluding consideration of externalities of the Project and of agricultural production, the Project is considered to be significantly more economically 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 production) the Project is estimated to have net benefits to Australia of between \$1,244M and \$1,568M (Gillespie Economics, 2012) and therefore the Project is considered more efficient than the agricultural production that would be displaced.

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

6 CONCLUSION

In the local region:

- The regional output value of 2007/08 coal production was over 80% of the value of all agricultural production.
- The annual output value of the Project would be greater than the output value of agriculture production in the local 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 \$1,244M and \$1,568M.

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 8

Desktop Investigation of the Potential for Coal Dust to Impact on Cotton Fibre Colour (Quality)

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Desktop investigation of the potential for coal dust to impact on cotton fibre colour (quality).

Undertaken at the request of Hansen Bailey in relation to the risk potential of dust from the Shenhua Watermark Coal Project affecting the colour quality of cotton grown within the environs of the Project. Provided for the information of Hansen Bailey only.

Scott Barnett & Associates

Scott Barnett
Principal
8m February 2012

What is cotton and how is it harvested?

Sources:

- Cotton Australia, www.cottonaustralia.com.au
- Queensland Cotton (R Harch, Pers. comm..)
- Cotton Seed Distributors (R. Eveleigh, Pers comm..)

Cotton is a fibre produce from the seed boll of a member of the Hibiscus family. Predominantly Australian cotton is grown from *Gossypium hisustum*, also known as American Upland cotton. Though naturally it is a perennial shrub, it is grown as an annual crop, being a green leaf shrub that produces white to pink flowers. The resultant fruit is called a boll. The boll consists of four bracts as an outer shell, the cotton fibre (lint) and the cottonseed. The lint (fibre) surrounds and is attached to the seed.

The cotton plant flowers continuously over a period over approximately half the plants growing season (growing season from plant emergence to picking is approximately 180 days). Cotton flowers open for only 24 hours, during which pollination occurs. Four days after pollination the boll begins to form, reaching full size in about 25 days. After 35 to 55 days the boll bursts open exposing the actual cotton fibre.

After approximately 60% of bolls are open the crop is sprayed with a defoliant or conditioner and picked within two weeks of spraying. This stimulates the summer growing plant into an autumn response, speeding up boll opening and causes the leaves fall off the plant. Only open bolls are left on the plant, which is still alive. The cotton can be picked cleanly without leaves staining the lint.

Cotton is mechanically harvested. In NSW harvest is usually in late March to April. **The time from the first boll opening to harvest of the entire crop is usually around 8 weeks, weather dependant – maximum time the fibre is exposed to dust while still on the plant.**

Once cotton is picked it is transferred from field to edge of field by a tractor drawn “boll buggy” where the cotton is emptied into a module builder, which builds the freestanding cotton module. The modules, consisting of lint and cottonseed, are covered by tarpaulins to prevent rain damage.

After storage on farm they are transported to the cotton gin where they are stored outside until they are ginned (processed). Weather permitting cotton is usually ginned within 100 days of been picked. The majority of cotton is ginned within a far shorter time frame.

The ginning process involves:

1. Removing any green bolls, rocks and sticks
2. Adding or removing moisture to the require level required for ginning
3. Several different stages where “trash is removed, such as sticks, dust, dirt stalks and leaves
4. Separation of seed from lint
5. Removal of any remaining trash

6. Clean lint is pressed into bails.

Contamination of Australian Cotton

A CSIRO study (funded by Cotton Catchment Communities CRC – Project number: 4_05_01, Van Der Sluijs, R) found that Australia had the lowest levels of contaminants of all crops (2006/07) imported by an international spinning mill (compared to competitors such as Brazil, West Africa, US, Egypt India, China).

The major contaminants in the Australian cotton bales were:

- Cloths, clothes or rags made from cotton, polyesters or blends
- Yarn from cotton, polyester or blends
- Polypropylene yarn
- Bird feathers
- Jute/hessian yarn, human hair, plastics including shopping bags
- Lolly papers and garbage bag fragments,
- Paper from newsprint and notepads
- Metallic pieces such as nuts, bolts and wire

No mention was made of dust, dirt or sand.

Cotton Grading

There are three components of cotton grading:

- Trash;
- Preparation; and
- Colour.

Characteristics of quality that affect price are:

- Colour
- Trash
- Preparation
- Staple length
- Micronaire
- Strength
- Extraneous matter

Colour is a major quality issue and is measured against an “universal standard” referred to the US Department of Agriculture for Upland Cotton Standard. It refers to the graduation from whiteness to yellow to the worse case of grey.

