Baal Bone Colliery
ENVIRONMENTAL ASSESSMENT

March 2010

Volume 1 - Main Report

Prepared for The Wallerawang Collieries (TWCL)
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Certification

Submission of Environmental Assessment (EA)

prepared under the Environmental Planning and Assessment Act 1979 Section 75F

EA prepared by		
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qualifications	Bachelor of Science (Marine Science) Project Scientist	Bachelor of Arts (Regional and Urban Planning) Industry Director/National Practice Leader
address	AECOM Australia Pty Ltd Level 5, 828 Pacific Highway Gordon NSW 2072	AECOM Australia Pty Ltd Level 5, 828 Pacific Highway Gordon NSW 2072
in respect of	Continuation of Operations, Baal Bone Colliery	
project application	The Wallerawang Collieries Limited	
applicant name	PO Box 13	
applicant address	Lithgow NSW 2790	
land to be developed	The proposed project is to be carried out on land known as 29/755759, 1/796723, 78/755759, 33/664527, 30/755759, 43/755759, 28/755759, B/421385, 2/235194, 31/755759, 89/755759, 3/235194, 101/723771, 102/723771, 83/755759, 50/755759, 51/755759, 1/620791, 2/620791, 91/755759, 35/755759, and State Forest 434.	
lot no., DP/MPS, vol/fol etc		
proposed project	Map(s) attached	
Environmental Assessment	an Environmental Assessment (EA) is attached	
Certification	I certify that I have prepared the contents of this Environmental Assessment and to the best of my knowledge it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.	
	Signature	Signature
	Name: Kate Tilden	Name: Michael England
	Date: 4/3/10	Date: 4/3/10

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Glossary of Terms

Term	Definition
AUSPLUME model	Ausplume, developed in 1986, is the regulatory plume dispersion model in Australia. Using Ausplume dispersion model, the ground level concentration of pollutants or odours emitted from different sources (e.g. point sources such as stacks, area sources and volume sources), can be predicted.
Box Cut Sump	The Box Cut Sump is located at the northern end of the Northern Rehabilitation Area and collects some local runoff from this area along with seepage from most areas of the site. Water is pumped from the Box Cut Sump to the Dirty Water Dam to supplement the process water demand.
Closure	Closure is often associated with valley bulging, particularly in deep, steep sided valleys and refers to the measured horizontal displacement of the flanking ridges towards the centre of the valley.
dB(A)	Decibels – A-weighted scale: unit used for measuring environmental noise, based on the typical response of the human ear to sounds of different frequencies.
Ecologically Sustainable Development (ESD)	Using, conserving and enhancing resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.
Ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
Emission	The discharge of a substance into the environment.
Fault	Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
Goaf	That part of a mine from which the coal has been partially or wholly removed by longwall mining and where the unsupported roof collapses into the void.
Greenhouse Gases	Gases with the potential to cause climate change (eg. Methane, carbon dioxide and non-methane volatile organic compounds). Expressed in terms of global warming potential carbon dioxide equivalent.
Groundwater	All waters occurring below the land surface. Areas of saturation are termed water table.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks of the earth's crust.
Igneous	A rock which originated as molten magma from beneath the earth's surface and subsequently came to the surface as an extrusion, or remained below ground as an intrusion.
Leachate	Leachate is the liquid that drains or 'leaches' from a tailings dam.
Longwall Mining	Longwall mining extracts all machine-minable coal between the floor and ceiling within a contiguous block of coal, known as a panel, leaving no support pillars within the panel area.
Maingate	The gate road along one side of the block.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 290-250 million years.
Photogrammetry	The science of deriving the physical dimensions of objects from measurements on aerial photographs.

Term	Definition
Rating Background Level (RBL)	The overall single-figure sound background level representing each assessment period (day/evening/night) over the whole monitoring period, and is the level used for assessment purposes.
Rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
Run of Mine (ROM)	Raw coal production; unprocessed.
Sensitive Receptor	A sensitive receptor is defined by DECCW as anywhere someone works or resides or may work or reside, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar.
Solcenic Emulsion	Solcenic is a 98% to 2% mixture of water and hydraulic fluid.
Strain	Strain is determined by calculating the horizontal change in length of a section of land surface, and dividing this by the horizontal length of this section. Maximum strains coincide with the maximum curvature of the profile.
Subsidence	The vertical lowering, sinking or collapse of the ground surface.
Tilt	The change in slope of the surface landform, calculated as the difference in subsidence between two points on the land surface, divided by the distance between those two points.
Upsidence	Upsidence occurs where a valley is undermined. It is often observed that the valley floor subsides less than surrounding ridges tops. The difference in subsidence between the ridge top and the valley floor is in these cases is referred to as ‘uplift’. In extreme cases the valley floor may actually rise, rather than subside, and this is known as upsidence.

Acronyms

Acronym	Definition
AADT	Annual Average Daily Traffic
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHMP	Aboriginal Heritage Management Plan
AQIA	Air Quality Impact Assessment
BSL	Beam Stage Loader
CCC	Community Consultative Committee
CCL	Consolidated Coal Lease
CO_2	Carbon Dioxide
Co_2-e	Carbon Dioxide Equivalent
CMHS Act	*Coal Mines Health and Safety Act 2002*
CHPP	Coal Handling and Preparation Plant
CL	Coal Lease
DA	Development Application
dB(A)	Decibels - A-weighted scale
DEC	Department of Environment and Conservation (now DECCW)
DECCW	Department of Environment, Climate Change and Water
DoP	Department of Planning
DII	Department of Industry and Investment (formerly Department of Primary Industries – Mineral Resources)
DWE	Department of Water and Energy (now NSW Office of Water, part of DECCW)
EA	Environmental Assessment
DGRs	Environmental Assessment Requirements
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMS	Environmental Management System
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development
GHG	Greenhouse Gas

Acronym	Definition
GIS	Geographic Information System
GLC	Ground Level Concentration
Ha	hectares
HFCs	hydrofluorocarbons
ICCRs	Interim Community Consultation Requirements for Applicants
IFD	Intensity-frequency-duration
IGAE	*Intergovernmental Agreement on the Environment*
INP	Industrial Noise Policy
Infrastructure SEPP	*State Environmental Planning Policy (Infrastructure) 2007*
kL/day	Kilolitres per day
LCS	Lithgow Coal Seam
LEP 1994	*Lithgow City Local Environmental Plan 1994*
LGA	Local Government Area
L_{Aeq}	Equivalent continuous noise level
ML	Mining Lease
ML/annum	Megalitres per annum
MPL	Mining Purposes Lease
Model Provisions	*Environmental Planning and Assessment Model Provisions 1980*
MOP	Mine Operations Plan
m/s	Metres per second
MSC Act	*Mine Subsidence Compensation Act 1961*
Mt	Million tonnes
Mtpa	million tonnes per annum
MREMP	Mining Rehabilitation and Environmental Management Process
NES	National Environmental Significance
NGA Factors	National Greenhouse Accounting Factors
NGLG	Noise Guide for Local Government
NPI	National Pollution Inventory
NP&W Act	*National Parks and Wildlife Act 1974*
OH&S	Occupational Health and Safety
OH&S Act	*Occupational Health and Safety Act 2000*
PCI	Pulverised Coal Injection
PEA	Preliminary Environmental Assessment
PFCs	Perfluorocarbons
PFM	Planning Focus Meeting
PM_{10}	Particulate matter less than 10µm

Acronym	Definition
POEO Act	*NSW Protection of the Environment Operations Act 1997*
RBL	Rating Background Level
REA	Reject Emplacement Areas
REF	Review of Environmental Factors
REP No. 1	*Drinking Water Catchments Regional Environmental Plan No. 1*
RHMP	Road Haulage Management Plan
ROM	Run of Mine
RTA	Roads and Traffic Authority
SEPP	State Environmental Planning Policy
SEPP 2005	*State Environmental Planning Policy (Major Development) 2005*
SEPP 2007	*State Environmental Planning Policy (Mining Petroleum Production and Extractive Industries) 2007*
SMP	Subsidence Management Plan
SNRP	Site Noise Reduction Program
SO_x	Sulphur oxide gas
t	Tonnes
TMP	Truck Management Plan
tpa	Tonnes per annum
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total Suspended Particulates
TWCL	The Wallerawang Collieries Limited
WM Act	*Water Management Act 2000*

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Executive Summary

Introduction

AECOM Australia Pty Ltd (AECOM) has been engaged by The Wallerawang Collieries Limited (TWCL) to prepare this Environmental Assessment (EA) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the continuation of currently approved operations at Baal Bone Colliery (Baal Bone), near Cullen Bullen, New South Wales (NSW) (Baal Bone).

Baal Bone is an existing coal mine with an approved prepared saleable coal production of approximately 2.0 million tonnes of coal per annum (Mtpa), equating to about 2.8 Mtpa of Run of Mine (ROM) coal. Baal Bone currently operates under a number of separate development consents and approvals. The primary development consent for the operation was issued by the Honourable Eric Bedford, Minister for Planning and Environment on 13 September 1982. Operations at Baal Bone currently extract coal from the Lithgow Coal Seam (LCS) via longwall mining methods. ROM coal is transferred to the Surface Infrastructure Area at Baal Bone for processing and stockpiling. Coal produced from underground operations is currently transported by road and rail to both domestic and international markets.

The primary consent issued for Baal Bone in 1982 was issued under Part 4 the EP&A Act. Current mining activities at Baal Bone are taking place within Longwalls 29 to 31 which have been authorised by approval under Part 5 of the EP&A Act. *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005) includes transitional provisions, under which the Part 5 approved activities cease to be of effect from 1 August 2010. As existing longwall operations are not scheduled for completion until 2011 or beyond, TWCL is proposing to continue existing mining operations and associated infrastructure at Baal Bone beyond the expiration of the Part 5 approval. Project Approval under Part 3A of the EP&A Act is required to allow continued mining operations at Baal Bone. The approval regime is described in **Section 1.6** and **Section 5** of the EA.

Project Approval under Part 3A of the EP&A Act is sought for the continuation of operations at Baal Bone, including the following:

- Continuation of underground mining within the Underground Mining Area, including Longwalls 29 to 31, which are the subject of a current approved Subsidence Management Plan (SMP) and Mining Operations Plan (MOP);
- Continued operation of associated surface infrastructure and a prepared saleable coal production of 2.0 Mtpa (equating to 2.8 Mtpa ROM coal);
- Continued transport of prepared saleable coal to markets in accordance with current approvals; and
- Mining of other isolated Remnant Areas within existing workings.

This Project Application relates to activities that are either previously mined, already currently being carried out at Baal Bone or are approved to be carried out but have not yet commenced. In this regard, Baal Bone currently holds all requisite development consents or approvals required for its mining activities, coal haulage and associated infrastructure (including ventilation shafts). In addition Baal Bone holds all mining authorities required for the project and also has an approved SMP for its current mining activities, including Longwalls 29 to 31.

The project has been declared to be a major project by the Minister under the provisions of the EP&A Act and *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act.

AECOM Australia Pty Ltd has been engaged by TWCL to prepare this Environmental Assessment (EA) to assess potential impacts associated with the Project. This EA has been prepared in accordance with the provisions of Part 3A of the EP&A Act, together with the Environmental Assessment Requirements (DGRs) issued by the Director General of the Department of Planning on the 28 October 2009.

Strategic Context and Need for the Project

The proposed project involves the continuation of an existing underground coal mine and use of existing approved surface infrastructure facilities within an existing mining lease area. The utilisation of existing infrastructure provides an economically viable means of extracting the coal resource from the existing mining lease area.

The project would also result in a number of significant economic benefits to both the local area and the State, including the following:

- Continuation of existing employment at Baal Bone, including some 190 full time positions for employees and contractors in the Lithgow LGA where employment has declined over the last decade due, in part, to a number of mine closures;
- Indirect economic benefits associated with maintaining local employment, and expenditure on local goods and services;
- Payment of royalties to the State for the recovery of up to approximately 2.0 Mtpa of saleable coal; and
- Export earnings for Australia.

This EA provides a detailed justification and associated benefits of the project, and considers potential environmental, social and economic impacts locally and on the State. The project need and alternatives are further detailed in **Section 3** of the EA.

Site Description

The Project Area is located approximately 25 km north west of Lithgow and 5 km north east of the township of Cullen Bullen in the Lithgow LGA, NSW. The location and regional context of Baal Bone is shown in **Figure 1.1** of the EA. The Project Area incorporates the following components, (refer to **Figure 1.3** of the EA):

- Surface Infrastructure Area, which covers an area of approximately 380 ha of freehold land owned by TWCL and also incorporates Crown Road Reserves and road permits within and adjacent to the site, comprising the following:
  - CHPP and other mining related facilities (including the rail loop) located in the centre of the Surface Infrastructure Area;
  - Northern and southern rehabilitation areas, which comprises former open cut workings which are in various stages of rehabilitation;
  - Reject emplacement area, located in the southern portion of the Surface Infrastructure Area; and
- Underground Mining Area, incorporating extracted longwall panels 1 to 28 (including the Remnant Areas), and the current mining area. longwalls 29 to 31.

Most of the underground operation underlies land managed by Forests NSW (now part of Department of Industry and Investment (DII)), namely the Ben Bullen State Forest and Wolgan State Forest. A small section of the Project Area includes Crown Land held under a Grazing Licence. The land managed by Forests NSW and Crown land overlying the Underground Mining Area contain no dwellings or private land holdings.

The Castlereagh Highway (State Route 86) is situated to the west of the Project Area. The Castlereagh Highway joins the Great Western Highway just south of Lithgow, and continues north to the Queensland border. To the west of the Castlereagh Highway runs the Wallerawang-Gwabegar railway line. The Wallerawang-Gwabegar railway line branches from the Main Western Railway line, which provides a connection to the Main Suburban Line between Sydney's Central Station and Parramatta. Baal Bone is serviced by a 7 km long spur line from the Wallerawang-Gwabegar railway line, which terminates at a 200 m radius balloon loop where coal is loaded onto trains. The Project Area is bordered to the north and east by the Capertee and Wolgan Valleys, respectively. The Gardens of Stone National Park is situated to the north of the site.

Alternatives Considered

Mining Alternatives Considered for Remnant Areas

TWCL has considered a number of alternative options for undertaking the proposed mining of the Remnant Areas project, which include alternative options for the following:

- Bord and Pillar; and
- Partial Extraction.

It was determined that partial extraction of the pillars would be the preferred mining option for the Remnant Areas and would be detailed in an Extraction Plan prior to commencement of mining.

Transport Alternatives Considered

An analysis of the transportation options of coal from Baal Bone to the Mount Piper and Wallerawang power stations, the continued road haulage of 900,000 t of coal utilising the Castlereagh Highway was the preferred option. Given the remaining life of Baal Bone, the construction of new infrastructure for the transport of coal is not considered to be an economically feasible option. The preferred option would not require new infrastructure and there would not be additional environmental impacts generated as a result of the continued use of the Castlereagh Highway, above those previously assessed and approved for the existing development consent.

Project Description

Project Approval is sought for the continuation of current operations at Baal Bone including operation of the Surface Infrastructure Area, as well as longwall mining and extraction of Remnant Areas within the Underground Mining Area. Baal Bone is an existing coal mine with an approved prepared saleable coal production of approximately 2.0 Mtpa, equating to about 2.8 Mtpa of ROM coal. Underground mining operations target the Lithgow Coal Seam of the Illawarra Coal Measures.

The activities at Baal Bone for which Project Approval is sought are described below.

Continuation of Underground Mining Area

Project Approval is sought for the continued operation of underground longwall mining activities within the Underground Mining Area, which includes Longwalls 29 to 31. Longwalls 29 to 31 are located beneath Ben Bullen and Wolgan State Forests as well as a small parcel of Crown land, to the west of Wolgan Road and east of the Coxs River.

TWCL has identified a number of Remnant Areas of coal within the existing workings in the Underground Mine Area. These predominantly include barrier pillars within the existing workings of Longwalls 1 to 28, which were not extracted as part of the original longwall mining campaign. The proposed Remnant Areas are shown on **Figure 4.3**.

The proposed method of extraction for these areas is by conventional underground continuous mining methods, similar to methods employed for previous underground mining at the Colliery.

Continued Operation of the Surface Infrastructure Area

TWCL is seeking Project Approval for the continued operation of the Surface Infrastructure Area. The primary surface infrastructure and facilities at Baal Bone include the CHPP and other mining related facilities, the Reject Emplacement Area, and northern and southern rehabilitation areas. All existing infrastructure and processes currently undertaken at the site would continue to be operational.

Mine Closure and Rehabilitation

The objective for the rehabilitation of disturbed land at Baal Bone identified in the MOP (July 2009) is to return the site to a condition where its landform, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land fabric.

As such, the proposed final land use for the site includes a combination of grazing and bushland/wildlife habitat and would be designed to be compatible with adjoining lands. Rehabilitation of a substantial section of the mine surface area has already been completed.

Statutory Planning

Commonwealth Legislation

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the approval of the Commonwealth Minister for the Environment, Water, Heritage and the Arts for actions that may have a significant impact on matters of National Environmental Significance (NES). Approval from the Commonwealth is in addition to approvals under NSW legislation. However a bilateral agreement has been concluded between the NSW and Commonwealth governments which provides for the accreditation of the NSW assessment and approvals process such that one approval may be granted covering both State and Commonwealth requirements.

The proposed project is not anticipated to affect matters of NES under the EPBC Act and as such an EPBC Referral to the Minister for the Environment, Water, Heritage and the Arts is not required.

Environmental Planning and Assessment Act 1979

The proposed project has been declared by the Minister as a 'major project' under the provisions of the EP&A Act and SEPP 2005, and is therefore subject to the provisions of Part 3A of the EP&A Act with the Minister being the approval authority.

The current proposal seeks the approval of the Minister pursuant to section 75E of the EP&A Act for the carrying out of development under Part 3A of the EP&A Act.

Environmental Planning Instruments

A range of Environmental Planning Instruments (EPI), created under the EP&A Act, provide further detailed guidance and regulation for development at a State, regional and local level.

In accordance with Clauses 75J and 75O of the EP&A Act, in deciding whether or not to approve the carrying out of a Project, the Minister may (but is not required to) take into account the provisions of EPIs that would not apply if the Project were approved. As this is a discretionary matter for the Minister, a range of EPIs have been considered in relation to the Project, including:

- State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.
- State Environmental Planning Policy (Major Development) 2005.
- Lithgow City Local Environment Plan 1994.

Approvals

Under section 75U of the EP&A Act if the project is granted approval under Part 3A of the Act, the following authorisations, which may otherwise have been relevant, would not be required to carry out the Project.

Authorisations That Do Not Apply

Act	Authorisations
Fisheries Management Act 1994	Permit for works or structures within a waterway.
Heritage Act 1977	Disturbance to an item listed on State Heritage Register or Interim Heritage Order; Excavation permit.
National Parks & Wildlife Act 1974	s87 preliminary research permit; s90 consent to destroy relics.
Water Management Act 2000	Water use approval, water management work approval or activity approval.
Native Vegetation Act 2003	Consent for the clearing of native vegetation.
Threatened Species Conservation Act 1995	Licence to harm or pick threatened species, populations or ecological communities or habitat.

If the Project is granted approval under Part 3A of the EP&A Act, the following authorisations, which would be required for the Project, must not be refused by the relevant approval authority and must be substantially consistent with the terms of the Project approval.

Approvals Legislation to be Applied Consistently

Act	Approval	Authority
Mining Act 1992	Mining Lease	Department of Industry and Investment (DII) (formerly Department of Primary Industries – Mineral Resources)
Protection of the Environment Operations 1997	Environment Protection Licence	DECCW
Roads Act 1993	Permit to impact on a public road	Local roads – Lithgow City Council
Coal Mine Health and Safety Act 2002	Section 100	DII

Mining Act 1992

Baal Bone has an approved MOP incorporating Longwall 29 to 31 underground mining operations. The MOP would be updated and provided to DII to incorporate mining of the Remnant Areas prior to mining in these areas.

As required by specific mining authorities, a Subsidence Management Plan (SMP) has been prepared and approved for mining of Longwalls 29 to 31. A further SMP or Extraction Plan would be required prior to mining of the Remnant Areas.

Consultation

This EA has been prepared in accordance with Part 3A of the EP&A Act and its Regulation. Part 3A of the EP&A Act ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision making process.

In preparing this EA, the Director-General's DGRs have been addressed as required by Clause 75F of the EP&A Act. The key matters raised by the Director-General for consideration in the EA are outlined in **Table 6-1** of the EA.

Statutory and Agency Consultation

TWCL has undertaken consultation with key local and state Government agencies during the preliminary design phase and preparation of this EA and as specified in the DGRs. The purpose of this consultation is to provide an overview of the project and to clarify methods of assessment for the EA.

In this regard, face to face meetings, where possible, have been held with relevant statutory agencies identified in the DGRs, to assist with the preparation of the EA.

Briefings have been held with a number of relevant statutory authorities including DECCW, DoP, DII (including Department of Primary Industries-Mineral Resources, Forests NSW and NSW Office of Water), Roads and Traffic Authority (RTA), and Lithgow City Council.

Table 6-2: Statutory and Agency Consultation Log

in the EA describes the consultation log undertaken as part of the EA for statutory and agency stakeholders.

Community Consultation

The overall objective of the Community Consultation Strategy implemented for the Project was to ensure clear, effective, open, two-way communication at all times by listening, recording and responding to issues.

The key community groups involved in the consultative process primarily include the Baal Bone Community Consultative Committee (CCC), Blue Mountains Conservation Society (BMCS) and the Colong Foundation for Wilderness (CFW).

An overall introduction to the project and proposed stakeholder consultation strategy took place on 29 January 2009 with Baal Bone Community Consultative Committee (Workshop No. 1). A CCC meeting involving discussion of the project was also held on 3 June 2009, where the CCC was advised that the new area of proposed underground mining no longer constituted part of this Project Application, and would not be considered as part of the project in the EA.

Issues Identification and Prioritisation

Issues associated with the continued operations at Baal Bone Project Approval were determined to include:

- Subsidence;
- Groundwater management;
- Noise and vibration;
- Water management, including site water balance;
- Visual impact;
- Ecology (flora and fauna);
- Heritage;
- Tailings and reject management;
- Transport and traffic;
- Air quality (dust and greenhouse gas);
- Social and economic; and
- Rehabilitation and mine closure.

The prioritisation of issues has been undertaken using an environmental risk analysis, based on the current and proposed operations at Baal Bone, number and proximity of potential receptors surrounding Baal Bone, existing physical environment, and management practices currently employed at the site.

An issues prioritisation matrix was used to identify priorities. Each issue was given a ranking between one and three for the severity of effects and the perceived consequences of those effects if left unmanaged. These two numbers were added together to provide a numerical ranking for the issue that was used to categorise each issue into high, medium or low priority.

The table below identifies the prioritisation of environmental issues, and therefore the focus of assessment for the proposed project was as follows:

Issues Prioritisation

Low	Medium	High
Air Quality	Subsidence	
Noise	Water Management	
Tailings and Reject Emplacement	Social and Economic	
Flora and Fauna	Heritage and Cultural	
Visual		
Land Use		
Traffic		
Rehabilitation and Mine Closure		

Subsidence

The proposed continued operations at Baal Bone include the underground mining of Longwalls 29 to 31, as well as the potential for mining of Remnant Areas within existing workings at some time in the future.

A subsidence assessment was prepared as part of the Subsidence Management Plan (SMP) as well as the earlier REF prepared for Longwalls 29 to 31 (Umwelt, 2007). The EA assessed subsidence features and predictions along with impacts on surface features, infrastructure, heritage areas, watercourses, groundwater, swamps, wetlands, and flora and fauna.

It is considered that the previous predictions for potential subsidence impacts for mining operations at Baal Bone for Longwalls 29-31 are conservative and within the parameters of previous subsidence experience at the Colliery. Consequently, the potential impacts upon the Wolgan Escarpment, other surface rock formations, ecology, heritage items, infrastructure, watercourses, groundwater and water dependent ecosystems within the angle of draw of Longwalls 29-31 is expected to be minimal.

Mine subsidence as a result of extraction of the Remnant Areas is expected to be similar to maximum subsidence experienced over adjacent longwall panels. Surface features have been identified overlying the Remnant Areas which require protection from subsidence impacts, including three areas of cliff formations and a section of Ben Bullen Creek. Subsidence protection zones have been identified which are based on an angle of draw of 26.5 degrees which is considered appropriate to provide a high level of protection against subsidence impacts (refer **Appendix C**). Subsidence would be minimised and managed through the mine layout and development of an Extraction Plan.

Noise

Atkins Acoustics was engaged by AECOM to undertake a noise assessment (refer **Appendix E**) for current activities occurring at the Surface Infrastructure Area in order to identify current and predicted noise impacts from operations at the site.

It was concluded that the continued operations at Baal Bone including activities within the Surface Infrastructure Area and Underground Mining Area are unlikely to result in significant changes to the existing noise environment. Predicted noise levels exceed criteria at the nearby residential receptors due to the close proximity of residences established post-commissioning of the Colliery. However, Baal Bone has a minimal complaint history, currently implements a range of noise mitigation measures and practices, and proposes to investigate further mitigation techniques in order to reduce noise levels. Given the existing environment, history of operations, and mitigation measures, the project is not expected to result in significant noise impacts.

Water Balance

A water balance assessment was conducted to assess the sustainability of current site water management practices. This assessment involved the following scope of work:

- A review of existing information;
- Determine inputs, outputs and internal water use at the site;
- Develop a water balance model to evaluate sustainable water management including an assessment of potential impacts due to climate change; and
- Provide an assessment which summarises key information and assumptions.

This assessment determined that the current water management strategy is sustainable if the current practises are maintained. The water balance assessment was based on the assumption that process water demands remain constant for at least the next 10 years, which provides a use for all runoff water collected on site. This provides a conservative assessment, as process water demands would likely decrease following completion of mining of Longwalls 29 to 31 and the Remnant Areas in approximately three to four years. The high level of water recycling on site ensures that discharges off site are high quality. The water that leaves the site is runoff generated from rehabilitated areas and from mine dewatering; other water collected from potentially contaminated areas is collected and used on site.

Groundwater

The hydrogeology of the Project Area is strongly influenced by the topography and geology, which comprises the coal seams of the Illawarra Coal Measures overlain by the sedimentary strata of the Narrabeen Group. Erosion in the north of the Project Area has completely removed the Narrabeen Group and Illawarra Coal Measures are exposed at the surface. Cover depths over the LCS range from 25 metres in the north of the Project Area where the Illawarra Coal Measures are exposed, to approximately 200 metres in the south of the Project Area where the Narrabeen Group is present.

The fracture zone associated with mining of Longwalls 29 to 31 and the Remnant Areas is not expected to reach the strata of the Narrabeen Group, where present, which lies a minimum of 95 m above the extracted LCS. As such, additional cumulative impacts to the groundwater regime or swamps within the Project Area as a result of the proposed future mining are not considered likely to be significant.

Ongoing implementation of the Surface and Groundwater Response Strategy and a Mine Water Make Monitoring Program as part of the SMP across the Project Area, would enable the groundwater regime within the Project Area to be monitored and adverse impacts readily identified and managed.

Tailings and Reject Management

A background review was undertaken as part of the EA based on available information to determine the current capacity of Reject Emplacement Area. A Tailings Capacity Assessment was undertaken to estimate the tailings storage capacity to facilitate continued operations at the Colliery. The assessment utilised information obtained from the background review, and also investigated other voids in the Reject Emplacement Area that could have the potential to be commissioned to extend the overall tailings storage capacity of Baal Bone.

The tailings capacity assessment concluded that the tailings and coarse reject generated by continuation of operations at Baal Bone could be adequately accommodated by REA 6 and the Southern Void for approximately 5.5 years, or until the end of 2015, at the maximum emplacement rate. Additionally, the area currently has sufficient capacity to accommodate coarse rejects for the remainder of the life of the mine at Baal Bone.

Mine Closure and Rehabilitation

Detailed Mine Closure Planning has commenced at Baal Bone due to the remaining life of the mine which is expected to be a nominal 10 years, including rehabilitation, and ongoing maintenance and monitoring. Mine closure planning timeframe estimates have been identified based on the expected remaining life of the Colliery at this stage. These are regarded as planning estimates only, and include:

- **Completion of underground mining** - including mining of Longwalls 29 to 31 and the Remnant Areas. It is estimated that mining of Longwalls 29 to 31 would be complete by the end of 2011, and mining of the Remnant Areas would subsequently be undertaken over a period of approximately 24 to 36 months;
- **Rehabilitation** - including decommissioning and removal of plant and infrastructure, recontouring and shaping in accordance with the final landform, and revegetation of disturbed areas in accordance with the final land use. It is anticipated this phase would be undertaken over approximately 18 to 24 months; and
- **Maintenance and monitoring** – maintenance and monitoring of rehabilitation works, estimated to be for a period of approximately 5 years.

The Final Landuse has been determined and the post-mining landscape would be dominated by native woodland and grazing both Class IV (occasional cultivation) and Class VI (no cultivation).

The Colliery has been stockpiling coarse rejects and freedig material to assist in the shaping and capping of the final design landform once mining activities have concluded and final rehabilitation activities on the remaining areas has commenced.

Site rehabilitation activities and Detailed Mine Closure Planning activities are well advanced and the continued operation of Baal Bone to allow the completion of Longwalls 29 to 31 and the identified Remnant Areas would not impact upon these activities.

Traffic and Transportation

The continued operations at Baal Bone would not create additional traffic impacts. No additional traffic movements, other than what has already been approved previously for Baal Bone, would be generated.

Baal Bone currently transports coal via the existing rail infrastructure to transport coal to Port Kembla with some minor road haulage of coal on an as needs basis, depending upon contracts with domestic customers. Should Baal Bone transport coal by road at the currently approved rate of 900,000 t per annum, as per the current development consent, the Colliery's existing Road Haulage Management Plan (RHMP) would be implemented.

The continued use of rail infrastructure for the transportation of coal product to Port Kembla for export is not expected to create adverse environmental impacts. The continued implementation of the existing management measures and procedures between Baal Bone and ARTC would minimise identified impacts associated with the use of the Baal Bone Rail Loop.

Air Quality

An Air Quality Impact Assessment was undertaken for this EA which included preparation of an AUSPLUME atmospheric dispersion model in accordance with DECCW guidelines, using emissions from surface infrastructure and facilities and mine ventilation shafts, and assessment of predicted air quality emissions against assessment criteria using the DECCW Approved Methods (DEC, 2005).

The assessment predicted that ground level concentrations and deposition rates for all modelled parameters, TSP, PM_{10}, deposited dust and odour, met all regulatory assessment criteria at the nearest representative sensitive receptor. Continued operations at Baal Bone are not expected to generate significant impacts to air quality as has been demonstrated by the existing operations. The continued operations and mining of the Baal Bone are not expected to adversely impact the air quality of the local community around the Colliery.

Greenhouse Gas

A Greenhouse Gas (GHG) Assessment was undertaken for this EA in order to estimate the annual GHG emissions associated with the operation of the Colliery. Scope 1, 2 and 3 GHG have been estimated for the Baal Bone using the *National Greenhouse Accounts Factors* (NGA) (DCC, 2008) and the *Xstrata Coal Estimation of Scope 3 Emissions SEE Version December 2008* (2008) document and excel spreadsheet originally developed by Energetics for Xstrata.

This assessment determined that the continuation of operations at Baal Bone would result in the continuation of greenhouse gas emissions. Scope 1, 2 and 3 GHG emissions associated with the operation of the Colliery based on a ROM coal production value of 2.2 Mtpa were assessed. Direct and indirect GHG emissions relating to the proposed continuation of mining operations and mining of Remnant Areas at Baal Bone have been calculated to be a total of 4,375,724 t CO_2-e per annum, which represents approximately 2.7% of the NSW GHG emissions, and approximately 0.73% towards the total national GHG emission.

Geology and Soils

The existing environment and soil landscapes for the site were assessed along with potential impacts. It was determined that the continued operations of the Baal Bone surface infrastructure, mining of approved Longwalls 29 to 31, and mining of Remnant Areas are not likely to result in additional geological or soil impacts given continuation of the current Land Management Plan, TARPs and successful mitigation techniques. Soil and geology would be considered as part of rehabilitation practices leading to the Final Landform.

Ecology

A flora assessment was conducted and has identified ecological communities and threatened species within the Project Area. Two threatened species were identified which are listed under the TSC Act as vulnerable, with one also being listed under the EPBC Act. Two seven part tests and an EPBC assessment were undertaken and concluded the impact on these communities and species as a result of the continued operations at Baal Bone were not significant, and an EPBC referral would not be required.

The fauna assessment demonstrated that the potential for threatened species to be significantly affected is low to very low and the effects from activities within the Underground Mining Area are likely to be low. The proposed project is therefore not likely to result in significant impacts upon threatened fauna species or populations.

Heritage

An Indigenous Heritage Assessment was undertaken for the Project (refer **Appendix N**). A review of the existing environment and previous surveys were undertaken. It was determined that the Surface Infrastructure Area for the site has diminished potential for heritage value and it is unlikely that the continued operations in this area would have further impacts to Aboriginal heritage. Due to predicted modelling and previous background surveys it was concluded that impacts to potential and existing heritage sites in the Longwall 29 to 31 area and proposed Remnant Areas would be minimal provided the management measures recommended in the EA are implemented.

The heritage assessment concluded that although there are some existing sites of cultural significance, potential impacts are not expected to be significant.

Social and Economic

Social and economic profiles were assessed and it was concluded that the proposed continuation of mining operations at Baal Bone is anticipated to provide numerous social and economic benefits for Lithgow and the greater region through continued employment, revenue and community support.

The mine injects approximately $77 million into the NSW economy on an annual basis, of which $13 million goes directly to the Lithgow LGA. Taking into account multiplier effects, the discontinuation and closure of the mine would have a noticeable impact on the local and State economy as well as businesses invested with the mining services. This impact is estimated as an overall reduction of $141 million in State output.

With an extension of the life of the mine, social and economic benefits would continue to filter throughout the local and wider community and promote ongoing stability for the regional population.

Statement of Commitments

In accordance with the DGRs issued under Part 3A of the EP&A Act, a Statement of Commitments (SoC) for the Project is included in **Section 21** of the EA. The SoC sets out TWCL's environmental commitments and details on the environmental management and monitoring of the proposed project during its continuation of operations.

The Proponent is committed to ensuring the preparation and implementation of the environmental management and monitoring plans, further investigations and studies and environmental mitigation measures detailed in the SoCs for the proposed Project Approval.

Residual Risk

The Residual Environmental Risk Analysis for the proposed continued operations is based on a process adapted from Australian Standard AS 4360:2004 Risk Management. The process is qualitative and is based on the Residual Risk Matrix shown in Table 23-1.

Residual Environmental Risk is assessed on the basis of the significance of environmental effects of the proposed project and the ability to confidently manage those effects to minimise harm to the environment.

The Residual Environmental Risk Analysis indicates that the proposal presents an overall low to medium risk in relation to each of the identified environmental issues, provided that the recommended mitigation, management and monitoring measures are implemented.

Cumulative Impacts

The cumulative impacts of Baal Bone have been considered in relation to each of the identified environmental issues in Section 8 to Section 21 of this EA. Cumulative impacts of the continued operations at Baal Bone, particularly with respect to land use, noise and air quality have been considered in each of the technical studies undertaken in respect of this proposal.

The cumulative impacts of the continued operation at Baal Bone were also considered taking into account other existing and recent developments and operations, as well as major projects planned in the local area.

The cumulative impact assessment concluded that the continued operations of Baal Bone would have negligible cumulative impacts given the remaining lifespan of operations.

Project Justification

The Director-General's DGRs issued for the Project require justification for the Project to be provided, having regard to environmental, social and economic considerations together with the principles of ESD. The environmental impact assessment of the Project undertaken in this EA has addressed the relevant biophysical, economic and social considerations. It concluded that the proposed continuation of operations at Baal Bone has been considered in the context of the principles of ESD and considered to be consistent with these principles. The project is not expected to result in significant environmental impacts provided the current environmental management is maintained at the site and recommended additional safeguards and mitigation measures are implemented.

Conclusion

Project Approval is sought for the continuation of an existing underground coal mine and use of existing approved surface infrastructure facilities within an existing mining lease area.

The project satisfies the requirements of a Major Development under SEPP 2005 and has therefore been assessed in accordance with Part 3A of the EP&A Act.

The continuation of operations at Baal Bone does not involve activities that would require additional processes at the site, therefore this EA has assessed the potential environmental management and impacts of the current operations. This EA concludes that the current operations at Baal Bone are not resulting in significant impacts to the environment. The existing environmental management measures are therefore considered to be adequate for the current operations at the site. This EA recommends the preparation of additional environmental monitoring and management requirements for the potential mining of the Remnant Areas, which form part of the Statement of Commitments for the project.

The project would result in benefits to the local community and economy associated with the continued employment of some 190 full time equivalent employees. The project has been considered in respect of biophysical, economic and social grounds and is considered to be consistent with the principles of ESD.

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1.0 Introduction

1.1 Overview

AECOM Australia Pty Ltd (AECOM) has been engaged by The Wallerawang Collieries Limited (TWCL) to prepare this Environmental Assessment (EA) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the continuation of currently approved operations at Baal Bone Colliery (Baal Bone), near Cullen Bullen, New South Wales (NSW) (Baal Bone).

Baal Bone is an existing coal mine with an approved prepared saleable coal production of approximately 2.0 million tonnes of coal per annum (Mtpa), equating to about 2.8 Mtpa of Run of Mine (ROM) coal. Baal Bone currently operates under a number of separate development consents and approvals. The primary development consent for the operation was issued by the Honourable Eric Bedford, Minister for Planning and Environment on 13 September 1982. Operations at Baal Bone currently extract coal from the Lithgow Coal Seam (LCS) via longwall mining methods. ROM coal is transferred to the Surface Infrastructure Area at Baal Bone for processing and stockpiling. Coal produced from underground operations is currently transported by road and rail to both domestic and international markets.

The primary consent issued for Baal Bone in 1982 was issued under Part 4 the EP&A Act. Current mining activities at Baal Bone are taking place within Longwalls 29 to 31 which have been authorised by approval under Part 5 of the EP&A Act. *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005) includes transitional provisions, under which the Part 5 approved activities cease to be of effect from 1 August 2010. As existing longwall operations are not scheduled for completion until 2011 or beyond, TWCL is proposing to continue existing mining operations and associated infrastructure at Baal Bone beyond the expiration of the Part 5 approval. Project Approval under Part 3A of the EP&A Act is required to allow continued mining operations at Baal Bone. The approval regime is described in **Section 1.6** and **Section 5**.

Project Approval under Part 3A of the EP&A Act is sought for the continuation of operations at Baal Bone, including the following:

- Continuation of underground mining within the Underground Mining Area, including Longwalls 29 to 31, which are the subject of a current approved Subsidence Management Plan (SMP) and Mining Operations Plan (MOP);
- Continued operation of associated surface infrastructure and a prepared saleable coal production of 2.0 Mtpa (equating to 2.8 Mtpa ROM coal);
- Continued transport of prepared saleable coal to markets in accordance with current approvals; and
- Mining of other isolated Remnant Areas within existing workings.

This Project Application relates to activities that are either already previously mined, currently being carried out at Baal Bone or are approved to be carried out but have not yet commenced. In this regard, Baal Bone currently holds all requisite development consents or approvals required for its mining activities, coal haulage and associated infrastructure (including ventilation shafts). In addition Baal Bone holds all mining authorities required for the project and also has an approved SMP for its current mining activities, including Longwalls 29 to 31. Due to the transitional provisions of the SEPP 2005, this Project Application would enable continued underground mining of approved Longwalls 29 to 31 beyond 1 August 2010.

As part of its SMP application in 2007, Baal Bone commissioned the preparation of various reports to assess the likely impacts of the proposed mining activities on the environment. As the mining operations which were the subject of the SMP are the same as those which are the subject of this application, these reports have been utilised and supplemented where required to take account of the most up-to-date information available in relation to the project, and to assess likely impacts.

This Project Application would enable continuation of underground mining of approved longwall panels and operation of associated existing surface infrastructure. The continued operation of Baal Bone would not result in changes to currently approved coal processing capacity, ROM production, or significant changes to ancillary handling infrastructure and activities.

Preliminary stakeholder consultation was undertaken for the proposed project with stakeholders including community representatives, non-government organisations, and statutory agencies. This consultation has included discussions on the proposed continuation of operations at Baal Bone, as well as discussions regarding a potential new area of proposed underground mining within the Project Area boundary, known as the Northern Area. Since the preliminary consultation, and due to economic considerations, the new area of proposed underground mining no longer constitutes part of this Project Application, and would not be considered as part of the project in the EA. Stakeholders have been informed of this decision.

1.2 The Proponent

The proponent for the proposed project is The Wallerawang Collieries Limited (TWCL), a company that is 95% owned by Oakbridge Pty Ltd and 5% owned by Sumitomo Pty Ltd. The major shareholder in Oakbridge Pty Ltd is Xstrata Coal Pty Ltd, which currently manages the Colliery.

1.3 Project Location and Site Context

Baal Bone is located on the Castlereagh Highway 5 km north east of the township of Cullen Bullen, and approximately 25 km north west of Lithgow in the Lithgow Local Government Area (LGA) in NSW. The location of Baal Bone is shown in **Figure 1-1**.

The Project Area is bordered to the north and east by the Capertee and Wolgan Valleys respectively, to the south by the Invincible Colliery and private property to the west which adjoins the Castlereagh Highway. Other active coal mines and associated electricity generating infrastructure near to the site include Cullen Valley Colliery, Angus Place, Pinedale, Lamberts Gully and Springvale Collieries, and the Mount Piper and Wallerawang Power Stations.

Other surrounding land uses are predominantly State Forest including Ben Bullen and Wolgan State Forest areas, which are used for recreation activities such as bushwalking, motorcycling, four wheel driving, and camping. The Bicentennial National Trail follows a forest track within the Ben Bullen and Wolgan State Forests and is part of a series of linked stock routes along eastern Australia which are now primarily used for horse riding. The Castlereagh Highway is the closest significant transport route located adjacent to the western boundary of the Project Area.

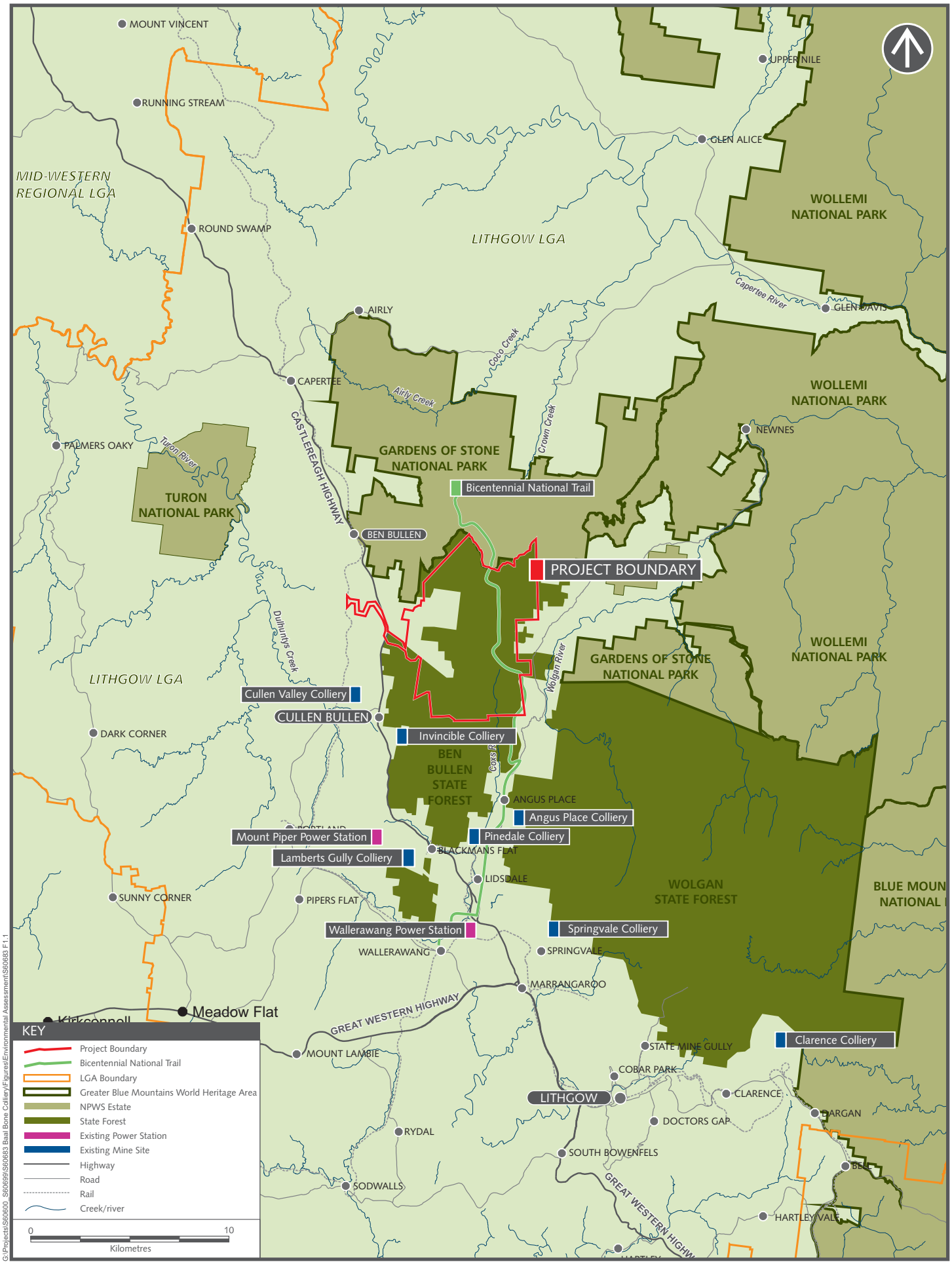
The surrounding landscape consists of gently undulating forested plateaus which give way to steep escarpments and valleys. These are the dominant features in the surrounding environment and provide high local visual amenity. Baal Bone is generally located on the plateau of the surrounding escarpments. The project site and context is further discussed in **Section 2** of this EA.

1.4 Existing Approved Operations

The Colliery operates under a number of mining authorities, namely Consolidated Coal Lease (CCL) 749, Mining Leases (ML) 1302, 1389 and 1607, Coal Lease (CL) 391 and Mining Purposes Lease (MPL) 261 as shown in **Figure 1-2**. These mining authorities are collectively referred to as the Colliery Holding. Relevant consents, approvals, licences, and mining authorities for current operations at Baal Bone are shown below in **Table 1-1**.

Underground mining operations target the Lithgow Coal Seam of the Illawarra Coal Measures. The current existing operations at the Colliery include the following:

- Operation of the Coal Handling and Preparation Plant (CHPP) and other mining related facilities;
- Underground longwall mining operations (Longwalls 29 to 31) and associated operation of ventilation shaft and transmission line easement;
- Loading and transport of coal to domestic and international markets; and
- Development mining throughout the Project Area, the subject of various mining authorities.



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BAAL BONE COLLIERY REGIONAL SITE CONTEXT

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 1.1

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Baal Bone operates 24 hours per day, seven days per week, with coal mining operations carried out 24 hours per day Monday to Friday. Maintenance operations including stone dusting, roadway work and limited longwall production are undertaken on weekends. The location of the existing Surface Infrastructure Area and Underground Mining Area are shown on **Figure 1-3**.

Table 1-1 outlines the relevant consents, approvals, licences and mining authorities which apply to operations at Baal Bone.

Table 1-1: Relevant consents, approvals, licences, and mining authorities for Baal Bone

Regulatory Body	Approval Number	Issue Date	Expiry / Review Date	Scope
Mining Authorities				
Department of Primary Industries – Mineral Resources	CCL 749	5/04/1990	23/03/2010 (note: renewal application lodged by Baal Bone on 06/02/2009)	Mining Entitlement (Consolidates MPL 209, CL 246, CL 329, CL 330, CL331 and CL332). Various depths.
	MPL 261	22/08/1990	22/08/2011	Mining Entitlement (Southern mine dewatering bores) Parish: Ben Bullen. Depth: Surface – 10 m below ground level (BGL).
	CL 391	24/02/1992	24/02/2013	Mining Entitlement Parish: Ben Bullen. Depth: > 20 m BGL.
	ML 1302	29/09/1992	29/09/2013	Mining Entitlement Parish: Ben Bullen Depth: >20 m BGL.
	ML 1389	9/05/1996	09/05/2017	Mining Entitlement Parish: Ben Bullen. Depth: Surface – unlimited Surface – 20 m BGL.
	ML 1607	8/01/2008	8/01/2018	Mining Lease (Purposes) Parish: Cox Depth: Surface – 10 m BGL.
Mining Operations Plan				
Department of Primary Industries – Mineral Resources	06/4648	10/07/2009	10/07/2016	Underground operations within CCL 749, CL 391, ML 1302, ML 1389, ML 1607 and MPL 261.
Subsidence Management Plan				
Department of Primary Industries – Mineral Resources	06/7570	07/12/2007	01/12/2014	Subsidence Management Plan for extraction of Longwalls 29 to 31.
Environment Protection Licence				

Regulatory Body	Approval Number	Issue Date	Expiry / Review Date	Scope
Department of Environment, Climate Change and Water	765	28/04/2006	10/09/2014	
Development Consents				
Department of Planning	Nil	13/9/1982	Perpetuity	Original Development Consent for Baal Bone comprising two-stage development and extraction of coal for export.
		31/12/1992	Perpetuity	Modification to original Development Consent (13/09/1982) to include road haulage of coal of 150,000 tpa for industrial purposes.
Greater Lithgow Council	DA 186/95	27/02/1996	Perpetuity	Development Consent for open cut mining activities. Open cut activities have since ceased, however former open cut voids are now managed as reject emplacement areas for the CHPP. These areas would be rehabilitated as part of the Mine Closure for Baal Bone.
Department of Planning	DA 164/98	19/08/1999	30/12/2000	Road haulage of 1.5 Mtpa for domestic market.
		25/08/2000	31/12/2003	Modification (DA 164/98) for the extension of coal haulage time for 900000 tpa to and from Baal Bone by public road.
		23/12/2003	31/12/2015	Modification (DA 164/98) for the extension of the duration of road haulage from Baal Bone to Mount Piper and Wallerawang Power Stations.
Relevant Approvals				
Department of Planning	MP 07_0035	24/10/2007	Perpetuity	Construction and operation of Ventilation Shaft and Power Line Corridor associated with Longwalls 29 to 31.

1.5 Need for the Project

The proposed project involves the continuation of an existing underground coal mine and use of existing approved surface infrastructure facilities within an existing mining lease area. The utilisation of existing infrastructure provides an economically viable means of extracting the coal resource from the existing mining lease area.

The project would also result in a number of significant economic benefits to both the local area and the State, including the following:

- Continuation of existing employment at Baal Bone, including some 190 full time positions for employees and contractors in the Lithgow LGA where employment has declined over the last decade due, in part, to a number of mine closures;
- Indirect economic benefits associated with maintaining local employment, and expenditure on local goods and services;
- Payment of royalties to the State for the recovery of up to approximately 2.0 Mtpa of saleable coal; and
- Export earnings for Australia.

This EA provides a detailed justification for and outlines the associated benefits of the project, and also assesses potential environmental, social and economic impacts locally and on the State. The project need and alternatives are further detailed in **Section 3**.

1.6 The Environmental Assessment Process

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *EP&A Regulation 2000* provide a framework for environmental planning in NSW.

Prior to a decision to proceed with a proposal that may have an impact on the environment, a detailed assessment of the likely impacts of the project must be undertaken. The proposed project has been declared by the Minister as a 'major project' under the relevant provisions of the EP&A Act and *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act with the Minister being the approval authority.

1.6.1 Major Development

Project Approval is sought for the continued operations at Baal Bone including operation of the CHPP and mining related facilities within the Surface Infrastructure Area, and mining of Longwalls 29 to 31 and Remnant Areas within the Underground Mining Area. The proposed continuation of mining operations does not seek to alter the approved extraction limit.

Part 3A 'Major Infrastructure and Other Projects' was added to *the Environmental Planning & Assessment Act 1979* (EP&A Act) by the *Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act 2005*. Part 3A of the EP&A Act commenced on 1 August 2005.

Pursuant to section 75B (1) of the EP&A Act, Part 3A of the EP&A Act applies to development declared to be a project to which Part 3A applies. Such a declaration is by way of a State Environmental Planning Policy (SEPP) or order of the Minister published in the NSW Government Gazette (section 75B (1) of the EP&A Act).

SEPP 2005 identifies projects which are to be assessed under Part 3A of the EP&A Act.

Clause 6 and Item 5 of Schedule 1 of the SEPP 2005 declares the following development to be a project to which Part 3A of the EP&A Act applies:

> ***5 Mining***
>
> *(1) Development for the purpose of mining that:*
>
> *a) is coal or mineral sands mining, or*
>
> *b) is in an environmentally sensitive area of State significance, or*
>
> *c) has a capital investment value of more than $30 million or employs 100 or more people.*

Clause 14 of the SEPP 2005 provides transitional provisions relating to development for the purposes of a mine.

Baal Bone is within the Lithgow City Local Government Area and is therefore subject to the Lithgow City Local Environmental Plan 1994 (Lithgow LEP). Clause 5 of the LEP adopts almost all of the Model Provisions and in particular Clause 35, and therefore clause 14(4) and 14(5) apply to development carried out at the mine.

From 1 August 2010 the transitional provisions cease to have effect for the development carried out underground at Baal Bone (Longwalls 29 to 31).

Consequently, following 1 August 2010, approval is required for the project to which Part 3A of the EP&A Act applies pursuant to Clause 6 and Item 5 of Schedule 1 of the SEPP 2005 and for which there is no development consent.

The current proposal seeks the approval of the Minister pursuant to section 75E of the EP&A Act for the carrying out of development under Part 3A of the EP&A Act.

1.6.2 Preliminary Environmental Assessment

A Preliminary Environmental Assessment (PEA) was submitted to the Director-General with an outline of the proposed project and background environmental data on the site and the proposed project, as required under section 75E of the EP&A Act. This allowed the key environmental issues of significance and the level of environmental assessment required for the application to be established.

The PEA for the proposed project identified key issues for assessment in the EA, including:

- Subsidence;
- Water Management (surface water and groundwater);
- Air Quality; and
- Noise.

1.6.3 Environmental Assessment Requirements

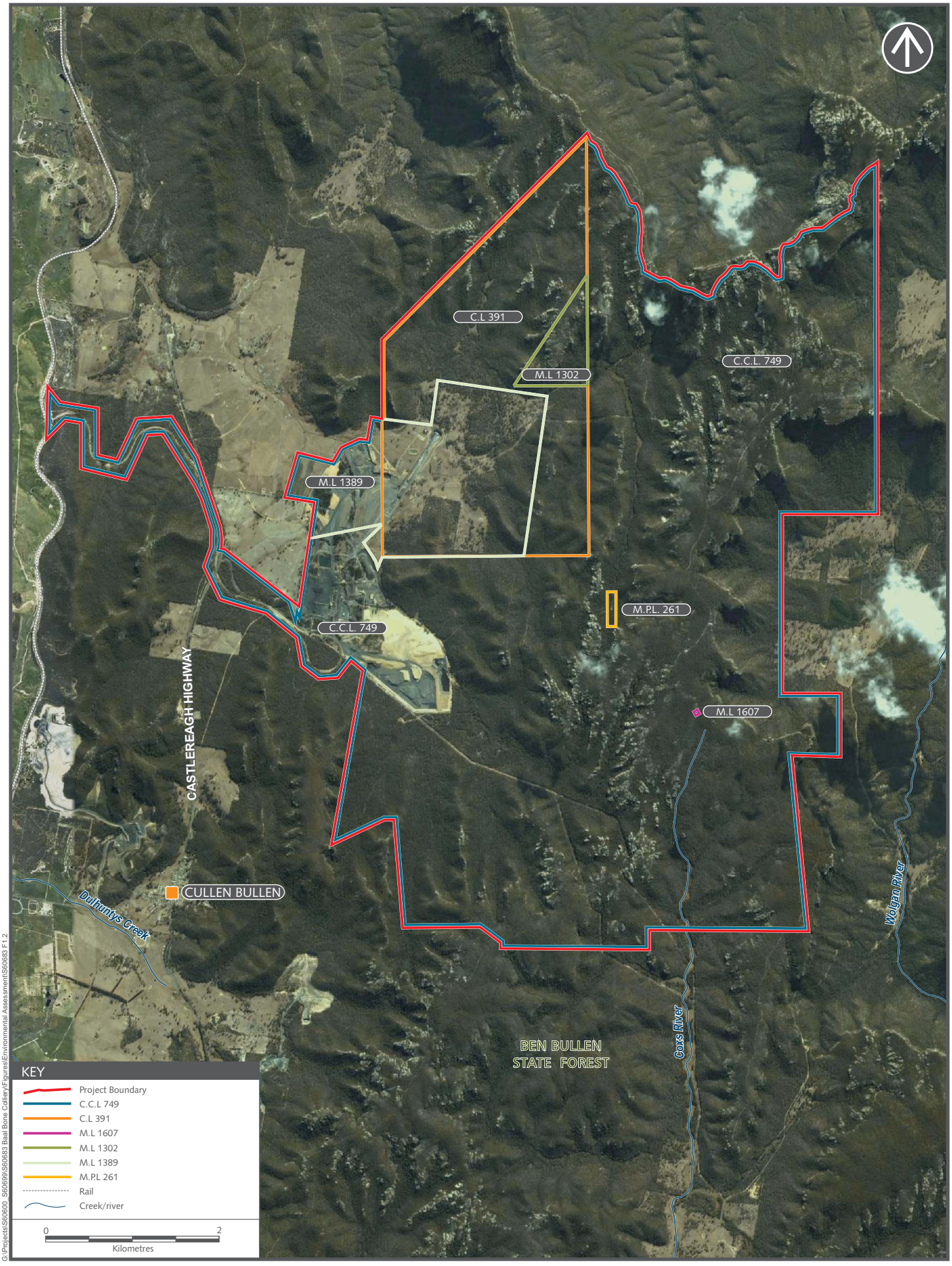
Under section 75F of the EP&A Act, the EA must be prepared in accordance with the Director-General's Requirements (DGRs) for the EA issued by the Director-General of the Department of Planning (DoP). The DGRs were issued on 28 October 2009. A copy is attached as **Appendix A** to this EA. This EA has been prepared in accordance with the DGRs.

1.6.4 Stakeholder Consultation

During the preparation of this EA, key stakeholders were consulted. Stakeholders included local community groups as well as key government agencies. Throughout the preparation of the EA, these stakeholders have been kept informed of the progress of the project and these stakeholders have requested certain matters be addressed. Further details on consultation are discussed in **Section 6**.

1.6.5 Purpose of this Report

In accordance with Part 3A of the EP&A Act, this EA has been prepared in accordance with the DGRs. The purpose of this report is to describe the proposal, assess the environmental effects of the proposal, and to describe the measures necessary to manage the impact of identified adverse environmental effects in order that that the Minister for Planning can make an informed decision with regard to the project.



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BAAL BONE COLLIERY MINING AUTHORITY PLAN

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 1.2

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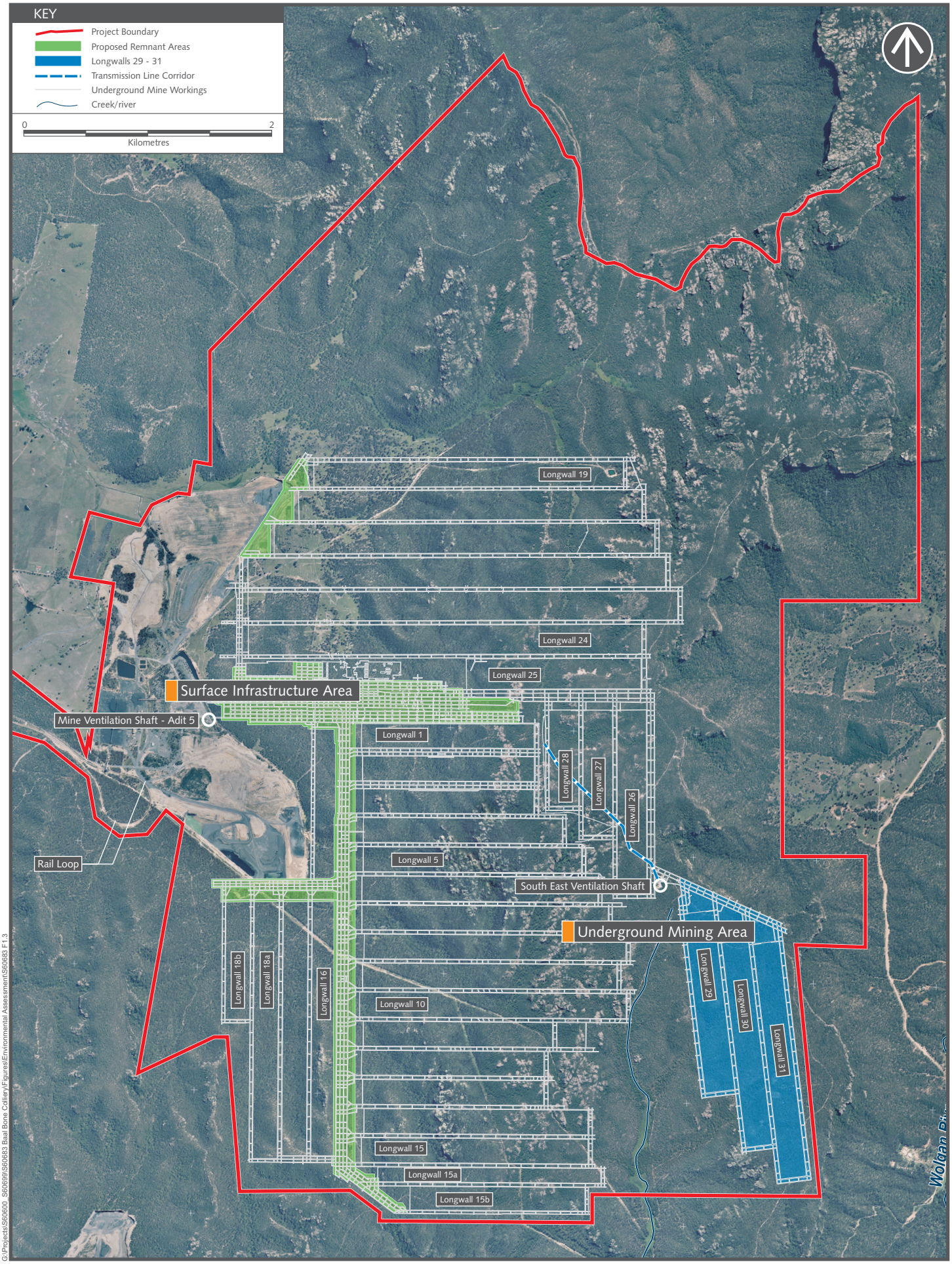

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LOCATION OF EXISTING SURFACE INFRASTRUCTURE FACILITIES AND UNDERGROUND MINE WORKINGS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 1.3

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1.7 Structure of this Environmental Assessment

This EA has been prepared to provide information based on the following structure:

- Section 1 – provides an introduction to the project, including information about the applicant, context to the project, the need for the project and the approvals regime;
- Section 2 – provides the site context and location of the current operations, as well as a brief description of the surrounding land uses and land ownership to Baal Bone;
- Section 3 – provides information on the need for the project and outlines the alternatives that were considered by TWCL during the development of the Project Application;
- Section 4 – describes the continued operations at Baal Bone and the scope of the Project Application;
- Section 5 – describes the approvals pathway for the continued operations at Baal Bone;
- Section 6 – describes the consultation process undertaken in accordance with the DGRs.
- Section 7 – provides a summary of the environmental issues identified in the PEA and their prioritisation.
- Section 8 – Subsidence –reviews the predicted subsidence from the approved mining activities at Baal Bone and outlines the potential effects on the surrounding environment.
- Section 9 – Noise - describes the existing noise environment with respect to identified sensitive receivers and the predicted noise levels and outlines a Noise Management Strategy.
- Section 10 – Surface Water - provides a water balance for the site including the Process Water and Mine Water Make.
- Section 11 – Groundwater - outlines the existing groundwater environment and provides a review of the groundwater impact predictions for mining activities on the surrounding environment.
- Section 12 –Tailings and Reject Management - provides a review of the coarse reject and tailings management at Baal Bone and analyses the remaining capacity for the life of the mining operations.
- Section 13 – Mine Closure and Rehabilitation – outlines the rehabilitation requirements for Baal Bone and provides detail on the Mine Closure Planning process.
- Section 14 – Traffic and Transportation – outlines the historical transportation of coal from Baal Bone to domestic locations via the road network and also provides information on the rail transportation of coal.
- Section 15 – Air Quality – provides an assessment of the air quality impacts from the operation of Baal Bone with respect to the identified nearby sensitive receivers.
- Section 16 – Greenhouse Gas – provides an assessment of the greenhouse gases produced by the Colliery for Scope 1, Scope 2 and Scope 3 emissions.
- Section 17 – Geology and Soils – provides a review of the geology and soils in the Baal Bone area and those subject to mining activities for the continued operation of the Colliery.
- Section 18 – Ecology - provides a review of the flora and fauna, including threatened species, communities and habitats, with respect to the continued operation of Baal Bone, including the mining of LW29-31 and identified Remnant Areas.
- Section 19 – Heritage - provides a review of the heritage values of the Baal Bone area with respect to the continued operation of Baal Bone, including the mining of LW29-31 and identified Remnant Areas.
- Section 20 – Land Use – provides a brief description of the surrounding land uses near Baal Bone and an assessment of potential impacts.
- Section 21 – Social and Economic – provides a brief analysis of the social and economic environment from Baal Bone's operations.
- Section 22 – Statement of Commitments - details the Statement of Commitments by TWCL to allow for the continued operation of Baal Bone.

- Section 23 - Residual Environmental Impacts – outlines the residual environmental impacts arising from the continued operation of Baal Bone.
- Section 24 – Project Justification – details the justification of the project with respect to the principles of Ecological Sustainable Development (ESD).
- Section 25 – Summary of Findings.

2.0 Site and Context

2.1 Site Description and Land Ownership

The Project Area is located approximately 25 km north west of Lithgow and 5 km north east of the township of Cullen Bullen in the Lithgow LGA, NSW. The location and regional context of Baal Bone is shown in **Figure 1-1**. The Project Area incorporates the following components, which are shown on **Figure 1-3.**

- Surface Infrastructure Area, comprising the following:
  - CHPP and other mining related facilities (including the rail loop) located in the centre of the Surface Infrastructure Area;
  - Northern and southern rehabilitation areas, which comprises former open cut workings which are in various stages of rehabilitation;
  - Reject emplacement area, located in the southern portion of the Surface Infrastructure Area; and
- Underground Mining Area, incorporating extracted longwall panels 1 to 28 (including the Remnant Areas), and the current mining area, Longwalls 29 to 31.

The Surface Infrastructure Area covers an area of approximately 380 ha of freehold land owned by TWCL, and also incorporates Crown Road Reserves and road permits within and adjacent to the site. The boundary of freehold land owned by TWCL is shown on **Figure 2-1**. The Underground Mining Area operated by the Colliery is located to the east of the Surface Infrastructure Area, and is located within the mining authorities operated by Baal Bone which cover an area of approximately 4622 ha. The Underground Mining Area and associated mining authorities are shown in **Figure 1-2**.

A majority of the Underground Mining Area underlies land managed by DII, namely the Ben Bullen State Forest and Wolgan State Forest. A small section of the Project Area includes Crown Land held under a Grazing Licence. The land managed by Forests NSW and Crown land overlying the Underground Mining Area contains no dwellings or private land holdings.

The Castlereagh Highway (State Route 86) is situated to the west of the Project Area. The Castlereagh Highway joins the Great Western Highway just south of Lithgow, and continues north to the Queensland border. To the west of the Castlereagh Highway runs the Wallerawang-Gwabegar railway line. The Wallerawang-Gwabegar railway line branches from the Main Western Railway line, which provides a connection to the Main Suburban Line between Sydney's Central Station and Parramatta. Baal Bone is serviced by a 7 km long spur line from the Wallerawang-Gwabegar railway line, which terminates at a 200 m radius balloon loop where coal is loaded onto trains. The Project Area is bordered to the north and east by the Capertee and Wolgan Valleys, respectively. The Gardens of Stone National Park is situated to the north of the site.

2.2 History of Operations

Baal Bone is one of a number of active coal mines located in the Western Coalfields area of NSW. Mining on the site commenced in the late 1940s with the operation of the Ben Bullen Open Cut Mine by the NSW Mining Co Ltd, a subsidiary of the State and Federal Government owned Joint Coal Board. The mine was worked as a number of rectilinear areas, each being filled with spoil/overburden behind an advancing cut. With the cessation of mining in 1952, the former mine site was left with only minimal rehabilitation and ribs of spoil and a series of exposed high walls.

TWCL was initially granted Authorisation to Prospect (Coal) in 1979 covering an area north east of Cullen Bullen which also included the former Ben Bullen Open Cut Mine. Development consent was granted in 1982 for the development of Baal Bone in two stages. Stage 1 involved construction of surface facilities and the use of continuous miners. Once mined, coal was transported via truck to the Wallerawang Colliery for washing, stockpiling and despatch by train to the Balmain Ship loader or the Port Kembla Coal Terminal.

Stage 2 of the development involved commissioning an underground longwall mining system, the construction of a CHPP, product handling facilities and a railway spur line including a loop, loading bin, signalling equipment and conveyors located within the Surface Infrastructure Area.

The Stage 1 development commenced in 1983 with continuous miner operations, and Stage 2 development commenced in 1986 which included the commissioning of longwall mining and the CHPP. Following the introduction of longwall mining operations in 1986, total ROM production from the Colliery increased. The current approved prepared saleable coal production is approximately 2.0 Mt per annum.

2.3 Regional Environment

2.3.1 Topography and Geology

The Lithgow Region is situated on the western margin of the Sydney Basin and consists of gently undulating forested plateaus that give way to steep escarpments and valleys.

Baal Bone is located within the Great Dividing Range bordering the Wolgan Valley at an elevation of approximately 860 m AHD. The topography is regionally characterised by hilly to rugged terrain with moderate to high relief, with the presence of steep gullies, sandstone cliffs and rock formations. The Wolgan Escarpment overlies Baal Bone to the east and north east. The soils of the project area are generally shallow on crests and moderately deep on upper and mid-slopes.

The exposed escarpments and rocks in the region comprise Triassic sandstones of the Narrabeen Group, which enable the presence of pagodas. In addition to pagodas, the nearby Newnes Plateau contains several aeolian sand dunes formed by sand from local soils being stripped by winds and deposited as dunes in the lee of cliff-lines, approximately 20000 to 30000 years ago (Hesse et al., 2003).

The soils of plateaux in the area are infertile, sandy and acidic, with deficiencies in plant nutrients. The soils of the valley swamps on the plateaux and on the headwaters of Coxs River are considered organic and highly acidic.

West and north of Newnes Plateau, the Coxs and Wolgan Rivers have cut through the sandstone to expose the softer Permian Coal Measures and the Shoalhaven Group of sediments below them. The Permian coal seams and oil shale layers of the Western Coalfields, which include the commercially-extracted Upper Katoomba and Lower Lithgow seams, are encountered some 200 to 400 m below the plateau. Ecological communities such as grassy white box woodlands, are located where the coal seams outcrop.

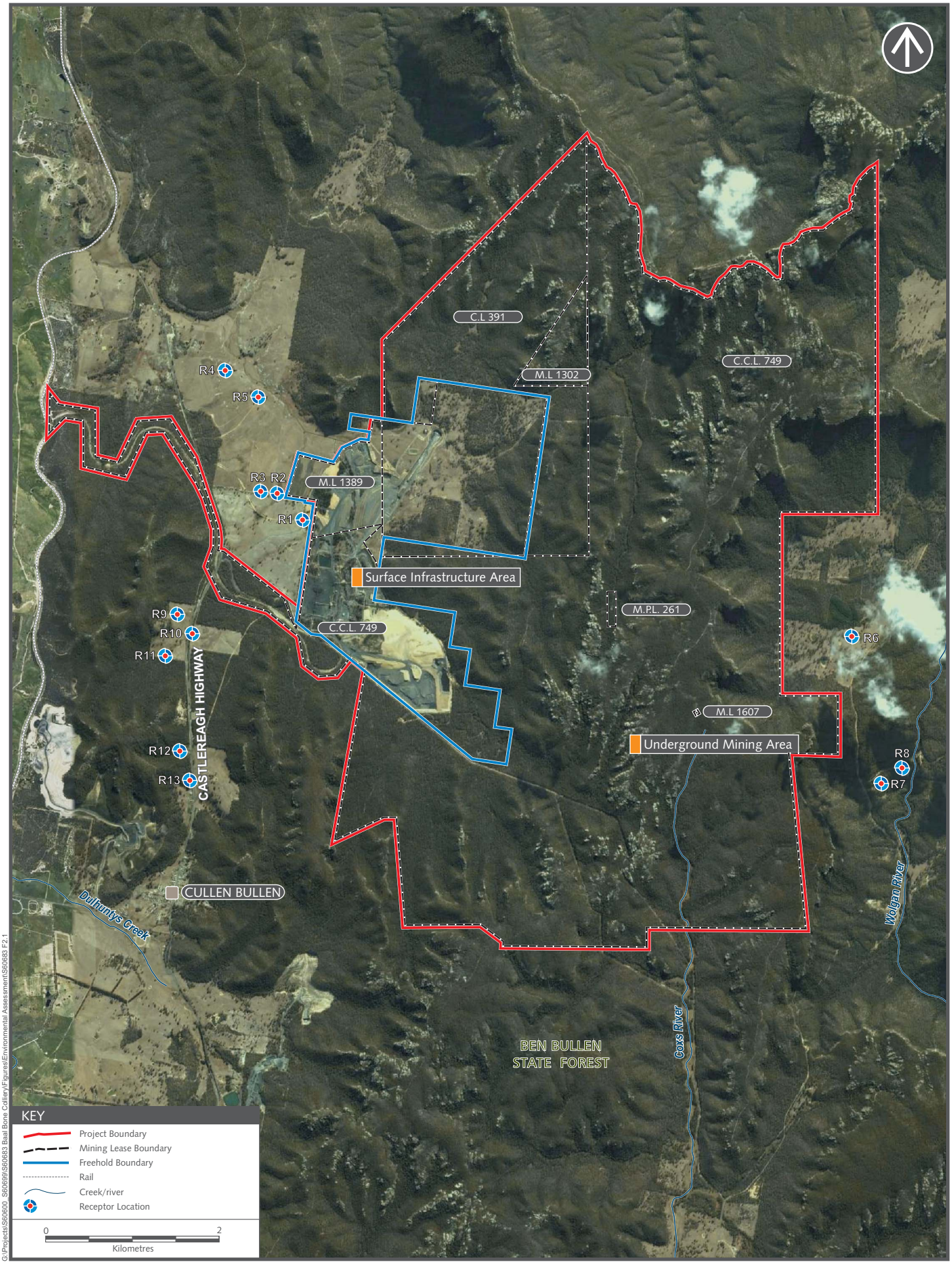
2.3.2 Catchment Areas

Baal Bone is located within the Great Dividing Range, which separates the Hawkesbury-Nepean Catchment from the Central West Catchment near the town of Cullen Bullen.

The areas within the north, east and south of the Project Area form part of the Hawkesbury Nepean Catchment. The northern and eastern portions contain three major subcatchments, the Capertee, Wolgan and Wollemi River subcatchments, which eventually flow east to the Colo River. The Colo River subcatchment is important to the health of the Hawkesbury River, as it supplies a significant volume of clean water to the river (HNCMA, 2009).

The south eastern portion of the Project Area includes the headwater streams of the Coxs River within the Upper Coxs River subcatchment, part of the Hawkesbury Nepean Catchment. The Coxs River forms part of the Sydney Water Catchment and eventually flows to Warragamba Dam, the main water supply for Sydney.

The area to the north west and west of the Project Area forms part of the Central West Catchment. Baal Bone Creek, Ben Bullen Creek and Jews Creek, which are located within the Project Area, lie within the Central West Catchment and are the predominate receivers of water discharged from Baal Bone's surface facilities and infrastructure. These tributaries flow westward to the Turon River which joins to the Macquarie River. The Macquarie River flows northward through steep gorge areas in the Hill End area and is impounded by Burrendong Dam upstream of Wellington (CWCMA, 2009). The Macquarie Marshes Nature Reserve, listed as a wetland of international importance under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) is located within the Central West Catchment. Baal Bone is located within the same catchment area as the Nature Reserve, which is located some 250km west of the site.



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BAAL BONE COLLIERY LAND OWNERSHIP PLAN

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 2.1

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2.3.4 Vegetation

Vegetation patterns within the Baal Bone Project Area have been identified as primarily containing nine vegetation types. These are predominantly characterised by forest, grassland, woodland and heath vegetation complexes. Recent field surveys identified a total of 227 native flora species within the Project Area, which represents a high level of species richness. Eight species of conservation significance have been identified within the vicinity of Baal Bone.

The surrounding plateaux, are characterised by pagoda rock sparse shrubland, montane open forests and woodland of Eucalypts (DEC, 2006). The NSW TSC Act protects 21 vulnerable species and 11 endangered species of flora in the Lithgow LGA (DECCW Atlas of NSW Wildlife, 2009).

An assessment of vegetation within the Project Area has been undertaken as part of this EA and is discussed in **Section 18**.

2.3.5 Fauna

Extensive studies and a number of fauna surveys have previously been undertaken within the Project Area since the Colliery's operation which have either identified presence of, or the potential for the occurrence of threatened species in the area. Studies and surveys have been undertaken since the early 1980s and provided a list of terrestrial and aquatic species located in the Baal Bone area. Within the last ten years, a further thirteen reports have been prepared detailing the fauna species of the Baal Bone area and as such, the faunal environment of the site is well known.

Some 36 threatened species have been identified as known to occur within 20 km of the Project Area. An assessment of existing fauna habitat has been undertaken for this EA, and is discussed in **Section 18**.

2.3.6 Cultural Heritage

The wider region has a recorded history of Aboriginal occupation likely affiliated with the Dharug and Wiradjuri language groups. Food was likely more abundant in the Capertee, Coxs and Wolgan valleys, and in the Newnes Plateau swamps, demonstrated by the large number of recorded occupation sites. The archaeological deposits associated with shelters bordering some of these swamps have high densities of artefact material and the majority remain unstudied. The Aboriginal sites contain engravings and axe grinding grooves on flat rock surfaces, rock shelters containing archaeological deposits and art, and dense surface deposits often associated with the high altitude shrub swamps. The rock art in the 550 hectare Blackfellows Hand Cave Reserve has been granted protection from mining operations. Activities such as forestry, mining and off road vehicles can impact upon Aboriginal artefacts and sites by disturbing soil and increasing erosion.

The area of Baal Bone has few recorded items of Indigenous heritage. However, an Indigenous heritage survey has been undertaken which involved consultation with stakeholders from local Aboriginal groups. The results of this assessment are presented in **Section 19**.

2.3.7 Climate

The closest Bureau of Meteorology automatic weather station to the site is at Lithgow, approximately 25 km to the south east of Baal Bone. Average annual rainfall for the area (1889 to 2006) is approximately 858.1 mm with the range typically between 700 mm and 900 mm (Bureau of Meteorology, 2009). Winter and summer total rainfalls are relatively consistent however intense rainfalls, often associated with thunderstorms, are more common in summer. Mean daily temperature ranges from 10.4^{o}C to 25.5^{o}C in summer and 0.4 ^{o}C to 12 ^{o}C in winter.

2.4 Surrounding Land Uses

2.4.1 Towns and Sensitive Receivers

The population in the surrounding Lithgow LGA has trended towards decline over the last decade, with a current population of approximately 19300. An aging population and notable drift of young people to other nearby areas is attributed in part to the changing economic environment and the growth of the town of Bathurst for new industry and educational opportunities (Coakes Consulting, 2008).

Cullen Bullen is the closest village to Baal Bone (approximately 5 km south) and comprises a population of approximately 300 people. The village was established by European settlers in 1821 and expanded in the1840s as gold was discovered close by. It is now a village largely sustained by employment at local coal mines and power stations.

Rural residential receivers in close proximity to Baal Bone include three rural residences located to the north west of the existing surface infrastructure area.

2.4.2 National Parks and State Forests

Land uses surrounding Baal Bone predominantly comprise state forests and national parks, including the Ben Bullen and Wolgan State Forests, and the Gardens of Stone National Park. These areas provide significant and high local visual amenity which are used for numerous recreational activities as further described below in **Section 2.4.4**.

There is currently a proposal submitted by the Colong Foundation for Wilderness, Blue Mountains Conservation Society and The Colo Committee to extend the Gardens of Stone and Blue Mountains National Parks and create a Gardens of Stone State Conservation Area and a Western Escarpment State Conservation Area to include the Western Escarpment, Airly-Genowlan Mesa, Newnes Plateau and related Crown lands.

2.4.3 Natural Resources

The wider Central West regional economy is mainly supported by manufacturing and agriculture, but is also maintained by mining, food processing, tourism and retail. Wool, cattle and wheat are the main forms of agricultural production with some growth occurring in horticulture and viticulture. The region is rich in natural resources including coal, gold, copper, timber and water supplies.

Coal seams in the Western Coalfield have been subject to open cut and underground mining for more than 120 years. As such, there are several active coal mines in the region. Centennial Coal operates the Clarence, Springvale, Lambert's Gully and Angus Place collieries near Lithgow. Charbon and Charbon Open-Cut operations (primarily owned by Centennial Coal) are located at Kandos. Other active mines in the region include Cullen Valley, Invincible and Pinedale.

There are also two coal-fired power stations in the region, Mount Piper and Wallerawang Power Stations, which are located approximately 9 km and 18 km to the south, respectively. These power stations source coal from nearby collieries.

There are three approved sand mining operations nearby, predominantly on the Newnes Plateau. Two of these, owned by Kables Sands (Pioneer Concrete) and ROCLA Quarries are currently operating. A third quarry owned by Boral Resources is currently not operational.

There are logging operations associated with the Blue Mountains Ash (*Eucalyptus oreades*) in the Ben Bullen, Wolgan and Newnes Plateau State Forests. There is also a radiata pine plantation in the centre of Newnes Plateau.

2.4.4 Recreational Uses

There are numerous recreational uses within the region, particularly associated with the Ben Bullen and Wolgan State Forests and the Garden of Stones National Park. The scenic values in the region make it popular for bushwalking and camping. The Bicentennial National Trail follows a forest track within the Ben Bullen and Wolgan State Forests and is part of a series of linked stock routes along eastern Australia primarily for horse riding.

Adventure recreational activities such as canyoning, abseiling and climbing are undertaken in the region. Fourwheel driving and motorcycling are also popular activities, particularly along the rough access tracks originally established for logging operations.

Emirates Hotels and Resorts, a subsidiary of Emirates Airlines, is currently constructing a conservation area and luxury resort in the Wolgan Valley. The western boundary of the property is located approximately 4 km to the east of the Project Area. The property covers over 2000 ha, most of which was previously farmland to the east and south of Donkey Mountain.

2.4.5 Rural Lands

Land surrounding Baal Bone to the north west, west and south west is predominantly rural, with land uses primarily pastoral and grazing purposes. Nearby rural townships include the populations of Glen Davis, Capertee, Cullen Bullen and Newnes.

3.0 Project Needs and Alternatives

3.1 Need for the Project

The proposed project involves the continuation of an existing operating underground coal mine and associated surface infrastructure facilities within an existing mining lease area. The project is focussed on timely recovery of a state significant resource in a manner that minimises environmental and social impact and maximises the use of resources and existing infrastructure.

Of all the electricity generated worldwide, about 40 per cent is produced from coal. It is also the principal form of reductant in the metallurgical industries, with over 66 per cent of world steel production and a number of other industries (e.g. alumina refineries, cement manufacturing, paper manufacturing, breweries and the chemical and pharmaceutical industries) dependent on coal. Combined, black and brown coal accounts for over 85 per cent of Australia's electric power, with black coal accounting for around 60 per cent (Australian Coal Association, 2009). Large base-load black coal-fired power stations are located in relatively close proximity to the extensive black coalfields in both New South Wales and Queensland.

Black coal, which is the type of coal mined at Baal Bone, is a sedimentary organic rock consisting of anthracite, bituminous and sub-bituminous rank coals (Australian Mines Atlas, 2009). Black coal is Australia's largest commodity export, with exports worth approximately $24.4 billion in 2007-08. Australia is also the world's largest single coal exporter with exports of approximately 252 million tonnes (Mt) in 2007-08, or approximately 30% of the world total. Total production of saleable black coal in Australia in 2007-08 was approximately 327 Mt (Australian Coal Association, 2009). As such there is an existing need, both nationally and internationally, for the extraction of coal to sustain the energy demand and to support the associated industries currently reliant on coal.

Coal from the Lithgow Coal Seam in the Baal Bone area is predominantly dull, non-swelling bituminous, medium volatile, low sulphur (0.6%) and of moderate ash content. The benefit of low sulphur coal is that when burnt, it emits minimal sulphur dioxide gas into the atmosphere, reducing the likelihood of acid rain and associated environmental and health impacts. The low sulphur content of the Baal Bone coal provides potential for it to be blended with higher sulphur coals to allow strict environmental standards to be met. The ash content after washing meets export specifications for thermal purposes.

Baal Bone is situated in close proximity (within approximately 15 km) to two coal-fired power stations, being Mount Piper and Wallerawang Power Stations. As such, there is potential for the coal from Baal Bone to be utilised in these power stations, thus minimising transport costs and minimising environmental impacts associated with transport.

Australian coal is currently exported to more than 35 countries around the world. Japan and other Asian economies account for more than 80% of the export market for Australian coal, with smaller amounts exported to Europe, South America and South Africa (Australian Coal Association, 2009).

In 2008, Baal Bone exported the majority (approximately 98.5%) of its coal to overseas markets via rail from the Colliery to Port Kembla with the remainder sold for the Australian domestic market. The product coal extracted from Baal Bone as part of this proposal would continue to have significant economic benefits to NSW and Australia through:

- Continuation of existing employment at Baal Bone, including some 190 full time positions for employees and contractors in the Lithgow LGA where employment has tended to decline over recent years;
- Indirect economic benefits associated with maintaining local employment, and expenditure on local goods and services;
- Payment of royalties to the State for the recovery of up to approximately 2.0 Mtpa of saleable coal;
- Export earnings for Australia; and
- Further establishing export markets for Australian coal.

The project would utilise existing surface infrastructure and facilities and as such, no new infrastructure is required at the site resulting in minimal surface disturbance. The use of existing infrastructure provides an economically viable means of handling and processing the coal resource from the Project Area with minimal environmental impacts. Additionally transport routes for the despatch of coal are already established from the site, which includes access to the railway, the primary means of transport of coal from the Colliery, as well as access to the Castlereagh Highway. As such, the use of the existing transport routes minimises potential environmental impacts associated with the need to establish new transport infrastructure.

3.2 Alternatives Considered

The project involves the continuation of an existing operation with established surface infrastructure and facilities. As such, alternatives have not been considered for infrastructure and facilities at the site. Where relevant, this EA has assessed the current site processes to determine their suitability for continued operations, and mitigation measures and safeguards are proposed where required.

Similarly, alternative mining methods have not been considered for Longwalls 29 to 31, as mining of this area has already commenced, and utilises existing infrastructure which is already in place. Given the estimated life of the mine, current planning estimates indicate that Longwalls 29 to 31 would be complete by the end of 2011. Altering the method of extraction at this stage is not considered to be an economically viable option, and as such alternative mining methods have not been considered.

3.2.1 Mining Alternatives Considered for Remnant Areas

TWCL has considered two alternative options for mining the Remnant Areas. These methods include bord and pillar mining, and partial extraction, and are discussed below.

Bord and Pillar Mining

Bord and pillar methods of mining involve the division of the coal seam into a regular block like array by driving through it primary roadways or ‘headings’ which are intersected at regular intervals by connecting accessways or ‘cut throughs’. The headings and cut throughs leave blocks of coal known as ‘pillars’. The pillars support the overlying strata and are left in place, unless further extraction (secondary extraction) is conducted in which subsidence impacts are amplified on the surface. The bord and pillar mining method also results in the sterilisation of coal resources.

Partial Extraction

Partial extraction refers to a number of mining methods where additional (secondary) coal extraction takes place. This technique leaves a large proportion of the resource in place to control impacts of surface subsidence. This restriction of surface subsidence effects protects surface features and/or drainage, and would therefore be selected where surface subsidence impacts were predicted to be significant. The partial extraction method of work also seeks to improve productivity and resource recovery.

Pillar design is considered in terms of strength to loading ratio as a desirable pillar strength is required to support overburden and reduce difficulties in management and instability. It is desirable for the pillar design to be able to maintain, if not increase, strength as they become overloaded and subsequently negating the likelihood of collapse.

Pillar design may be optimised at shallow depths; however, the current geometries for Baal Bone are considered to be appropriate for mine design purposes. Considering pillar design may provide greater flexibility should unexpected geological conditions be encountered.

As such, partial extraction is the proposed mining option for the Remnant Areas. An Extraction Plan would be prepared prior to commencement of mining, which would detail the extraction method and mine plan for the Remnant Areas.

3.2.2 Transport Alternatives Considered

TWCL is seeking to continue haulage of coal in accordance with existing consents, however a majority of saleable coal produced at Baal Bone is transported via rail to international markets. The current consent permits the road haulage of 900000 tpa of saleable coal by road from Baal Bone to domestic customers. No additional road haulage above the approved 900000 tpa is proposed as part of this project.

Several alternative options for the road haulage of coal have been considered for the purpose of this EA. A number of haulage options for the transport of coal were identified and evaluated by Parsons Brinkerhoff (2007) for the transport of coal from Baal Bone to the nearby Mount Piper Power Station. In the 2006 financial year, prior to the assessment, approximately 0.628 Mt of coal was transported to local power stations via public road. Options considered included:

- Continuation of existing coal haulage using public roads.
- Use of rail between Baal Bone and Delta Electricity's proposed Western Rail Coal Unloader.
- Use of rail between Baal Bone and a coal unloader constructed by the company or a coal supplier group.
- Construction of a private haul road to Mount Piper or part thereof.

The Castlereagh Highway is the currently approved haulage route between Baal Bone and Mount Piper Power Station under the existing development consent. Haulage of 900000 tpa of coal via this route has been approved under DA 164/98 (as modified). The approved route is described in **Section 14**.

Based on a review of social, economic and environmental considerations, Parsons Brinkerhoff recommended the continuation of existing coal haulage arrangements by public road. No traffic accidents specifically related to coal haulage from the Colliery have been recorded during its operation since 1982. In 2003, the DoP considered that the traffic safety and amenity impacts associated with coal haulage to and from Baal Bone were negligible. Mitigation measures including noise barriers in residential areas have also been implemented over the period of operation. Continuation of the existing road haulage does not threaten local ecology as no clearing or disturbance would be required. Baal Bone has also historically received a very low level of public complaint regarding road haulage between the Colliery and local power stations, suggesting the current route is sufficient to support the continuation of operations at the Colliery.