The major cause of colour deterioration is rainfall causing colour to leach from the bracts while the boll is open and fungal growth on the lint.

Opportunities for cotton to be effected by dust, sand and dirt.

There are four stages of cotton growing and the logistics system prior to ginning where the fibre is exposed to airborne contaminants such as dust, sand and dirt. These are:

- In field when bolls are open (a period of approximately eight weeks)
- On farm storage of modules prior to transport to gin
- While being transported by road from farm to gin
- Storage of modules at gin prior to ginning.

The length of time could range from approximately 2 weeks to 23 weeks.

No references sighted indicated that dust, sand or dirt was a major contaminant of cotton nor was an issue with cotton quality and pricing. Discussions with cotton industry professionals in Australia (agronomists, gin managers, cotton classers, researchers into cotton fibre quality) also failed to identify any references to dust, sand or dirt contamination of cotton fibre being an issue.

Specific Comments:

Geoff Valentine, Chairman of Australian Cotton Ginners Association and Executive General Manager Operations, Queensland Cotton:

- Did not know of any references to or instances of dust and coal dust being an issue in cotton fibre quality;
- Queensland Cotton have gin in Moura near Moura Mine (Anglo American) and draw cotton from around the coal mining areas of Central Queensland – knows of no issues with dust (and made specific reference to dust from mine) and cotton
- Possible that there may be dust from roads getting into first one or two roads of cotton next to boundary fences or internal roads with heavy traffic use
- Known issue with grease from spinners on cotton harvesters affecting fibre

Ross Hatch, Gin Manager, Queensland Cotton's Moura Gin

- No report issues and no anecdotal stories known
- No case studies of coal dust on coal mine
- Gin approx 3km from Moura Mine, can see dust from mine come across but never affected cotton modules stored in gin yard or in gin
- Cotton also drawn from district show no signs of dust from coal mines or dust in general being a problem.
- Did not know of any cotton farm immediately adjacent to a mine

Rob Eveliegh, Agronomist, Cotton Seed Distributors, Wee Waa

- Knows of no known substantiated issues with dust affecting cotton quality, including in field dust contamination from farming practices
- No issues with road dust from black soil country of Northern NSW cotton areas (soils not pulverised to dust like red soils of Macquarie Valley and lower Lachlan Valley cotton districts).
- Had heard of anecdotal stories of road dust from farm roads etc affecting Cotton at Warren NSW

David Pratt, Gin Manager, Auscot Warren

- Has had modules from Southern NSW arrive with road dust contamination from transporting over dirt roads
- Heard of one farmer last year (2010/11 cotton season) having road dust affect crop in field.
- Is not an issue affecting quality
- Dust easily and effectively removed at the pre cleaning phase of the ginning process

Rene van der Sluijs, Textile researcher, CSIRO Geelong

- Potential for dust on wet cotton (rain on open bolls) to causing staining
- Limited risk as usually if cotton fibre is wet after rain, soil also wet and little dust is in the environment
- Rainfall can cause discolouration when no dust present (staining and spotting, fungal growth) which results in quality downgrade affecting price received by grower

Other potential issues of (coal) dust affecting cotton quality

Dust, sand and dirt, (dust) from what ever source can potentially affect cotton fibre quality (in theory at least). This is dependent on quantum of dust and amount of time the cotton plant is exposed to the dust. The effect is decreased photosynthesis due to either:

- Leaf coating, or
- Leaf blasting.

The effect on cotton fibre quality results from the decrease photosynthesis of the plant leading to less carbohydrate production and fill by the plant during fibre development. This can result in decrease fibre micronaire (finer fibres) and/or less fibre elongation (short fibres).

The level of dust deposition and size of dust particles drive the probability of these effects being seen. Finer particles would be of less risk to cause leaf blasting than larger coarser dust particles (such as sand) but a dust load of the same weight of finer dust would restrict photosynthesis more than coarser particles due to more complete leaf coverage. However it should be noted that significant dust loads for extended periods of time are required for the plant to suffer any negative impact.

Difference between dust in wool and cotton

Wool carrying a higher dust load is marked down at market. Dust is a greater problem in wool than cotton because the wool fleece also consists of lanolin. Wool is sold greasy with lanolin, dust and vegetable matter still present. Dust adheres to the lanolin within the fleece and therefore is carried within the fleece and causes discolouration of the fleece (fleece is dirty and lacks “brightness”). The dust is visible when presented for sale and decreases the fleece yield (clean fleece weight as percentage of greasy fleece weight).

Cotton is not “greasy” like wool and any dust does not adhere to the fibre as in wool. Cotton is also classed and sold after it has been ginned, therefore any dust present is removed before marketing.