Due to completion of current contracts and prevailing market conditions, road transport of coal has been minimal over the past two years. Road haulage of coal has decreased from 0.628 Mt in 2006, to approximately 0.044 Mt in the 2007 financial year, and 0.003 Mt in the 2008 financial year.

The majority of coal produced at Baal Bone is currently transported to Port Kembla via rail for export to overseas markets. It is anticipated that coal produced at Baal Bone as part of the continued operations would continue to supply overseas markets. As such, it is intended that haulage of coal would continue primarily to Port Kembla via rail.

As the proposed continued operations of Baal Bone would not increase rates and quantity of coal to be transported, the quantity of existing approved coal haulage is considered to be sufficient. Should Baal Bone decide to recommence the supply of coal to local power stations at some point in the future, it is expected that road haulage would continue to be the most feasible method of transport. Given the remaining life of Baal Bone, the construction of new infrastructure for the transport of coal is not considered to be an economically feasible option. The preferred option would not require new infrastructure and there would be not be additional environmental impacts generated as a result of the continued use of the Castlereagh Highway, above those previously assessed and approved for the existing development consent.

3.3 Consequences of Not Proceeding

Not proceeding with the continued operation of Baal Bone would result in the subsequent closure of the Baal Bone in 2010 and would have the following implications:

- Early loss of employment for 190 full time equivalent employees and contractors;
- Loss of coal production contributions to the regional and State economy;
- Potential sterilisation of a valuable resource; and
- Failure to satisfy increasing resource demand.

The Lithgow area has been experiencing a slow decline in population. Mining is one of the main industries to this area, and as a result of mine closure and subsequent unemployment, many workers and their families may relocate. As the majority of Colliery workers live in the Lithgow area, a resultant decline in population may occur. Local expenditure may also decline as a result of re-location of employees and many local businesses that supply services to the mine and/or employees may also re-locate or close due to loss of business.

Xstrata have recently contributed $50 000 to the Lithgow City Council for the development of a Cultural Plan, including development of a Cultural Precinct and tourism marketing and promotions strategy. If the operations were to cease, these community benefits would also be lost. As discussed in **Section 21.2**, economic impacts are considered significant, with multiplier impacts to the local economic output being in the order of $19 million a year. This contribution would be lost if the Colliery were to discontinue operations.

TWCL is currently involved in community sponsorship and donations. Community contributions in 2007/08 totalled an estimated $19 500. Primary recipients of the contributions included local schools namely Cullen Bullen School and Capertee, Cullen Bullen and Wallerawang Primary Schools, receiving a combined total of $12 000 (Coakes, 2008).

The continued operation of Baal Bone would provide immediate benefits to the community through the continuation of employment and through allowing a proper transition into new employment, as well as providing revenue to the State. If the development does not proceed, these opportunities would be lost.

4.0 Project Description

4.1 Overview

Project Approval is sought for the continuation of current operations at Baal Bone including operation of the Surface Infrastructure Area, as well as longwall mining and extraction of Remnant Areas within the Underground Mining Area. Baal Bone is an existing coal mine with an approved prepared saleable coal production of approximately 2.0 Mtpa, equating to about 2.8 Mtpa of ROM coal. Underground mining operations target the Lithgow Coal Seam of the Illawarra Coal Measures.

Project Approval under Part 3A of the EP&A Act is sought for the following existing and proposed activities at Baal Bone:

- Continuation of underground mining within the Underground Mining Area, including Longwalls 29 to 31, which are the subject of a current approved Subsidence Management Plan (SMP) and Mine Operations Plan (MOP);
- Continued operation of the Surface Infrastructure Area, and associated prepared saleable coal production of 2.0 Mtpa (equating to 2.8 Mtpa ROM coal);
- Continued transport of prepared saleable coal to markets in accordance with current approvals; and
- Mining of identified Remnant Areas within the existing workings.

The location of principal surface infrastructure and underground mine workings is shown in **Figure 4-1**.

Approval for the operation of the existing Underground Mining Area and Surface Infrastructure Area was granted under previous development consents, as discussed in **Section 1**.

The activities at Baal Bone for which Project Approval is sought are described in the following sections.

4.2 Continuation of Underground Mining Area

4.2.1 Current Underground Longwall Mining

Project Approval is required for the continued operation of underground longwall mining activities within the Underground Mining Area, which includes Longwalls 29 to 31. Longwalls 29 to 31 are located beneath Ben Bullen and Wolgan State Forests as well as a small parcel of Crown land, to the west of Wolgan Road and east of the Coxs River. A plan of current underground longwall panels is shown on **Figure 4-1**. Longwalls 29 to 31 are situated on a north north east to south south east axis, immediately east and south east of previously mined longwalls (refer **Figure 4-1**). Based on the current MOP, the estimated recoverable reserve for this area is approximately 5 Mt. Mining of Longwalls 29 to 31 would be in a southerly to northerly direction for each panel commencing with Longwall 29.

Mine Layout

The layout of Longwalls 29 to 31 has been designed based on previous mining experience at the site, monitoring results, and geotechnical subsidence recommendations to maximise resource recovery while at the same time avoiding sensitive surface features including the Wolgan Escarpment, Coxs River Swamp and other sensitive surface features. The total void width of panels is 250 m in Longwall 29, 226 m in Longwall 30 and 220 m in Longwall 31. Chain pillars and main heading pillars are 25 m wide rib to rib.

The initial design width of Longwall 31 was 250 m, however following further investigations, and to afford the Wolgan Escarpment a high degree of protection, the total void width of the panel was reduced to 220 m. This provides an additional protection barrier between Longwall 31 and the Wolgan Escarpment of 30 m. A long history of subsidence monitoring has been established at Baal Bone and there is a high level of confidence in the proposed design (refer to discussion in **Section 8.2**).

Depth of cover over Longwalls 29 to 31 varies primarily due to surface topography, and ranges from 150 m below a valley midway along Longwall 29, to 240 m at the southern end of Longwall 31. Typical depth of cover over most of the longwall area is 200 to 230 m. Assessments undertaken for the Longwalls 29 to 31 predict maximum subsidence to be in the order of 1.30 to 1.60 m. The potential subsidence impacts of the project and further detail on the design of longwall panels for Longwalls 29 to 31 is discussed in **Section 8**.

Mining Method

Current underground mining operations at Baal Bone are by continuous miner and longwall mining methods. Longwall mining involves the extraction of panels of coal using longwall shearing machinery supported by hydraulic roof supports. The shearing machinery travels back and forth across the coal face cutting a slice of coal from the face on each pass. A face conveyor located along the face of the panel transports ROM coal away from the face to a series of conveyors. Conveyors deliver ROM coal to the ROM stockpile within the Surface Infrastructure Area. The ROM stockpile and other related mining facilities are discussed further in **Section 4.3** below.

Current underground longwall mining is undertaken in accordance with relevant approvals from Department of Primary Industries – Mineral Resources (DPI-MR), now part of DII) and managed in accordance with an approved SMP and MOP. The SMP for Longwalls 29 to 31 was approved by DPI-MR in 2007. The MOP comprises underground extraction of Longwalls 29 to 31, which is expected to be complete by the end of 2011. Therefore, at the current rate of extraction these longwall panels would not be fully extracted prior to the expiration of consent on 1 August 2010.

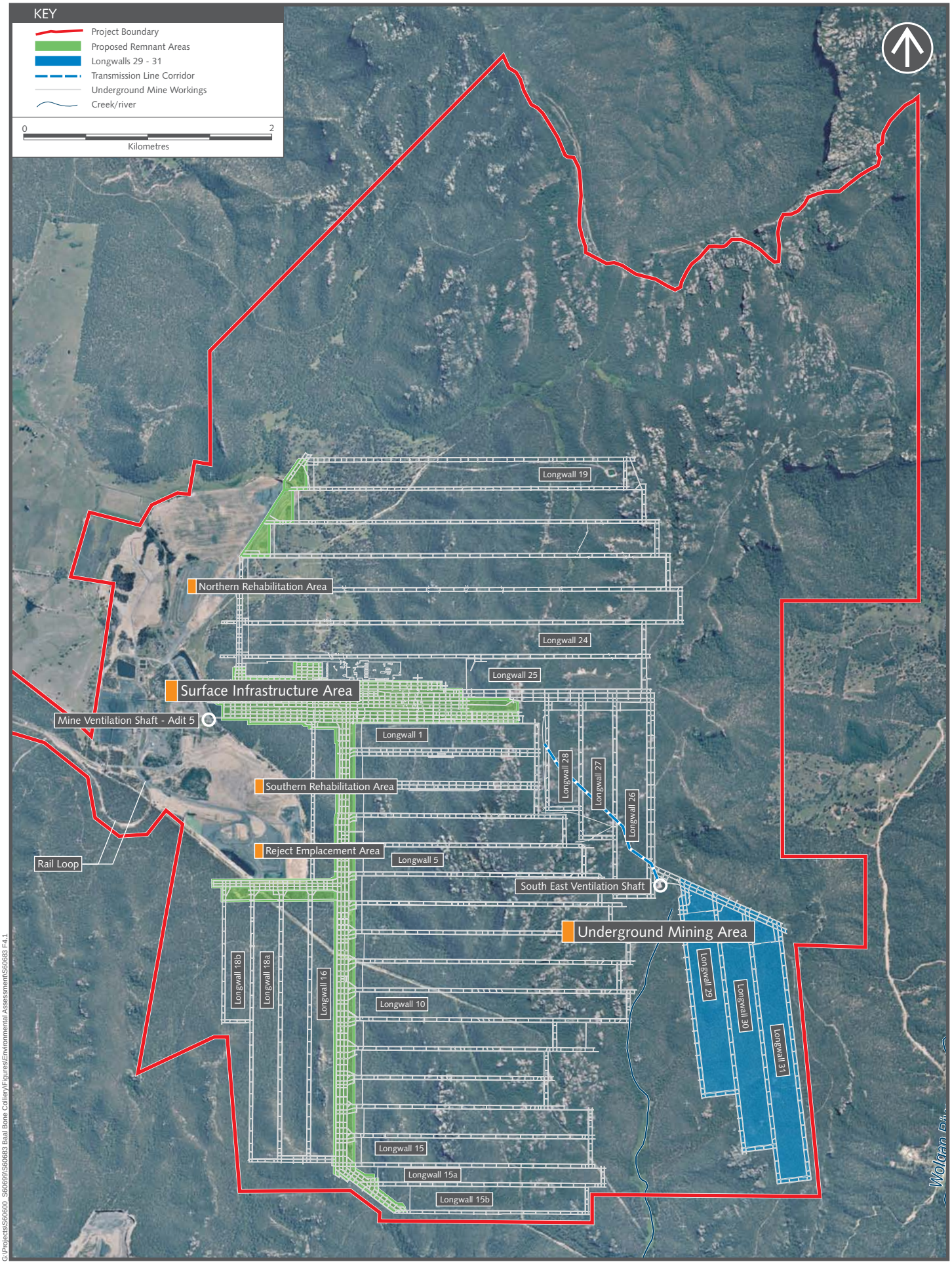
Project Approval is sought to extend the life of the Colliery to allow continuation of current underground longwall mining and associated operation of the Surface Infrastructure Area which supports the underground mine.

4.2.2 Proposed Underground Mining of Remnant Areas

Baal Bone has identified a number of Remnant Areas of coal within the existing workings in the Underground Mine Area. These mainly include barrier pillars within the existing workings of Longwalls 1 to 28, which were not extracted as part of the original longwall mining campaign. The proposed Remnant Areas are shown on **Figure 4-1**.

The proposed method of extraction for the Remnant Areas is utilising a continuous miner for partial extraction. This technique allows a mine plan to be developed which allows a portion of the resource to be left in place in order to manage impacts of surface subsidence. The proposed mine layout would be detailed in an Extraction Plan which would be prepared prior to commencement of mining, and the design would be based on the presence of surface features, to manage potential subsidence impacts at the surface.

In order to manage potential subsidence impacts on identified sensitive surface features, including the three cliff formations and Ben Bullen Creek, the likely areas of affectation would be protected from being directly mined under by an angle of draw of 26.5 degrees or greater. Subsidence protection zones surrounding each of these surface features have been identified in **Section 8**, and are based on an angle of draw of 26.5 degrees. Preventing undermining of surface features by this angle of draw is considered to provide a high level of protection against surface subsidence impacts for these sensitive features.



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LOCATION OF PRINCIPLE SURFACE INFRASTRUCTURE FACILITIES AND UNDERGROUND MINE WORKINGS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.1

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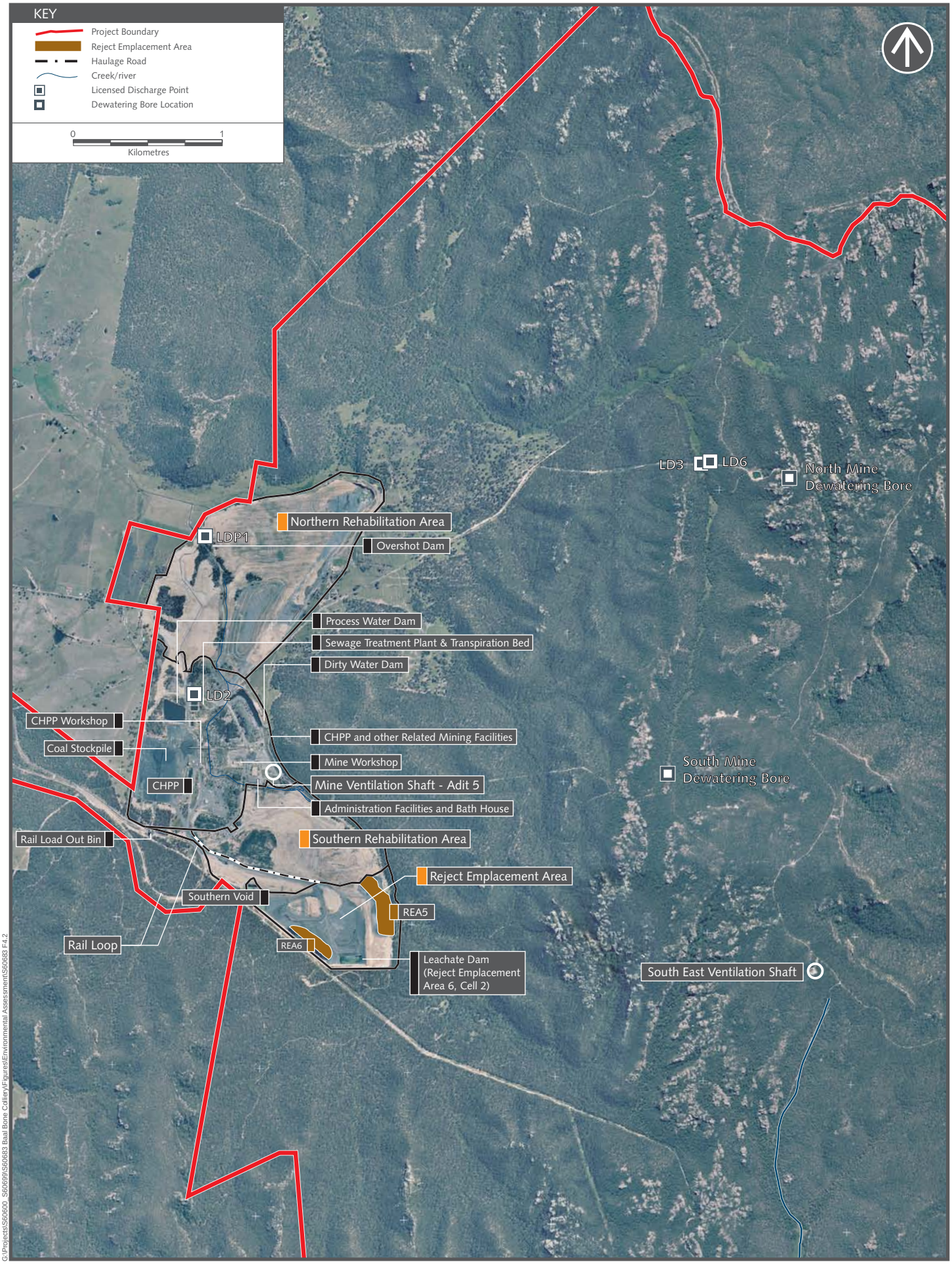

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SURFACE INFRASTRUCTURE AREA

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.2

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4.3 Continued Operation of the Surface Infrastructure Area

TWCL is seeking Project Approval for the continued operation of the Surface Infrastructure Area. The primary surface infrastructure and facilities at Baal Bone include the CHPP and other mining related facilities, the Reject Emplacement Area, and northern and southern rehabilitation areas. All existing infrastructure and processes currently undertaken at the site would continue to be operational.

A site layout of the primary Surface Infrastructure Area and other ancillary items are shown on **Figure 4-2 and 4-3**, and are described in further detail below.

4.3.1 CHPP

The primarily components of the CHPP are the crushing and breaking plant, the washery plant, and associated coal conveyors. The CHPP receives ROM coal via conveyor which is reclaimed from the ROM stockpile. The CHPP crushes, separates washes and grades coal, which is then stockpiled as product coal according to the properties of the product. A description of the processes undertaken at the CHPP is provided below.

ROM coal is transported directly from underground to the ROM stockpile and then to the crushing and breaking plant (Bradford Breaker). ROM coal is screened in the crushing and breaking plant based on particle size, with oversized coal (greater than 100 mm) crushed to reduce particle size. Rock and low grade coal are removed and transported to a collection hopper, and subsequently relocated to the active reject emplacement area via truck. The crushed ROM coal is transported via conveyor to the washery plant.

At the washery plant, coal is separated into three fractions based on the diameter of the particle size; less than 1.4 mm, 1.4 to 25 mm, and 25 to 100 mm. The three fractions of coal undergo various processes of washing, further crushing (of the larger fractions), dewatering and transfer to coal product stockpiles via conveyor. Ultra-fine material present in the raw coal and resulting from various pumping and handling systems is transferred to a tailings thickener. During this process flocculants are added to aid the settling of fine particles and production of clarified supernatant, which is pumped back to the plant for use in the process. Sludge within the thickener is collected and pumped to the reject disposal area.

Coal products produced at Baal Bone have previously included steaming coal, Pulverised Coal Injection (PCI) product, premium coal, and thermal coal. Coal product produced at Baal Bone now primarily comprises thermal coal for export purposes.

Coal is stockpiled on a 14 ha coal stockpile pad located immediately west of the CHPP (refer **Figure 4-3**), with a storage capacity of up to approximately 1 Mt of coal product.

4.3.2 Coal Stockpiles and Clearance Infrastructure

There are two coal stockpile areas operated as part of the Surface Infrastructure Area.

- ROM stockpile – ROM coal is transported by conveyor from underground to the ROM surcharge stockpile prior to transfer to the CHPP.
- Washed coal stockpiles – a series of conveyors transport washed product coal to the product stockpile area. Coal is then moved to the train loading facility through hoppers and conveyors housed in reclaim tunnels located beneath the product stockpile. Coal dispatched by road is loaded by front end loader directly from the product stockpiles.

The conveyor system is indicated on the site layout on **Figure 4-3**.

4.3.3 Product Coal Transport

Three grades of washed coal are typically produced, principally for the export market, these being 9%, 14% and 18% ash coal. The principal export markets for the product are Japan, Korea and Taiwan. Baal Bone also supplies domestic coal according to market demands. Historically, Baal Bone has supplied both domestic and international markets. In recent times, due to a number of market factors, most of the product coal is transported by rail to Port Kembla and exported to international markets.

Rail Haulage

Baal Bone is serviced by a rail loop which is a 7 km long spur line from the Wallerawang-Gwabegar line, terminating at a 200 m radius balloon loop. The loop is equipped with a comprehensive signalling system and 1,000 t loading bin. Based on current production rates, approximately 6000 t of coal is transported daily via rail, equating to a total of 1.5 Mtpa of product coal annually via rail from Baal Bone.

Road Haulage

Baal Bone has an existing development consent which permits the transportation of coal via road to domestic markets. Baal Bone has historically supplied some coal via road haulage to local power stations in accordance with DA 164/98. Due to completion of current contracts and prevailing market conditions, road transport of coal to these power stations has been minimal over the past two years; however supply of minor quantities of coal via road to other domestic customers continues to occur periodically.

4.3.4 Ancillary Facilities

Ancillary facilities which form part of the Surface Infrastructure Area are described below. Project Approval is sought for the continued operation of these facilities as part of operation of the Surface Infrastructure Area at Baal Bone.

- **Workshops** – There are two workshops within the Surface Infrastructure Area. A mine pit top workshop for the underground operations contains machinery involved in the repair of mining equipment, and the CHPP workshop for surface repairs and service installations.
- **Administration Facilities and Bath House** – The administration facilities contain offices for management and administration staff. The bath house incorporates showers and washing facilities, toilets, lockers and first aid room.
- **Ventilation Facilities and Transmission Line** – a raised bore ventilation shaft (known as the south east ventilation shaft) and associated 1.7 km transmission line, both approved under Part 3A of the EP&A Act, are located in Ben Bullen State Forest and were constructed to service Longwalls 29 to 31. Ventilation facilities are also located at Adit 5 within the Surface Infrastructure Area. The location of the ventilation facilities and transmission line are shown on **Figure 4-1**. The operation of the south east ventilation shaft and transmission line was approved by the Minister for Planning on 24 October 2007 (MP 07_0035) and will continue to operate under that approval. Therefore these facilities do not form part of this Project application.

Additionally, electricity is supplied to Baal Bone via an existing 66 kV transmission line. The project would not result in the consumption of additional electricity on an annual basis and would not require the construction of additional electricity infrastructure.

4.3.5 Water Management System

Baal Bone has an existing Process Water Management System in place to control runoff and drainage, and reuse of water on site. Each of the components of the Process Water Management System are described below.

Surface Water Management System

The Surface Water Management System includes separation of “clean” and “dirty” water systems with regular monitoring of water quality in both systems. Water quality monitoring is undertaken in accordance with EPL No. 765 and also includes an additional 22 internal monitoring locations around the Colliery area.

Site runoff from pit-top areas, roads, product stockpiles, the CHPP, and leachate from the tailings dam into the “dirty” process water circuit and storage dam. Water is pumped into the process water dam, prior to being reused in general site operations, dust suppression, fire fighting, washdown and at the CHPP. During high intensity rainfall events, treated water may be discharged into Baal Bone Creek via a discharge point licensed under the EPL.

Sewage and Grey Water Treatment

Sewage and grey water effluent from site facilities, infrastructure and amenities is collected in a sump and directed to an on-site sewage treatment plant. The waste is treated by an activated sludge treatment process then allowed maturation before being discharged via a discharge point licensed under the EPL to a transpiration bed.

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SURFACE INFRASTRUCTURE AREA - CHPP AND MINING RELATED FACILITIES

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.3

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Potable Water

Potable water is purchased from State Water and is supplied through a connection into the Fish River Water Supply Pipeline, which runs through the site. This connection services the administration facilities and bath house, and is also used underground in a solcenic emulsion (a 98% to 2% mixture of water and hydraulic fluid) for the longwall hydraulic roof support system.

4.4 Reject Emplacement Area

Coal handling and preparation processes generate both coarse reject and fine tailings waste which are disposed of in approved Reject Emplacement Areas (REA). The Reject Emplacement Area is shown in **Figure 4-4**. Coarse reject and tailings waste is classified depending on particle size, as either coarse (100 µm to 100 mm) or fine (tailings, <100 µm). Non-coal material waste such as sedimentary rock and clay occurring within the coal seam or seam floor and roof materials extracted during mining is also disposed of at the REA.

The continued operations of the Surface Infrastructure Area and Underground Mining Area would not result in additional impacts or alterations to the existing tailings and reject management processes or capacities at the site. The capacity of the Reject Emplacement Area for the storage of coarse reject and tailings has been assessed as part of this EA, and is detailed in **Section 12** and **Appendix H**. The assessment concluded that there is sufficient storage capacity in the current Reject Emplacement Area to accommodate coarse rejects and tailings associated with continued operations at Baal Bone.

Placement of coarse rejects in the REA is being strategically undertaken to create the final design landform for the area. This is further discussed in **Section 12**.

4.5 Northern and Southern Rehabilitation Areas

The northern and southern rehabilitation areas, shown on **Figure 4-2** are the site of former open cut operations at the site. These areas contain limited infrastructure and have been mostly rehabilitated. Rehabilitation of these areas would continue in accordance with the MOP for the site, as discussed in **Section 4.10** below and **Section 13**.

4.6 Environmental Management

There is already an established process for environmental management at Baal Bone, which primarily occurs through three main mechanisms:

- Implementation of an Environmental Management System (EMS) which encompasses the environmental monitoring and management requirements of relevant development consents for operations at the site;
- Preparation and implementation of a Subsidence Management Plan (SMP) and SMP Approval issued by DPI-MR (now part of DII) for Longwalls 29 to 31; and
- Preparation of a Mining Operations Plan (MOP) which regulates environmental protection and rehabilitation of mining leases issued under the *Mining Act 1992* (Mining Act).

The EMS presents a framework which incorporates a range of plans and procedures which are required by development consents and internal company operating standards for best practice environmental management at the site. These plans include:

- Biodiversity and Land Management Plan;
- Cultural Heritage Management Procedure;
- Social Involvements Plan;
- Community Complaints Management Procedure;
- Conflict Resolution Procedure;
- Hydrocarbon Management;
- Mine Closure Plan;
- Product Stewardship Management Plan;
- Subsidence Management Plan;
- Public Safety Management Plan;
- Land Management Plan;

- Aboriginal Heritage Management Plan;
- Truck Management Plan;
- Waste Management Plan;
- Water Quality Management Plan; and
- Training and Competency Management Plan.

Of particular relevance are the Biodiversity and Land Management Plan, Water Quality Management Plan and the Truck Management Plan, which are discussed further in this EA in **Sections 10**, **14** and **18**. The EMS is reviewed and updated on a regular basis and reporting to relevant authorities is undertaken in accordance with the development consent requirements, which are identified where required in the relevant plans in the EMS.

A SMP has been prepared and approved for Longwalls 29 to 31. The SMP contains a suite of management plans and monitoring programs to be implemented prior to, during and following mining operations, which relate to the monitoring and management of mining induced subsidence impacts associated with mining of Longwalls 29 to 31.

Environmental performance of the mining lease issued under the Mining Act is managed through the MOP, and reported to DII and other relevant authorities through the AEMR which is required under the Mining Act. The AEMR reports the environmental performance of activities, including rehabilitation undertaken within mining leases on an annual basis.

The continuation of operations at Baal Bone would be undertaken in accordance with the existing environmental management mechanisms established at the site.

4.7 Workforce and Hours of Operation

Baal Bone currently employs a full-time equivalent workforce of approximately 190 people. It is not expected that there would be an increase in permanent employment as a result of the project, and it is anticipated that employment requirements for the proposed works would essentially remain the same as the current operations.

Baal Bone operates 24 hours per day, seven days per week, with underground mining operations carried out 24 hrs per day Monday to Friday. Maintenance operations including stone dusting, roadway work and limited longwall production are undertaken on weekends. No changes to the hours of operation are proposed.

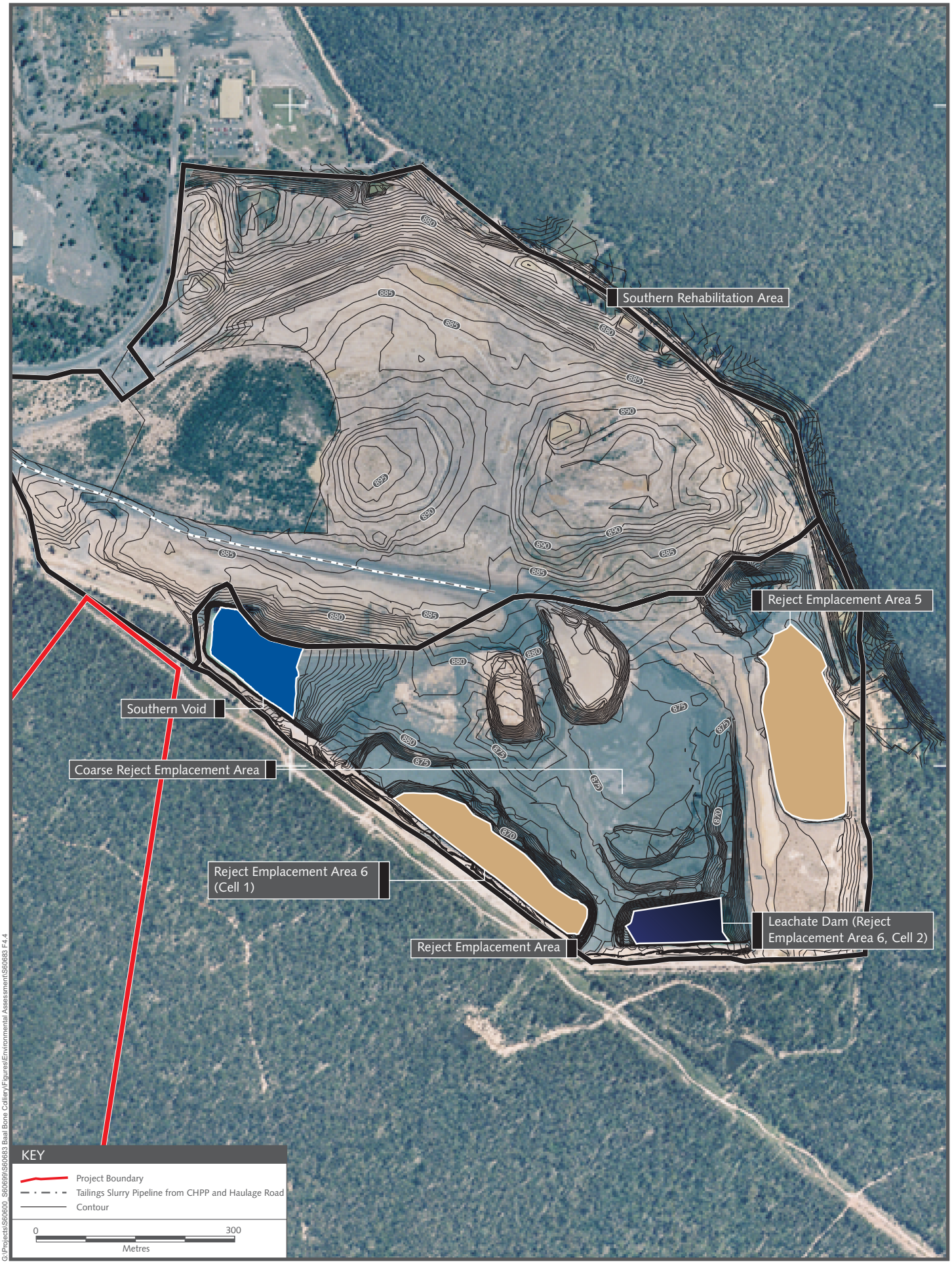
4.8 Operational Life

TWCL is seeking approval to complete mining of Longwalls 29 to 31 as well as the Remnant Areas within existing workings. Based on the current mine schedule, the current underground mining area of Longwalls 29 to 31 has an operational life to the end of 2011. The continuation of existing operations at the site would allow the completion of extraction of the current approved mining area and would also allow the extraction of coal from remnant unmined coal resources within the existing workings.

Detailed Mine Closure Planning has commenced at Baal Bone due to the remaining life of the mine which is expected to be a nominal 10 years, including rehabilitation, maintenance and monitoring. Mine closure planning timeframe estimates have been identified based on the expected remaining life of the Colliery at this stage. These include:

- **Completion of underground mining** - including mining of Longwalls 29 to 31 and the Remnant Areas. It is estimated that mining of Longwalls 29 to 31 would be complete by the end of 2011, and mining of the Remnant Areas would subsequently be undertaken over a period of approximately 24 to 36 months;
- **Rehabilitation** - including decommissioning and removal of plant and infrastructure, recontouring and shaping in accordance with the final landform, and revegetation of disturbed areas in accordance with the final land use. It is anticipated this phase would be undertaken over approximately 18 to 24 months; and
- **Maintenance and monitoring** – maintenance and monitoring of rehabilitation works, estimated to be for a period of approximately 5 years.

These timeframes have been adopted as planning estimates only and operations may continue beyond these timeframes, but provide an indication based on anticipated life of the Colliery and current predicted mine closure activities.



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REJECT EMPLACEMENT AREA

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.4

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4.10 Mine Closure and Rehabilitation

The objective for the rehabilitation of disturbed land at Baal Bone identified in the MOP (July 2009) is to return the site to a condition where its landform, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land fabric.

As such, the proposed final land use for the site includes a combination of grazing and bushland/wildlife habitat and would be designed to be compatible with adjoining lands. Rehabilitation of a substantial section of the mine surface area has already been completed, and is shown on **Figure 4-5** and **Figure 4-6.** All previous rehabilitation and revegetation works undertaken at Baal Bone have been completed in accordance with this objective.

Rehabilitation and revegetation activities have been undertaken in both the northern and southern rehabilitation areas, as highlighted in **Section 4.6** above. An area of some 77 ha was seeded in 2008 in these areas, which included a mixture of improved pasture and native woodland species. An additional 2.25 ha was rehabilitated using a brush matting technique beneath the recently constructed transmission line to the ventilation shaft for Longwalls 29 to 31. Restoration works along Ben Bullen Creek were also undertaken during 2008. These works included re-creation of a system of pools, riffles and meanders; plus the immediate revegetation of several high risk areas of bank works. Correspondence from DII (dated 17/04/08) has commended Baal Bone for rehabilitation works undertaken in the northern open cut mine area and restoration of Ben Bullen Creek. Photographs of rehabilitation in the northern rehabilitation area are provided as **Figure 4-5** and **Figure 4-6**.

The Reject Emplacement Area would continue to be maintained for the disposal of tailings and coarse reject for the remainder of the life of the mine. Whilst these areas may be progressively or temporarily rehabilitated if the opportunity arises, final rehabilitation would be completed concurrent with mine closure.

Similarly, the CHPP and related mining infrastructure facilities, including the administration areas, bathhouses, workshops, conveyors and rail loop would not be decommissioned and rehabilitated until after mine closure occurs. These areas would be decommissioned and rehabilitated in accordance with the Mine Closure Plan, and to the satisfaction of DII. Generally, disturbed surface areas would be reshaped, covered, and revegetated in accordance with objectives of the MOP described above.

Final closure rehabilitation plans are currently being prepared by Baal Bone as part of the Mine Closure Plan (see **Section 13**).

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PLATE 1

PLATE 2

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PRE AND POST REHABILITATION IN THE NORTHERN REHABILITATION

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.5

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PLATE 3

PLATE 4

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PRE AND POST REHABILITATION IN THE NORTHERN REHABILITATION

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 4.6

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5.0 Statutory Planning

5.1 Commonwealth Legislation

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the approval of the Commonwealth Minister for the Environment, Water, Heritage and the Arts for actions that may have a significant impact on matters of National Environmental Significance (NES). Approval from the Commonwealth is in addition to approvals under NSW legislation. However a bilateral agreement has been concluded between the NSW and Commonwealth governments which provides for the accreditation of the NSW assessment and approvals process such that one approval may be granted covering both State and Commonwealth requirements.

The EPBC Act also provides for the identification, conservation and protection of places of National Heritage significance and provides for the management of Commonwealth Heritage places.

The EPBC Act lists seven matters of NES which must be addressed when assessing the impacts of a proposal which are:

- World Heritage properties;
- National heritage places;
- Ramsar wetlands of international significance;
- Listed threatened species, critical habitats and ecological communities;
- Listed migratory species;
- Commonwealth land, marine areas or reserves; and
- Nuclear actions.

An EPBC Protected Matters search to identify matters of NES and other protected matter was undertaken in respect of the project on 10 March 2009. The results are summarised in the table below:

Table 5-1: EPBC Protected Matters Database Search

Matter	Records within 10 km of Site
Matters of NES	
World Heritage Properties	**The Greater Blue Mountains Area** The Greater Blue Mountains Area World Heritage Property is located to the north and east of the Project Area and includes the Gardens of Stone National Park, Wollemi National Park and Blue Mountains National Park in the vicinity of Baal Bone. The project is not anticipated to directly or indirectly impact the existing character or heritage values of the areas which form part of The Greater Blue Mountains Area.
National Heritage Places	**The Greater Blue Mountains Area** As discussed above, the project is not predicted to affect The Greater Blue Mountains Area.
Ramsar Wetlands of International Significance	**Macquarie Marshes Nature Reserve** Macquarie Marshes Nature Reserve is located some 250 km from Baal Bone, however Baal Bone is identified as being located within the same catchment as the nature reserve. The project is not anticipated to generate off site impacts and as such, Macquarie Marshes Nature Reserve is not likely to be affected by the project (refer **Section 10**).
Threatened Species	Twenty nine threatened species recorded within 10 km of Baal Bone. The flora and fauna impact assessment undertaken for the project (refer **Section 18** and **Appendix L** and **M**) concluded that no threatened species would be significantly affected by the project.

Matter	Records within 10 km of Site
Threatened Ecological Communities	Two threatened ecological communities are identified as being located, or having the potential to be located within 10 km of the Project Area. Temperate Highland Peat Swamps on Sandstone (may occur within area) and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (may occur within area). A flora assessment was undertaken in respect of the project, discussed in **Section 18.1**. These threatened ecological communities were not identified within the areas affected by the continued operations at Baal Bone, specifically in the vicinity of Longwalls 29 to 31 and the Remnant Areas, and are therefore not anticipated to be affected by the project.
Migratory species	Fourteen migratory species were identified as potentially occurring within 10 km from Baal Bone. Listed species have been assessed in terms of likelihood of occurrence in the proposed Remnant Areas, and the likelihood of a significant impact from the project if the species has the potential to occur. The ecological assessment concluded that migratory species are not likely to be affected by the project.
Commonwealth Marine Areas	None
Nuclear Action	Not applicable
Other Protected Matters	
Commonwealth Lands	None
Commonwealth Heritage Places	None
Places on the Register of the National Estate (RNE)	Two places listed on the RNE are located within 10 km of Baal Bone: Pantoneys Crown Nature Reserve (now located within the Gardens of Stone National Park) and Wollemi National Park. These listed places are not anticipated to be affected by the project.
Listed Marine Species	Twelve marine bird species may overfly the site and surrounding areas. These species are each listed as migratory species under Matters of NES discussed above, and are not likely to be affected by the project.
Whales and Other Cetaceans	None
Critical Habitats	None
Commonwealth Reserves	None

The proposed project is not anticipated to affect matters of NES under the EPBC Act and as such an EPBC Referral to the Minister for the Environment, Water, Heritage and the Arts is not required.

5.1.2 Native Title Act 1993

The Commonwealth *Native Title Act 1993* (Native Title Act) is administered by the National Native Title Tribunal. The Tribunal is responsible for maintaining a register of native title claimants and bodies to whom native title rights have been granted. These native title holders and claimants must be consulted prior to the granting of a mining lease over land to which the native title claim or right applies. This process is designed to ensure that Indigenous people who profess an interest in the land (or part thereof) have the opportunity to express this interest formally, and to negotiate with the Government and the applicant about the proposed grant or renewal, or consent to access native title land. The Native Title Act prescribes that native title can be extinguished under certain circumstances, including the granting of freehold land.

The NSW *Mining Act 1992* must be administered in accordance with the Native Title Act. As such, native title holders and claimants must be provided with the 'right to negotiate' in relation to the grant and some renewals of exploration and mining titles.

The National Native Title Tribunal website indicates that portions of the Project Area are within the boundaries of Native Title Claim NC97/7, Gundungurra Tribal Council Aboriginal Corporation #6. OzArk (OzArk 2007a). Negotiations were conducted between TWCL and the Gundungurra Tribal Council Aboriginal Corporation in relation to ML 1607, and an agreement was reached.

The Project does not involve the renewal of an existing mining lease, or the grant of a new exploration or mining title. Furthermore, no change to the tenure of land within the Project Area is proposed. As such consultation in relation to the Project with native title holders and claimants is not required.

5.2 NSW State Legislation and Planning Policies

5.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning & Assessment Act* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) provide the framework for environmental planning in NSW and include provisions to ensure that proposals which have the potential to impact the environment are subject to detailed assessment, and also provide opportunity for public involvement. The objectives of the Act relevant to the Project are shown in **Table 5.2**.

Table 5-2: Objectives of the Act relevant to the Project.

Objective	Relevance to the Proposed Project
(a)(i)to encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,	The Project would result in benefits to the local community and economy associated with the continued employment of some 190 full time equivalent employees. The project has also been considered in respect of biophysical, economic and social grounds and is considered to be consistent with the principles of ESD (see **Section 24**).
(a)(ii)to encourage the promotion and co-ordination of the orderly and economic use and development of land,	The Project involves the continuation of an existing operation, which utilises existing infrastructure to extract a known, viable coal source, and as such the Project is considered to meet this objective.
(a)(vi)to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats;	The Project would not result in any significant impacts to the environment. Existing environmental management measures are in place which ensure that any potential environmental impacts are minimised. These management measures are detailed in **Sections 8 to 21.**
(a)(vii)to encourage ecologically sustainable development,	The Project has been considered in the context of the principles of ESD and is considered to be consistent with these principles. Refer to **Section 24**.

The site currently operates under a number of project approvals and development consents issued under Part 4 and Part 5 of the EP&A Act respectively. These existing consents/approvals are summarised in **Section 1.4**. As the existing Part 5 approval applying to Longwalls 29 to 31 is due to expire in August 2010 and mining operations are planned to extend beyond this time, Project Approval is required to allow for the continued operation of the mine.

The project has been declared to be a major project by the Minister under the provisions of the EP&A Act and *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act.

Eligibility for assessment under Part 3A of the EP&A Act

The *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005) identifies development eligible for assessment under Part 3A of the EP&A Act.

Clause 14 of the SEPP 2005 applies to development for the purposes of a mine, as described in item 7 of Schedule 1 of the Model Provisions. The definition of a mine under the Model Provisions means:

> *any place, open cut, shaft, tunnel, pit, drive, level or other excavation, drift, gutter, lead, vein, lode or reef whereon, wherein or whereby any operation is carried on for or in connection with the purpose of obtaining any metal or mineral by any mode or method and any place on which any product of the mine is stacked, stored, crushed or otherwise treated, but does not include a quarry.*

The existing and proposed operations at Baal Bone fall under the Model Provisions definition of a mine.

Clause 6 and Item 5 of Schedule 1 of the SEPP 2005 declares the following development to be a project to which Part 3A of the EP&A Act applies:

> *' **5 Mining***
>
> *(1) Development for the purpose of mining that:*
>
> *a) is coal or mineral sands mining, or*
>
> *b) is in an environmentally sensitive area of State significance, or*
>
> *c) has a capital investment value of more than $30 million or employs 100 or more people.*
>
> *(2) Extracting a bulk sample as part of resource appraisal or a trial mine comprising the extraction of more than 20000 tonnes of coal or of any mineral ore.*
>
> *a) Development for the purpose of mining related works (including primary processing plants or facilities for storage, loading or transporting any mineral, ore or waste material) that:*
>
> *b) is ancillary to or an extension of another Part 3A project, or*
>
> *c) has a capital investment value of more than $30 million or employs 100 or more people."*

Clause 14 of the SEPP 2005 however provides the following transitional provisions:

> *(1) If, immediately before the commencement of this Policy on 25 May 2005:*
>
> *a) a development application in respect of any development had been made but not finally determined, and*
>
> *b) the development was not State significant development,*
>
> *this Policy (as in force on that commencement) does not apply to or in respect of the determination of that development application.*

(2) If, immediately before the commencement of this Policy on 25 May 2005:

a) a development application in respect of any development had been made but not finally determined, and

b) the development was State significant development,

this Policy (as in force on that commencement) applies to and in respect of the determination of that development application.

(3) Subclauses (1) and (2) are subject to the provisions of Part 3A of the Act and the regulations made under the Act for the purposes of that Part.

(4) Subject to subclause (3), this Policy does not operate to make the carrying out of development for the purposes of a mine, as described in item 7 of Schedule 1 to the Environmental Planning and Assessment Model Provisions 1980, a project to which Part 3A of the Act applies if the carrying out of the development would be prohibited or require consent but for the authority conferred by:

a) the adoption of clause 35 and that item of those Model Provisions under an environmental planning instrument applying to the land concerned, or

b) a provision of an environmental planning instrument, applying to the land concerned, that has the same effect in relation to mines as clause 35 and that item of those Model Provisions.

(5) Subclause (4) ceases to have effect:

a) in relation to development carried out underground on 1 August 2010, or

b) in any other case on 1 August 2007.

For the avoidance of any doubt, nothing in subclause (4) prevents an application to carry out development for the purposes of a mine from being made during the transitional period (as referred to in subclause (5)) for the type of development concerned."

The current proposal seeks the approval of the Minister pursuant to section 75E of the EP&A Act for the carrying out of a 'project' under Part 3A of the EP&A Act.

Permissibility of the project

The Lithgow City Local Environment Plan 1994 (Lithgow LEP) is the relevant local Environmental Planning Instrument (EPI) applying to Baal Bone. The land comprising existing surface infrastructure area, parts of the former open cut areas, and the reject emplacement and tailings management areas is zoned 1(a) Rural (General). The land overlying former underground workings and the current underground longwall mining area (Longwalls 29 to 31) is located within the 1(f) Rural (Forestry) zone.

Clause 9 of LEP 1994 sets out the objectives of the 1(a) Rural (General) zone, which are to promote the proper management and utilisation of natural resources by:

a) protecting, enhancing and conserving:

(i) rural land, in particular prime crop and pasture land, in a manner which sustains its efficient and effective agricultural production potential;

(ii) soil, by controlling and locating development in accordance with soil capability;

(iii) forests of existing and potential commercial value for timber production;

(iv) valuable deposits of minerals, coal and extractive materials, by controlling the location of development for other purposes in order to ensure the efficient extraction of those deposits;

(v) trees and other vegetation in environmentally sensitive areas, where the conservation of the vegetation is significant for scenic amenity or natural wildlife habitat or is likely to control land degradation;

(vi) water resources for use in the public interest, preventing the pollution of water supply catchment and major water storages;

(vii) localities of significance for nature conservation, including places with rare plants, wetlands and significant wildlife habitat; and

(viii) items of heritage significance,

b) preventing the unjustified development of prime crop and pasture land for purposes other than agriculture;

c) facilitating farm adjustments;

d) minimising the cost to the community of:

(i) fragmented and isolated development of rural land; and

(ii) providing, extending and maintaining public amenities and services,

e) providing land for other non-agricultural purposes, in accordance with the need for that development, and

f) providing for the separation of conflicting land uses.

The objectives of the 1(f) Rural (Forestry) zone are:

a) to identify land managed by the Forestry Commission under the Forestry Act 1916,

b) to preserve existing forests within the City of Lithgow, while allowing compatible development, and

c) to prevent pollution of water supply catchments and water quality in major water storages.

The proposed project is considered to be generally consistent with the objectives of each of the land use zones located within the Project area as the Project enables extraction of an identified coal resource utilising existing coal processing and handling infrastructure, while minimising potential impacts to forests, biodiversity, water resources and items of heritage significance.

Section 75J(3) of the EP&A Act and clause 8O of the EP&A Regulation provide that the Minister cannot approve the carrying out of a project that would be wholly prohibited under an environmental planning instrument that would not (because of section 75R) apply to the approved project. Hence, if a project is wholly prohibited by a LEP then the Minister cannot approve the project; the Lithgow LEP is relevant to the permissibility of this Project.

The project is not specifically defined under Lithgow LEP. For the purposes of defining the project, clause 5 of Lithgow LEP adopts the Model Provisions. Under the Model Provisions, a mine is defined as:

any place, open cut, shaft, tunnel, pit, drive, level or other excavation, drift, gutter, lead, vein, lode or reef whereon, wherein or whereby any operation is carried on for or in connection with the purpose of obtaining any metal or mineral by any mode or method and any place on which any product of the mine is stacked, stored, crushed or otherwise treated, but does not include a quarry.

The existing and proposed underground mining operations and existing surface infrastructure and facilities at Baal Bone fall under the Model Provisions definition of a mine.

Under Lithgow LEP, mining is permissible with consent in both the 1(a) Rural (General) zone and 1(f) Rural (Forestry) zone. As such, the project is permissible with consent under Lithgow LEP. Additionally, clause 7(1) of the *Mining, Petroleum Production and Extractive Industries State Environmental Planning Policy 2007* (SEPP 2007) provides that underground mining can be carried out on land with consent. The proposed project is therefore permissible.

Clause 8 of SEPP 2007 contains provisions which relate to the permissibility of development for the purposes of mining under local environmental plans. As the project is permissible with consent under the relevant local environmental plan, Lithgow LEP, this EA is not required to consider the special provisions of Lithgow LEP that may otherwise be relevant to the project.

As the project is permissible with consent, the Minister is not prohibited from approving the project under the provisions of section 75J(3) of the EP&A Act and clause 8O of the EP&A Regulation.

Approvals That Do Not Apply

Under section 75U of the EP&A Act if the project is granted approval under Part 3A of the Act, the following authorisations, which may otherwise have been relevant, would not be required to carry out the Project (refer to **Table 5-3**).

Table 5-3: Authorisations That Do Not Apply

Act	Authorisations
Fisheries Management Act 1994	Permit for works or structures within a waterway.
Heritage Act 1977	Disturbance to an item listed on State Heritage Register or Interim Heritage Order; Excavation permit.
National Parks & Wildlife Act 1974	s87 preliminary research permit; s90 consent to destroy relics.
Water Management Act 2000	Water use approval, water management work approval or activity approval.
Native Vegetation Act 2003	Consent for the clearing of native vegetation.
Threatened Species Conservation Act 1995	Licence to harm or pick threatened species, populations or ecological communities or habitat.

Approvals Legislation to be Applied Consistently

If the Project is granted approval under Part 3A of the EP&A Act, the following authorisations, which would be required for the Project, must not be refused by the relevant approval authority and must be substantially consistent with the terms of the Project approval (refer to **Table 5-4**).

Table 5-4: Approvals Legislation to be Applied Consistently

Act	Approval	Authority
Mining Act 1992	Mining Lease	DII
Protection of the Environment Operations 1997	Environment Protection Licence	DECCW
Roads Act 1993	Permit to impact on a public road	Local roads – Lithgow City Council
Coal Mine Health and Safety Act 2002	Section 100	DII

5.2.2 Mining Act 1992

The *Mining Act 1992* (Mining Act) makes provision for a variety of mining authorities, including mining leases and exploration licences which are required for the prospecting and mining of minerals and coal. The Mining Act also makes provision for the protection of the environment in relation to mining activities, including rehabilitation of areas affected by mining activities.

Part 5 of the Act sets out provisions related to Mining Leases which allow the holder to prospect and mine on the land subject of the lease as well as carry out primary treatment operations associated with the mining activities such as crushing, sizing, grading, washing and leaching. Section 65 of the Act states that a mining lease cannot be granted unless an appropriate development consent is in force.

Exploration licences and assessment leases granted under the Mining Act allow the holder to prospect for specified minerals on the land to which the licence or lease applies. Baal Bone operates under a number of mining tenements detailed in **Section 1.3** of this EA issued under the Mining Act. No new mining authorities are proposed as part of this project, however existing mining authorities detailed in **Table 1-1** may need to be renewed during the project if they are due for expiry or renewal.

Part 11 of the Mining Act deals with the protection of the environment and provides that conditions may be imposed upon a mining authority or mineral claim requiring that land affected by mining activities be rehabilitated. Standard conditions generally imposed upon a mining lease include requirements to submit a MOP prior to the commencement of mining operations as well as Annual Environmental Management Reports (AEMR). These documents form the Mining Rehabilitation and Environmental Management Process (MREMP).

Baal Bone has an approved MOP incorporating Longwall 29 to 31 underground mining operations. The MOP would be updated and provided to DII to incorporate mining of the Remnant Areas prior to mining in these areas.

As required by specific mining authorities, a Subsidence Management Plan (SMP) has been prepared and approved for mining of Longwalls 29 to 31. A further SMP or Extraction Plan would be required prior to mining of the Remnant Areas.

5.2.3 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the principal NSW legislation relating to environmental regulation and in particular contains strict provisions regulating water, air, noise and land pollution. A key feature of the POEO Act is the requirement for certain *'scheduled activities'* which are listed in Schedule 1 of the POEO Act to have an Environment Protection Licence (EPL).

Clause 28 of Schedule 1 to the POEO Act relates to mining for coal and provides that coal mines with a capacity to produce more that 500 t of coal per day are classified as *'scheduled activities*'. Baal Bone is a coal mine with the capacity to extract up to approximately 2.8 Mtpa ROM coal, which equates to greater than 500 t per day. As such, an EPL is required for the mine to operate.

The Colliery currently operates under EPL No. 765 which permits coal production. The scale of operations at the site is not proposed to be increased under the proposed project. It is not anticipated that a variation to the existing EPL would be required in respect of the project.

5.2.4 Mine Subsidence Compensation Act 1961

The *Mine Subsidence Compensation Act 1961* (MSC Act) establishes a scheme for the payment of compensation for damage sustained to surface improvements by subsidence resulting from the mining of coal or shale.

Section 10 of the Act establishes the Mine Subsidence Compensation Fund. Colliery proprietors are required to make an annual contribution to this fund based upon the land value of the Colliery. Under the Act, claims can then be made against this fund for damage arising out of subsidence. The Proponent would make contributions as appropriate and required under this Act in relation to the continued operations at Baal Bone.

Section 15 of the MSC Act makes provision for the establishment of mine subsidence districts and requires that an application be lodged with the Mine Subsidence Board for the alteration or erection of improvements or the subdivision of land within mine subsidence districts. The Project Area is not located within a declared mine subsidence district under the MSC Act. As such, the provisions under Section 15 do not apply.

5.2.5 Coal Mine Health and Safety Act 2002

The *Coal Mine Health and Safety Act 2002* (CMHS Act) operates in conjunction with the *Occupational Health and Safety Act 2000* (OH&S Act) with the key objects being:

a) to assist in securing the objects of the Occupational Health and Safety Act 2000 in relation to coal operations (including the object of securing and promoting the health, safety and welfare of people at work at coal operations or related places), and

b) to put in place special provisions necessary for the control of particular risks arising from the mining of or exploration for coal, and

c) to ensure that effective provisions for emergencies are developed and maintained at coal operations and related places.

Part 5 of the CMHS Act sets out the duties of the mine operator in relation to health, safety and welfare at coal operations. The Act requires that the mine operator have a health and safety management system providing the following:

a) the basis for the identification of hazards, and of the assessment of risks arising from those hazards, by the operator of the coal operation, and

b) for the development of controls for those risks, and

c) for the reliable implementation of those controls.

The Act may also require the operator to have in place a:

- Major hazard plan;
- Management structure;
- Contractor management plan; and
- Emergency management system.

These documents form part of the general health and safety management system applying to the Baal Bone.

The existing health and safety management system for the Baal Bone would remain in place and be updated where necessary to reflect the proposed project to ensure that the Proponent's obligations under the CMHS Act continue to be met.

5.2.6 Roads Act

The *Roads Act 1993* (Roads Act) is administered by the NSW Roads and Traffic Authority, local Council or the Department of Lands.

Under section 138 of the Roads Act, a person must not:

a) erect a structure or carry out a work in, on or over a public road, or

b) dig up or disturb the surface of a public road, or

c) remove or interfere with a structure, work or tree on a public road, or

d) pump water into a public road from any land adjoining the road, or

e) connect a road (whether public or private) to a classified road, otherwise than with the consent of the appropriate roads authority.

The Project does not involve of the activities listed under section 138 of the Roads Act and as such consent is not required.

5.2.7 Forestry Act 1916

Some of the land subject of the project application is State Forest, therefore certain provisions of the *Forestry Act 1916* (Forestry Act) may apply.

Section 21 of the Forestry Act relates to land subject to mining law and states that:

Land within a State forest or flora reserve shall be subject to such of the provisions of the Mining Act 1992 and of the Petroleum (Onshore) Act 1991 as are applicable to land permanently dedicated; but the exercise of any right there under within a State forest or flora reserve shall be subject to such conditions and restrictions relating to forestry or the purposes of the reserve, as the case may be, as may be prescribed.

Provided that the Minister, with the concurrence of the Minister for Mines, by notification in the Gazette, may take any part of a State forest or flora reserve out of the operation of those provisions, and revoke or alter any such notification.

As the existing operations are being undertaken in accordance with an existing mining lease under the provisions of the *Mining Act 1912*, the proposed project is permissible within the relevant State Forest areas. Forests NSW has been consulted regarding the continued operations of Baal Bone during the preparation of the EA and did not raise significant issues regarding the continued operations at Baal Bone.

5.2.8 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NP&W Act) provides for the establishment, care control and management of national parks, historic sites, nature reserves, State conservation areas, Aboriginal areas and state game reserves.

The NP&W Act also provides for the protection of Aboriginal objects and the protection of native flora and fauna. As the project falls under Part 3A of the EP&A Act, once the proposal is approved under Part 3A, it is exempt from requirements for approvals required for impacting on Aboriginal sites under the NP&W Act. However, an assessment of the impact of the project on items protected under the NP&W Act, has been undertaken as part of this EA. Potential impacts to Aboriginal places and objects, and historic sites are considered in **Section 19** of this EA. Potential impacts to native flora and fauna and National Parks are considered in **Section 18** of this EA. No significant impacts are anticipated to matters protected under the NP&W Act.

5.2.9 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) provides for the conservation of threatened species, populations and ecological communities of animals and plants. This is achieved by the following:

- conserving biological diversity and promoting ecologically sustainable development;
- preventing extinction and promoting the recovery of threatened species, populations and ecological communities;
- protecting critical habitat of threatened species, populations and ecological communities;
- eliminating or managing certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities; and
- encouraging the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The TSC Act provides a framework to ensure that the impact of an action affecting threatened species is assessed. Schedule 1 of the TSC Act lists endangered species, populations and ecological communities, Schedule 2 lists vulnerable species and Schedule 3 lists key threatening processes. Part 3 of the TSC Act defines critical habitat.

Whilst the TSC Act does not strictly apply to projects subject to Part 3A of the EP&A Act, the EA has considered items protected under the TSC Act with respect to the continued operations of Baal Bone in the flora and fauna assessments undertaken for the project. The results of these assessments are discussed in **Section 18**. Underground mining within the Project Area is not expected to affect matters protected under the TSC Act. No significant impacts to threatened species protected under the TSC Act are anticipated.

5.2.10 Heritage Act 1977

The purpose of the *Heritage Act 1977* (Heritage Act) is to protect and conserve non-Aboriginal cultural heritage, including scheduled heritage items, sites and relics. The Heritage Act is administered by the NSW Heritage Office.

The Heritage Act makes provision for a place, building, work, relic, moveable object, precinct, or land to be listed on the State Heritage Register. As the project falls under Part 3A of the EP&A Act, once the proposal is approved under Part 3A, it is exempt from requirements for approvals required under the Heritage Act. However an assessment of Aboriginal heritage has been undertaken as part of the EA which provides an assessment of the potential impact of the project on items or places of heritage significance. The heritage assessment is provided in **Appendix N**, and is discussed in **Section 19** of this EA.

5.2.11 Water Management Act 2000

The Water Management Act 2000 (WM Act) is administered by the NSW Office of Water and provides for the regulation of access to water. The WM Act provides for the issue of water access licences in areas where a water sharing plan applies as well as administering controlled activity approvals for certain works within 40 metres of a watercourse. The Project Area is not located in an area to which a water sharing plan applies.

Approvals under Section 89, 90 or 91 of the WM Act are not required for projects approved under Part 3A of the EP&A Act.

No increase to the level of water usage is proposed as part of the Project.

5.2.12 Water Act 1912

Licences issued under the *Water Act 1912* authorise the taking of water, the use of water and the water supply works. Baal Bone currently holds a number of licences issued under the *Water Act 1912* for mine dewatering and the taking of water from bores at the site. Licensed extraction bores at Baal Bone are occasionally used for non-potable purposes including use in the washery plant and dust suppression. A number of these bores are licensed in perpetuity, while others are renewed as required.

5.2.13 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

State Environmental Planning Policy (Mining Petroleum Production and Extractive Industries) 2007 (SEPP 2007) recognises the importance of mining, petroleum production and extractive industries within the State.

Clause 7(1) of the SEPP 2007 identifies development which can be carried out with consent and includes underground mining on land, and facilities for the processing or transportation of minerals or mineral bearing ores on land on which mining may be carried out (but only if they were mined from that land or adjoining land). This clause therefore allows for the proposed project, being 'mining', to be carried out with consent.

Part 3 of the SEPP 2007 sets out matters for consideration for development applications for the purposes of mining, petroleum production or extractive industry, although they do not strictly apply to Part 3A. The clauses relevant to the project are nevertheless discussed below.

Clause 12

Clause 12 specifically sets out the matters which must be considered prior to granting consent for the purposes of mining, petroleum production or extractive industry. These matters are considered in the Table below.

Table 5-5: Clause 12 matters for consideration

Matter for Consideration	Comment
(a) consider: (i) the existing uses and approved uses of land in the vicinity of the development, and	The existing and approved land uses in the vicinity of Baal Bone include agricultural uses, State Forest primarily used for recreational purposes, and other coal mines including Cullen Valley, Angus Place, Pinedale, Lamberts Gully, Invincible and Springvale Collieries. Potential land use impacts associated with the project are discussed in **Section 20** of this EA.
(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and	Potential land use impacts associated with the project are discussed in **Section 20** of this EA. The project is generally considered to be compatible with existing and preferred uses in the vicinity of the Colliery.
(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and	Potential land use impacts associated with the project are discussed in **Section 20** of this EA. The project is generally considered to be compatible existing and preferred uses in the vicinity of the Colliery.

Matter for Consideration	Comment
(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and	Potential land use impacts and conflicts are assessed in **Section 13** and **20** of this EA.
(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).	Environmental safeguards to minimise land use incompatibilities are discussed in **Section 22** of this EA.

Clause 14

Clause 14 requires that consideration be given to natural resource and environmental management when assessing proposals for mining, petroleum production or extractive industry. Clause 14 states:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:*
>
> *a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,*
>
> *b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,*
>
> *c) that greenhouse gas emissions are minimised to the greatest extent practicable.*

This EA considers potential impacts on water resources, including surface and groundwater resources in **Sections 10** and **11** of this EA. The assessments undertaken indicate that no significant impacts are anticipated.

The potential impacts of the project on threatened species and biodiversity are assessed in **Section 18** of this EA, and includes mitigation measures where required to minimise or avoid potential impacts. No significant impacts are predicted.

A greenhouse gas assessment has been undertaken as part this EA and is provided in **Appendix K** and discussed in **Section 16**. No significant impacts are anticipated as a result of the project.

The Proponent has prepared a Statement of Commitments to ensure the development is undertaken in an environmentally responsible manner as required by Clause 14 above.

Clause 15

Clause 15 contains provisions relating to resource recovery. Clause 15 states:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery.*
>
> *(2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material.*
>
> *(3) The consent authority may refuse to grant consent to development if it is not satisfied that the development would be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials.*

The proposed project involves the extraction of the full seam thickness of Longwalls 29 to 31, as well as Remnant Areas within the existing workings (Longwalls 1 to 28). Longwalls 29 to 31 have been designed to maximise resource recovery, while minimising potential impacts to sensitive surface features located in the area, including the Wolgan Escarpment and other significant cliff formations, as discussed in **Section 4.2**.

By mining the Remnant Areas the Proponent is optimising the resource by mining an area already subject to mining and using existing surface facilities. Mining in the Remnant Areas would be undertaken by pillar extraction. Pillar design may be optimised at shallow depths, however, the current geometries at Baal Bone are considered to be appropriate for mine design purposes. Pillar design may provide greater flexibility should unexpected geological conditions be encountered. An Extraction Plan would be prepared prior to commencement of mining, which would detail the extraction method and mine plan for the Remnant Areas, and would aim to maximise resource recovery.

Clause 16

Clause 16 contains provisions relating to transport and states:

> *(1) Before granting consent for development for the purposes of mining or extractive industry that involves the transport of materials, the consent authority must consider whether or not the consent should be issued subject to conditions that do any one or more of the following:*
>
> *a) require that some or all of the transport of materials in connection with the development is not to be by public road,*
>
> *b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,*
>
> *c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.*

TWCL is seeking to continue haulage of coal in accordance with existing consents, however a majority of saleable coal produced at Baal Bone is transported via rail to international markets. The current consent permits the road haulage of 900000 Mtpa of saleable coal by road from Baal Bone to domestic customers. No additional road haulage is proposed as part of this project.

Road transport of saleable coal is predominantly transported to local power stations including Wallerawang and Mount Piper via the Castlereagh Highway. Residential areas including Cullen Bullen are located along the haulage route on the Castlereagh Highway. Cullen Bullen Public School is also located along the haulage route in Cullen Bullen. Colliery traffic through these areas is managed in accordance with a Road Haulage Management Plan and Truck Management Plan. Potential traffic impacts of the project are assessed in **Section 14** and **Appendix I** of this EA.

Clause 17

Clause 17 contains provisions relating to rehabilitation. Clause 17 states:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that would be affected by the development.*
>
> *(2) In particular, the consent authority must consider whether conditions of the consent should:*
>
> *a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or*
>
> *b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or*
>
> *c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under section 145C of the Act and the Contaminated Land Management Act 1997), or*
>
> *d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety.*

Rehabilitation at Baal Bone is being undertaken progressively at the site. Extensive rehabilitation has already been undertaken in the northern portion of the Baal Bone freehold area at the site of former open cut operations and former reject emplacement areas in accordance with the MOP. A Mine Closure Plan is currently being prepared for the site, and would further detail the end use and final landform proposed for the site. Mine closure and rehabilitation is addressed in **Section 13** of this EA.

5.2.14 State Environmental Planning Policy (Drinking Water Catchments Regional Environmental Plan No 1)

SEPP Drinking Water Catchments Regional Environmental Plan No. 1 (former REP No. 1) is a former Regional Environmental Plan (REP) for the environmental, social and economic future of the catchments that supply drinking water to Sydney, Blue Mountains and the Illawarra. Under the new Division 2, Part 3 of the EP&A Act, existing REPs (such as former REP No.1) is deemed to be a SEPP. Catchments to which REP No. 1 applies include the headwaters of the Coxs River.

Parts of the CCL 749 in the southern part of the Project Area fall within the hydrogeological catchment of the Coxs River. Clauses 26 and 27 of REP No. 1 states that developments under Part 4 and Part 5 of the EP&A Act are required to have a neutral or beneficial effect on water quality. The project is not being undertaken under Part 4 or Part 5 of the EP&A Act, and as such the provisions do not strictly apply to the project. However an assessment of potential impacts to water quality is undertaken in **Section 11** of this EA.

6.0 Consultation

6.1 Introduction

Preliminary stakeholder consultation was undertaken for the proposed project with stakeholders including community representatives, non-government organisations, and statutory agencies. This consultation has included discussions on the proposed continuation of operations at Baal Bone, as well as discussions regarding a potential new area of proposed underground mining within existing mining leases within the Project Area. Since the preliminary consultation, and due to economic considerations, the new area of proposed underground mining no longer constitutes part of this Project Application, and would not be considered as part of the project in the EA.

6.2 New South Wales Formal Procedures

This EA has been prepared in accordance with Part 3A of the EP&A Act and its Regulation. Part 3A of the EP&A Act ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision making process.

In preparing this EA, the DGRs have been addressed as required by Clause 75F of the EP&A Act. The key matters raised by the Director-General for consideration in the EA are outlined in **Table 6-1** below, together with the relevant section of the EA which addresses that matter. A full copy of the DGRs for the project is provided in **Appendix A**.

Table 6-1: Director Generals Environmental Assessment Requirements

General Requirements	Reference in EA
An Executive Summary	**Executive Summary**
A detailed description of: • Existing and approved mining operations and infrastructure on the site, including a copy of all relevant statutory approvals; • Existing and approved mining operations in the vicinity of the site; • Historical mining operations on the site; • Any existing and/or approved biodiversity and heritage offset areas relating to these operations; and • The existing environmental management regimes for these operations.	**Section 1.4** **Section 2.4** **Section 2.2** **Section 4.6**
A detailed description of the project, including the: • Need for the project; • Alternatives considered, including justification for the proposed mine plan; • Likely staging of the project; • Likely interactions between the project and existing and approved mining operations; and • Projected life of the mine.	**Section 3.1** **Section 3.2** **Section 4** **Section 23.2.2** **Section 4.8**
• A risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment	**Section 7**
• Detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: - Description of the existing environment, using sufficient baseline data; - An assessment of the potential impacts of all stages of the project on this environment, including any cumulative impacts, taking into consideration any relevant laws, policies, guidelines and plans; and - Description of the measures that would be implemented to avoid, minimise, and if necessary offset the potential impacts of the project.	**Sections 8 to 21**

General Requirements	Reference in EA
• A statement of commitments, outlining the proposed environmental management and monitoring measures.	**Section 22.2**
• A conclusion justifying the project, taking into consideration the economic, social and environmental impacts of the project as a whole; and whether the project is consistent with the objects of the *Environmental Planning & Assessment Act 1979*.	**Section 24**
• A signed statement from the author of the Environmental Assessment, certifying that the information contained within the document is neither false nor misleading.	At the front of this EA
Subsidence	
Including: • Accurate predictions of the potential subsidence effects (both systematic and non-systematic) including potential cumulative effects and a sensitivity analysis; • Identification of sensitive receptors potentially affected by subsidence (such as environmental features and infrastructure) and an assessment of significance of those receptors; • Assessment of the potential impacts of these subsidence effects on the natural and built environment, with particular reference to sensitive receptors such as cliff lines and other geomorphologic features; • Identification of how mine design has been or will be used or adapted to manage and mitigate subsidence impacts; • Identification of how subsidence impacts will be rehabilitated, including methodologies and response times; and • Identification of further research required to address any uncertainties or information gaps.	**Section 8.3, 8.4 and 8.6**. **Section 8.4** and **8.5**. **Section 8.4, 8.5** and **8.6**. **Section 8.4** and **8.5**. **Section 8.7**. **Section 8.9**.
Traffic and Transport	
Including: • Accurate predictions of road and rail traffic resulting from the project; • A road safety audit of the roads used by traffic from the project, including consideration of school bus routes; and • Justification for the proposed continuation of coal haulage via public roads, including a detailed consideration of alternatives.	**Section 14** **Section 14.3** **Section 14.** **Section 14.4.1** and **Section 3.2.2**
Soil and Water	
Including: • A site water balance for the project; and • An assessment of the potential impacts of the project on surface and ground water resources, including water quality and quantity.	**Section 10** **Section 10, 11 and 17**
Air Quality	
• A greenhouse assessment.	**Section 16**

General Requirements	Reference in EA
Noise	
• An assessment of the potential low frequency noise and off-site road and rail noise.	**Section 9**
Biodiversity	
Including: • A detailed assessment of the potential impacts of the project on any terrestrial and aquatic threatened species, populations, ecological communities or their habitats; and • A detailed description of the measures that would be implemented to maintain or improve the biodiversity values of the surrounding region in the medium to long term.	**Section 18**
Rehabilitation	
A detailed description of the proposed rehabilitation strategy, including: • Rehabilitation objectives and demonstration that these objectives can be achieved; • Identifying specific domains for rehabilitation and proposed final land use/s and final landforms for each domain, having regard to any relevant strategic land use planning or resource management plans or policies; and • Identifying the strategic level rehabilitation success/completion criteria for each domain having regard to each stage of rehabilitation and also for natural features affected by subsidence.	**Section 13.2** and **13.3** **Section 13.5** **Section 13.5** and **13.6**
Mine Closure	
• Including the measures that would be implemented to minimise the potential socio economic impacts for the mine's employees following closure.	**Section 13.5.4** and **Section 21.2**

Written comments were received from relevant statutory agencies identified in the DGRs to assist with the preparation of the EA (and are provided in **Appendix A**). The table below summarises the comments received together with the relevant section of the EA which addresses the matter.

Table 6-2: Agency Environmental Assessment Requirements

Issues Raised	Comment/Reference in EA
Department of Industry and Investment (DII) – Mineral Resources	
Rehabilitation • Rehabilitation objectives and demonstration that these objectives can be achieved;	**Section 13.2** and **13.3**
• Identify specific domains for rehabilitation and proposed final land use/s and final landforms for each domain, having regard to any relevant strategic land use planning or resource management plans or policies; and	**Section 13.5**
• Identify the strategic level rehabilitation success/completion criteria for each domain having regard to each stage of rehabilitation and also for natural features affected by subsidence.	**Section 13.5** and **13.6**
Subsidence • Potential cumulative subsidence effects and sensitivity analysis;	**Section 8.3**
• Identification of sensitive receptors potentially affected by subsidence (such as environmental features and infrastructure) and an assessment of significance of those receptors;	**Section 8.2, 8.4** and **8.5**.
• Assessment of the potential impacts of these subsidence effects on the natural and built environment, with particular reference to sensitive receptors such as cliff lines and other geomorphologic features and consequential impacts;	**Section 8.4** and **8.5**
• Predictions of the potential subsidence effects (both systematic and non-systematic) identification of how mine design has been or will be used or adapted to manage and mitigate subsidence impacts;	**Section 8.4** and **8.5**
• Identification of how subsidence impacts will be rehabilitated, including methodologies and response times; and	**Section 8.7**
• Identification of further research required to address any uncertainties or information gaps.	**Section 8.8**
Department of Industry and Investment (DII) – Fisheries	

Issues Raised	Comment/Reference in EA
Aquatic Habitat • General description of Aquatic Habitat aquatic habitat areas (creeks and wetlands) within the study area including the extent and potential impact of aquatic habitat modification which may result from the proposed development, particularly disturbance to rivers and creeks due to subsidence and vibration; and • Aspects of the management of the proposal which relate to impact minimisation e.g. Environmental or Subsidence Management Plans, Compensatory Habitat and Rehabilitation Plans.	No permanent creeks or streams overly LW 29 – 31 and therefore subsidence associated impacts are unlikely to affect key fish habitat. The Coxs River Swamp is within the vicinity of Longwalls 29 to 31, however as described in **Section 11** and **18**, potential impacts on the swamp are not anticipated. One permanent creek, Ben Bullen Creek, overlies parts of the proposed remnant areas. However, the creek would be protected by a 26.5 degree angle of draw and would not be directly undermined. The section of creek above the mine site has little or no defined drainage channel. A site visit by DPI (now DII) indicated the section of creek in question would be ranked as Class 4, Unlikely Fish Habitat under DPI Fisheries classification system. The restoration of Ben Bullen Creek is expected to have positive impacts for aquatic ecology once rehabilitation is complete. No direct impact on aquatic or riparian habitats is expected to result from the Project.
NSW Office of Water	
Security and adequacy of water supply.	**Section 10**
Site water demands, sources, storage and management.	**Section 10**
Water management and site water balance, including assessment against Water Sharing Plans or embargoes. .	**Section 10.1.1**
Groundwater resource protection, including impact on adjacent groundwater users including landholders and groundwater dependent ecosystems.	Potential impacts of mining on base flow to groundwater dependent ecosystems are considered in **Section 11.1.5, 11.2.3** and **11.3.1.** Groundwater resource usage is addressed in **Section 11.1.6**. Recovery following mining is addressed in **Section 11.3.2**.
Interception of groundwater, predicted dewatering volumes, water quality and disposal / retention.	**Section 11.1.6**.
Protection of waterways and riparian zones, and restoration works along Ben Bullen Creek.	**Section 10.2.2** and **13.6.2**.
Identification of works requiring water licensing under the *Water Management Act 2000* or *Water Act 1912.*	**Section 11.1.6**.

Issues Raised	Comment/Reference in EA
Mitigation measures and monitoring requirements to address potential surface and groundwater impacts.	**Section 10.4** and **11.5**.
General environmental risk analysis.	**Section 7**.
Rehabilitation, landform and void rehabilitation.	**Section 13**.
Department of Environment, Climate Change and Water (DECCW)	
DECCW endorses the content in the DGRs with respect to air, water and noise pollution, Aboriginal cultural heritage and flora and fauna matters.	Refer to **Table 6-1** for reference in EA.
Roads and Traffic Authority (RTA)	
Undertake traffic study including origin-destination of vehicles, including staff, contractors, construction, and maintenance personnel during all stages of the project/development.	**Section 14**.
Cumulative impacts associated with the concurrent operation of the Project with other existing or approved mining operations in the region.	**Section 14.6**.
Review of road safety.	**Section 14.4** and **Appendix I**.
Consideration of school bus routes and shift times.	**Section 14.1.4.**
Speed and fatigue management.	Speed and fatigue management would be in accordance with the existing Truck Management Plan (TMP). Refer to **Section 14.2.2**.
Train operations study.	No level crossings located between Baal Bone and the main railway line and as such a train operations study is not required.
Affect on public roads where there is a potential for subsidence.	Subsidence from the Project would not affect public roads. Refer **Section 8.5.2**.
Affect on public roads where there is a potential for blasting to affect operation or structures such as bridges.	No blasting is proposed as part of the Project.
Lithgow City Council (LCC)	
LCC endorses the content in the DGRs	Refer to **Table 6-1** for reference in EA.

6.3 Stakeholder Consultation Strategy

A Stakeholder Engagement Strategy has been prepared for the project in order to guide the consultation process in accordance with statutory requirements and obligations, and in accordance with Xstrata's environmental approval policies and procedures which are a key element of this process. Xstrata's standards and procedures guide the stakeholder engagement standards for Baal Bone.

The Stakeholder Engagement Strategy identifies key stakeholders for the project and identifies the consultation approach for the course of the project. Key stakeholders identified include local residents and adjacent landholders, members of the Baal Bone Community Consultative Committee (CCC), representatives of the local and wider indigenous community, Lithgow City Council, statutory authorities with interest in the project, and members of environmental groups.

A number of methods of consultation with key stakeholders have been identified, including:

- Workshops with key community stakeholders;
- Distribution of 250 newsletters to the local community (**Appendix B**); and
- Individual meetings with agencies and stakeholders.

Each of the key stakeholder groups and the consultation process are discussed in the following sections.

6.4 Consultation with Stakeholders and Relevant Authorities

6.4.1 Statutory and Agency Consultation

TWCL has undertaken consultation with key local and state Government agencies as specified in the DGRs during the preliminary design phase and preparation of this EA. The purpose of this consultation has been to provide an overview of the project and to seek input into matters they would like to see addressed in the EA.

In this regard, face to face meetings, where possible, have been held and continue to be held with relevant statutory agencies identified in the DGRs, to assist with the preparation of the EA.

Briefings have been held with a number of relevant statutory authorities including DECCW, DoP, DII (including Forests NSW), Department of Water and Energy (DWE), Roads and Traffic Authority (RTA), and Lithgow City Council.

The proposed approach to each of the assessment methodologies for issues to be covered in the EA was discussed with relevant agencies in order to ensure that the EA meets the relevant agency requirements.

Table 6-2 below describes the consultation log undertaken as part of the EA for statutory and agency stakeholders.

Table 6-2: Statutory and Agency Consultation Log

Issue	Date	Details
Department of Primary Industries – Mineral Resources		
Mine Plan	23/03/09	Meeting with a number of representatives from the DPI-MR (now DII) including Vince Fallico, Judith Egan, Chris Rudens, Tracy Godwin, Jeff Inmew and Edward Morgan to present the Conceptual Project Development Plan for consideration of DII. On 24 March 2009, DPI-MR provided a letter to NSW Department of Planning advising that they had reviewed the proposal and requested that Baal Bone contact the Department of Planning to progress the project to a Part 3A Approval.
	4/05/09	Discussions with Vince Fallico were undertaken to advise that following a detailed review of the economics of the proposed Northern Area, the company (Xstrata) had decided to not include this development in the proposed Part 3A approval process.
Department of Environment and Climate Change		
Ecology	10/02/09	Discussions with Peter Christie from DECCW's Bathurst office were held by telephone to determine appropriate assessment methodology for ecological surveys for the EA. DECCW provided a number of comments and suggestions via email for consideration as part of the assessment methodology, which would be taken into account for the project.
Heritage	3/02/09	DECCW was contacted as part of the Indigenous heritage consultation process. DECCW identified a number of Indigenous groups and individuals to be contacted as part of the consultation process.

Issue	Date	Details
Noise	10/12/08	A meeting was held with Larry Clark from the DECCW Noise Branch to discuss the proposal and determine likely noise assessment requirements for the EA. Determined that the EA would need to address the noise generation from the existing surface infrastructure, loading and despatch, and potential effects on nearby sensitive rural residential receivers. Noise emissions from the site would be required to comply with NSW Industrial Noise Policy (INP) criteria.
Roads and Traffic Authority (RTA)		
Traffic and road transport	10/03/09	Discussions with Wade Hazelton from RTA's Dubbo office were undertaken. RTA supported the proposed assessment approach of a review of the existing traffic environment and traffic generation associated with the continued operations at Baal Bone.
Traffic and road transport		Discussions with Joe Sulicich from RTA's Western office were undertaken in response to the submission received from the RTA in response to the request for EARs for the project. The Director-General's EARs stated that a Road Safety Audit would be required for the Project. The RTA supported a reduced scope to assess road safety, and stated that a formal Road Safety Audit would not be required. Correspondence from the RTA confirming this approach is provided in **Appendix A**.
Lithgow City Council		
Project introduction	7/01/09	A meeting was held with Roger Bailey, General Manager of Lithgow City Council to provide an introduction to the project and outline the likely timeframe and approval process for the project.

6.4.2 Community Consultation

The overall objective of the Community Consultation Strategy implemented for the Project was to ensure clear, effective, open, two-way communication at all times by listening, recording and responding to issues. Specific objectives included:

- To ensure the community was aware of the proposal and that an EA was being prepared for these works;
- To facilitate information exchange from an early stage between the study team and the community to enable joint understanding of the key issues;
- To provide opportunity for public comment and to assist and supply interested parties with information;
- To provide an explanation of the EA process;
- To identify, analyse and address community issues and suggestions;
- To identify potentially conflicting issues at an early stage in the project which may lead to problems during other stages of the program; and
- To demonstrate that issues were being addressed.

The key community groups involved in the consultative process primarily include the Baal Bone Community Consultative Committee (CCC), Blue Mountains Conservation Society (BMCS) and the Colong Foundation for Wilderness (CFW).

An overall introduction to the project and proposed stakeholder consultation strategy took place on 29 January 2009 with Baal Bone CCC (Workshop No. 1). A CCC meeting involving discussion of the project was also held on 3 June 2009, where the CCC was advised that the new area of proposed underground mining no longer constituted part of this Project Application, and would not be considered as part of the project in the EA.

The consultation log of community consultation undertaken as part of the EA is described below in **Table 6-3**.

Table 6-3: Community Consultation Log

Purpose	Date	Details
Community Consultation		
Project introduction	29/01/09	A community workshop was held at Cullen Bullen Community Hall, which was attended by four community representatives, a representative from Baal Bony Colliery and three AECOM representatives. The workshop provided an introduction to the project and outlined the proposed community consultation process, and provided an opportunity for the community to identify issues they would like to see addressed in the EA.
Project Update	July 2009	A Project Newsletter was circulated to local landholders, and to the Cullen Bullen and Portland communities outlining the proposed project.
Blue Mountains Conservation Society (BMCS)		
Project Introduction	29/01/09	A meeting was held with Brian Marshall from BMCS. The meeting provided an introduction to the project and outlined the proposed community consultation process. BMCS stated that key issues of concern to be addressed in the EA would likely be subsidence impacts on surface features and loss of water flows.
Project Update	11/06/09	A phone discussion took place to advise the BMCS of the revised scope of the project for the continued operations at Baal Bone.
Project Update	July 2009	A Project Newsletter was mailed out to BMCS.
Colong Foundation for Wilderness (CFW)		
Project Introduction	5/02/09	A meeting was held with representatives of the CFW. The meeting provided an introduction to the project and outlined the proposed community consultation process. The CFW stated that key issues of concern would likely be subsidence impact on surface features, and justification of the project.
Project Update	09/06/09	A phone discussion took place to advise the CFW of the revised scope of the project for the continued operations at Baal Bone.
Project Update	July 2009	A Project Newsletter was mailed to the CFW.

6.4.3 Indigenous Consultation

As part of the Indigenous heritage assessment undertaken for the continued operations at Baal Bone, consultation with Indigenous stakeholders was undertaken in accordance with the *National Parks & Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants (ICCRs)*. At the time that consultation was undertaken, the mining area known as the Northern Area was also proposed. Since completion of heritage surveys and consultation this new mining area no longer forms part of this Project Application. However, a full Indigenous heritage assessment was undertaken as part of the SMP for Longwalls 29 to 31, which included consultation with Indigenous stakeholders in accordance with the relevant DECCW consultation guidelines. The results of this Indigenous heritage assessment are discussed in **Section 19** and **Appendix N** of this EA.

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7.0 Risk Prioritisation

7.1 Issues Identification

As identified in the following sections of this report, issues associated with the continued operations at Baal Bone Project Approval include:

- Subsidence;
- Air quality (dust and greenhouse gas);
- Water management (surface water and groundwater);
- Noise;
- Tailings and reject emplacement;
- Flora and fauna;
- Social and economic;
- Heritage and cultural;
- Visual;
- Land use;
- Traffic; and
- Rehabilitation and mine closure.

7.2 Prioritisation of Risks

7.2.1 Approach

The prioritisation of issues has been undertaken using an environmental risk analysis, based on the current and proposed operations at Baal Bone, number and proximity of potential receptors surrounding Baal Bone, existing physical environment, and management practices currently employed at the site.

The operation of the Surface Infrastructure Area, and Underground Mining Area including mining of the existing Longwalls 29 to 31 at Baal Bone are approved developments which are currently undertaken in accordance with operational environmental management plans and reporting requirements.

This EA has considered the existing operations and surface infrastructure in the context of a site wide cumulative assessment for identified technical issues. These technical assessments include subsidence, noise, water balance, air quality and greenhouse gas. The impacts associated with these technical assessments have been addressed in this report. Studies have also considered the cumulative impacts of the continued operations on site.

Table 7-1 provides the *Issues Prioritisation Matrix* upon which the ranking of environmental issues has been based. This method assesses priority on the basis of the potential severity of environmental effects and the likely consequences of those potential effects if left unmanaged. The potential severity and consequence of the environmental effect are each given a numerical value between 1 and 3. The numbers are added together to provide a result which is then ranked and shaded in the matrix by the level of priority being High, Medium or Low.

The allocation of risk is based upon the following considerations:

Severity of Risk

Low:	localised implications; imperceptible or short term cumulative impacts.
Medium:	regional implications; modest or medium term cumulative impacts.
High:	inter-regional implications: serious or long term cumulative impacts.

Consequences of Unmanaged Effects

Low:	minor environmental change; offsets readily available.
Medium:	moderate adverse environmental change; offsets available.
High:	important adverse environmental change, offsets not readily available.

Table 7-1: Issues Prioritisation Matrix

Severity Of Risk	Consequence of Unmanaged Effects		
	3 High	2 Medium	1 Low
1 Low	4 (Medium)	3 (Low)	2 (Low)
2 Medium	5 (High)	4 (Medium)	3 (Low)
3 High	6 (High)	5 (High)	4 (Medium)

7.2.2 Assessment

The prioritisation of environmental issues related to the proposed project is shown in **Table 7-2.** This assessment aims to allow the prioritisation of issues for assessment and does not consider the application of mitigation measures to manage environmental effects. In all cases, appropriate and proven mitigation measures, chosen based upon the experience of regulators and other similar projects, would be used to minimise potential impacts. These measures have been described in detail in **Section 22** of this EA.

Table 7-2: Prioritisation Analysis

Issue	Severity	Consequence	Priority
Subsidence			
Potential effects of subsidence on surface water.	1	2	3 (Low)
Potential effects of subsidence on surface features.	1	2	3 (Low)
Potential effects of subsidence on groundwater resources.	1	2	3 (Low)
Air Quality			
Potential air quality impacts due to continued operations.	1	1	2 (Low)
Greenhouse gas emissions associated with continued operations.	2	1	3 (Low)
Water Management (Surface Water and Groundwater)			
Hydro-fracturing from mining resulting in dewatering and disruption to shallow and deep groundwater aquifers.	1	2	3 (Low)
Impacts on local water resources and users due to due to loss of, or alterations to, surface flows from mining activities.	1	2	3 (Low)
Degradation of water quality in the local area due to dewatering at discharge points.	1	2	3 (Low)
Noise			
Degradation of noise environment due to continued operation of surface infrastructure and facilities.	1	2	3 (Low)
Tailings and Reject Emplacement			
Capacity of existing tailings and reject management emplacement areas inadequate for continuation of existing operations.	1	1	2 (Low)

Issue	Severity	Consequence	Priority
Flora and Fauna			
Indirect impacts to threatened vegetation and habitat due subsidence impacts.	1	2	**3 (Low)**
Social and Economic			
Demand upon community, natural or transport resources resulting from continued operations.	1	1	**2 (Low)**
Impacts upon amenity of surrounding properties such as noise, visual, etc resulting from continued operations.	1	2	**3 (Low)**
Impacts upon community resulting from mine closure.	2	2	**4 (Medium)**
Heritage and Cultural			
Impacts on natural heritage due to subsidence impacts upon surface features (i.e. significant rock formations and escarpments).	2	2	**4 (Medium)**
Impacts on Indigenous heritage due to subsidence impacts upon surface features.	1	1	**2 (Low)**
Visual			
Visual impacts associated with subsidence and associated impacts to surface features (i.e. significant rock formations and escarpments).	1	2	**3 (Low)**
Land Use			
Incompatibility of proposed mining land use with surrounding environment	1	1	**2 (Low)**
Traffic			
Effects on existing traffic (road and rail) network resulting from continued operations.	1	1	**2 (Low)**
Rehabilitation and Mine Closure			
Incompatibility of final landform with surrounding land uses.	1	2	**3 (Low)**

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8.0 Subsidence

8.1 Introduction

The proposed continued operations at Baal Bone include the underground extraction of Longwalls 29 to 31, as well as the potential for mining of Remnant Areas within existing workings at some time in the future.

Numerous subsidence investigations have previously been undertaken at Baal Bone by SCT Operations Pty Ltd (SCT). Those of particular relevance to the continued operations at Baal Bone, and used to assess potential subsidence impacts of the Project, include:

- SCT (2007a). Subsidence Assessment for Longwalls 29, 30 and 31 Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3248.
- SCT (2007b). Review of Subsidence Monitoring and Impacts of Mining on Sandstone Cliff Formations at Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3259.
- SCT (2008). Protection of Wolgan Escarpment from Longwall 31 Mining Subsidence. SCT Operations Pty Ltd Report BBO3432.
- SCT (2009). Subsidence Zones in Remnant Areas at Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3559.

The subsidence investigations undertaken by SCT are briefly described below and in more detail in the following sections, and are presented in **Appendix C**.

Other relevant investigations include:

- Connell Wagner (2006). Baal Bone Colliery Longwalls 29 to 31 SMP Hydrogeological Assessment. Connell Wagner Pty Ltd. Prepared for Xstrata Coal.
- HMS (2006). Longwall Mining Subsidence Risk Assessment. Hawcroft Miller Swan Consultants Pty Ltd. Prepared for Xstrata Coal.

The hydrogeological assessment undertaken by Connell Wagner (2006) is provided in **Appendix G**, and the subsidence risk assessment prepared by HMS (2006) is provided in **Appendix D**.

The mining of Longwalls 29 to 31 has previously been assessed and approved by DII under Part 5 of the EP&A Act and in accordance with the requirements of the *Mining Act 1992*. A subsidence assessment was prepared for Longwalls 29 to 31 SCT (2007a) which assessed subsidence predictions and potential impacts on surface features in the areas affected by subsidence from mining of Longwalls 29 to 31. A more general summary of previous experience of mining under cliff formations was also undertaken (SCT, 2007b) to describe the results of experienced at Baal Bone.

A SMP was prepared for the mining of Longwalls 29 to 31, and approved by DII on 07/12/2007. A condition of the SMP approval by DII required that a specific plan of management for the Wolgan Escarpment be prepared. SCT (2008) prepared a technical basis for this plan of management, which involved reducing the width of Longwall 30 by some 30 m to increase the barrier of protection to the Wolgan Escarpment.

The continued operations at Baal Bone also include the potential for mining of Remnant Areas within the existing workings, as discussed in **Section 4.2.2** and shown in **Figure 4-1**. A report was prepared by SCT (2009) to identify surface features within the Remnant Areas that would likely require particular consideration to manage subsidence and potential impacts to surface features as a result of mining this area.

An overview of the subsidence features experienced at Baal Bone is described below in **Section 8.2**. The subsidence predictions for Longwalls 29 to 31 and associated potential impacts are discussed in **Section 8.3** and **8.4**, and potential impacts associated with mining of the Remnant Areas are discussed in **Section 8.5**.

8.2 Subsidence Features

Longwall mining at Baal Bone involves the progressive removal of portions of the coal seam, which creates a void the width of the longwall panel, typically some 250 m wide. The extraction of coal results in the subsequent collapse of overlying strata, resulting in subsidence, with some vertical lowering of the ground surface above the longwall panel. The roof of the void is unable to support itself following extraction, and the overlying strata fracture and cave into the void (known as the goaf). The settlement and bending of the strata results in a subsidence trough developing at the surface. Maximum subsidence of the ground surface typically occurs in the central portion of the depression created at the surface. At Baal Bone, previous experience indicates this generally occurs above the centre line of the longwall panel. Maximum subsidence at Baal Bone has been measured at up to 1700 mm, but due to the depth of cover is predicted to range between 1300 mm to 1600 mm for Longwalls 29 to 31.

Other parameters besides subsidence noted in the description, prediction and assessment of surface movements resulting from underground mining are described as follows (SCT, 2007b):

- Tilt – tilt is the change in slope of the surface landform, calculated as the difference in subsidence between two points on the land surface, divided by the distance between those two points.
- Strain – strain is determined by calculating the horizontal change in length of a section of land surface, and dividing this by the horizontal length of this section. Maximum strains coincide with the maximum curvature of the profile.
- Closure – this is often associated with valley bulging, particularly in deep, steep sided valleys and refers to the measured horizontal displacement of the flanking ridges towards the centre of the valley.
- Upsidence – occurs where a valley is undermined. It is often observed that the valley floor subsides less than surrounding ridges tops. The difference in subsidence between the ridge top and the valley floor is in these cases is referred to as ‘uplift’. In extreme cases the valley floor may actually rise, rather than subside, and this is known as upsidence.

The subsidence trough that develops above the longwall panel is generally wider than the panel that has been extracted. The extent of subsidence is defined by the angle of draw, which is the angle between the vertical and the line joining the edge of the mining void with the limit of vertical subsidence, usually taken as 20 mm. The defined angle of draw for longwall mining in the NSW Western Coalfields is 26.5 degrees (DPI, 2003), to provide protection of surface features from the surface impacts associated with subsidence. The defined angle of draw for longwall panels and areas affected by subsidence in longwall mining is illustrated in **Figure 8-1**.

Subsidence behaviour is strongly related to the ratio of the individual longwall panel widths to overburden depth ratio. Therefore as overburden depth decreases compared to panel width, the panel width to depth ratio increases. Subsidence behaviour at panel to depth ratios of greater than 1.0 to 1.2 is referred to as super-critical width panels, where full subsidence develops in the central part of each longwall panel, with much lower levels of subsidence over the chain pillars between longwall panels. For example, in Longwalls 29 to 31 where longwall panels are 225-250 m wide and the overburden depth ranges from 150-240 m, the panel width to overburden depth ratio is 1.0-1.7. The subsidence behaviour is such that full subsidence develops in the central part of each panel.

The magnitude of full subsidence in the centre of each panel is a function of seam thickness. Maximum subsidence in the centre of each panel would typically reach 55-65% of seam thickness. Seam thickness in Longwalls 29 to 31 is approximately 2.4 m, equating to maximum subsidence of up to some 1 600 mm.

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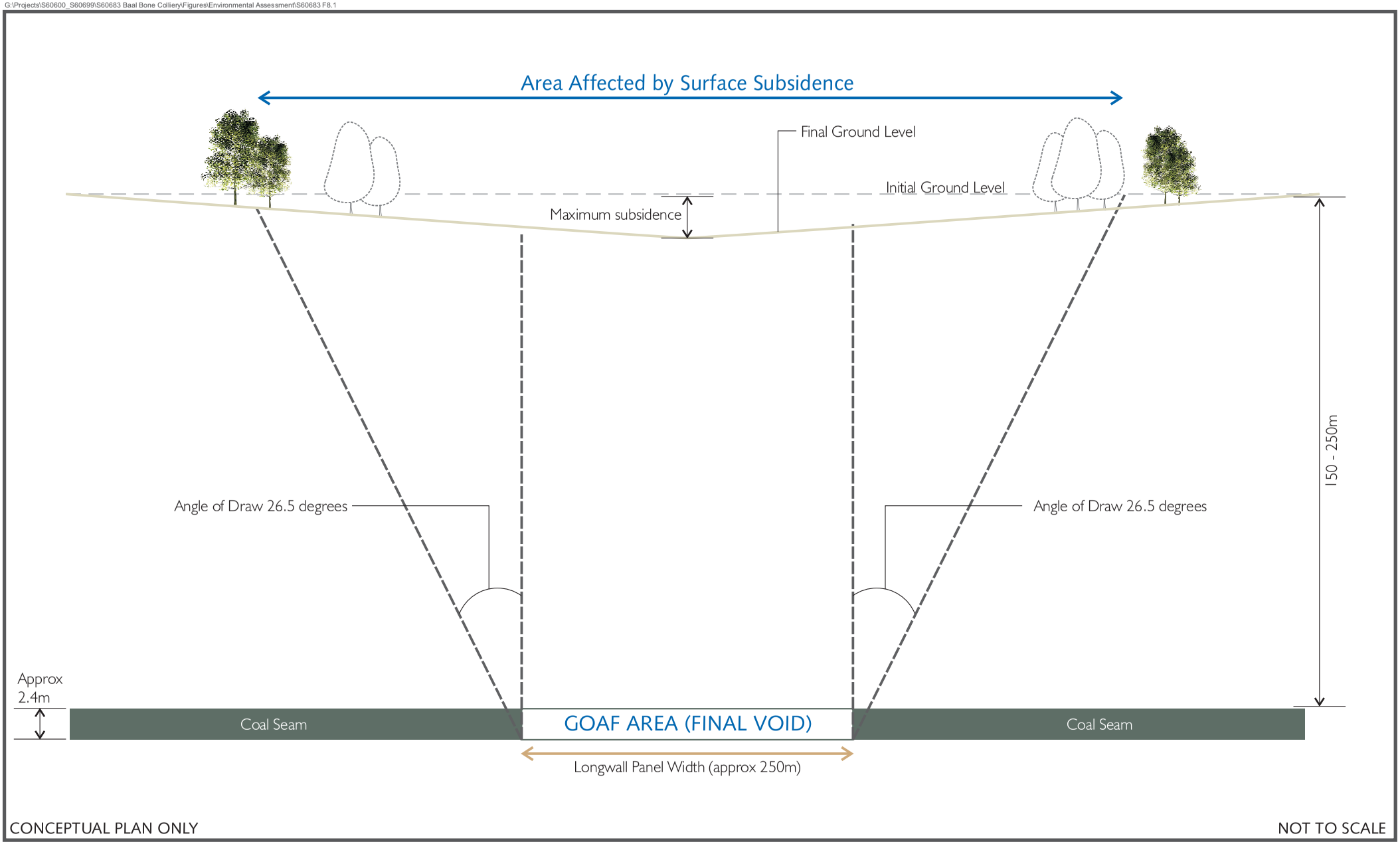

AECOM

INDICATIVE EXTRACTED LONGWALL PANEL WIDTH CROSS SECTION

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 8.1

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8.3 Sensitivity Analysis

A risk assessment and sensitivity analysis was conducted at Baal Bone on 5 December 2006 by Hawcroft, Miller Swan Consultants Pty Ltd (refer **Appendix D**), to identify, assess and evaluate potential subsidence impacts to surface and sub-surface as a result of mining Longwalls 29-31 (HMS 2006).

The potential impact arising from maximum theoretical subsidence was considered and the risk assessment concluded that any potential cumulative impacts were likely to be manageable. No high risk issues were identified and this was generally attributable to the mine design. Some agreed actions were developed, including subsidence and environmental monitoring programs, which have subsequently been approved and are implemented on an ongoing basis.

The risk assessment also took account of matters raised during the community consultation process, which was conducted in November 2006. In particular, matters relating to the Wolgan Escarpment, internal clifflines, rock formations, groundwater, watercourses, endangered ecological communities and threatened and protected species were considered.

Subsidence monitoring and management has been undertaken at Baal Bone since the commencement of underground longwall mining operations in 1985. Subsidence behaviour in relation to cliff formations is well understood, and includes studies undertaken since commencement of Longwall 1. Initial subsidence investigations included conventional subsidence monitoring (SCT, 1992). Three dimensional subsidence monitoring was used to study subsidence impacts from mining of Longwalls 4 to 7 on cliff formations (Kay,1991 in SCT, 2007b). Following the completion of Longwall 8, a detailed review of surface subsidence behaviour was undertaken.

From Longwall 8 onward, routine subsidence monitoring and more targeted studies have utilised photogrammetry, GPS, three dimensional surveying and closed-space continuous monitoring to provide information on the mechanics of subsidence behaviour at Baal Bone, and subsequent impacts on surface features.

Subsidence movements at Baal Bone Colliery have generally been confined within 26.5 degree angle of draw of the goaf edge, and no significant subsidence movements have been observed outside this area. Monitoring has shown the actual angle of draw measured at Baal Bone for previous longwall operations has been generally less than 17 degrees.

8.4 Subsidence Predictions – Longwalls 29 to 31

A subsidence assessment was prepared as part of the Subsidence Management Plan (SMP) for Longwalls 29 to 31 (SCT, 2007a). Longwalls 29 to 31 are located in the south eastern portion of the Project Area. The proposed total void width for each of the longwall panels is shown in **Table 8-1**. Typical overburden depth is 200-230 m, but varies between 150-240 m depending on topography. Seam thickness is approximately 2.4 m.

Table 8-1: Panel Width and Overburden

Longwall	Nominal panel width (total void) (m)	Depth of overburden range (m)
29	250	150-220
30	225	165-230
31	220	210-240

The main natural features in the vicinity of Longwalls 29 to 31 are the Wolgan Escarpment, as well as several other notable sandstone rock formations predominantly at the southern end of the longwall panels, and Coxs River Swamp located some 300 m to the west of the longwall panels.

The maximum subsidence predictions for Longwalls 29 to 31 are estimated to be between 1300 mm and 1600 mm in the centre of each longwall panel with less than 500 mm of subsidence over the chain pillars. Systematic tensile strains of up to 16 mm/m and systematic compressive strains of up to 21 mm/m are expected. Tensile strains are expected to be greatest on ridge tops and near the start of the panel. Compressive strains are expected to be greatest in valleys. Maximum ground tilt of up to 52 mm/m is expected at a distance of approximately 0.3 times overburden depth from the goaf edge.

The final subsidence profile for Longwalls 29 to 31 is expected to be three subsidence troughs centred over the panels. By comparison to the natural surface gradients, the troughs are expected to be barely perceptible (SCT, 2007a).

8.5 Longwall 29 to 31 - Impacts on Surface Features

8.5.1 Escarpments, Cliffs and Rock Formations

The Wolgan escarpment is located to the east of Longwall 31, and is located outside the area defined by 26.5 degree angle of draw from the goaf edge. The layout of Longwalls 29 to 31 was specifically designed during mine planning to maximise resource recovery and minimise potential for impacting surface rock formations in the area and prevent disturbance to the Wolgan Escarpment.

An angle of draw of 26.5 degrees is generally accepted as effective protection of high cliffs against mining induced subsidence, however at Baal Bone an additional barrier has typically been included for reasons associated with mine geometry and the particular nature of individual cliff formations. An additional barrier has been provided to the Wolgan Escarpment adjacent to Longwall 31 because of the high significant of this feature. The size of the barrier was provided based on a review of previous barriers successfully used at Baal Bone Colliery to protect high cliff formations (SCT, 2008).

A review of protection barriers applied to previous longwalls at Baal Bone indicates that a barrier based on an angle of draw of 26.5 degrees plus 50 m would be consistent with barriers used successfully at Baal Bone to protect high cliff formations on previous occasions. With barriers of this size, there have been no perceptible impacts on the protected cliff formations, although it is recognised that a smaller barrier may also have been effective. An angle of draw of 26.5 degrees plus an additional barrier of 30 m is considered to provide a very conservative barrier against potential rock falls associated with nearby longwall mining (SCT, 2008). The northern pinch point has been protected with a barrier of 155 m from the top of the cliff, necessitating a reduction in width of Longwall 31 from the originally planned 250 m to 220 m. At the southern pinch point, the nature of the cliff formation in this area is such that a barrier of 145 m is considered sufficient to provide a very high level of protection.

It should however be noted, that the Wolgan Escarpment itself is the result of natural weathering processes that induce rock falls occasionally. The presence of barriers to protect the formation from longwall mining does not preclude the possibility of natural rock falls that may occur coincidentally prior to, during or following mining (SCT, 2007a).

Potential subsidence impacts were also considered in the layout of longwall panels on other significant surface rock pagoda formations. This included not mining within a 26.5 degree angle of draw of sandstone formations greater than 20 m high, and not mining directly under most other smaller formations (SCT, 2007a). No significant impact on these formations is expected. Mining of Longwalls 29 to 31 is not expected to significantly affect two pagoda formations at the southern end of Longwall 31 or an isolated boulder at the northern end of Longwall 31.

A general summary of previous experience of mining under cliff formations was undertaken by SCT (2007b) to describe the results of experienced at Baal Bone. Results indicated that a protection barrier of 26.5 degrees angle of draw is provided between longwall mining and sandstone cliff formations, the impacts of mining become imperceptible and a high level of protection is afforded to the cliff formations.

By realigning the longwall panels and adjusting their width, the Wolgan Escarpment and major sandstone cliff formations to the south have been afforded a high level of protection by design. Given that significant impacts to these surface features are not expected, there are not expected to be significant visual impacts associated with the mining of Longwalls 29 to 31. Ground subsidence impacts within bushland areas are not expected to be perceptible due to the nature of vegetation and topographic features. Therefore, visible impacts to surface features, apart from some surface cracking, are unlikely to result from underground mining induced impacts.

8.5.2 Infrastructure

Infrastructure which has the potential to be affected by subsidence from Longwalls 29 to 31 is limited to forestry access tracks, including a section of the Bicentennial National Trail. Although significant subsidence levels are predicted along some roads and trails, due to the incremental nature of the impact, the integrity of structures is not likely to be significantly affected. There is the possibility of surface cracks developing on some sections of the road surface; however previous experience at Baal Bone has shown that minor remedial earthworks are adequate to fill cracks which may develop. No public roads would be affected by subsidence. No significant impact on infrastructure as a result of subsidence is expected.

Baal Bone has prepared a Public Safety Management Plan for the area to ensure the safety of all persons using access tracks throughout the affected area. The Plan forms part of the SMP and includes the following:

- Identification of risks;
- Regular monitoring of the effects of mining;
- Regular assessment of monitoring and inspections;
- Immediate response and remedial measures, including immediate public notification;
- Reporting; and
- Reviewing.

The Plan provides a management program which identifies risks, nominates triggers, and provides an appropriate level of management action or response for the management of public safety in all surface areas affected by subsidence. The scope of the Plan includes subsidence related impacts on forest roads and access tracks, surface rock pagoda formations, the Wolgan Escarpment, watercourses and an Aboriginal rock shelter located within the Longwalls 29 to 31 area (refer to **Section 19**).

The SMP also contains a Land Management Plan, Subsidence Monitoring Program and Environmental Monitoring Program which each provide management programs and Trigger Action Response Plans (TARP) that allow for identification of impacts, nominate triggers, and provide management actions and responses for remediation and rehabilitation of surface features that might be affected by mining induced subsidence. Forest roads and access tracks, and surface rock formations including the Wolgan Escarpment are monitored and managed under the Land Management Plan. The monitoring schedule with the Land Management Plan includes inspection frequencies and responsibilities for various types of monitoring including visual, photographic, video and surveying.

8.5.3 Heritage

Potential impacts to Indigenous archaeological sites in the vicinity of Longwalls 29 to 31 are discussed in **Section 19** of this EA, and have previously been assessed by Ozark (2007). Two potential archaeological sites have been identified, including an isolated find considered to be of overall low significance and rock overhang with potential as an Aboriginal occupation site. The isolated find, a one-off drop artefact is not expected to be affected by subsidence.

The potential rock shelter comprises a rock overhang forming part of a significantly weathered rock formation, anticpated to be in the advanced stages of weathering. The rock shelter has the potential to be affected by subsidence-induced rock falls, although this is considered to have a less than 10% chance of occurring. The potential rock shelter is being managed in accordance with an Aboriginal Heritage Management Plan to monitor potential impacts during longwall mining in the vicinity.

TARPs within the Land Management Plan and the Public Safety Management Plan contain trigger levels for subsidence induced impact, and corresponding actions where subsidence impacts are greater than expected.

8.5.4 Watercourses

An analysis of predicted subsidence undertaken by SCT (2007a) and of hydrogeological impacts undertaken by Connell Wagner (2006) indicated (refer **Appendix G**) that impacts on ephemeral stream flows as a result of subsidence would be minor. A number of longitudinal profiles were analysed and based on maximum predicted subsidence. Based on these predictions, no in-channel or out-of-channel ponding of tributaries or creek lines is anticipated (Connell Wagner, 2006). Slopes are expected to change by less than 1.1%, and stream gradients are not likely to be significantly affected.

Subsidence is unlikely to significantly affect watercourses as a result of mining Longwalls 29 to 31.

8.5.5 Groundwater

Potential impacts of subsidence on groundwater are discussed in **Section 11** and **Appendix G** of this EA. The mining of Longwalls 29 to 31 is not expected to result in impacts to groundwater supply. Subsidence would result in fracturing of strata above the Lithgow Seam, and draining of aquifers contained within these strata; however drawdown is already expected in the area as a result of previous longwall mining and the incremental impact of Longwalls 29 to 31 is expected to be minimal.

8.5.6 Swamps, Wetlands and Water Dependent Ecosystems

The potential impact of changes to aquifers as a result of subsidence on swamps and other water dependent ecosystems was considered by Connell Wagner (2006) (refer **Appendix G**) in respect of mining of Longwalls 29 to 31. The Coxs River Swamp and Coxs River, while they lie outside the area affected by subsidence, are reliant on shallow aquifers as a source of water. Connell Wagner (2006) noted that subsidence effects including tilting, strains, and uplift have the potential to alter surface and groundwater flow directions and volumes, and sub-surface deformations may result in draining of aquifers potentially depriving reliant ecosystems of a source of water. These potential effects were considered, however it is concluded that the changes to the groundwater regime in the vicinity of the Coxs River Swamp as a result of mining induced subsidence was unlikely to have a significant impact on the swamp. Previous experience of mining Longwall 14 and 15 indicates that although there is a drawdown in the piezometric pressure within the rock strata below the swamp as a result of longwall mining, there is not likely to be a perceptible impact on the swamp or swamp vegetation.

A series of peizometers have been installed to monitor ground water levels in an around the swamp prior to, during and post mining. Details are provided in Section 11.

8.5.7 Flora and Fauna

Potential impacts to flora and fauna as a result of subsidence associated with Longwalls 29 to 31 have been considered in **Section 18**, and in **Appendices L** and **M**. Flora impacts are not anticipated given that vegetation units that are most susceptible to impacts of subsidence are not located within the affected area. Sensitive ecosystems such as heath and swamp communities have been avoided in the design of longwall panels to minimise potential impacts to these communities. Mining of Longwalls 29 to 31 is not expected to result in a detectable impact to vegetation units in the affected area.

As vegetation habitat areas are unlikely to be affected, fauna habitat and threatened fauna species are not likely to be affected by subsidence impacts from Longwalls 29 to 31.

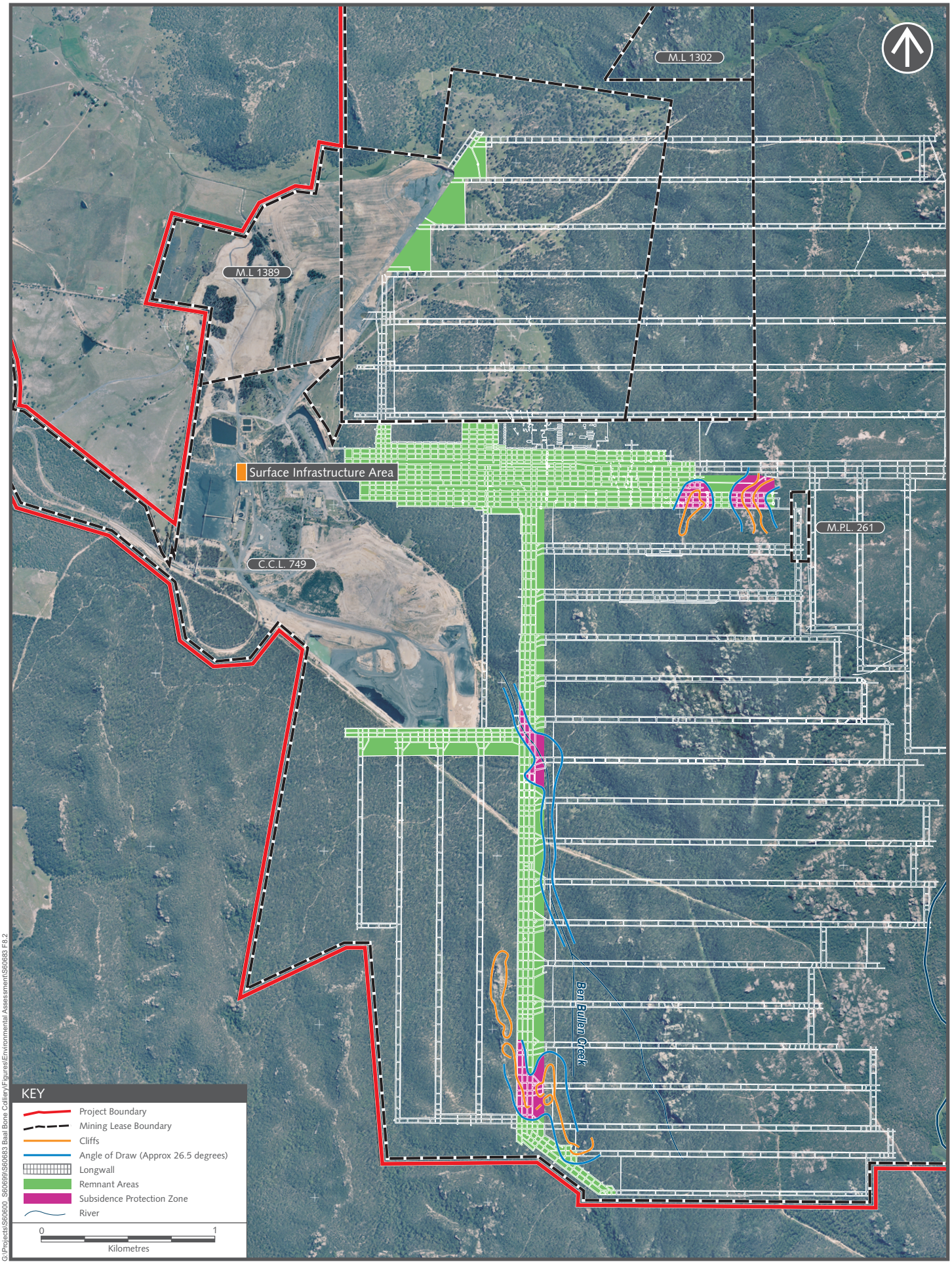
8.6 Remnant Areas – Subsidence Zones for Extraction Plan

Baal Bone has identified a number of Remnant Areas of coal within the existing workings in the Underground Mine Area. These predominantly include barrier pillars within the existing workings of Longwalls 1 to 28, which were not extracted as part of previous longwall mining campaigns. The proposed Remnant Areas are shown on **Figure 8.2**.

A review of potential subsidence impacts associated with the extraction of remnant pillars was undertaken by SCT (2009) (refer **Appendix C**). The Remnant Areas are located adjacent to existing longwall panels and subsidence has already occurred as result of mining these areas. Surface features overlying the Remnant Areas are similar to those overlying adjacent extracted longwall panels, however the tolerance of subsidence impacts on surface features has changed, and as such, mining of the Remnant Areas would need to be designed to manage surface subsidence in recognition of the surface features that may be affected by mining subsidence.

Surface features potentially impacted by subsidence include three areas where cliff lines would potentially be impacted and one area located some 40 m beneath Ben Bullen Creek. These surface features are shown on **Figure 8-2**. Extraction of remnant pillars underneath these four areas has the potential to cause subsidence impacts, primarily rocks falls from cliff formations, of a similar nature to that experienced with adjacent longwalls. It is possible that rock falls have already occurred directly over and immediately adjacent to the Remnant Areas due to the proximity of previously extracted longwall panels.

Surface cracking and cracking of overburden strata below Ben Bullen Creek is likely to have occurred during previous longwall mining, and would be expected if pillar extraction occurs directly beneath the creek.



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AECOM

REMNANT AREA SUBSIDENCE PROTECTION ZONES

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 8.2

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Remediation of surface cracking is likely to be an effective means of preventing direct ingress of surface flow due to the ephemeral nature of the Creek, however significant disturbance to surface vegetation would be required.

Extraction of the Remnant Areas would therefore need to be designed to minimise subsidence in order to minimise further impacts to the identified surface features, including falls from cliff formations and surface cracking impacts to Ben Bullen Creek.

In order to manage potential impacts on these identified sensitive surface features, including the three cliff formations and Ben Bullen Creek, from subsidence impacts, the likely areas of affectation would be protected from being directly mined under by an angle of draw of 26.5 degrees or greater. Subsidence protection zones surrounding each of these surface features have been identified and are shown on **Figure 8-2**, based on an angle of draw of 26.5 degrees. This angle of draw is considered to provide a high level of protection against surface subsidence impacts.

No significant surface features have been identified overlying the Remnant Areas outside the subsidence zones shown on **Figure 8-2.** As such, subsidence impacts are not anticipated to be significant through these areas. As discussed above, these areas are likely to have already experienced some subsidence impacts at the surface due to extraction of adjacent longwall panels. Maximum subsidence and surface impacts within the Remnant Areas would be expected to be similar to the maximum subsidence experienced over adjacent longwall panels, however it may be more irregular and vary depending on the extent and geometry of extraction areas and remnant pillars.

Mining layouts within the Remnant Areas would be designed to minimise surface subsidence. An Extraction Plan would be developed for all second workings within the Remnant Areas, and would incorporate predictions of conventional and non-conventional subsidence effects. Additionally, Subsidence Monitoring and Management Programs would be prepared and implemented for the Remnant Areas which would incorporate management and monitoring programs to minimise subsidence impacts.

8.7 Rehabilitation of Potential Subsidence Impacts

Potential subsidence impacts have been identified in **Sections 8.3** to **8.5**. Rehabilitation of these potential impacts include measures identified in the existing TARPs contained within the approved Land Management Plan, Environmental Monitoring Program and Subsidence Monitoring Program for the Baal Bone LW 29-31 SMP Area.

The identification and assessment of the degree of impact would be in accordance with the standards identified in the Land Management Plan, Environmental Monitoring Program and Subsidence Monitoring Program TARPs. The TARPs provide triggers for the severity or degree of the impact based on measurable parameters. A response can then be developed and appropriate mitigation or rehabilitation response implemented.

Trigger values and criteria for predicted potential subsidence impacts, and associated response times and rehabilitation methodologies, as contained within the currently approved TARPs (which are subject to periodic review), are outlined below in **Table 8-2**.

Table 8-2: Potential Subsidence Impacts, Response Times and Rehabilitation Methodologies

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Surface cracking / erosion on forest roads and access tracks	
Objectives	• Negligible impact on forest roads and access tracks, including: - Surface cracking less than 100 mm - No noticeable increase in erosion

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Minor Impact Trigger Values Surface cracking 100-200mm. Noticeable increase in level of recent rill erosion along track and/or table drains.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Note GPS location and orientation of cracking or erosion and photograph • Review public safety • Maintain warning signs, erect additional signs (where required) • Increase monitoring frequency (twice weekly) until satisfactorily remediated • Consultation with Departments to discuss/confirm level of action/remediation • Review of subsidence predictions, review monitoring program (if required) **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks by excavation, fill and/or grading, concrete and grout, and install drainage structures if required). • Review mine plan in consultation with Principal Subsidence Engineer.
Major Impact Trigger Values Surface cracking > 200mm. Perceived imminent threat to public safety from anomalous situation (ie. Adjacent mass movement, rock instability).	**Response** The response for a major impact would include those similar as above, in addition to the following: • Increase monitoring frequency (daily) until satisfactorily remediated or made safe • Site inspection by specialist soil conservationist. Departments to discuss/confirm level of action/remediation • Detailed review of subsidence predictions, review monitoring program **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks by excavation, fill and/or grading, concrete or grout, and install drainage structures if required. • Review mine plan in consultation with Principal Subsidence Engineer.
Surface cracking / rock falls on surface pagoda rock formations	
Objectives	• Negligible impact on surface features and rock formations, including: - Surface cracking up to 100 mm on flat horizontal shelf rock associated with northern end of pagoda formations within 26.5 degree angle of draw - No observable surface cracking on vertical surfaces associated with pagoda formations within 26.5 degree angle of draw - No areas of visible instability or threat to public safety - No areas of rock fall
Minor Impact Trigger Values Surface cracking 100-200mm on flat, horizontal shelf rock associated with northern end of	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Note GPS location and orientation of cracking or erosion and photograph

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
pagoda formations within AOD. Surface cracking up to 25mm on vertical surfaces associated with southern end of pagoda formations within AOD. Visible instability with potential threat to public safety. No areas of rock fall.	• Review public safety • Maintain warning signs, erect additional signs and barriers (where required) • Increase monitoring frequency (twice weekly) until satisfactorily remediated or made safe • Consultation with Departments to discuss/confirm level of action/remediation • Review of subsidence predictions, review monitoring program (if required) **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks and install erosion controls and surface/sub surface drainage systems. • Review mine plan in consultation with Principal Subsidence Engineer.
Major Impact Trigger Values Surface cracking > 200mm on flat, horizontal shelf rock associated with northern end of pagoda formations within AOD. Surface cracking > 25mm on vertical surfaces associated with southern end of pagoda formations within AOD. Visible instability with imminent threat to public safety. Rock fall.	**Response** The response for a major impact would include those similar as above, in addition to the following: • Increase monitoring frequency (daily) until satisfactorily remediated or made safe • Site inspection by expert structural and/or geotechnical engineer. Departments to discuss/confirm level of action/remediation • Detailed review of subsidence predictions, review monitoring program **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks and install erosion controls and surface/sub surface drainage systems. • Support and stabilise unstable areas in accordance with engineering advice. • Review mine plan in consultation with Principal Subsidence Engineer.
Wolgan Escarpment	
Objectives	• No impact on the Wolgan Escarpment, including: - No observable surface cracking in the area between 26.5 degree angle of draw and the edge of the Wolgan Escarpment - No areas of observable damage or instability - No evidence of rockfall
Major Impact Trigger Values Any damage to the Wolgan Escarpment will be considered a major impact. Visible surface cracking of any size in area between 26.5 degree AOD and edge of escarpment. Areas of observable damage or instability. Evidence of recent rockfall.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours; • Prepare for immediate suspension of longwall mining operations; • Note GPS location and orientation of anomaly and photograph; • Review public safety; • Increase monitoring frequency to daily until area has satisfactorily been made safe; • Maintain warning signs, erect additional signs and barriers (where required);
	• Site inspection by expert structural and/or geotechnical engineer. Departments to discuss/confirm level of action/remediation;

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
	• Undertake detailed review of subsidence predictions, review monitoring program and consult with Principal Subsidence Engineer. **Rehabilitation Methodology** • Implement stabilisation and/or remediation works (if practicable) in accordance with advice from appropriate authorities and specialist consultants; • Review mine plan and options for continued mining in consultation with Principal Subsidence Engineer.
Surface cracking, mass movement, mining induced erosion in other general areas	
Objectives	• Negligible impact on surface features and other general areas, including: - Surface cracking up to 100 mm on surface features - No evidence of mass movement or slumping - No evidence of accelerated rill or gully erosion
Minor Impact Trigger Values Surface cracking 100-200mm. Some minor areas of mass movement or slumping can be observed (<100m^2.). Surface rilling to a depth < 300mm.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Note GPS location and orientation of anomaly and photograph • Review public safety • Maintain warning signs, erect additional signs and barriers (where required) • Increase monitoring frequency (twice weekly) until satisfactorily remediated • Consultation with Departments to discuss/confirm level of action/remediation • Undertake detailed review of subsidence predictions, review monitoring program and consult with Principal Subsidence Engineer. **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks by excavation, fill and/or grading, concrete or grout, and install drainage structures if required. • Review mine plan in consultation with Principal Subsidence Engineer.

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Major Impact Trigger Values Surface cracking > 200mm. Large areas of mass movement or slumping identified (>100m2.). Surface rilling and/or gullying to a depth > 300mm.	**Response** The response for a major impact would include those similar as above, in addition to the following: • Increase monitoring frequency (daily) until satisfactorily remediated or made safe • Site inspection by specialist soil conservationist. Departments to discuss/confirm level of action/remediation • Undertake detailed review of subsidence predictions, review monitoring program and consult with Principal Subsidence Engineer. **Rehabilitation Methodology** • Following consultation with appropriate authorities and specialists, and in accordance with the appropriate Management Plan, repair cracks by excavation, fill and/or grading, concrete or grout, and install drainage structures if required. • Review mine plan in consultation with Principal Subsidence Engineer.
Surface cracking / rock falls in Aboriginal rock shelter (BBC-RS1)	
Objectives	• Negligible impact on known Indigenous heritage sites within the Project Area, including: - No areas of visible instability resulting in threats to public safety
Minor Impact Trigger Values Minor cracking (<50mm) and/or widening of existing joints. Visible instability with potential threat to public safety. No areas of roof fall.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Note GPS location and orientation of anomaly (if applicable) and photograph • Review public safety • Erect warning signs and barriers (if required) • Increase monitoring frequency (twice weekly) until area has been satisfactorily made safe • Meeting with Aboriginal Heritage Working Group (AHWG) to review monitoring results and discuss options for ongoing management of the site in a culturally appropriate manner **Rehabilitation Methodology** • Initiate management procedures and/or remedial/stabilisation works if required following meeting with AHWG.
Major Impact Trigger Values Cracking or joint widening >50mm Visible instability with imminent threat to public safety. Observed areas of roof fall.	**Response** The response for a major impact would include those similar as above, in addition to the following: • Increase monitoring frequency (daily) until area has been satisfactorily made safe • Site inspection by expert structural and/or geotechnical engineer. Consultation with appropriate Departments (including AHWG to discuss/confirm level of action/remediation in a culturally appropriate manner **Rehabilitation Methodology** • Initiate management procedures and/or remedial/stabilisation works if required following meeting with AHWG.

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Impact on surface watercourses (visual observations)	
Objectives	• Negligible impact on the quantity and quality of surface waters, including: - Bed cracking up to 50 mm - No observable change to stream flow characteristics - No evidence of change to watercourse morphology and/or stability - No visible change to water quality, instream aquatic ecology and/or riparian vegetation
Minor Impact Trigger Values Bed cracking 50-100mm, or any crack where water is seen to disappear. Minor areas of localised bank slumping or instability can be observed (<100m2). Localised, minor levels of turbidity, iron staining and/or water discolouration in watercourse. Some evidence of localised and/or short term (< 4 weeks) impact (ie. reduced health / vigour) of individual aquatic and/or riparian species which are not related to climatic conditions or other external factors.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Note GPS location and orientation of anomaly (if applicable) and photograph • Review public safety • Maintain warning signs, erect additional signs • Review standing water levels and water quality parameters in nearby groundwater monitoring bores • Consultation with landholder (Forests NSW) and relevant government agencies to discuss/confirm level of action/remediation required • Undertake detailed review of subsidence predictions, review monitoring program and consult with Principal Subsidence Engineer. **Rehabilitation Methodology** • Repair cracks by excavation, fill and grading or concrete grout with program approved by Forests NSW.
Major Impact Trigger Values Bed cracking > 100mm. Large areas of mass movement or slumping identified (>100m2.). Widespread and/or significant levels of turbidity, iron staining and/or water discolouration in watercourse. Existence of iron-oxidising bacterial mats/blooms. Widespread and/or longer term (>4 weeks) impact (ie. mortality / dieback) of instream aquatic ecology and/or riparian communities which are not related to climatic conditions or other external factors.	**Response** The response for a major impact would include those similar as above, in addition to the following: • Site inspection by hydrogeologist and/or aquatic ecologist. Consultation with appropriate Departments (including landholder, Forests NSW) to discuss/confirm level of action/remediation. • Undertake detailed review of subsidence predictions, review monitoring program and consult with Principal Subsidence Engineer. **Rehabilitation Methodology** • As per agreed recommendations from hydrogeologist and/or aquatic ecologist, other expert consultants and relevant Government Departments. Initiate engineering solution as approved; eg. repair cracks by excavation, fill, compaction and grading or concrete grout.
Impact on deeper groundwater aquifer	
Objectives	• Negligible impact on deep water aquifers, including: - No significant long term change in groundwater levels, as detailed in the Surface and Groundwater Response Strategy

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Minor Impact Trigger Values Groundwater level shows anomalous trend (groundwater level change >1 metre over a period of 6 months) and is outside the normal level range or expected response to climatic conditions. Minor to moderate level of change* in groundwater quality for two consecutive months in a number of boreholes: pH < 4.6 EC > 300uS/cm Cu > 0.041 mg/L Fe > 15.25 mg/L Zn > 0.143 mg/L * 50th percentile does not exceed baseline 80th percentile (Aurecon 2009)	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Undertake field inspection. • Resample relevant bores within 96 hours. • Data review by hydrogeologist, geochemist and other expert consultants as required. • Discuss/confirm appropriate level of action/remediation with relevant Departments **Rehabilitation Methodology** • As per agreed recommendations, if required.
Major Impact Trigger Values Anomalous trend continues or worsens (groundwater level change >10 metres over a 6 month period) and is well outside the normal level range or expected response to climatic conditions.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • For water quality triggers, review data for BBP4 (background monitoring bore). If this value is above its 80th percentile, data for BBP1, BBP2, BBP3, BBP5 and BBP6 should be corrected in accordance with procedure detailed in Section 3.1 of Aurecon 2009
Major level of change in groundwater quality** for more than two consecutive months in a number of boreholes, viz: pH < 4.2 EC > 300 uS/cm Cu > 0.043 mg/L Fe > 24.26 mg/L Zn > 0.175 mg/L ** 50th percentile exceeds baseline 80th percentile by two standard deviations (Aurecon 2009)	• If values still exceed trigger levels, resample all bores within 48 hours. • Field inspection and site meeting. • Undertake detailed review process with hydrogeologist, geochemist, other expert consultants and relevant Government Department to determine appropriate actions. • Review mine plan in consultation with Principal Subsidence Engineer. **Rehabilitation Methodology** • As per agreed recommendations from hydrogeologist, other expert consultants and relevant Departments. Utilise engineering solutions (if anomalous trends are noted in swamp).
Impact on shallow (swamp) groundwater aquifer	
Objectives	• Negligible impact on shallow water aquifers, including: - No significant long term change in groundwater levels, as detailed in the Surface and Groundwater Response Strategy

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
Minor Impact Trigger Values Groundwater level shows anomalous trend (groundwater level change >0.5 metre over a period of 6 months) and is outside the normal level range or expected response to climatic conditions. Minor to moderate level of change* in groundwater quality for two consecutive months in a number of boreholes, viz: pH < 4.6 EC > 300uS/cm Cu > 0.041 mg/L Fe > 15.25 mg/L Zn > 0.143 mg/L * 50th percentile does not exceed baseline 80th percentile (Aurecon 2009)	**Response** *As per impact on deep aquifer* **Rehabilitation Methodology** • As per agreed recommendations from hydrogeologist, other expert consultants and relevant Departments.
Major Impact Trigger Values Anomalous trend continues or worsens (groundwater level change >2 metres over a 6 month period) and is well outside the normal level range or expected response to climatic conditions, loss of some swamp vegetation. Major level of change in groundwater quality** for more than two consecutive months in a number of boreholes, viz: pH < 4.2 EC > 300 uS/cm Cu > 0.043 mg/L Fe > 24.26 mg/L Zn > 0.175 mg/L ** 50th percentile exceeds baseline 80th percentile by two standard deviations (Aurecon 2009)	**Response** *As per impact on deep aquifer* **Rehabilitation Methodology** • As per agreed recommendations from hydrogeologist, other expert consultants and relevant Departments. • Water diversion into swamp, consider other engineering solutions (if condition is due to subsidence damage).
Impact on floral communities	
Objectives	• Negligible impact on the ecology of the Project Area, including flora species, communities and habitats; - No unseasonal changes in flora species population, composition and health
Minor Impact Trigger Values Significant decline in condition / health, decline in population numbers compared with	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Undertake field inspection and site meeting

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
baseline monitoring; not related to climatic conditions or other external factors.	• Additional and/or more frequent monitoring. • Obtain opinion from expert ecologist • Discuss/confirm appropriate level of action/remediation with relevant Departments **Rehabilitation Methodology** • As per agreed recommendations from ecologist, other expert consultants and relevant Departments.
Major Impact Trigger Values Major dieback of flora compared to baseline monitoring (not related to climatic conditions or other external factors). Significant changes in species diversity.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Undertake field inspection & site meeting • Additional and/or more frequent monitoring. • Detailed review process with ecologist, other expert consultants and relevant Department to determine appropriate actions
	• Review mine plan in consultation with Principal Subsidence Engineer. **Rehabilitation Methodology** • As per agreed recommendations from ecologist, other expert consultants and relevant Departments. • Initiate engineering solution as approved.
Impact on faunal communities	
Objectives	• Negligible impact on the ecology of the Project Area ,including fauna species, communities and habitats; - No unseasonal changes in fauna species population, composition and health
Minor Impact Trigger Values Decline in population numbers and/or species diversity compared with baseline monitoring; not related to climatic conditions or other external factors.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Undertake field inspection & site meeting • Additional and/or more frequent monitoring. • Obtain opinion from expert ecologist/zoologist • Discuss/confirm appropriate level of action/remediation with relevant Departments **Rehabilitation Methodology** • As per agreed recommendations from ecologist, other expert consultants and relevant Departments.
Major Impact Trigger Values Significant reduction in species diversity or change in species composition compared to baseline monitoring; not related to climatic conditions or other external factors.	**Response** • Notify Principal Subsidence Engineer and other relevant stakeholders within 24 hours. • Undertake field inspection & site meeting • Additional and/or more frequent monitoring. • Detailed review process with ecologist/zoologist, other expert consultants and relevant Department to determine appropriate actions • Review mine plan in consultation with Principal Subsidence Engineer.

Potential Impact / Trigger	Response Times and Rehabilitation Methodologies
	Rehabilitation Methodology • As per agreed recommendations from ecologist, other expert consultants and relevant Departments. • Initiate engineering solution as approved.

8.8 Environmental Safeguards

8.8.1 Longwalls 29 to 31 Subsidence Monitoring Program

A Subsidence Monitoring Program has been prepared as part of the SMP approval requirements for Longwalls 29 to 31. The program includes detailed survey and scientific monitoring which would be undertaken prior to, during and following the mining of Longwalls 29 to 31. Survey and monitoring includes the following:

- Three-dimensional subsidence monitoring of:
  - Tilt, strain and angle of draw along a number of survey lines perpendicular and parallel to longwall panels and the escarpment;
  - An array of semi-permanent glass prisms/reflectors located along the edge of the Wolgan Escarpment adjacent to the northern and southern pinch points;
  - The Wolgan Gap Trigonometrical Station;
  - A series of reflective prisms or targets on various points on the exterior, floor material and in the vicinity of the potential rock shelter and on selected pagoda rock type formations;
- Horizontal stress changes in the cliff forming sandstones of the Wolgan Escarpment using stress change monitoring instruments; and
- Temperature changes in the rock formation as a basis for understanding thermal stress changes.

In addition, the Land Management Plan addresses management of surface impacts including surface cracking and erosion on roads and tracks, rock falls and surface cracking in the vicinity of the Wolgan Escarpment and pagoda formations and surface cracking in other general surface areas. Visual inspections, plus photographic and video monitoring would continue to be conducted over the surface area at regular intervals during mining of the longwall panels.

8.8.2 Remnant Areas Extraction Plan

The review of surface features overlying the Remnant Areas undertaken by SCT (2009) (**Appendix C**) identified that sensitive surface features including three cliff lines and Ben Bullen Creek would be afforded a high level of protection if these features are protected from being directly undermined by an angle of draw of 26.5 degrees or greater. Other subsidence impacts would be able to be sufficiently managed through preparation of a Subsidence Management Plan, and preparation of an Extraction Plan. An Extraction Plan would be prepared and implemented for all second workings in the Remnant Areas. This plan would be approved by the Director-General before the Proponent is allowed to carry out the second workings covered by the Extraction Plan, and would include:

- A detailed plan for the second workings, which has been prepared to the satisfaction of DII, and provides for adaptive management for the identified Remnant Areas;
- Detailed plans of associated surface construction works;
- The following to the satisfaction of DII:
  - a coal resource recovery plan that demonstrates effective recovery of the available resource;
  - revised predictions of the conventional and non-conventional subsidence effects and subsidence impacts of the extraction plan, incorporating relevant information that has been obtained; and
  - a Subsidence Monitoring Program to:
    - validate the subsidence predictions; and
    - analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and ensuing environmental consequences.

8.9 Conclusion

It is considered that the previous predictions for potential subsidence impacts for mining operations at Baal Bone for Longwalls 29-31 are conservative and within the parameters of previous subsidence experience at the Colliery. Consequently, the potential impacts upon the Wolgan Escarpment, other surface rock formations, ecology, heritage items, infrastructure, watercourses, groundwater and water dependent ecosystems outside the angle of draw of Longwalls 29-31 is expected to be minimal.

The layout of Longwalls 29 to 31 has been designed based on previous mining experience at the site, monitoring results, and geotechnical subsidence recommendations to maximise resource recovery while at the same time avoiding sensitive surface features including the Wolgan Escarpment, Coxs River Swamp and other sensitive surface features. To afford the Wolgan Escarpment an even higher degree of protection, the total void width of Longwall 31 panel was subsequently reduced to 220 m. This provides a protection barrier between Longwall 31 and the Wolgan Escarpment equivalent to 26.5 degrees angle of draw plus an additional 30 m. A long history of subsidence monitoring has been established at Baal Bone and there is a high level of confidence that the proposed design will not result in significant impacts or significant cumulative impacts.

Maximum subsidence as a result of extraction of the Remnant Areas is expected to be similar to maximum subsidence experienced over adjacent longwall panels. Surface features have been identified overlying the Remnant Areas which require protection from subsidence impacts, including three areas of cliff formations and a section of Ben Bullen Creek. Subsidence protection zones have been developed based on an angle of draw of 26.5 degrees. These protection zones are considered to provide a high level of protection against subsidence impacts. Subsidence would be minimised through the mine layout and development of an Extraction Plan within these Remnant Areas.

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9.0 Noise

9.1 Existing Environment

The primary sensitive noise receptors close to the Project Area are three residential dwellings located north-north west of the Surface Infrastructure Area, and a further three residential receivers located further to the east of the Project Area. A sensitive receptor is defined by DECCW as anywhere someone works or resides or may work or reside, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar.

The sensitive receptors located near the Surface Infrastructure Area include:

- Receptor 1 (R1) – 'Muldoon' Residence (Lot 95 DP 755759, Ben Bullen);
- Receptor 2 (R2) – 'Speirs' Residence (Lot 4 DP 734531, Ben Bullen); and
- Receptor 3 (R3) – 'Desch' Residence (Lot 3 DP 734531, Ben Bullen).

The existing noise environment at sensitive receptors is currently influenced by noise from activities occurring within the Surface Infrastructure Area, as well as traffic noise from the Castlereagh Highway, and other domestic and rural noise sources. Current mining operations at Baal Bone are underground and, as such, do not directly contribute noise to sensitive receivers at the surface. Receptor locations R1 and R2 are considered to be representative of the background noise levels at receptor R3, and as such, noise measurements have not been undertaken at R3. Operations at Baal Bone pre-date the construction and occupation of these nearby residences.

The three residential receivers located further to the east of the Project Area in the Wolgan Valley have the potential to be affected by noise emissions from the south east ventilation shaft within the Underground Mining Area, near Longwalls 29 to 31. These receptors are identified for the purposes of this assessment as:

- Receptor 6 (R6);
- Receptor 7 (R7); and
- Receptor 8 (R8).

The location of each of the sensitive noise receptors is shown on **Figure 9-1**.

A noise impact assessment predicting impacts from the south east ventilation shaft on R6, R7 and R8 was undertaken by Heggies (2007) as part of an Environmental Assessment (Umwelt, 2007) prepared for the construction and operation of the south east ventilation shaft and powerline corridor (MP 07_0035). Noise modelling for these receptors predicted that noise emissions from the ventilation shaft would not be discernable at these receptors. A Project Approval was issued for MP 07_0035 on 24/10/2007. Noise emissions from the south east ventilation shaft are managed in accordance with noise limits set out in Baal Bone's EPL. Compliance monitoring was undertaken at R6 during both construction and following commencement of operation of the south east ventilation shaft. This monitoring confirmed noise emissions were well below limits set by the Project Approval and specified in the EPL. Operational emissions were below levels specified in the DECCW's *Industrial Noise Policy* (INP).

Given noise modelling predicted no discernable noise impacts at receptors R6, R7 and R8, noise emissions at these receptors are not assessed further in this EA.

9.2 Noise Assessment Methodology

Atkins Acoustics was engaged by AECOM to undertake a noise assessment for current activities occurring at the Surface Infrastructure Area in order to identify current and predicted noise impacts at sensitive receptors R1 and R2, from operations at the site. The noise assessment is presented in **Appendix E**.

The methodology adopted for the noise assessment is as follows:

- Inspections of the Surface Infrastructure Area and surrounds;
- Site attended noise audit measurements at nearby representative residential receivers (R1 and R2);
- Unattended noise monitoring and assessment of existing ambient noise levels at representative residential receivers (R1 and R2);
- Establishment of target noise assessment goals in accordance with DECCW's NSW *Industrial Noise Policy* (INP) (DEC, 1999) and DECCW's *Noise Guide for Local Government* (NGLG) (DECC, 2009); and
- Assessment of operational noise levels against target noise assessment goals.

A review of potential traffic noise impacts has also been undertaken in **Section 9.5**.

9.2.1 Local Meteorological Conditions

Meteorological data demonstrates that the area is subject to seasonal prevailing winds and temperature inversions. It is recognised that the effects of these meteorological conditions can enhance or reduce noise propagation and noise perceived at distant receptors.

In the near field, wind has only a minor influence on measured down wind sound levels. Wind effects become more important as distances increase. Depending on wind speed and distance from a noise source, up wind noise measurement levels compared to down wind conditions can vary by over ±10dB(A). Temperature gradients create similar enhancement effects to wind, however the effects are generally less than wind effects and uniform in all directions.

It was concluded that F stability class conditions (moderate temperature inversions) are a feature of the area. As a result, noise predictions under temperature inversion conditions are considered in the operational noise modelling.

Wind data compiled for annual and seasonal wind conditions for day, evening and night assessment periods (refer **Appendix E**) demonstrate that south westerly winds (winds blowing away from the receivers) are a feature of the area. Accordingly, noise modelling for adverse wind condition was not required for assessing noise referenced to the residential receptor locations.

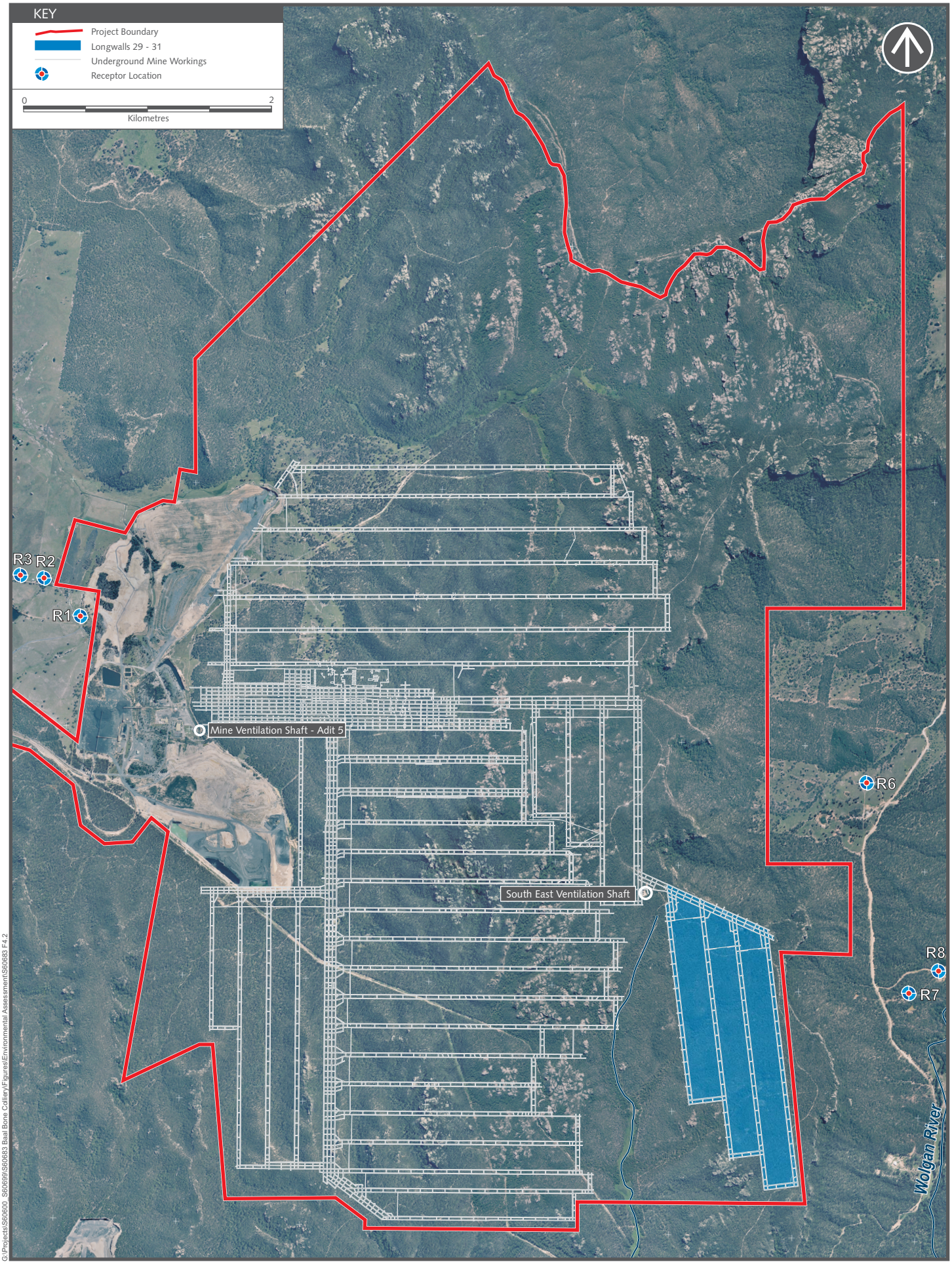
9.2.2 Background Noise Monitoring

Background noise monitoring was undertaken on two occasions to obtain background noise levels, or Rating Background Level (RBL), at two of the sensitive receptor locations, R1 and R2. The noise monitoring locations selected to install unattended noise loggers and undertake site attended audits were R1 and R2. R3 was not selected as it was concluded that R1 and R2 would be representative of maximum noise levels at R3.

The two occasions are representative of two different operational scenarios at the Surface Infrastructure Area:

- Scenario 1 – CHPP not operational; and
- Scenario 2 – All equipment and plant within Surface Infrastructure Area fully operational.

Unattended noise monitoring results are shown in **Table 9-1** below. In the table, the RBL is described by the L_{A90} descriptor, which represents the A-weighted sound pressure that is exceeded for 90% of the sound measurement period, and is considered to represent the background noise level. The Equivalent Continuous Level is described by the L_{Aeq} noise descriptor, and represents the average noise level occurring over a measurement period.



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SENSITIVE NOISE RECEPTOR LOCATIONS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 9.1

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Table 9-1: Measured RBL and LAeq Noise Levels (dB(A))

Receptor Location	Rating Background Level (RBL) L_{A90}			Equivalent Continuous Level L_{Aeq}		
	Day	Evening	Night	Day	Evening	Night
Scenario 1						
R1 – Muldoon Residence	29	32	32	43	42	42
R2 / R3 – Speirs and Desch Residences	32	33	33	49	43	42
Scenario 2						
R1 – Muldoon Residence	32	34	37	44	47	43
R2 / R3 – Speirs and Desch Residences	32	34	36	44	45	43

The results of attended noise measurements undertaken approximately 100 m south of receptor R1 during Scenario 2 (a worst case scenario) are presented in **Table 9-2**. Prevailing weather conditions were clear with light west wind drift.

Table 9-2: Attended Audit Measurement Results dB(A) – Scenario 2

Receptor Location	Measured Noise Levels (dB(A))				Calculated Noise Contribution $L_{Aeq15min}$	Comments
	L_{Aeq}	L_{A90}	L_{A10}	L_{Amin}		
R1 – Muldoon Residence	45.8	41.4	48.6	36.6	46	Mine operations clearly audible, notable dozer working on product stockpile at exposed and elevated position.
R2 / R3 – Speirs and Desch Residences	37.3	35.3	38.8	34.4	37	Dozer engine and tracks audible. Bird noise also audible.

Observations during attended monitoring events confirmed ambient noise levels were influenced by road traffic on Castlereagh Highway/Mudgee Road, natural elements and occasional domestic activities. The primary source of noise audible from the surface infrastructure area was a dozer operating on the coal stockpile area.

9.2.4 Noise Emission Sources

Plant and equipment operated within the Surface Infrastructure Area which generate noise emissions include:

- CHPP (including Bradford Breaker and washery plant);
- Mobile plant including front end loader and bulldozer operating on the product coal stockpiles;
- Mobile plant operating in the Reject Emplacement Area;
- Conveyors; and
- Ventilation shaft – Adit 5.

9.3 Noise Assessment Criteria

9.3.1 Project Assessment Noise Goals

For existing industrial premises established prior to residential development, the DECCW INP provides guidelines for assessing and managing environmental noise. As the residential receptors R1, R2 and R3 were constructed and occupied following commencement of operations at Baal Bone, these guidelines are relevant to the Project.

For industries established before noise sensitive development occurs in close proximity, the INP recognises that the range of mitigation measures available to reduce noise from the industry may be limited and/or not feasible or practical. The three residential receptors proximate to Baal Bone were established after operation at the Colliery had commenced.

The INP provides two separate noise criteria to meet environmental noise objectives, one to account for intrusive noise and the other to protect the amenity of particular land uses. The INP recommends that the more stringent of the two criteria be applied as the relevant project noise assessment goal.

For assessment of intrusive noise, the INP recommends that the $L_{Aeq,15min}$ source noise should not exceed the RBL by more than 5dB(A).

The assessment goal for preservation of amenity requires noise levels to be within the acceptable levels for the locality and land use. Acceptable noise levels for different land use types are provided in the INP. The amenity criteria relate only to industrial-type noise. If levels approach the criterion value, then consideration should be given to ensure that cumulative effects do not produce noise levels that would significantly exceed the criterion.

Table 9-3 presents a summary of the INP intrusive and amenity assessment goals.

Table 9-3: Operational Noise Assessment Goals dB(A)

Period	Existing RBL	Existing $L_{Aeq, period}$ Noise Level	Amenity $L_{Aeq, period}$ Noise Criterion	Intrusive Criterion $L_{Aeq, 15min}$ Noise Level
R1 – Muldoon Residence				
Day	29	43	50-55	35
Evening	32	42	45-50	37
Night	32	42	40-45	37
R2 / R3 – Speirs / Desch Residences				
Day	32	49	50-55	37
Evening	33	43	45-50	38
Night	33	42	40-45	38

Notes: Daytime: 7am to 6pm Monday to Saturday, 8am to 6pm Sunday and Public Holidays
Evening: 6pm to 10pm
Night: 10pm to 7am Monday to Saturday, 10pm to 8am Sunday and Public Holidays
* In accordance with INP procedures (Section 3.1.2) if the RBL is <30dB(A), then it is set to 30dB(A)

Table 9-3 indicates that the most stringent noise criteria are the intrusive criteria, which is presented as the Project Assessment Goal. The intrusive criteria have been used for the purposes of the noise assessment.

9.3.2 Night Time Disturbance

The NGLG aims to provide practical guidance in the management of local noise issues and in the interpretation of existing policy and legislation. It focuses on how to assess and manage noise issues such as neighbour-to-neighbour problems and those resulting from commercial or industrial premises (DECC, 2009).

As the Colliery operates 24 hours a day, there is potential for noise to be emitted during night-time hours that could give rise to sleep disturbance. To avoid possible disturbance during night hours, the NGLG recommends that the A-weighted sound pressure level that is exceeded for 1% of the time over a 1 minute time period ($L_{A1,1min}$ noise levels) when assessed outside a bedroom window, should not exceed the background L_{A90} noise level by more than 15dB(A).

As such, the target assessment noise goals recommended for assessing intermittent noise during night time hours (10.00 pm to 7.00 am) are 47dB(A) and 48dB(A) at receptor locations R1 and R2/R3 respectively.

9.4 Operational Noise Assessment

9.4.1 Predicted Operational Noise Levels

Operational noise from the Colliery, including emission sources identified above has been predicted using the Environmental Noise Model.

The model takes account of noise attenuation due to distance separation, ground effect, atmospheric absorption, shielding from intervening structures and topography. Atmospheric conditions assumed for the noise modelling included calm conditions with 20°C air temperature and 80% relative humidity. Additional weather conditions considered for noise modelling included stability class F 3°C/100m temperature inversion.

Plant and equipment sound power levels adopted for the noise modelling are detailed in **Appendix E**. From these sound power levels it was concluded that predominate sources of noise were the CHPP (Bradford Breaker) and the dozer operating on the product coal stockpile.

The predicted noise levels at the residential receptors R1 and R2/R3 are shown in **Table 9-4**. The predicted noise levels have been presented both with and without the dozer operating on the product coal stockpile area, given that the dozer does not operate continuously, or generally after 10.00 pm. Furthermore, the dozer was previously identified during attended background noise measurements as a dominant source of noise emissions from the Surface Infrastructure Area. Predicted noise levels concluded that operational noise levels without the dozer are generally lower by some 3 dB(A) than operational noise levels with the dozer.

Table 9-4: Predicted Operational Noise Levels $L_{Aeq(15min)}$ dB(A)

Receptor Location	Project Assessment Noise Goal $L_{Aeq15min}$			Predicted $L_{Aeq15min}$ Sound Pressure Level	
	Day	Evening	Night	Without Dozer	With Dozer
Operational Noise – Calm Meteorological Conditions					
R1 – Muldoon Residence	35	37	37	43	46
R2 / R3 – Speirs / Desch Residences	37	38	38	38	41
Operational Noise – Temperature Inversion (night time only)					
R1 – Muldoon Residence	-	-	37	48	51
R2 / R3 – Speirs / Desch Residences	-	-	38	43	46

The noise predictions assume all plant and equipment is operating simultaneously. Whilst it is unlikely that all plant and equipment would be operating simultaneously all of the time, the noise modelling represents the likely worst-case operating scenario.

For assessing intermittent noise during night hours, the modelling considered noise emissions from the washery plant at the CHPP. The predicted noise levels at the residential receptors are summarised in **Table 9-5**.

Table 9-5: Predicted Intermittent Noise Levels - Night $L_{A1, 1min}$ dB(A)

Reference Location	Assessment Noise Goal $L_{A1,1min}$	Predicted Noise Level $L_{A1,1min}$
R1 - Muldoon Residence	47	42
R2 / R3 – Speirs / Desch Residences	48	39

Table 9-5 indicates that the predicted night time noise levels comply with NGLG assessment noise goals.

9.4.2 Potential Low Frequency Noise

An assessment of the potential for low frequency noise was undertaken as part of the noise assessment prepared for the Project. Low frequency noise is identified in the DECCW INP as a noise source containing acoustic energy within the frequency range between 20 Hz and 250 Hz. The INP recommends that where that difference between the measured / assessed C- and A- weighted sound pressure levels is 15 dB or more, the noise source is classified as low frequency.

For the purposes of assessing low frequency noise from the Surface Infrastructure Area, attended noise audits were conducted at R1 on 18 November 2009. Audible noise sources identified included the washery plant, breaker plant, a dozer working on the coal product stockpile, road traffic noise and natural elements.

The audit measurements confirmed the difference between the LCeq,15 min (measured as 53.8 dBC) and LAeq,15min (measured as 39.6 dBA) was 14.2 dB. This difference is less than 15 dB and as such low frequency noise is not considered to be a characteristic of noise emissions from the Project.

9.5 Traffic Noise Assessment

9.5.1 Road Traffic Noise

The transportation route for road haulage of coal from Baal Bone requires that all trucks travel from the Surface Infrastructure Area along the private Colliery access road to the intersection with the Castlereagh Highway. The trucks then turn left and travel south along the Castlereagh Highway to Boulder Road (for coal deliveries to Mount Piper Power Station, 9.9 km from Baal Bone) or directly to the Wallerawang Power Station coal receival entry (approximately 18 km from Baal Bone). A minor quantity of coal is periodically transported to other domestic destinations by road beyond the power stations.

The transportation of coal from the Colliery is permitted to occur between 7am and 7pm Monday to Saturday. No coal is permitted or is proposed to be transported on Sundays or public holidays.

An assessment of road traffic noise impacts associated with coal haulage from Baal Bone at residences in Cullen Bullen along the Castlereagh Highway was undertaken for a Statement of Environmental Effects (SEE) (Corkery, 1998) accompanying the development application for an increase in coal haulage from 0.5 Mtpa to 1.5 Mtpa (DA 164/98). The SEE identified that the incremental increase in noise associated with raising transport volumes from 0.5 Mtpa to 1.5 Mtpa would be between 0.2 and 0.8 dBA. This is below levels specified in DECCW's Environmental Criteria for Road Traffic Noise (ECRTN) which states that traffic arising from land use developments with potential to create additional traffic on existing freeways or arterial roads should not lead to an increase in existing noise levels of more than 2 dB.

The SEE concluded that road haulage of 1.5 Mtpa would not result in perceptible impacts to residential amenity at residences along on the Castlereagh Highway. Given the maximum level of transport of coal from Baal Bone would be 900000 tpa, which is considerably less than the 1.5 Mtpa assessed above, the incremental increase in road traffic noise is expected be less than 0.8 dBA, should haulage of up to 900000 tpa recommence. Furthermore, Annual Average Daily Traffic (AADT) volumes along the Castlereagh Highway have reduced in recent times (refer to **Section 14.5.1**), therefore cumulative noise impacts are not anticpated. It is also noted that vehicles used for coal haulage have also likely improved with respect to noise emissions. Therefore, the conclusions of the SEE (Corkery, 1998) are considered to provide a conservative assessment of the likely noise impacts of road haulage on sensitive receivers along the haulage route to local power stations.

A modification to DA 164/98 was sought in 2003 to continue road haulage of coal to local power stations. Development consent was granted, for the continued road haulage of coal. As a condition of the modified development consent (DA 164/98 as modified), a Road Haulage Management Plan (RHMP) was to be prepared. The key components of the RHMP included the assessment of noise impacts on dwellings associated with trucks travelling to and from Baal Bone and the implementation of reasonable noise mitigation works on properties adversely impacted by road haulage noise directly attributable to the Baal Bone operations. This RHMP has largely been implemented in the vicinity of Cullen Bullen due to the close proximity of residences to the Castlereagh Highway and their exposure to noise emanating from the coal haulage trucks from Baal Bone.

In compliance with the requirements of DA 164/98, Baal Bone commissioned noise monitoring and acoustic modelling studies, and undertook inspections of residences in Cullen Bullen. Reports were prepared by Acoustic Logic Consultancy Pty Ltd (10 May 1999) and Heggies Pty Ltd (22 March 2001), both of which included noise mitigation strategies for nominated residences. Noise insulation works were progressively undertaken at a number of the residences identified in the reports.

The status and effectiveness of the noise mitigation works previously installed was reviewed in 2007 and this review confirmed that these residents of Cullen Bullen did not generally have ongoing concerns with trucks hauling coal from Baal Bone. The review stated that all but four identified residences had reasonable noise mitigation works progressively undertaken at the time of cessation of road haulage from Baal Bone. Should road haulage of coal product recommence from Baal Bone to local power stations in accordance with DA 164/98 (as modified) in the future, the Colliery would review the RHMP and complete outstanding noise mitigation works in the identified residential properties in Cullen Bullen.

9.5.2 Rail Traffic Noise

TWCL currently transports coal to Port Kembla for export via the existing rail loop at the Surface Infrastructure Area. From Baal Bone, trains travel along the Wallerawang-Gwabegar Rail Line to Lithgow and then to the coal terminal at Port Kembla via the Main Western Rail Line.

On average, approximately 8 to 10 train movements are generated per week, although train movements are generally irregular and may occur for several days at a time, separated by extended periods where no coal is hauled from the site, depending on market requirements. There would be no change to the approved quantity of coal transported from the site by rail, and timing and frequency of train movements would continue as required.

Locomotives utilised for coal transport from Baal Bone would comply with relevant noise limits specified in RailCorp's Environment Protection Licence (EPL) conditions. This Project would not result in a change to the noise profile down-line of the site, including mix, length or quantum of noise emitted from trains utilising the Wallerawang-Gwabegar and Main Western Rail Lines.

9.6 Potential Impacts

The results of the noise modelling indicate that during calm meteorological conditions, operational levels exceed the target noise assessment goals at R1. At R2/R3, with the exception of a 1dBA exceedance during daytime hours, the noise predictions indicate that the noise assessment goals are satisfied without the dozer operating.

Predicted operational noise levels during calm conditions with the dozer operating exceeded the day, evening and night time noise assessment goals at both R1 and R2/R3 receptor locations. During adverse meteorological conditions (temperature inversions) the predicted night time operational (L_{Aeq}) noise levels for all three receivers exceed the noise assessment goals, both with and without the dozer operating.

The assessment of sleep disturbance against criteria set by the NGLG during night time hours indicates that the predicted $L_{A1,1min}$ noise levels satisfy the relevant noise assessment goals.

Baal Bone has been operational prior to the establishment of these three residential receptors proximate to the site. Although noise levels exceed criteria, these exceedances are generally considered acceptable, given that Baal Bone is an existing operation which pre-dates the residential receptors, as well as maintaining a relatively minimal history of complaints from nearby receptors. Current operations within the Surface Infrastructure Area operate in accordance with existing noise management practices, which aim to reduce noise impacts to feasible and reasonable levels for operations at the site. These primarily involve stockpile management practices including utilising existing stockpiles as noise barriers to minimise emissions from the dozer operating on the stockpile. Where practicable, further operational management and mitigation measures would be implemented to mitigate peak noise levels, as described in **Section 9.7.**

9.7 Operational Noise Management

Where practicable and feasible, operational mitigation measures could be implemented at the site to reduce noise emissions from the Surface Infrastructure Area. A Site Noise Reduction Program (SNRP) would be prepared, which would include investigation of the following items to reduce noise generated from the site where feasible:

- Close off facade openings in the Washery to Stockpile Transfer Building;
- Close off facade opening in the Washery Building;
- Investigate options to assess the feasibility and possibility of enclosing the Bradford breaker;
- Investigate options to replace the dozer during night hours;
- A revised program of regular inspections of site plant including the dozer to ensure that the installed noise suppression controls are functioning and require no maintenance; and

- Should road haulage of coal product recommence in the future from Baal Bone to local power stations in accordance with DA 164/98, the Colliery would undertake a review of the existing RHMP and complete outstanding noise mitigation works in the identified residential properties in Cullen Bullen.

The following procedures are currently being implemented to manage noise related complaints from residents:

- Procedures for residents to contact the site environmental manager in regard to noise complaints or requests for information;
- Procedures to inform residents of actions implemented following receipt of noise complaints; and
- Procedures for the recording, investigation and follow up of noise complaints, and if required, site attended noise audits to identify additional procedures to minimise noise emissions from the site.

Given the Colliery's minimal complaint history and remaining lifespan of mining operations, existing management measures are practicable. However, further safeguards would be investigated where possible.

9.8 Conclusion

The continued operations at Baal Bone, including activities within the Surface Infrastructure Area and Underground Mining Area, are unlikely to result in significant changes to the existing noise environment. Predicted noise levels exceed criteria at three nearby residential receptors due to the close proximity of residents established post-commissioning of the Colliery. However, Baal Bone has a minimal complaint history, currently implements a range of noise mitigation measures and practices, and proposes to investigate further mitigation techniques in order to reduce noise levels. Given the existing environment, history of operations, and mitigation measures, the project is not expected to result in significant noise impacts.

10.0 Surface Water

An assessment of surface water quality and usage has been undertaken for the Project. A water balance has been undertaken for the Colliery, discussed in **Section 10.1** below and is provided in **Appendix F**.

10.1 Water Balance

10.1.1 Overview

A site water balance assessment for Baal Bone was undertaken by AECOM (refer **Appendix F**) and involved the following scope of work:

- A review of existing information;
- Determine inputs, outputs and internal water use at the site;
- Develop a water balance model to evaluate sustainable water management including an assessment of potential impacts due to climate change; and
- Provide an assessment which summarises key information and assumptions.

The site water balance assessment is presented in **Appendix F**.

Large areas of the Surface Infrastructure Area have been filled with overburden, contoured and rehabilitated with native grass and bushland species. An overview of the site showing the boundary of the Surface Infrastructure Area, major catchment areas and other relevant features is shown in **Figure 10-1**.

Features of the site relevant to the site water balance assessment (and shown in **Figure 10-1**) include:

- Northern Rehabilitation Area (including Box Cut Sump);
- Southern Rehabilitation Area;
- Pit Top Area;
- Stockpile/CHPP Area;
- Overshot Dam;
- Sewage treatment plant, ponds and transpiration bed;
- Dirty Water Dam;
- Process Water Dam;
- Office workshop and adits;
- Southern Void;
- Leachate Dam; and
- REA 6 Tailings Dam.

Runoff from some of these areas is diverted to Ben Bullen Creek which has previously been diverted from its original path through the site. Downstream of the Colliery, Ben Bullen Creek eventually flows into Jews Creek, which in turn flows into the Turon River and then into the Macquarie River.

TWCL holds a number of licences for Baal Bone under the *Water Act 1912*. A review of water sharing plans was undertaken, however no water sharing plans affecting the Project Area were identified. An embargo on further applications for licences under Part 5 of the *Water Act 1912* is applicable to the site, however no application for a water licence is proposed. The Colliery would continue to operate in accordance with current licences.

10.1.2 Site Description

Water Catchment and Storage

The largest catchment areas within the Surface Infrastructure Area are rehabilitated open cut areas and reject emplacement areas. There are seven major catchment areas identified within the mine site which are summarised in **Table 10-1** with their respective area size.

Table 10-1: Summary of the Characteristics of the Catchment Areas within the Baal Bone Mine Site

Description of Catchment	ID	Area
North Rehabilitation Area (Box Cut)	A1	38.5 ha
North Rehabilitation Area (Remainder)	A2	91.8 ha
Ben Bullen Creek Catchment	A3	49.6 ha
ROM Stockpile/CHPP Area	A4	20 ha
Pit Top Area	A5	5.4 ha
South Rehabilitation Area	A6	48.8 ha
Reject Emplacement Area	A7	53.4 ha

The water storages within the Surface Infrastructure Area and their approximate volumes are as follows:

- Dirty Water Dam 37 ML
- Process Water Dam 55 ML
- Leachate Dam 50 ML
- Box Cut Sump 6.9 ML

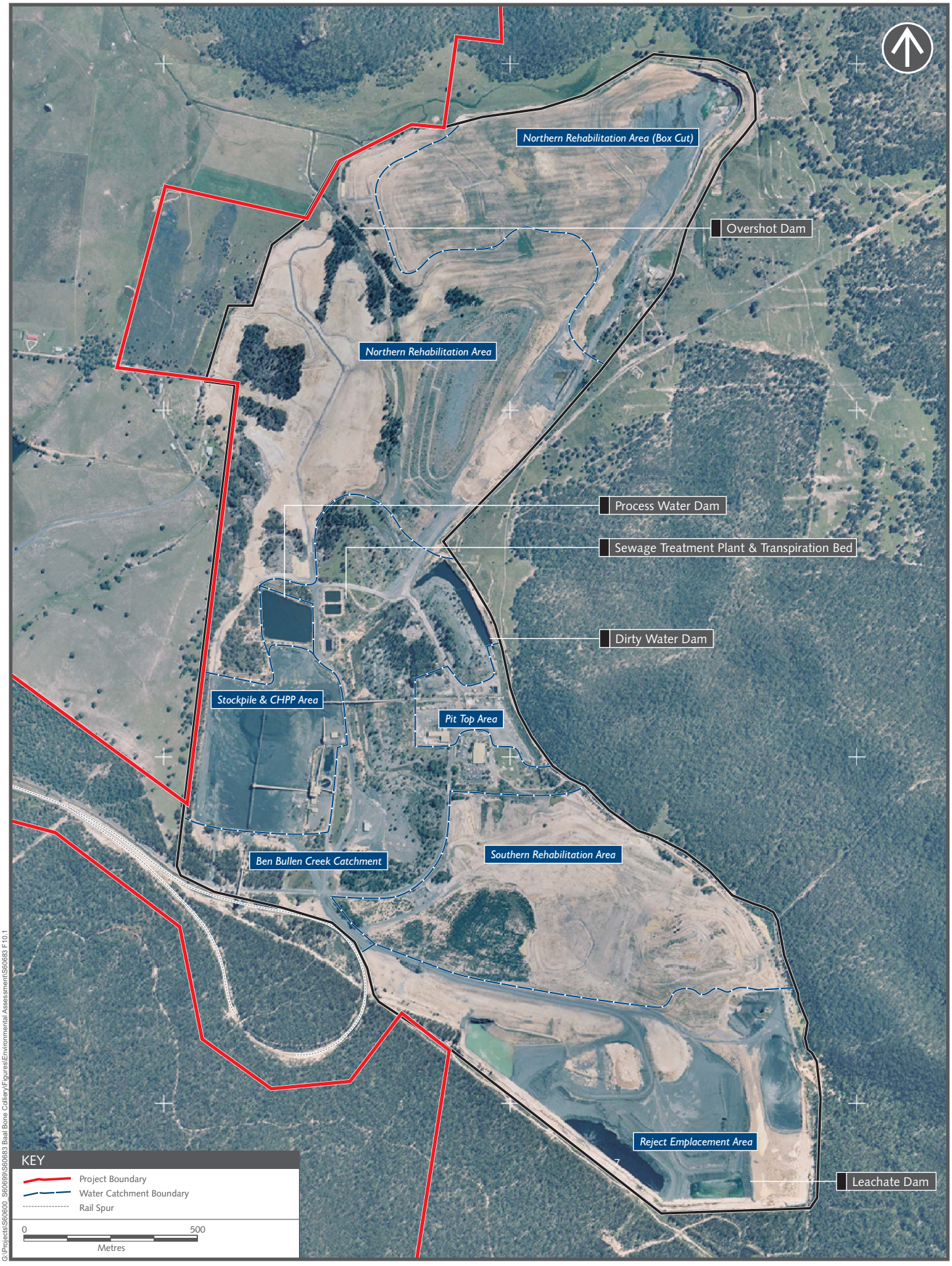
Runoff from the Southern Rehabilitation Area is diverted to Ben Bullen Creek, and approximately one third of runoff from the Northern Rehabilitation Area is also diverted to the Ben Bullen Creek. The remainder flows to the Box Cut Sump. Most of the infiltration from both the southern and northern rehabilitation areas migrates via subsurface flows to the Box Cut Sump.

Water Sources

Potable water is sourced from the Fish River Water Supply owned and operated by State Water. Baal Bone has two connections to the potable water supply each with individual water meters plus additional water meters to track the internal use of potable water on the mine site. Approximately 61 kL/day (or up to 23 ML/annum) of potable water is used primarily for drinking, showers and toilet flushing with the remainder diverted for underground use in hydraulic roof supports.

Other sources of water include two existing production bores on site, the north mine dewatering bore and south mine dewatering bore, shown on **Figure 10.2**, which can be used to supplement site water if required.

Flows entering the site from upstream via Ben Bullen Creek have not been included in the site water balance as they are not used on site.



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AECOM

SURFACE INFRASTRUCTURE CATCHMENT BOUNDARIES

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 10.1

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Discharge Points

The discharge of excess water from the site is licensed under the POEO Act by the DECCW in accordance with EPL 765. The details of discharge points licensed under the EPL are shown in **Table 10-2** below and their location is presented in **Figure 10-2**.

Table 10-2: Summary of Licensed Discharge Points - EPL 765

Discharge Point	Description	Flow Limit (kL/day)	EPL Identification No.
LDP1	LDP1 discharges water from the Surface Infrastructure Area into Ben Bullen Creek via the Overshot Dam. Runoff from areas in the Southern and Northern Rehabilitation Areas also enter the network upstream of LDP1.	-	11
LD2	LD2 discharges water from the sewage treatment plant to an on-site transpiration bed / utilisation area.	-	2
LD3	This discharge point pumps water from the south mine dewatering bore (refer **Figure 10.2**) into Baal Bone Creek.	-	3
LD6	This discharge point pumps water from the north mine dewatering bore (refer **Figure 10.2**) into Baal Bone Creek.	12000	6

The approximate off-site discharges from the Baal Bone comprise the following:

- 1,500 ML/annum groundwater that flows into the underground mining operation and is dewatered directly offsite via LD3 and LD6 to Baal Bone/Jews Creek;
- 135 ML/annum average site overflow from the Overshot Dam (assumed to be equivalent to the runoff from the Southern Rehabilitation Areas and runoff from the Northern Rehabilitation Areas) via LDP1 into the Ben Bullen Creek; and
- 76 ML/annum average water losses through coal washing and export of coal.

10.1.3 Water Balance Inputs

A process flow diagram has been presented in **Figure 10.3** to represent the site water balance. The major inputs of water into the site water cycle include:

- A portion of the groundwater inflow to the Underground Mining Areas (extracted at the north and south mine dewatering bores, shown on **Figure 10.2**);
- Runoff from the main catchment areas in the Surface Infrastructure Area; and
- Potable water from the Fish River water supply.

Groundwater

The topography of the Project Area means that groundwater flows from surrounding areas outside the Project Area into the Underground Mining Areas. The nature of the site water balance is such that groundwater flowing into the existing workings is generally pumped offsite into Baal Bone Creek through licensed discharge points LD3 and LD6, as described in **Table 10-2**.

For the purposes of the mine water balance, historic flow records have been maintained which provide an average volume of mine water to be dewatered from the operational mining areas. In 2008, approximately 1.5GL of groundwater was dewatered from the mine into Baal Bone Creek via LD3 and LD6. It has been determined that the volumes of water would not change significantly as a result of continued operations at Baal Bone.

Runoff

Rainfall and evaporation data for the area from between 1889 to 2008 was analysed to determine key trends including the frequency distribution for both annual rainfall and evaporation. This data was used to model the runoff from catchment areas within the mine and assess the potential evaporation losses from free water surfaces such as the Dirty Water Dam, Process Water Dam and Leachate Dam.

Average annual potential evaporation rates are higher than the average annual rainfall resulting in a net evaporation of water from the free water surfaces. However, the total annual process water use is in the order of 650 ML/annum and the net evaporation is in the order of 30ML/annum which is less than 5% of the total annual process water use at the mine. As the net evaporation of the site is a minor component of the total process water use (less than 5%), losses due to evaporation from free water surfaces have not been included in this water balance, however evaporation rates have been considered in the catchment modelling.

The runoff from all catchments, described in **Section 10.2.1** was modelled using the following inputs and assumptions:

- Catchment areas calculated directly from aerial topographic site information (refer **Figure 10-1** and **Appendix F**);
- Maximum soil water deficit observed at the site would be in the order of 20mm for rehabilitated areas (including the Reject Emplacement Areas) and 10mm for the pit top, stockpile and CHPP areas;
- Average runoff yield of 0.65 for pit top, CHPP and stockpile areas;
- Average runoff yield of 0.30 for rehabilitated areas; and

Average runoff yield of 0.20 for the Reject Emplacement Areas.

The average annual runoff from the individual catchments as a result of runoff calculations utilising the assumptions above are shown in **Table 10-3**.

Table 10-3: Average Annual Runoff from the Individual Catchments at Baal Bone

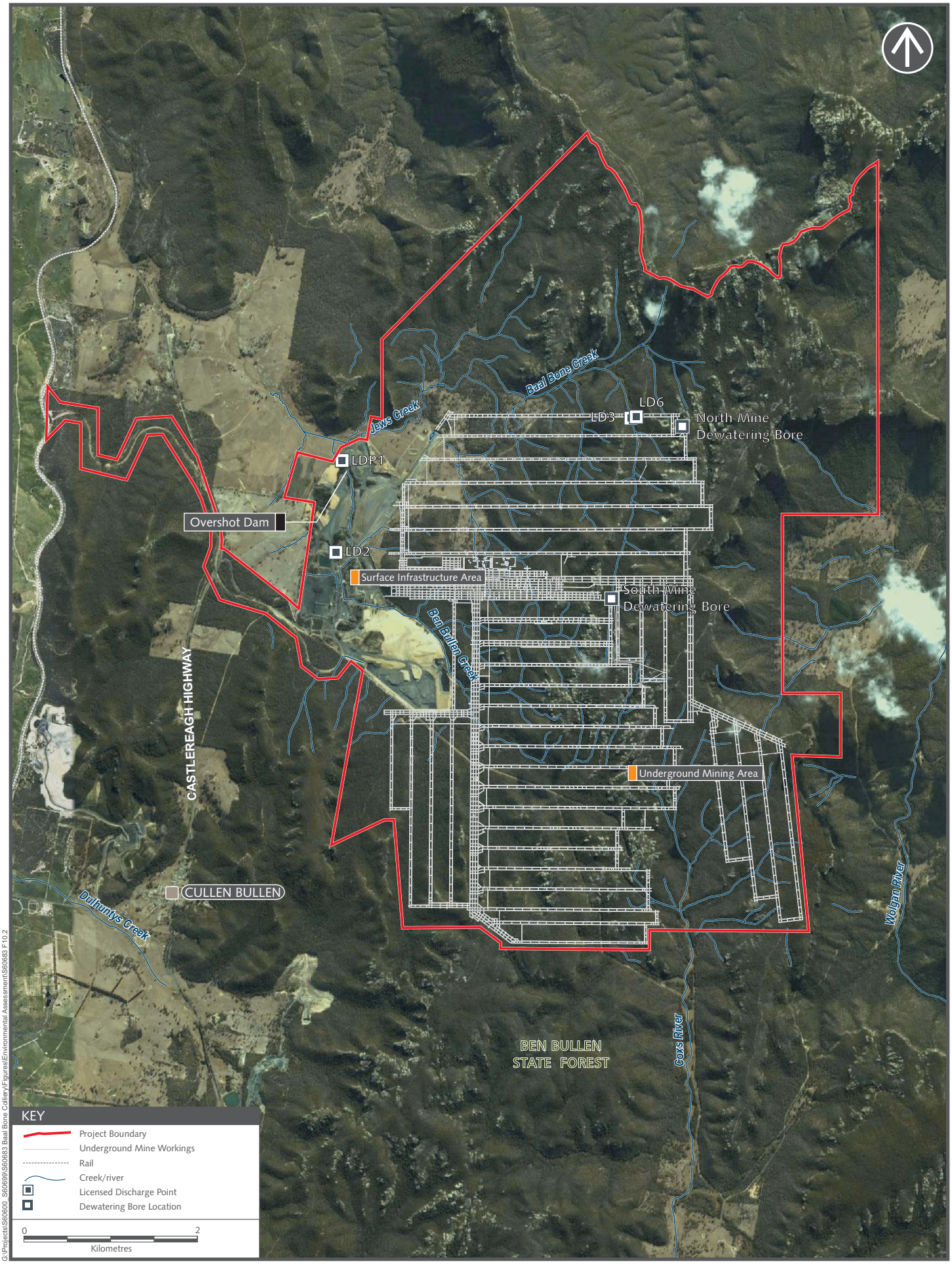
Description	ID	Area	Median Annual Runoff
North Rehabilitation Area (Box Cut)	A1	38.5 ha	16 ML/annum
North Rehabilitation Area (Remainder)	A2	91.8 ha	38 ML/annum
Ben Bullen Creek Catchment	A3	49.6 ha	66 M L/annum
ROM Stockpile/CHPP Area	A4	20 ha	26ML/annum
Pit Top Area	A5	5.4 ha	7 ML/annum
South Rehabilitation Area	A6	48.8 ha	20 ML/annum
Reject Emplacement Area	A7	53.4 ha	11 ML/annum

Runoff from each of these areas is diverted to different water storages and, ultimately, into different parts of the mine water cycle. Runoff from the Southern Rehabilitation Area is diverted to Ben Bullen Creek then to the Overshot Dam. Runoff from the Northern Rehabilitation Area is diverted to either the Box Cut Sump or Ben Bullen Creek via the Overshot Dam. Runoff from the CHPP, coal stockpile and pit top areas is diverted to the Dirty Water Dam via primary arrestors to remove sediment, grease and oils.

Maximum Storage Volumes

Intensity-frequency-duration (IFD) data was obtained for the geographical area and was used to ascertain the maximum rainfall event that could be contained by the Dirty Water Dam storage.

As the Surface Infrastructure Area catchments are disturbed and, particularly in the case of the central area of the site, contain impervious areas and areas of compacted soils and roads/hardstand (adopted 60% impermeable areas), methods of estimating runoff coefficients for disturbed/urbanised catchments as outlined in Book VIII of Australian Rainfall and Runoff (Pilgrim (Ed), 1998) were adopted.



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LICENSED DISCHARGE POINTS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 10.2

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The Dirty Water Dam receives runoff from catchment areas A4 and A5 (refer to **Table 10-3**) and has a total capacity of 37 ML. Assuming the Dirty Water Dam is operated at a 30% level, it has the capability to contain a 1 in 50 year, 24 hour storm, which was calculated using the rainfall data for the area.

Even in a wet year, there is a deficit of runoff from the catchments A4 and A5 to the Dirty Water Dam and the water would need to be supplemented. Therefore, there is very low risk of overflows from the Dirty Water Dam unless there is a peak storm event, i.e. in this case, an event exceeding a 1 in 50 year, 24 hour storm event.

10.1.4 Process Water Cycle

The process water cycle is shown in **Figure 10-3** and is described in the following sections.

Coal Handling and Preparation Plant

Process water used to wash coal in the CHPP is sourced from the Process Water Dam. The process water in turn is sourced from the Dirty Water Dam. Up to 50% of the water used in the CHPP is recycled water from the process return (leachate) water.

Process Water Dam

The total outflow from the Process Water Dam is equivalent to the water transferred from the Dirty Water Dam. The difference between the inflow and the outflow of approximately 10% can be attributed to minor evaporative losses from the Process Water Dam.

Leachate Recovery

Excess leachate from the tailings is recovered in the Leachate Dam. Leachate is then pumped to the Dirty Water Dam and recycled to the Process Water Dam. Up to 50% of all water used on site is recovered via the leachate return system from the REA 6 Tailings Dam. Approximately 25% (or 103 ML/annum) of the water in the tailings is retained/trapped in the tailings voids or lost to seepage from the Reject Emplacement Area.

Flow that is lost to seepage is eventually intercepted at the Overshot Dam and subsequently seeps to the Box Cut Sump where it is collected. This water can be returned to the Dirty Water Dam to supplement the process water cycle.

Box Cut Sump

The Box Cut Sump collects some local runoff from the Northern mine rehabilitation area along with seepage from most areas of the site. Up to 365 ML/annum) can be pumped from the Box Cut Sump to the Dirty Water Dam to supplement the process water demand if required.

Recycled Water Use

A significant amount of water is recycled on site for coal processing, dust suppression and underground workings. Approximately 63% of the total water demand on site is recycled water comprising leachate return water and water from washdown return (surface runoff from the pit top and the CHPP areas). Approximately 75% of the leachate is recovered and recycled for process water. This leachate recycling accounts for approximately 50% of the process water used on site.

10.1.5 Mine Water Balance

Most of the pumped flows within the mine water cycle can be estimated using the flow meters that are currently installed. The major water components generated by the Colliery operations are summarised as follows:

- 23 ML/annum potable water from Fish River Water Supply;
- 33 ML/annum average runoff from pit top and CHPP areas;
- 151 ML/annum average runoff from the Northern Rehabilitation Area and Southern Rehabilitation Area;
- 381 ML/annum mine dewatering from southern underground mining areas;
- 1,168 ML/annum mine dewatering from northern underground mining areas; and
- 242 ML/annum mine dewatering from Adit No. 5.

On average, the Colliery uses approximately 635 ML/annum of water for potable uses, dust suppression and coal washing; however usage has recently been as high as 750 ML/annum. Of this amount, approximately 610 ML/annum was used for dust suppression and process water within the CHPP. Currently approximately 50% of the CHPP demand (or 310 ML/annum) is sourced by process return water (i.e. from the Leachate Dam).

Therefore, approximately 300 ML/annum additional water is required to be sourced from surface runoff and/or mine dewatering operations.

An analysis of the potential runoff from the on-site catchments to the Dirty Water Dam was undertaken. The average annual runoff to the Dirty Water Dam is approximately 33 ML/annum which is approximately 11% of the process water make-up requirement of 300 ML/annum. Even in extreme wet years, the collection of surface runoff to the Dirty Water Dam alone is insufficient to provide enough process water for the mine operations.

As a result, additional process make-up water is obtained from a smaller mine dewatering discharge at Adit No. 5 (approx 242 ML/annum) which augments process water circuit through the Dirty Water Dam. In addition, process make-up water may also be sourced from the Box Cut Sump (up to 365 ML/year) which can be added to the Dirty Water Dam if required.

10.2 Surface Water Quality

10.2.1 Surface Water Management System

Surface water quality at Baal Bone is managed through the separation of clean and dirty water systems, with regular monitoring of water quality in both systems in accordance with EPL 765. As discussed in **Section 10.1.1**, runoff from each of the catchment areas is diverted to different water storages and ultimately into different parts of the mine water cycle. The water storage areas and their respective water source catchments are shown in the table below.

Table 10-4: Surface Infrastructure Area Water Storage and Catchment Sources

Storage Area	Source Catchment
Dirty Water Dam (via primary arrestors to remove sediment, grease and oils)	Runoff from the ROM Stockpile/CHPP Area (A4), Pit Top Area (A5) and leachate from the Leachate Dam
Process Water Dam	Dirty Water Dam
Leachate Dam	Runoff from the Reject Emplacement Area (A7)
Box Cut Sump	Runoff from the North Rehabilitation Area (A1 and A2)
Ben Bullen Creek (ultimately discharged to Ben Bullen Creek via Overshot dam and LDP1)	Runoff from the Southern Rehabilitation Area (A6) and North Rehabilitation Area (A2)

Water within the storage areas including the Dirty Water Dam, Process Water Dam and Leachate Dam is maintained and recycled on site for use in the process water system. Surface runoff from the pit top area, coal stockpiles and CHPP, is managed by a system of grit traps and an oil separator facility and transferred to the Dirty Water Dam. Two grit traps are used to remove suspended solids from surface runoff; the Pit Top Grit Trap and Stockpile Grit Trap. Water enters the trap, where particles deposit and are later removed through dewatering and cleanout operations. Oil is removed from the trap by an oil skimmer before being recycled back into the process water cycle.

The oil separator maintains a mechanical oil recovery system, whereby surface oils are recovered for further processing and collection for storage and disposal. Oil is piped into adjacent concrete tank for storage before disposal. Water discharge from the oil separator is transferred to the Dirty Water Dam. All waste oil collected by the oil separator is transported offsite to a licensed waste processing/recycling facility by a licensed waste transporter.

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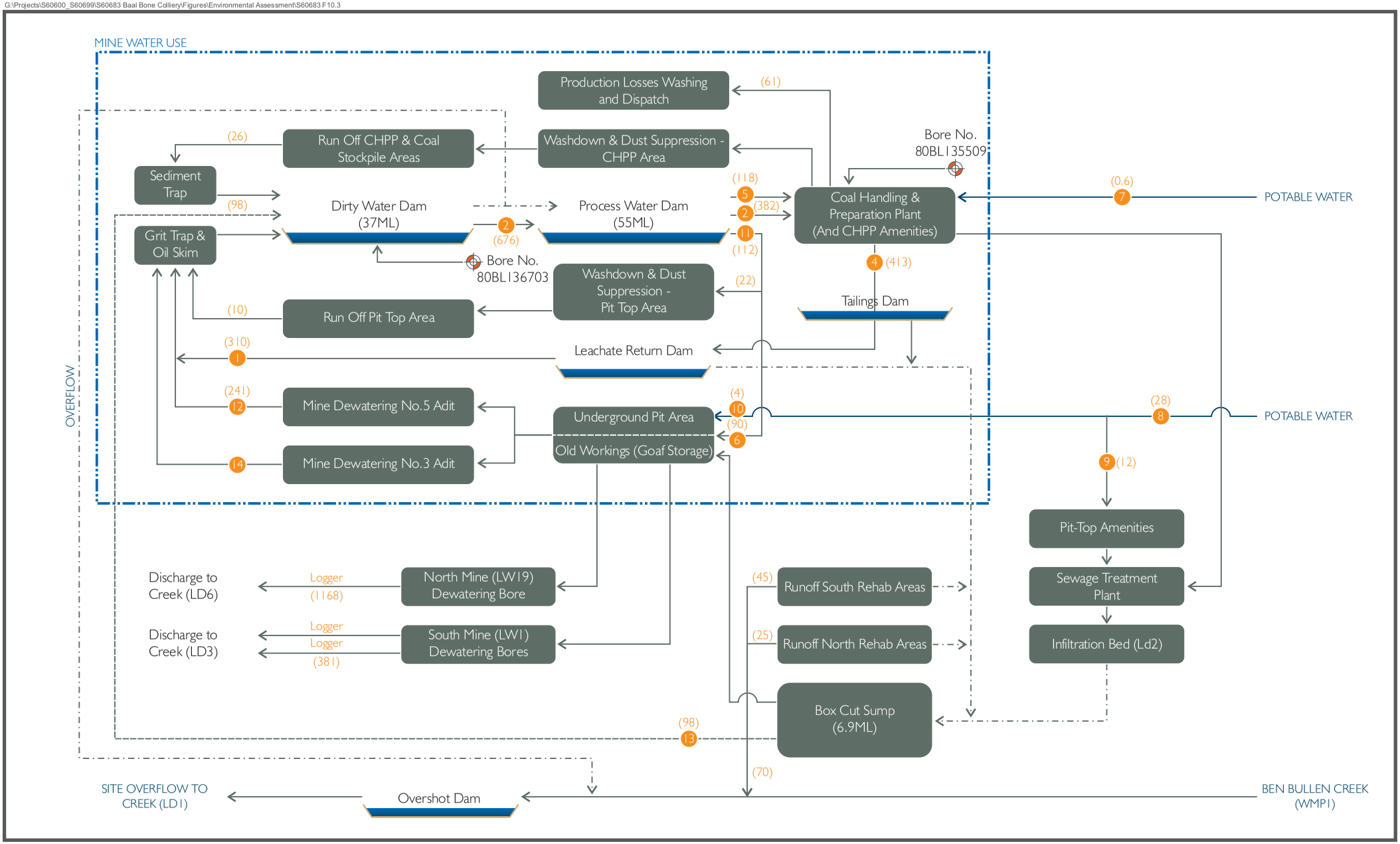

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(381) Annual flow in megalitres
13 Flow meter with ID number / Data logger
Direct transfer path
Alternate transfer path
Seepage path/overflow
Mine water use

MINE WATER CYCLE
Environmental Assessment
Baal Bone Colliery, Cullen Bullen NSW

Figure 10.3

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Water from the Dirty Water Dam is pumped into the Process Water Dam for re-use in mining and coal preparation operations, as well as fire fighting and dust suppression where required. Water used from the Process Water Dam in site operations is eventually recycled back into the Dirty Water Dam as either surface water runoff from the pit top area, coal stockpiles and CHPP. As discussed in **Section 10.1.2,** there is the potential for the Dirty Water Dam to overflow if there is a rainfall event exceeding a 1 in 50 year, 24 hour storm, however this is considered to be a very low risk. However, overflows from the Dirty Water Dam would not be directly discharged offsite, but would enter Ben Bullen Creek upstream of the Overshot Dam and LDP1 so that overflows are captured in the Overshot Dam. As such, no significant offsite water quality impacts are generated by the operation of the Dirty Water Dam, Process Water Dam or Leachate Dam.

As discussed in **Section 10.1.1**, all water discharged offsite is via discharge points licensed in accordance with the EPL for the site. Licensed discharge points are listed in **Table 10-2**. The primary discharge point which discharges water offsite from the Surface Infrastructure Area is LDP 1, which discharges water into Ben Bullen Creek via the Overshot Dam. Runoff from areas in the Southern and North Rehabilitation Areas (A2 and A6) also enter the network upstream of LDP1, as identified in **Table 10-4**. Water quality at this discharge point is monitored as required by the EPL. The Overshot Dam is managed in accordance with management procedures detailed in the EMS for the site. The water level in the Overshot Dam is monitored during and immediately after significant rainfall events, and water quality monitoring is undertaken when the water level is greater than 50% of live storage capacity. In the event that water levels and predicted rainfall indicate that an overflow has the potential to occur, water quality sampling and testing of water stored within the Overshot Dam is undertaken.

Other licensed discharge points which discharge offsite include LD3 and LD6 (refer **Table 10-2**), which discharge water from the south and north mine dewatering bores (refer **Figure 10.2**), respectively, into Baal Bone Creek. Water quality from these discharge points is also monitored in accordance with the requirements of the EPL. Water discharged offsite from the Colliery is managed in accordance with the conditions of the EPL and the Collieries EMS. In addition to monitoring undertaken in accordance with the EPL, Baal Bone undertakes monthly sampling, monitoring and analysis of a range of surface and subsurface waters in accordance with its EMS for the site at another 22 monitoring locations.

Monitoring results for EPL discharge and monitoring points in 2008 indicated that all samples recorded were within EPL concentration limits. Monitoring results included:

- all samples for both TSS and Total Iron were within EPL specified concentration limits of 50mg/L and 1.0mg/L respectively;
- all samples returned oil and grease concentration levels of <2mg/L, which is well below the EPL Concentration Limit of 10mg/L; and
- all samples returned pH results that were within the upper and lower EPL Limits (8.5 and 6.5 respectively, consistent with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) guidelines (2000) for NSW lowland rivers).

Given the surface water management system retains potentially contaminated water on site, and offsite discharges are managed in accordance with EMS and EPL requirements, significant offsite impacts to surface water quality are not anticipated. As such, direct or indirect impacts to the Ramsar listed Macquarie Marshes Wetlands are unlikely to be significant. Additionally, the Project is not anticipated to result in potential impacts to water supply to the Macquarie Marshes Wetlands.

10.2.2 Watercourses

Ben Bullen Creek is the primary water course impacted by operations at Baal Bone. Restoration and rehabilitation of Ben Bullen Creek has been undertaken, and is described in **Section 13.6.2**. Connell Wagner (2006) (refer **Appendix G**) states that no swamps, springs or permanent streams are located within the Longwalls 29 to 31 area, as such the mining of Longwalls 29 to 31 is not anticipated to an impact on such features. Several small tributaries are located within the Longwalls 29 to 31. Potential impacts to surface drainage as a result of subsidence are not anticipated to be significant, and would be managed in accordance with the Environmental Monitoring Program contained within the Subsidence Management Plan (SMP). Mitigation measures primarily include repair of surface cracking by excavation and fill, or concrete grout if required. Where impacts are detected, notification of relevant agencies would be in accordance with the SMP.

10.3 Climate Change Assessment

The primary impact of climate change in New South Wales would be the potential change in the variability and extremes of precipitation. Predictions by the CSIRO (2004) indicate that the potential for drought may increase by 35% to 70% by 2030. A Monte Carlo style approach was used to determine the potential impact of climate change on the mine water cycle.

Firstly, the estimated annual volume discharged from the site was calculated for a range of different probability ranges. As noted previously, the discharges from site are dominated by the raw groundwater volumes dewatered from the south and north mine dewatering bores, which are discharged via LD3 and LD6 respectively.

The estimated 90th percentile value for discharge from the site is in the order of 2.6 GL/annum. The existing EPL allows for a discharge of up to 12000 KL/day (4.4GL/annum) via LD6. Other licensed discharge points do not restrict the quantity of water allowed to be discharged. Additionally, Bore Licences held under the *Water Act 1912* do not currently place a restriction on the ability of the mine to dewater. Therefore there is no risk of excess mine water accumulating in the workings, and preventing safe working conditions if these discharge arrangements are maintained.

Secondly, it is also important to ensure that there would be sufficient water available for the process water circuit (between 610 ML/annum to 750 ML/annum). In dry conditions (i.e. equivalent to a 20th percentile year) less than 20 ML/annum could be available via runoff from the pit top, coal stockpiles and CHPP areas. This is equivalent to a reduction of 40% of water available via runoff to the process water circuit in an average year. However, the water available from mine dewatering via Adit No. 5 and the potential supplementary water from the Box Cut Sump would be more than sufficient water to augment the process water circuit.

10.4 Environmental Safeguards

Environmental safeguards to manage water quality onsite, as well as offsite discharges are contained within existing management practises detailed in the EMS. Environmental safeguards and procedures to manage water contained within the EMS include:

- Complete containment of pit-top and CHPP surface dirty water systems, including grit traps and oil separation systems;
- Regular (monthly) onsite water quality monitoring in accordance with the EMS;
- Dewatering and cleanout operations of grit traps to maintain efficiency;
- Graded banks, lined channels, sediment basins and sumps on surface rehabilitation areas;
- Bunded chemical and hydrocarbon storage facilities and containers;
- Waste oil, filter and oily rag collection and disposal / recycling systems;
- Maintaining hydrocarbon spill kits onsite;
- Engineering and geotechnical designs of dams;
- Development and dissemination of Standard Operating Procedures; and
- Awareness training and inductions for employees and contractors.

Provided the EMS and the identified safeguards continue to be implemented at the site, impacts to surface water quality are not anticipated to be significant.

10.5 Conclusion

The following key points are concluded from the water balance and surface water quality assessment:

- The net water exported from the site is equivalent to approximately 1.5 GL/annum. Most of this water is generated by groundwater infiltration into the mine and is dewatered into Baal Bone Creek via LD3 and LD6;
- All runoff from the pit top area, stockpile area and CHPP area collected on site is used within the mine to supplement the process water circuit. Site process water is also supplemented with water from Mine Adit No. 5 dewatering, and surface runoff and seepage collected from the Box Cut Sump;
- Approximately 75% of leachate, equivalent to 50% of all water used in the process water system is recovered from the Tailings Dam (REA 6) and returned to the process system;

- Approximately 63% of all process water used on site is recycled water comprising leachate return water and wash down water from the CHPP, coal stockpile and pit top areas;
- Less than 4% of water used on site is potable water;
- Even in a wet year, there is very low risk of overflows from the Dirty Water Dam unless there is a rainfall event exceeding a 1 in 50 year, 24 hour storm. In the event that an overflow occurs, water would not be discharged directly offsite, but would be discharged upstream of LDP1 into the Overshot Dam prior to discharge into Ben Bullen Creek via LDP1; and
- The surface water management system retains potentially contaminated water on site, and offsite discharges are managed in accordance with the EMS and EPL requirements, thereby minimising significant offsite impacts to surface water quality.

The current water management strategy at Baal Bone is sustainable if current practices are maintained. The process water demands are expected to remain constant for at least the next 10 years which provides a use for all runoff water collected on site. The high level of water recycling on site ensures that discharges off site are high quality. The water that leaves the site is runoff generated from rehabilitated areas and from mine dewatering; other water collected from potentially contaminated areas is retained and used on site.

Existing license conditions are suitable to allow all groundwater infiltration into the mine workings to be discharged off site via both LD3 and LD6. It is also clear that there is sufficient groundwater both from Audit No. 5 and the Box Cut Sump to supplement the process water circuit and ensure there is sufficient water for operation of the mine even with the potential effects of future climate change.

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11.0 Groundwater

11.1 Hydrogeological Conceptual Model

To determine the impact of historical and future mining on the aquifer systems and swamps within the Project Area, it is necessary to establish a conceptual model for the local hydrogeological regime. The hydrogeological regime is defined as the occurrence of groundwater and its interaction with the local geological conditions.

There are little published data on the hydrogeological characteristics of the Western Coalfields strata. The following assessment is based on the hydrogeological conceptual model established by Connell Wagner (2006) for Baal Bone, data gathered from the Colliery's investigations and records, information acquired during other local investigations and local experience.

11.1.1 Geology and Geomorphology

TWCL is currently extracting coal at Baal Bone from the Lithgow Coal Seam (LCS), part of the Illawarra Coal Measures of the Western Coal Fields. The Illawarra Coal Measures comprise several coal seams interbedded with sandstone, siltstone and shale. The extracted thickness of the LCS in the Project Area is approximately 2.45 m (refer **Appendix G**).

The sedimentary strata of the Narrabeen Group overlie the Illawarra Coal Measures in the south and south-west of the Project Area. The strata of the Narrabeen Group are of freshwater origin and generally comprise a non-uniform sequence of interbedded sandstone, siltstone and shale of differing grainsize and strength properties. This distribution invariably gives rise to layers of rock with a wide range of permeabilities, which form a sequence of aquifers, aquitards/aquicludes within the overburden or overlying rock strata.

The strata across the Project Area are reported to dip towards the north-east (variably reported between 0.5° [Coffey 1995] and 5° [Mackie 1998]), with the depth of cover above the LCS ranging from approximately 25 m in the north west to in excess of 200 m in the south and south east. The depth of the overburden is largely influenced by topography. In areas that are topographically lower, the overlying Narrabeen Group has been eroded and in some parts completely removed to expose the upper units of the Illawarra Coal Measures (i.e. north and west of the Project Area). The maximum thickness of the Narrabeen Group is 100 m to the south of the Project Area.

The LCS is underlain by the Marrangaroo Conglomerate which is known to retain and yield groundwater. The conglomerate attains a thickness of between 1 and 2 m and is underlain by relatively impermeable mudstones and siltstones.

In undisturbed areas across the Project Area, limited unconsolidated alluvial and colluvial material is present above the interbedded sandstone, siltstone and shale that forms the Narrabeen Group. This material is likely to have a non-uniform lateral distribution that is largely influenced by topography.

The Coxs River Lineament Fault Zone is located in the south east corner of the Project Area. The fault zone is a north-south trending graben structure approximately 250 m wide. Displacement of up to 5 m is present, with seismic data indicating the presence of several smaller faults and brecciation of strata (Connell Wagner 2006). The Coxs River flows along the valley created by this fault zone.

The local stratigraphy within the Project Area is summarised in **Table 11-1**.

Table 11-1: Middle Permian to Tertiary Stratigraphy of the Study Area

Period	Group	Formation	Lithology	Comments
Triassic	Narrabeen Group	Burralow Formation	Shale/sandstone laminate.	Nil
		Banks Wall Sandstone	Quartzose sandstone.	Aquifer.
		Mt York Claystone	Red-brown claystone.	Likely aquiclude.
		Burra-Moko Sandstone	Quartzose to quartz-lithic sandstone.	Aquifer.
		Caley Formation	Claystone, shale and quartz-lithic sandstone.	Aquiclude associated with the formation of Coxs River Swamp.
Permian	Illawarra Coal Measures	Farmers Creek Formation	Claystone, coal, carbonaceous shale and siliceous shale.	Interbedded coal with mainly sedimentary strata. Sandstone and conglomerate units likely to accommodate some groundwater with claystone, siltstone and mudstone layers forming localised aquicludes.
		Gap Sandstone	Lithic sandstone.	
		State Mine Creek Formation	Claystone, siltstone, tuff and coal.	
		Angus Place Sandstone	Quartz-lithic sandstone.	
		Baal Bone Formation	Mudstone, siltstone and claystone.	
		Glen Davis Formation /Newnes Formation	Sandstone, claystone, coal and oil shale.	
		Irondale Coal		
		Long Swamp Formation	Sandstone, mudstone and coal.	
		Lidsdale Coal	Coal, claystone, siltstone, mudstone and conglomerate.	
		Blackmans Flat Conglomerate		
		Lithgow Coal		**Target seam. Groundwater likely to flow in a horizontal direction within the Lithgow Coal Seam.**
		Marrangaroo Conglomerate		Aquifer.

11.1.3 Perched Groundwater

Given that much of the surface of the Project Area has been disturbed, either by historical open cut mining in the Surface Infrastructure Area or subsidence associated with longwall mining in the Underground Mining Area, it is unlikely that significant areas of unconsolidated alluvial and colluvial material and subsequent perched groundwater exist. Where present, these saturated zones are likely to be laterally discontinuous and to occur in relatively isolated pockets, in undisturbed areas such as the Coxs River (to the south east) and Jews Creek (to the north) swamps, and to a lesser extent on the undisturbed ridges. Perched groundwater in these areas is likely to be accommodated by unconsolidated sands, silty sands and in particular, peat which has a high water retention capacity.

11.1.4 Bedrock Aquifers

Investigations have shown that the strata overlying the coal measures in the Western Coalfields generally have low permeabilities ($<10^{-8}$ m/s). However, within these low permeability layers, there are occasional layers that have a slightly higher permeability and are considered relative aquifers. The few aquifers noted to occur at depth within the bedrock overlying the LCS are considered fractured bedrock aquifers which display permeabilities up to two orders of magnitude greater than the surrounding strata due to the presence of interconnected bedding, joint and fracture patterns (**Appendix G**).

The Banks Wall Sandstone and the Burra-Moko Head Sandstone have previously been identified as the two main aquifers present within the Narrabeen Group. Aquicludes are formed by the Mt York Claystone which occurs between the more permeable Banks Wall Sandstone and Burra-Moko Sandstone, and the Caley Formation which immediately underlies the Burra-Moko Sandstone (refer to **Table 11-1**).

Within the Narrabeen Group, the strata are generally dipping less than 2 degrees towards the north east (**Appendix G**). Groundwater flow is generally horizontal, and being largely influenced by stratigraphy and topography, is also towards the north east. The presence of the Coxs River Lineament Fault Zone in the south of the Project Area may also serve as a conduit for groundwater flow and create localised variations in both horizontal and vertical flow direction.

Groundwater recharge within the Narrabeen Group is largely via vertical infiltration with the presence of the less permeable Caley Formation preventing or limiting further vertical infiltration into the underlying coal measures. Groundwater within the Narrabeen Group aquifers is of good quality with near neutral pH and electrical conductivities ranging from <10 to 90 µS/cm, indicating fresh water conditions.

11.1.5 Coal Measures

Although the strata of the Illawarra Coal Measures are essentially impermeable, some coal seams in the coal measures form aquifers due to fracturing and jointing within the seams. The Lithgow, Middle River and Katoomba seams have all been identified in the past as relative aquifers, and groundwater flow within these seams is almost exclusively horizontal as they are bounded by fine-grained sediments which act as aquicludes/aquitards.

Groundwater within the coal seams is generally of lower quality than in the near-surface sandstone aquifers of the Narrabeen Group and searches have shown that there are no domestic, industrial or agricultural users of the groundwater resources within these aquifers in the area surrounding Baal Bone, probably due their relatively low yield.

Analytical results indicate that groundwater within the coal measures is of fair quality, with a near neutral pH and electrical conductivities ranging from 1,080 to 1,470 µS/cm, indicating brackish conditions.

Recharge into these seams is largely from the west of the Project Area where they outcrop, although there would be some contribution from vertical infiltration. Prior to the commencement of mining at Baal Bone, the coal measures aquifers would have drained towards the escarpment to the east of the Project Area where they are exposed at the base of the cliff face. Previous studies have shown that the LCS, which has been extensively mined in the region, is largely drained of groundwater, although flow in this seam too would normally be towards the east (Connell Wagner 2006).

Extensive longwall mining and subsequent groundwater extraction within the Project Area is likely to have resulted in significant drawdown of the piezometric head within the coal measures aquifers.

11.1.6 Interaction with Swamps and Watercourses

The Coxs River Swamp is present in the south eastern corner of the Project Area and is reported to have formed due to the near surface presence of the Caley Formation, which acts as an aquiclude, restricting the infiltration of water and allowing the accumulation of water, sediment and organic material in the low-lying area. Both groundwater and rainfall are understood to contribute a supply of water to the Coxs River Swamp; however the groundwater contribution is probably relatively minor compared to the contribution by rainfall runoff (Connell Wagner, 2006).

Groundwater contribution to Coxs River Swamp is likely to be initiated by vertical infiltration into the overlying sandstone units exposed in the adjacent ridges. When groundwater intersects the Caley Formation, which is an impermeable layer, it travels laterally along the bedding until it reaches the ground surface where the aquifer subcrops beneath the swamp. At this point the seepage is discharged into the swamp. This movement of groundwater as seepage is believed to contribute to a proportion of the groundwater within the swamp areas (Connell Wagner 2006). This process is disrupted on the eastern side of the swamp, where faulting has dislocated the aquifer, so that there may not be a continuous lateral seepage path to the swamp.

Jews Creek Swamp, present in the north of Project Area, is likely to have formed by a similar process to that of the Coxs River Swamp. Groundwater contribution to the swamp is considered to be minor and it is understood that if mine water was not discharged to Jews Creek, the swamp would experience little change in wetness compared to its original state prior to commencement of operations at Baal Bone, excluding varying climatic influence.

Coxs River Swamp and Jews Creek are likely to constitute groundwater dependent ecosystems. No other groundwater dependent ecosystems have been identified within or in the vicinity of the Project Area. The location of the Coxs River Swamp and Jews Creek Swamp is presented in **Figure 11-1**.

Observations have shown that although groundwater is likely to supply a minor percentage of total water input to the swamps in the Project Area, the groundwater contribution is important in that it may sustain the swamp vegetation in times of prolonged drought. Monitoring data indicates that currently there is no impact on groundwater in the Coxs River Swamp.

The groundwater flow across the Longwalls 29 to 31 area is to the north east, due to the general dip of strata in the Narrabeen group in this direction. Since the Wolgan Valley intersects the strata in the escarpment north east of Longwall 31, groundwater flow in this direction will flow into the valley, and potentially contribute to the flow in the Wolgan River. It is not possible to determine the quantity of this groundwater contribution to the Wolgan River from the strata, as there are no permeability data and no piezometer data from the area.

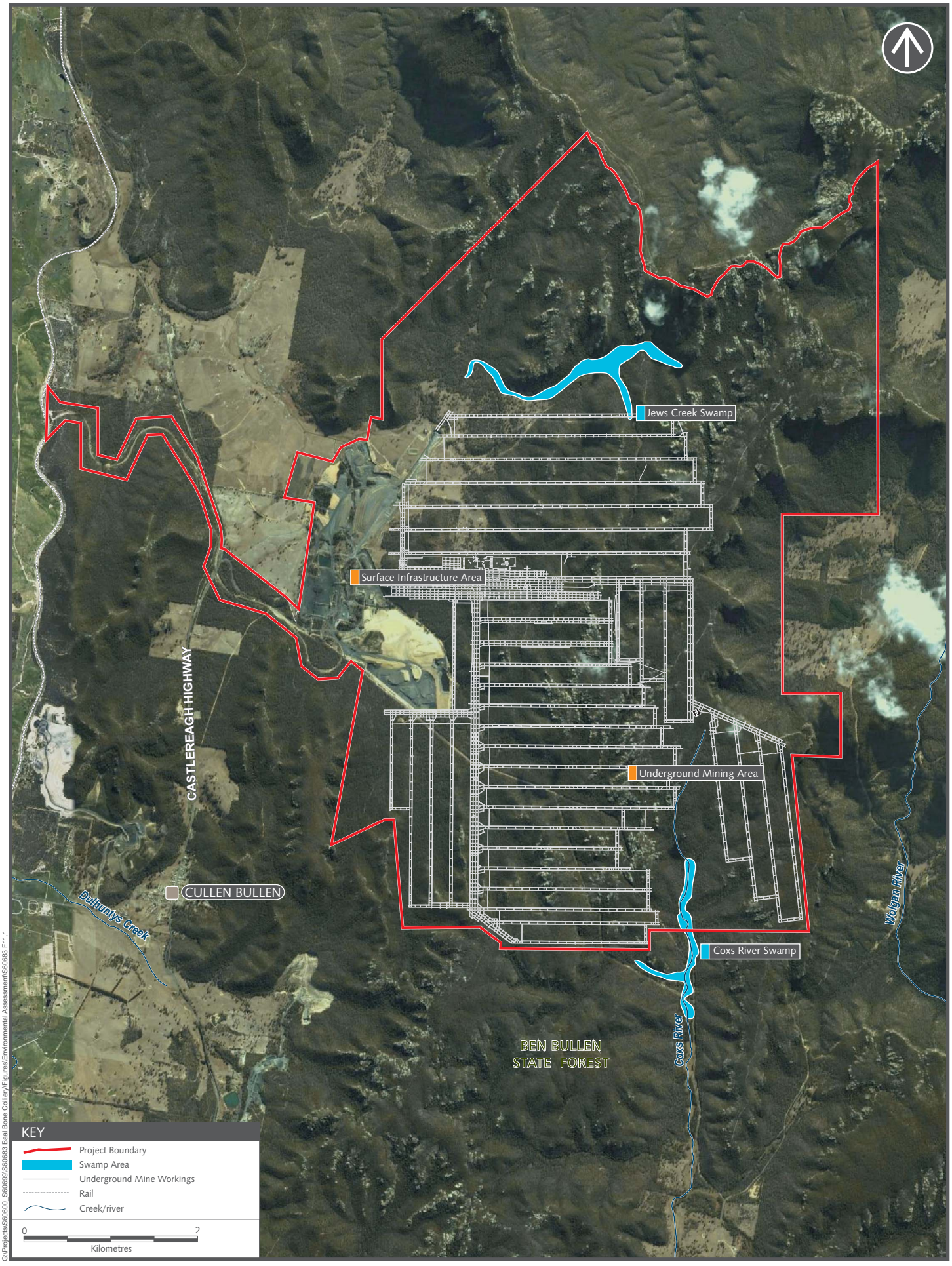
Nevertheless, the contribution to stream flow is likely to be negligible, as most of the strata are relatively impermeable and would produce no flow. Only one water-bearing horizon has been identified, and that is located just above the coal measures. As the head on this seam is only of the order of 10 m, any lateral flow to the escarpment would also be minor, as the hydraulic gradient would be very low. In addition, it is not anticipated that there will be any permanent impact on this zone from mining of Longwalls 29 to 31, and hence no loss of flow.

Most importantly, the volume of flow (if any) would be insignificant when compared to the runoff from the Wolgan River Catchment and groundwater contribution from the strata in the rest of the Wolgan River catchment.

11.1.7 Groundwater Usage

A database search of registered bores in the vicinity of the Project Area reported there were no domestic, industrial or agricultural users of the groundwater resources within the Project Area. Several registered bores were present within 3 km of the Project Area and were registered for use for stock watering purposes.

TWCL holds a number of licences for operations at Baal Bone under the *Water Act 1912*. It is acknowledged that these licences do not currently contain extraction limits. In 2008, approximately 1.5GL/annum of groundwater was pumped from the mine to Ben Bullen Creek via the licensed discharge points. The management of groundwater is directly related to the underground mining activities. Some areas of the mine must be dewatered to ensure the safety of staff working in the underground areas. The volume of groundwater removed from the mine in 2008 is representative of the volume of groundwater that needs to be dewatered annually to ensure safe working conditions in the areas to be mined (Longwalls 29 to 31 and Remnant Areas) over the operational life of the mine.



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Note:
Coxs River Swamp extends further south than shown on this figure. The area shown is applicable to this project

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SWAMP LOCATIONS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 11.1

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The topography of the Project Area results in groundwater flowing from surrounding areas outside the site into the Underground Mining Areas. While it is difficult to quantify the volumes of groundwater that flow into the Underground Mining Areas with accuracy, preliminary investigations suggests that it is in the order of 4 ML/day (refer **Appendix F**). The nature of the mine water balance is such that groundwater flowing into the workings is generally pumped offsite directly to Ben Bullen Creek via a discharge point licensed under the EPL.

A small portion of the groundwater that flows onto the operational areas of the mine is pumped out of the Adit No. 5 to the Dirty Water Dam. Historic flow records have been maintained for the site which provides an average volume of mine water to be dewatered from the operational mining areas. It has been assumed that the volumes of water to be collected and dewatered from these operational areas of the mine will not change significantly as there are no major operational changes planned at the Colliery. No additional works requiring licensing under the *Water Act 1912* or *Water Management Act 2000* are required as part of the Project.

11.2 Current Impacts of Mining on Groundwater Regime

As discussed in previous sections, both underground and open cut mining has been undertaken within the Project Area, with future mining proposed for Longwalls 29 to 31 and Remnant Areas within the existing longwalls (refer to **Figure 4.1**). Previous mining within the Project Area has already influenced the local groundwater regime and the following sections provide a brief overview of this impact.

11.2.1 Impact of Mining on Overburden

Longwall extraction results in collapse of the overlying rock strata into the void left by coal extraction. This collapsed zone is referred to as the goaf. The collapse propagates upwards until bulking of the goaf limits vertical movement and the tensile strength of the rock strata is sufficient to hold up the overburden without failure. The fracture pattern in a coal seam overburden is illustrated schematically in **Figure 11-2** and summarised below.

- Caved Zone: This zone comprises loose blocks of rock detached from the roof and occupying the cavity formed by mining. The Caved Zone can contain large voids and significant increases in bulk permeability occur in this zone. This zone can extend from two to ten times the seam thickness (2t to 10t) in height above the caving roof.
- Fractured Zone: This zone comprises material lying immediately above the Caved Zone which does not fall or detach but has sagged downwards. This sagging results in significant fracturing, opening of bedding planes and shearing and dislocation of beds. These beds rest on the underlying caved material causing it to compact. The Fractured Zone generally extends to a height of 24 to 30 times the seam thickness (24t to 30t) and displays significant increase in horizontal and vertical permeability, due to the interconnection of the fractures induced in the strata. As such, the hydrogeological regime is permanently altered.
- Constrained Zone: This zone is often referred to as the Aquiclude Zone. In this zone the strata sag; however because the strata is constrained and the imposed strains are lower than in the Fractured Zone, the degree of fracturing and dislocation of the strata is limited. Some horizontal bed separation or slippage is generally present, as well as discontinuous vertical cracking. Increases in horizontal permeability occur but no significant increase in vertical permeability is likely.
- Surface Zone: This zone comprises unconfined strata at the ground surface, in which mining induced tensile and compressive strains may result in the formation of cracks or ground heaving. If in soils, the soil properties may allow little or no crack development due to the plastic and brittle nature of many soils. If in rock, natural pre-existing fracturing may dilate but would have little effect on continuity. Vertical permeability may increase slightly in this zone.

The overburden would subside under the stress and form a trough-shaped depression over the subsided longwall panel. The extent of deformation over the longwall panels is influenced by many factors including the seam extraction height, depth of cover and physical properties of the overburden strata. These subsidence parameters are discussed in **Section 8.2**.

If there are only minimal quantities of groundwater contained within the overburden strata, then the strata disturbance and increased permeabilities described above would have little impact on groundwater inflow or the groundwater regime. When mining occurs under major aquifers (or surface water bodies) the nature and extent of the strata deformation zones can result in significant changes to the flow regime.

It is evident that the caved and fractured zone would normally experience an increase in vertical permeability and would therefore tend to drain groundwater from aquifers which occur in these zones. However, because the constrained zone contains few interconnecting fractures it has the potential to prevent significant vertical hydraulic

connection between the mine and overlying aquifers (or surface water bodies), provided the initial permeability of overburden strata is low.

The extent of the fracture zone above the mine workings at Baal Bone Colliery, or anywhere within the Western Coalfields, has not been accurately established. Previous studies have used what is considered a conservative fracture height of 100 m, which is 20 m greater than that verified in the Newcastle Coal Measures. Based on this fracture height, the fracture zone during mining of approved Longwalls 29 to 31 and identified Remnant Areas is likely to be restricted to the strata of the Illawarra Coal Measures which extends between 95 and 105 m above the LCS to the base of the Narrabeen strata.

Surface fracturing is normally limited to a depth of 10 to 15 m from the surface. Therefore, diversion of groundwater to aquifers can only occur where the aquifers are within about 15 m of the ground surface. Where there are no aquifers, surface flow into surface fractures will eventually emerge at the ground surface outside the subsided area. In the area above Longwalls 29 to 31, there are no known aquifers within 15 m of the surface where surface cracking occurs. The only known aquifer is located at a minimum depth of about 30 m beneath the western edge of longwall 29, and becomes deeper further to the east.

There may be minor aquifers present in the upper part of the Narrabeen Group which outcrop on the western flank of the ridge above Longwalls 29 to 31, so that there is a small chance that a limited volume of surface water is diverted into these aquifers. Some of this groundwater may be diverted to the east into the Wolgan River catchment. Although theoretically feasible, this scenario is highly unlikely to reduce the total water input to the swamp by any significant amount, since the swamp relies largely on direct rainfall.

Even if diversion of surface water flow occurs as described above, there will be no net effect on the natural run-off to the Coxs River Swamp since the shortfall in runoff from the eastern side of the swamp will be made up from the western side, where surface water flow on the western side of the ridge over Longwalls 1 to 15 will deliver additional surface water to the swamp by the same mechanism.

11.2.2 Impact of Mining on Aquifers

Depth of cover across the Project Area ranges from approximately 25 m in the north west up to approximately 200 m in the south and south east. Mining to date has resulted in fracturing to surface in goafed areas, particularly above extracted longwalls in the north of the Project Area where the depth of overburden is minimal.

Records indicate that groundwater seepage into the northern mine workings within the Project Area was not as high as the southern mine workings, likely due to the limited extent of water bearing strata in the north mine area and less depth of cover. Calculations and modelling based on current assumptions have indicated that the average total groundwater seepage into the mine is in the order of 4 ML/day.

Where the depth of cover increases and the Narrabeen Group is present overlying the coal measures to the south of the Project Area, the fracture zone is not expected to extend beyond the base of the Narrabeen Group, which lies a minimum of 95 m above the extracted LCS. Although some strata fracturing, including opening of bedding planes, and hydrogeological changes has probably occurred within the Narrabeen strata, these changes are not considered likely to be significant (**Appendix G**). As a result, potential impacts on the groundwater flow in the Narrabeen Group aquifers have most likely been minimal.

Subsidence induced fracturing within the coal measures would have resulted in the aquifers within the upper coal measure strata draining into the mine workings. The volume of groundwater currently being pumped from the mine suggests that this is occurring, and the coal seam aquifers within the coal measure strata above the LCS probably contribute a large proportion of the groundwater inflow to the current mine workings. As such, it is likely that most of the coal measure aquifers would be drained as a result of historical and current longwall extraction and significant drawdown of groundwater levels within the coal measures has and would continue to occur. This would not affect the supply of surface or groundwater to the Coxs River Swamp, as the source of groundwater supplying the swamp is within the Narrabeen Group, which would not be impacted.

Pumping records for the period January 2008 to May 2009 indicate that on average 4.25 ML/day is dewatered from both the north and south mine pumps, combined. Although the exact source of this groundwater has not been determined, it is likely that it drains from the coal seam aquifers in the upper coal measures strata, with a lesser contribution due to infiltration from higher up in the sequence.

Mine water discharge is monitored regularly as part of the environmental monitoring program for Baal Bone and the discharge water is generally neutral to slightly alkaline and of potable/brackish quality. Groundwater is

generally discharged to Jews Creek, with minor amounts being reused onsite. The current rate of dewatering is not expected to change considerably for the remaining mine life.

11.2.3 Impact of Mining on Base Flow to the Swamps

Observations have shown that although groundwater is likely to supply a minor percentage of total water input to the swamps in the Project Area, the groundwater contribution is important in that it may sustain the swamp vegetation in times of prolonged drought. As such, it is desirable that the groundwater flow to the swamps is maintained given the ecological significance of the swamp vegetation. The major groundwater contribution to the swamps in this area is from the sandstone aquifers in the Narrabeen Group.

There is evidence from previous experience that the groundwater base flow to the swamps has been unaffected by mining. The extraction of previous longwall panels adjacent to the Coxs River and Jews Creek Swamp did not appear to result in identifiable deleterious impacts on the swamp during the extraction of those longwalls, or in the protracted drought period (2006/07) which occurred subsequent to the completion of mining (Connell Wagner, 2006, refer **Appendix G**). This provides good evidence that future extraction can be carried out successfully without impacting on the groundwater in the swamps.

SMP approval conditions required the Colliery to prepare a Surface and Groundwater Response Strategy, which was to provide details of the establishment and operation of the groundwater and surface water monitoring program in the vicinity of the swamp. Methods of impact assessment were also included, as well as trigger levels for response actions to abnormal occurrences. The Surface and Groundwater Response Strategy (Connell Wagner, 2008) requires monitoring data to be reviewed regularly so that anomalies can be identified. The groundwater monitoring program targets two important groundwater systems:

- Groundwater in the sandstone aquifer within the Narrabeen Groun; and
- Groundwater in the Coxs River Swamp.

The hydrogelogical assessment (Connell Wagner, 2006, **Appendix G**) concluded that there would be no permanent impact on the near-surface groundwater or the Coxs River Swamp from the extraction of Longwalls 29 to 31. This contention was based on the fact that there had been 17 longwall panels extracted immediately west of the Coxs River watercourse and the Coxs River Swamp in the 1980s, with no apparent impact on the swamp vegetation at any time in the intervening period.

Although no groundwater data were available at the time the hydrogeological assessment was undertaken, six piezometers were installed in the vicinity of Longwalls 29 to 31 in 2007 (refer **Figure 11-3**) to monitor the groundwater in the Coxs River Swamp and in the sandstone aquifer within the Narrabeen Group which supplies the swamp. The groundwater in the sandstone aquifer is monitored for change, since abnormal or unexpected subsidence impacts could lead to changes in groundwater level or quality in the aquifer. This change would be the first noticeable sign that the subsidence impacts on the aquifer are not as predicted. If mining impacts are detected on the sandstone aquifer, then the swamp groundwater monitoring would indicate if there are consequent impacts on the swamp groundwater. Monitoring of the six piezometers was (and continues to be) undertaken monthly and included monitoring of pH, electrical conductivity, and a suite of other analytes. Data is reviewed two-monthly to determine if there are impacts from the mining on the local groundwater regime.

Groundwater monitoring prior to the commencement of mining of Longwall 29 showed that the groundwater levels in the swamp, and in the aquifer on the western side of the swamp, were at apparently normal levels. This is despite the fact that the water level in the adjacent workings has been maintained well below the base of the swamp by near-continuous pumping from the South Mine dewatering bore (refer **Figure 4-2**). This strongly suggests that there is no major hydraulic connection between the swamp or near surface aquifer and the mine workings. Since Longwalls 29 to 31 are down dip and further away from the swamp than the previously mined longwall panels, the risk of any impact on the swamp and the groundwater from the extraction of these panels is deemed to be much lower than for the previously mined panels.

Following data evaluation at the end of July 2009, the groundwater level data at the boreholes nearest the fault zones, BBP1 and BBP2, and to a lesser extent, BBP3, were found to contain anomalies of sufficient magnitude to qualify as a “moderate impact” under the Surface and Groundwater Response Strategy, which suggests that groundwater may have been drained from the aquifer adjacent to the fault zone during the extraction of Longwall 29.

There were no significant impacts on the groundwater in the aquifer further away from the fault (BBP3 and BBP4). An investigation of the anomalous results was undertaken in accordance with the Response Strategy, and considered a number of scenarios that could have influenced the changes to groundwater level that were experienced.

The most likely explanation for the observed changes is that there has been some loss of water into the Coxs River Lineament Fault Zone or on the structural/stress zones that have been located in the workings. This major fault passes close to all three affected boreholes and so movement could potentially affect all three of the impacted boreholes. Movement of water into this fault could result in the drainage of water from the aquifer into the fault zone. Longwall 29 panel converges with the fault as it retreats further, so it is possible that further losses may continue to occur as the mining progresses. The investigation concluded that there has not been a measurable impact on the groundwater in the swamp that could be attributed to the mining, which suggests that the observed impacts are temporary.

More recent monitoring data and observed impacts following good rainfall in early February 2010 shows a possible stabilising trend in the aquifer groundwater levels, and currently, there is no significant impact on groundwater in the Coxs River Swamp. Groundwater would continue to be monitored closely as part of the groundwater monitoring program, as well as implementation of a suite of recommendations from the groundwater investigation and continued implementation of the Surface and Groundwater Response Strategy as described in **Section 11.5**.

11.3 Potential Impacts

As discussed previously, mining operations to date would have largely depressurised the coal measures aquifers. As such, the incremental and cumulative impacts of mining approved Longwalls 29 to 31 and the identified Remnant Areas on the groundwater regime within the Project Area are considered minimal.

A detailed hydrogeological assessment of the likely impacts to the aquifers and swamps from the mining of Longwalls 29 to 31 was prepared by Connell Wagner (2006) (refer **Appendix G**) and is discussed in the preceeding sections. The assessment concluded that:

- The fracture zone of the overburden in the vicinity of Longwalls 29 to 31 is likely to be restricted to the Illawarra Coal Measures, which extends approximately 100 m above the LCS, and as such is not likely to intercept the sandstone strata containing aquifers in the overlying Narrabeen Group. Although it is possible that strata fracturing and hydrogeological changes may be experienced in the Narrabeen strata above this zone, the changes would not be significant and/or permanent;
- The incremental impacts on the regional hydrogeological regime at Baal Bone due to the extraction of Longwalls 29 to 31 are considered to be minimal; and
- The likelihood of extraction of Longwalls 29 to 31 resulting in a significant impact on the Coxs River Swamp is considered extremely low.

A monitoring program has also been implemented as a recommendation of the hydrogeological assessment to monitor the local hydrogeological changes to the groundwater system and swamps as a result of mining of Longwalls 29 to 31.

Mining of the identified Remnant Areas between the previously extracted longwall panels is not considered likely to cause significant further subsidence due to the limited extent of extraction proposed, and the degree of subsidence which has occurred as a result of mining adjacent longwall panels (SCT, 2009). The Remnant Areas are surrounded by areas that have previously been extracted, such that the incremental impact on the groundwater resource from the extraction of these areas would be negigible. Subsequently, no additional impact to the groundwater regime is anticipated as a result.

11.3.1 Potential impacts to Groundwater Flow to Swamps

Although mining is currently being undertaken in the vicinity of the Coxs River Swamp (Longwalls 29 to 31), the approved mine plan has been designed such that the none of the swamps is in the area that would be undermined directly (or are in the zone of influence of the subsidence effects) so that direct subsidence effects are unlikely to impact on the groundwater supply.

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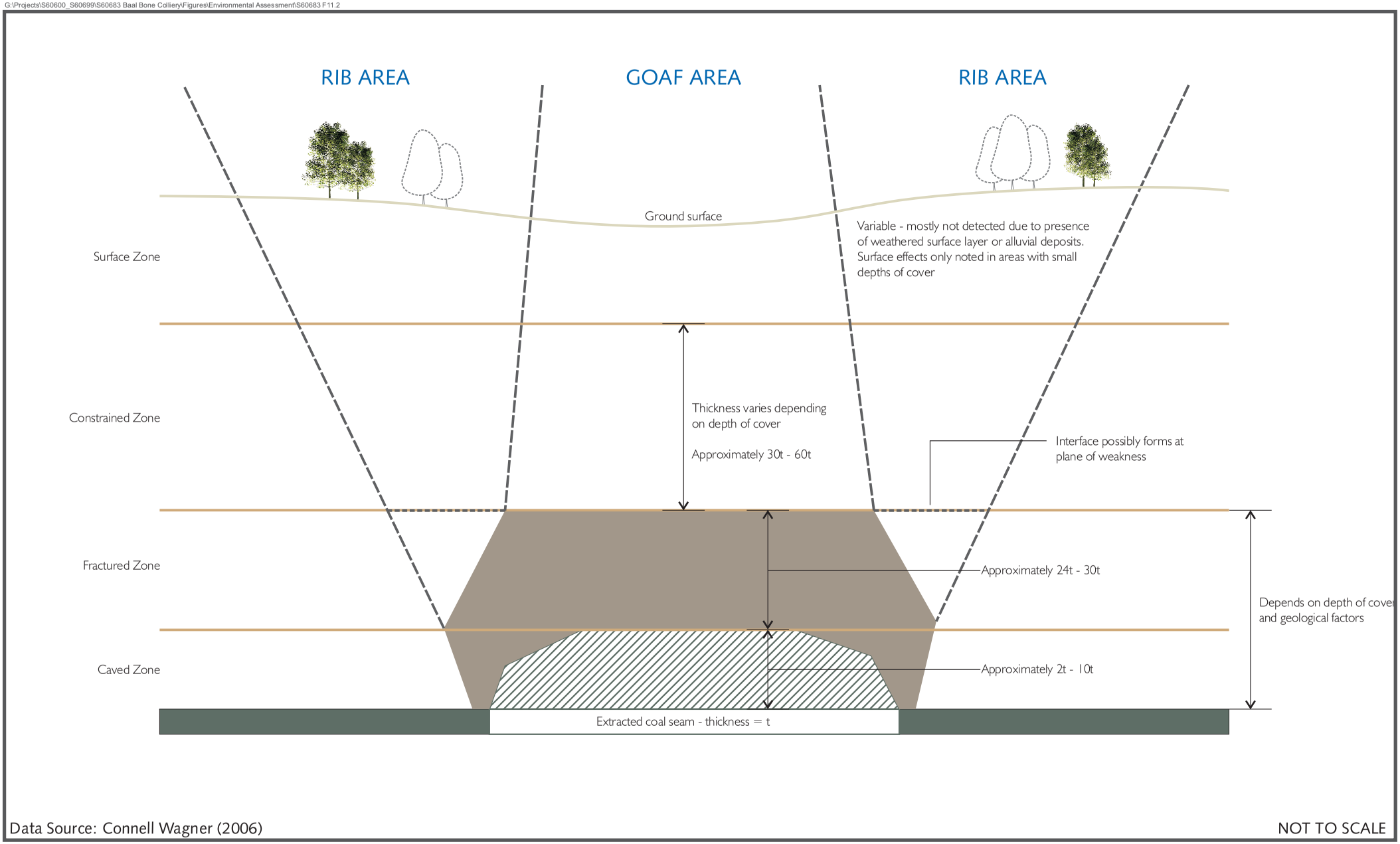

Data Source: Connell Wagner (2006)

NOT TO SCALE

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INDICATIVE EXTRACTED LONGWALL PANEL WIDTH CROSS SECTION

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 11.2

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LOCATION OF MONITORING BORES - COXS RIVER SWAMP

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 11.3

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Given the available data and previous experience at Baal Bone, there is a level of confidence that the proposed mining would not result in adverse impacts to the swamp. This is because the potential for impact on the groundwater flow in the Narrabeen Group aquifers is considered to be minimal, and hence the groundwater flow to the swamps is not expected to be affected significantly.

However, the potential for mining-induced movement on the major faults and/or structural zones to impact on the Coxs River Swamp is uncertain at this stage. Based on recent investigations in response to anomalous monitoring data, it is possible that movement of these zones could have some impact on the aquifer that discharges into the swamp, and so there is the potential for disruption of groundwater flow. In the event that groundwater flow to the swamp is disrupted in the future, the impact is likely to be localised, and limited to the area near the structure. If this occurs, base flow from these aquifers to the swamps should not be impacted, and would continue to be monitored for changes. At worst there may be some minor or transient changes to groundwater flow, which should result in negligible short-term impacts.

11.3.2 Recovery Following Mining

Once mining operations are completed at Baal Bone, and pumping from the underground working ceases, the strata would re-pressurise as the goaf fills with water. Previous experience has shown that pre-mining water levels within the coal measures would eventually re-establish following mining. This has been demonstrated at the Lithgow State Mine adjacent the Springvale Colliery, which ceased extraction in 1964. Since that time, the workings have completely filled with water, and the current groundwater head at seam level is very close to pre-mining levels (CSIRO, 2003).

Permanent impacts to the groundwater regime as a result of mining at Baal Bone would include increased permeability and connectivity, particularly within the coal measures aquifers as a result of the subsidence induced fracturing. Where fracturing has propagated to the surface in areas of less cover depth, increased infiltration to underlying aquifers may result. As there are no known users of groundwater within the Project Area, the consequences of these changes are considered negligible.

11.4 Environmental Safeguards

11.4.1 Surface and Groundwater Response Strategy

TWCL's general overall approach to groundwater monitoring, detailed within the Surface and Groundwater Response Strategy is as follows:

1) *Obtain baseline information* – Establish groundwater observation bores well in advance of the expected mining commencement date to provide background water level and quality data on the prevailing near-surface groundwater conditions in the swamp and the aquifer immediately west of the mining area.
2) *Monitor the effects of mining* – Carry out continuous monitoring of groundwater levels within the swamp and in the aquifer zone, collect local daily rainfall data and monitor groundwater quality at regular intervals during the extraction of the longwall panels.
3) *Regularly assess and interpret monitoring* – Compile, review and analyse the monitoring data on a two-monthly basis to identify any abnormal unexpected behaviour, taking into account the prevailing climatic conditions and the relative position of the active longwall panel.
4) *Reporting of monitoring results* – Results of the monitoring data will be included in the four-monthly Subsidence Management Status Reports. A summary will be provided in the Annual Environment Management Report and the progress reports after the completion of each longwall panel.
5) *Assess any impacts* – Where monitoring indicates the occurrence of abnormal conditions, and response trigger levels are exceeded, an additional assessment of the impacts will be undertaken, and a comparison of all available data will be carried out to determine the cause of the impact.
6) *Identify and implement remedial actions* **–** The additional assessment in conjunction with field inspections may indicate that permanent adverse consequences have occurred and remedial action is required. Appropriate Stakeholder consultation will be part of determining and implementing any necessary remedial actions.

The Surface and Groundwater Response Strategy identifies:

- Trigger levels for subsidence impacts on ground and surface water quality and quantity that require actions and responses. The trigger levels are identified in **Section 8.7** (refer **Table 8-2**);

- The procedures that would be followed in the event that the monitoring of ground or surface water indicates an exceedance of trigger levels. This procedure is identified in **Section 8.7** (refer **Table 8-2**);
- A protocol for the notification of identified exceedances of the trigger levels;
- Measures to mitigate, remediate and/or compensate any identified impacts;and
- A contingency plan in the event of interruptions to water supplies (water quality and/or quantity) due to subsidence impacts on water supply systems and/or sources.

The Surface and Groundwater Response Strategy would continue to be implemented at Baal Bone and applied to all underground works within the Project Area.

11.4.2 Groundwater Monitoring Program

Ongoing monitoring of groundwater across the Project Area is required to provide an ongoing assessment of the impact of mining works on the groundwater regime, to enable early detection of potential adverse impacts, and to monitor the recovery of the groundwater system following completion of mining.

A groundwater monitoring program has already been established within the Project Area for Longwalls 29 to 31 as previously described in **Section 11.2.3**. In order to formulate this monitoring plan, the key monitoring parameters were established. Since the identified risks related primarily to the Coxs River Swamp (Section 11.2.3), this was the set as the main focus for the monitoring effort. Three piezometers located across previous mine workings are currently monitoring quarterly, and six peizometers located in the vicinity of Longwalls 29 to 31 (**Figure 11-3**) are currently monitoring groundwater in the Coxs River Swamp and are measured monthly. Data is regularly reviewed two-monthly to determine potential impacts on the local mining regime. The peizometers monitor water levels and analytes including pH, electrical conductivity, iron, sulphates, oil and grease. A review of the Surface and Groundwater Response Strategy would need to be undertaken prior to mining of the Remnant Areas.

Groundwater level and quality monitoring data would be analysed by a specialist in conjunction with available climatic data. Graphs of all groundwater data would be generated and reviewed and the appropriate level of management action or response would be initiated, where necessary, in accordance with the TARP identified in the Surface and Groundwater Response Strategy.

Piezometers were also recently installed in the vicinity of Jews Creek Swamp in the north of the Project Area to enable variations in groundwater levels and quality to be monitored. Although further mining is not currently proposed in the vicinity of Jews Creek Swamp, it is recommended that these piezometers be added to the current groundwater program for the Colliery so that recovery of the groundwater regime can be monitored following the completion of mining in the Project Area.

11.5 Conclusion

The hydrogeology of the Project Area is strongly influenced by the topography and geology, which comprises the coal seams of the Illawarra Coal Measures overlain by the sedimentary strata of the Narrabeen Group. Historic erosion in the north of the Project Area has completely removed the Narrabeen Group and Illawarra Coal Measures are exposed at the surface. Cover depths over the LCS range from 25 m in the north of the Project Area where the Illawarra Coal Measures are exposed, to approximately 200 m in the south of the Project Area where the Narrabeen Group is present.

Mining to date has resulted in fracturing to surface in goafed areas, particularly above extracted longwalls to the north where the depth of cover is minimal. Such fracturing has resulted in leakage from overlying lithologies, allowed surface water to enter the mine working in some areas, and has undoubtedly resulted in a reduction in pressures within the mine area.

The fracture zone associated with mining of Longwalls 29 to 31 and the Remnant Areas is not expected to reach the strata of the Narrabeen Group, where present, which lies a minimum of 95 m above the extracted LCS. As such, additional cumulative impacts to the groundwater regime or swamps within the Project Area as a result of the proposed future mining are not considered likely to be significant.

Ongoing implementation of the Surface and Groundwater Response Strategy and a Mine Water Make Monitoring Program as part of the SMP across the Project Area, would enable the groundwater regime within the Project Area to be monitored and adverse impacts readily identified and managed.

12.0 Tailings and Reject Management

12.1 Existing Management

12.1.1 Background

A section of the Baal Bone Surface Infrastructure Area was formerly open cut mined in the 1950s, down to a depth of up to 15 m below natural surface levels in some areas of the site. An area of more recent open cut pit to the south of the site was reserved for the disposal of tailings. The remainder of the site has been rehabilitated in stages.

Coal handling and preparation processes generate both coarse reject and fine tailings waste which is managed and disposed of on site in approved Reject Emplacement Areas (REA). Reject and tailings waste is classified depending on particle size, as either coarse (100 µm to 100 mm) or fine (<100 µm). Fine reject material is known as tailings.

The CHPP at Baal Bone has a maximum design processing rate of 2.6 Mtpa, resulting in a maximum annual production of 114000m^3 of fine reject material (tailings) and 360000m^3 coarse reject material. Coarse reject is trucked via an internal haul road to the REA (refer **Figure 4-3**) and tailings is pumped as 20 to 25% slurry to the tailings dam.

12.1.2 Reject Emplacement Area

Baal Bone has previously operated a number of REAs. The current Reject Emplacement Area, REA 6, receives coarse reject and tailings waste from the CHPP (**Figure 12-1)**. All previous REA's have been fully rehabilitated and capped, while another (REA5) is currently drying out and would be fully rehabilitated in the near future.

The tailings dam in REA 6 is constructed in the void of the former southern open cut workings. It is bounded by a high wall to the south, and consists of two cells, Cell 1 and Cell 2, separated by an embankment. The embankment between the cells and the walls have been constructed of coarse reject. The base of the cells is the excavated coal seam floor and the top embankment level of REA 6 is 878 m AHD. Cell 1 is used for the emplacement of tailings, while Cell 2 is used to collect leachate generated by the tailings in Cell 1.

REA 6 has been used for the storage of tailings since 2008, and has a total capacity of some 485000 m^3.

12.1.3 Reject Classification

Coal reject generated by processes at Bone Colliery comprises a mixture of high ash coal and non-coal materials, such as sedimentary rock and clay. These materials occur within the coal seam and as floor and roof materials extracted during the mining operation. They are rejected during the beneficiation process on a specific gravity basis and are separated into coarse rejects and tailings rejects.

Coarse Reject

Baal Bone's coarse reject has a particle size ranging from 100 mm to 100 µm and comprises approximately 18% of washery feed. Analysis of the coarse reject material generated at Baal Bone confirms that it is non saline and pH is near neutral with negligible acid producing capacity. It does however, exhibit poor physical characteristics with a coarse texture and low water holding capacity.

Coarse rejects are currently being strategically placed in the REA to eventually create the design final landform. Three dimensional modelling completed in late 2006 confirmed that a further 4.73 Mt of coarse reject could be accommodated in this area at that time. Based on current production rates this area should provide sufficient capacity for the remainder of the life of the mine.

Tailings

The fine rejects are generally less than 100 µm in diameter and comprise around 7% of CHPP feed. Fine reject is pumped as 20 to 25 % slurry to REA 6.

Leachate generated by Cell 1 is collected in the adjacent leachate collection area, Cell 2, and is returned to the process water circuit for reuse by the CHPP. The process water circuit is further discussed in **Section 10**.

An assessment of the capacity of the Reject Emplacement Area to accommodate tailings reject generated by the continued operations at Baal Bone, in particular the mining of Longwalls 29 to 31 and Remnant Areas, has been assessed and the Tailings Capacity Assessment is provided in **Appendix H.** The results of the assessment are discussed in the following sections.

12.2 Assessment Methodology

A background review was undertaken based on available information to determine the current capacity of REA 6, and included the following:

- Survey data collected on 22 May 2009 by Craven, Elliston & Hayes Pty Ltd of the south eastern corner of the site (DWG No BBREH09);
- Report prepared by Umwelt (2008) Construction and Operation of Reject Emplacement Area 6 (REA6) at Baal Bone Colliery;
- Report prepared by Umwelt (2005) Construction and Operation of Reject Emplacement Area 5 (REA5) at Baal Bone Colliery; and
- Xstrata Tailings Storage Management, HSEC STD 8.1

12.3 Tailings Capacity Assessment

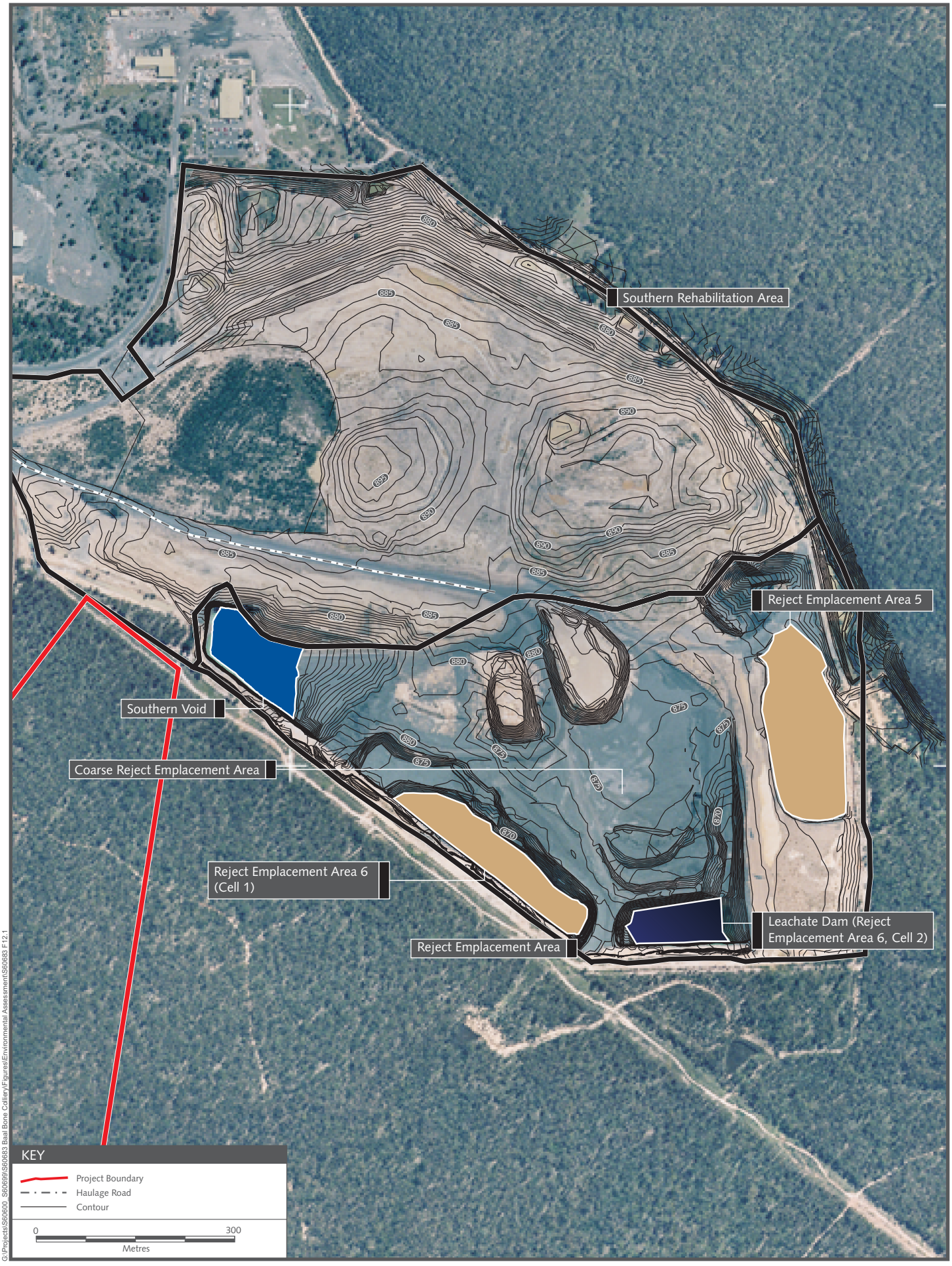
A Tailings Capacity Assessment (**Appendix H**) was undertaken in order to estimate the tailings storage capacity to facilitate continued operations at the Colliery. The assessment utilised information obtained from the background review, and also investigated other voids in the Reject Management Area that could have the potential to be commissioned to extend the overall tailings storage capacity of Baal Bone.

Investigations into potential tailings storage considered the following was considered in relation to the potential REAs:

- Allowance for flood events;
- Allowance for capping in accordance with the mine's tailings management plan; and
- Allowance for free water above the tailings surface at emplacement.

In calculating the volume of REA 6 tailings dam from recent survey work (Baal Bone Colliery Rehabilitation Survey, May 2009, drawing number BBREH09, dated 22/5/09), the volume of a slice at each RL was taken and added to give a total volume.

Based on the recent survey data for the site it was calculated that the tailings dam has a total remaining capacity of approximately 352000m^3 for tailings emplacement (Cell 1) and 102000m^3 for leachate collection and storage (Cell 2). At the maximum emplacement rate of 114000m^3 of tailings per year, it was calculated that this area can provide approximately 3.2 years of total storage, or to the middle of 2011. Following completion of Cell 1, Cell 2 can be used to accept tailings, thereby providing an additional 0.9 years of storage capacity.



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TAILINGS AND REJECT EMPLACEMENT AREA

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 12.1

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An alternative emplacement area known as the Southern Void (refer **Figure 12-1**) was identified at the Baal Bone Colliery site for deposition of fine tailings slurry. The area, a continuation of the remnant open cut void, is located north west of REA 6 and, based on recent survey data has a total volume of approximately 383000m^3. At the maximum emplacement rate of 114000 m^3, the Southern Void can provide tailings storage for approximately 3.3 years, or from about early 2012 to the end of 2015. A summary of the available tailings storage is provided in **Table 12-1** below.

Table 12-1: Reject Management Area - Tailings Storage Capacity

Reject Emplacement Area	Volume Remaining	Timeline
REA 6 – Cell 1	352000 m^3	Present – mid 2011
REA 6 – Cell 2	102000 m^3	Mid 2011 – early 2012
Southern Void	383000 m^3	early 2012 – end 2015

The Tailings Capacity Assessment conducted as part of this EA confirmed that Cells 1 and 2 of REA 6, based on expected emplacement rates, would have adequate capacity for emplacement for the proposed continued operations of the Colliery. Should the Colliery require further capacity, the Southern Void has been identified as a potential REA.

Consideration was given to the potential consequences resulting from a failure within REA 6; however, the likelihood was considered low to very low due to the internal structure of the emplacement area (Umwelt 2008).

12.4 Potential Impacts

As discussed in **Section 12.1.2**, the current REA6 has been constructed below natural ground surface, bound by a high wall and consists of two cells (Cell 1 and Cell 2) separated by an embankment. The embankment has been constructed of coarse reject from previous Baal Bone operations. Tailings slurry is placed in Cell 1, while leachate water from Cell 1 decants through a pipe to Cell 2. The base of the cells is the excavated coal seam floor which, due to its regional dip, facilitates the flow of leachate from Cell 1 to Cell 2. Leachate water from Cell 2 is piped back to the Dirty Water Dam as described in **Section 10** for reuse in the process water system.

The geotechnical design of the separation embankment for REA 6 has been completed by a geotechnical engineer as required at the time of approval in 2008 by the DPI-MR (now DII) under the *Coal Mines Regulation Act 1982*. A geotechnical review of this embankment is completed annually.

All dams and associated pipelines at Baal Bone are inspected on a daily, weekly and monthly basis as required.

The application for REA6 prepared in 2008 under Section 126 of the *Coal Mines Regulation Act 1982* gave consideration to the potential consequences resulting from a failure of the emplacement area. The assessment made the following conclusions:

- REA6 lies fully within an old open cut area such that it presents negligible hazards to any operation downstream;
- Structurally, the only feature of the emplacement area that has the potential for failure is the stability of the embankment between Cell 1 and Cell 2. As this embankment would not result in loss of containment of tailings or leachate, no significant environmental impacts would result in the case of such a failure;
- The design of the embankment facilitates drainage of leachate from Cell 1 to Cell 2 for reuse in the process water system; and
- The embankment is built on the *in situ* floor of the coal seam (intact rock) hence the only failure mode is through the coarse reject. During operations the worst-case condition regarding stability would occur during heavy rainfall whereby the embankment would be fully saturated.

An application to the NSW Dams Safety Committee (DSC) for a formal assessment in regards to a classification of REA6 under the *Dams Safety Act 1978* was submitted in 2007. The final determination confirmed that it the dam is not Prescribed (a catastrophic or high risk ranking) due to low risks associated with the proposed holding structure.

In this case, the consequence of failure was determined as low to very low (REA6), as the affected zone would involve the internal structure of the emplacement area, i.e. from Cell 1 to Cell 2, which does not represent a risk to the environment, as leachate is contained and transferred to the Dirty Water Dam.

Safeguards which are incorporated into existing operational management procedures are included in **Section 12.5** below.

12.5 Management Implications

Baal Bone has a number of operational controls which are implemented to mitigate potential impacts associated with the Reject Emplacement Area, which include:

- Regular visual inspections of the emplacement area including specific attention to the structural integrity of the embankment and the flow of leachate;
- All dams and associated pipelines at Baal Bone are inspected on a daily, weekly and monthly basis as required; and
- Operation of transport in the vicinity according to regulations.

It should be noted that none of the current dams at Baal Bone are of a catastrophic or high risk rating, however as a minimum, any future dams with a catastrophic or high risk ranking:

- Must have undergone an appropriate engineering design (e.g. relevant dam safety committee concurrence); or
- Where existing catastrophic or high risk dams have not been through an engineering design, a certification of competence for the design must be provided by a suitably qualified engineer.
- Any future dam constructed with a catastrophic or high risk hazard will have a specific management plan including operational requirements and monitoring program. The monitoring program may be incorporated into the regular inspection checklists, however, the person who is to inspect the catastrophic or high risk dams would be competent to do so.

These mitigation measures and safeguards would continue to be implemented as part of the continued operations at Baal Bone.

12.6 Conclusion

The tailings capacity assessment concluded that the tailings and coarse reject generated by continuation of operations at Baal Bone could be adequately accommodated by REA 6 and the Southern Void for approximately 5.5 years, or until the end of 2015, at the maximum emplacement rate. Additionally, the area currently has sufficient capacity to accommodate coarse rejects for the remainder of the life of the mine at Baal Bone. Consideration was given to the potential consequences resulting from a failure within REA 6; however, the likelihood was considered low to very low due to the internal structure of the emplacement area (Umwelt 2008).

13.0 Mine Closure and Rehabilitation

13.1 Existing Environment

As stated previously, Baal Bone lies on the lower north easterly slopes of the Ben Bullen range, within the catchments of Ben Bullen and Jews Creeks. The majority of the Surface Infrastructure Area has been disturbed by previous or current mining-related activities.

The Surface Infrastructure Area lies within the disturbed landscape of the former Ben Bullen State Open Cut Mine, which ceased operation in 1952. In many areas the natural surface and drainage systems have been extensively modified by prior open cut mining, spoil/overburden dumps and the construction of water containment structures. Land capabilities were classified as Class M (Mining and Quarry Areas), IV (Grazing – occasional cultivation) and VI (Grazing – no cultivation) and reflect the low fertility soils in the area (see **Section 17**).

13.2 Rehabilitation History

A Development Approval was granted by the Council of the City of Greater Lithgow in February 1996 to allow remnant open cut mining to be undertaken at Baal Bone. The scope of the project was twofold; to recover the remaining viable open cut reserves following cessation of the former Ben Bullen Open Cut mine and to generate a source of suitable land forming (i.e. waste rock) and land covering (i.e. clay loam, aka. Freedig) material for use in the rehabilitation of the former Ben Bullen Open Cut site.

Open cut mining commenced in late 2005 and was completed by mid-2007. Following the completion of open cut mining the disturbance footprint at Baal Bone has been reduced due to the substantial rehabilitation undertaken in both the northern and southern open cut precincts, as shown in **Figure 13-1**. This figure shows the current status of rehabilitation activities at Baal Bone.

Rehabilitation and drainage works have been developed following consultation with the NSW DII, DECCW and DWE through various meetings and site visits.

13.2.1 Recent Rehabilitation Activities

During the recent open cut and rehabilitation program at Baal Bone, approximately 7.75 million m^3 of waste rock from the open cut and coarse reject from the CHPP has been strategically placed in and around the southern and northern open cut pits to create the final design landform. Drainage paths, contour drains, ridgelines, and emplacements have been shaped in undulating informal profiles in keeping with natural landforms of the surrounding environment.

As part of this program, 110 ha has been shaped to final landform, covered with clay loam freedig material and treated with a range of structural soil conservation and stormwater management works. These areas have also been ameliorated with agricultural lime and gypsum and seeded with a range of native and improved pasture seed mixes.

Stabilisation and restoration works have also been recently completed along two sections of the Ben Bullen Creek. These works have been specifically designed and constructed using the philosophy of natural channel design; the program aims to reintroduce a range of endemic native riparian species to the site.

The Surface Infrastructure Area and the Reject Emplacement Areas have not been progressively rehabilitated due to ongoing activities associated with underground mining, coal preparation and handling. These areas would however be subject to rehabilitation once mining activities have ceased and the site has been decommissioned. Other areas that would be rehabilitated at that time include transmission lines, ventilation shafts, pipelines, various water management structures and the rail loop.

Approximately 331000 m^3 of clay loam freedig material has been stockpiled at several strategic locations around the site. This material would be utilised for capping and covering the Surface Infrastructure and Reject Emplacement Areas at some time in the future.

13.3 Conceptual Mine Closure Planning

13.3.1 Mine Closure and Rehabilitation Objective

Rehabilitation and Mine Closure Planning are intrinsically linked to the final landuse objective at Baal Bone. The principal objective for the rehabilitation of mined land at Baal Bone is to return the site to a condition where its landforms, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land fabric.

Draft Rehabilitation and Closure Criteria have been developed for the site and these are currently being reviewed in conjunction with the development of a Rehabilitation Maintenance and Monitoring Program which is being prepared as part of the Detailed Mine Closure Plan.

13.3.2 Xstrata and Industry Standards and Procedures

TWCL is in the final stages of preparing a Detailed Mine Closure Plan in accordance with the 'The Strategic Framework for Mine Closure' (ANZEC, 2006) for Baal Bone. Additionally, TWCL's Detailed Mine Closure Plan is also being prepared in accordance with the mine operators, Xstrata Coal, internal mine closure standards (XCN HSEC STD5.12 Mine Closure Planning).

The preparation of this Plan to date has included the completion of the following items:

- Desktop Constraints and Opportunities Analysis for Mine Closure;
- Final Landuse Options Workshop and Risk Register;
- Preparation of draft closure objectives and completion criteria for Final Landuse Options;
- Phase 1 and Phase 2 Contamination Survey and Assessment;
- Hazardous Materials Survey and Site Register;
- Completion of a Demolition and Dismantlement Closure Study for the site;
- Finalisation of Mine Seal Design for all mine entries, vent shafts etc;
- Indicative market valuation of Final Landuse options and accompanying cost to benefit and economic analysis of Landuse options;
- Mine Closure Social Impact Assessment;
- Detailed Environmental and Community Risk Assessment with respect to approval to Final Landuses; and
- Development and progressive implementation of Mine Closure Consultation Strategy.

13.4 Detailed Mine Closure Planning

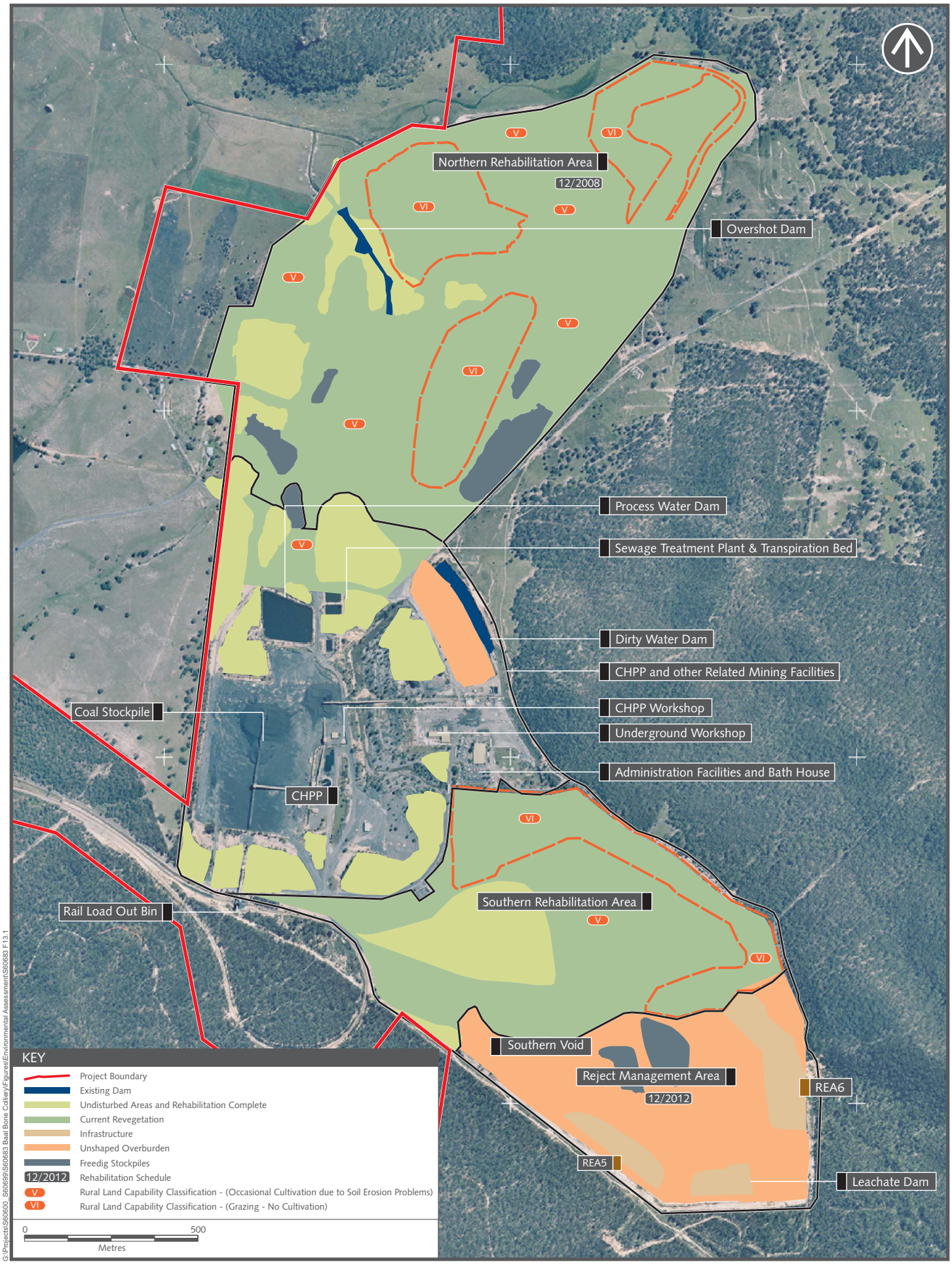
13.4.1 Mine Closure Plan Requirements

To achieve the final rehabilitation objectives, a number of rehabilitation activities would require completion. As indicated above, there are some areas that have not yet been rehabilitated and these are generally limited to the current Surface Infrastructure Area, including the pit top area, CHPP, ventilation shaft and fan compound, transmission lines, pipelines, various water management structures and the southern reject emplacement area. This is shown in **Figure 13-1**.

The Surface Infrastructure Area at Baal Bone is situated on land zoned 1(a) Rural (General) under the LEP 1994 (see **Section 5**). This zoning permits a range of land uses with and without development consent, with only the following developments being prohibited:

- Boarding Houses;
- Bulky Goods Salesroom and Showrooms;
- Commercial Premises;
- Motor Showrooms; and
- Residential Units and Shops (other than General Store).

In accordance with Xstrata and industry standards, a desktop Pre-feasibility Constraints and Opportunities Analysis for Mine Closure was completed in November 2007 by Umwelt (Australia) Pty Ltd.



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REHABILITATION PLAN (2009)

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 13.1

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This report identified a range of potential post mining sustainable landuse options and assessed the following:

- Post-mining constraints/opportunities to development/landuse;
- Preliminary geotechnical constraints;
- Preliminary ecological constraints/opportunities, including potential conservation areas;
- Preliminary archaeological constraints/opportunities;
- Preliminary contamination assessment;
- Preliminary land capability and suitability;
- Statutory controls and planning requirements;
- Preliminary access opportunities and constraints;
- Existing community service context;
- Social and economic opportunities/benefits; and
- Preliminary risk assessment of the extent to which values of the land and its physical, social and environmental context are likely to constrain future landuse options.

This analysis produced a list of potential final landuse options for the site. These preliminary landuse options were the subject of a more detailed analysis, undertaken as part of the Final Landuse Options Analysis as described below.

13.5 Final Landuse Options Plan

13.5.1 Final Landuse Options Analysis

The Final Landuse Options Plan was prepared by GSS Environmental Pty Ltd (GSSE) (March 2008) and forms part of the Detailed Mine Closure Planning process as detailed in **Section 13.3.2**. The Final Landuse Options Plan was prepared in order to assess possible landuse options identified during the Constraints and Opportunity stage of the process. The Final Landuse Options Plan was developed in consultation with a number of key stakeholders, external and internal, culminating in a stakeholder workshop session held at Baal Bone in late November 2007.

For the purposes of mine closure planning, and in order to best address the complexity of different land uses across the site, Baal Bone was been divided into series of management 'domains'. This domain approach enables better focus on the closure treatment of, and assigning of a final land use to 'like' areas. **Figure 13.2** illustrates the key management domains as they have been assigned during this mine closure planning process. The preferred land capability classification for the preferred final land use in each domain is described in **Table 13-1** and shown on **Figure 13-3**.

By addressing each like 'domain' systemically the specific aspects in the context of mine closure have been considered, including the location of the site, type of land disturbance and the specific environmental issues to be addressed in each domain in assigning a final land use.

Table 13-1: Management Domains and Final Land Use

Management Domain	Preferred Final Land Use
Domain 1: Northern Zone Void	Class VI Rural Land Capability Classification - (Grazing - No Cultivation) and Class VIII Rural Land Capability Classification - (Unsuitable for Agriculture)
Domain 2: Northern Zone – Rehabilitation Area	Class VI Rural Land Capability Classification - (Grazing - No Cultivation), Class IV Rural Land Capability Classification (Grazing - Occasional Cultivation)
Domain 3: Central Zone, including the CHPP, Rail Loop and Access Road	Class IV Rural Land Capability Classification (Grazing - Occasional Cultivation)
Domain 4: Central Zone, including the Pit Top Area	Class IV Rural Land Capability Classification (Grazing - Occasional Cultivation)

Management Domain	Preferred Final Land Use
Domain 5: Southern Zone – Rehabilitation Area	Class VI Rural Land Capability Classification - (Grazing - No Cultivation), Class IV Rural Land Capability Classification (Grazing - Occasional Cultivation)
Domain 6: Southern Zone, Reject Emplacement Area and Void	Class IV Rural Land Capability Classification (Grazing - Occasional Cultivation)

A number of potential landuse options for Baal Bone were analysed during the stakeholder workshop, with these being:

- Rural Land Use (Grazing);
  - Being able to sustainably graze the land at stocking rates that are comparable to the regional average, and be able to fatten cattle such that a return on investment may be able to be achieved in line with regional expectations.
- Rural Land Use (Agro-Forestry);
  - Being able to grow plantation trees at growth rates that are comparable to those rates achieved in the neighbouring forests, such as Ben Bullen State Forest.
- Native Woodland;
  - Being able to demonstrate that the biodiversity value is comparable to undisturbed areas of native vegetation adjacent to the site;
- Carbon Offsets and Carbon Credit;
  - Being able to demonstrate by scientific measurement that carbon is being sequestered. Note: Carbon Offsets and Carbon Credits generally cannot be obtained on land that is being rehabilitated as part of the normal business function or requirement under an approval.
- Future Mining Related Purposes;
  - Undertaking activities that are related to the mining of coal or supporting a process in the coal handling and preparation process such as coal washing, transportation and/or reject emplacement.
- Industrial Park Development;
  - Establishing a precinct that supports either one (1) single industrial user or a series of users.
- Non-mining Waste Disposal; and
  - Utilising the voids on the site to dispose of non-mining waste materials, (e.g. domestic/industrial wastes, fly ash from power stations etc).
- Recreational Pursuits.
  - Establishing or using facilities that support some form of recreational pursuit as 4WDing, motocross, camping, bushwalking, scout camps or conferences.

The Final Landuse Options Workshop included a range of agency and community stakeholders, and concluded that the preferred end land use for the site generally included a combination of grazing and bushland/wildlife habitat, with the option of retaining some areas for future mining related purposes where applicable. The stated land use combinations are compatible with adjoining land and satisfy the overarching rehabilitation objective for the site, with the guiding principle of creating the most beneficial future use of rehabilitated land, which can be sustained in view of the range of limiting factors.

The workshop session and subsequent analysis confirmed that the preferred post-mining rehabilitated landscape would be dominated by a mixture of Rural Landuse Grazing and Native Woodland activities on a landscape characterised by country with a Rural Land Capability classification of Class V (Grazing – occasional cultivation with structural soil conservation works) and Class VI (Grazing – no cultivation).

Although no social and economic impact assessment was undertaken for each specific landuse option at this stage, the community and employee's opinions were considered as part of the overall Social Impact Assessment (SIA) undertaken by Coakes (2008) and considered in the mine closure planning process. The general perspective of all stakeholders for overall landuse and final rehabilitation and closure of the site were considered in the final landuse options planning.

As detailed in the SIA, the majority of the employee and contractors felt that the site should be rehabilitated to its natural state, with others suggested the land be used for agriculture or industrial training purposes. A survey undertaken by Coakes (2008) regarding the future use of the site identified:

- 21.1% of personnel thought the site should be used as a wildlife/nature reserve;
- 11.2% for agricultural/farming uses;
- 7.9% for industry use;
- 6.6% for other recreational uses; and
- Other uses such as Landfill (4.6%), motorsport theme park (3.3%), prison camp (1.3%) or mine heritage site/museum (0.7%).

The remainder of employees did not specify a final landuse preference. The employees and contractors opinions have contributed to the Final Landuse Options Plan and demonstrate the product of effective consultation of the colliery with its staff.

13.5.2 Mine Closure and Completion Criteria

Mine closure and completion criteria are currently in planning stages and are being refined further include specific and measurable Key Performance Indicators (KPI) for each criterion. All relevant stakeholders are being included in this process and will also include a rehabilitation/lease relinquishment Risk Assessment and workshop.

Draft closure criteria have been developed for each of the final land use options discussed in **13.4.2**. The range of generalised criteria for each land use option are described in **Table 13-2**; the development of relevant KPI's for each criterion are currently being finalised and will be confirmed as part of the consultation and workshop process.

Table 13-2: Draft Final Landuse and Rehabilitation Criteria

Final Landuse Option	Aspect	Rehabilitation / Closure Completion Criterion
Retain for Future Mining Related Purposes	Future Mining	Sale to external parties and/or approval of mine plan for northern mine area
	Continued operation as a coal processing / dispatch facility	Sale to external parties and/or approval of mine plan for northern / western mining areas.
	Continued use and operation as a reject emplacement area in conjunction with CHPP	Sale to external parties and/or approval of mine plan for northern / western mining areas.
Rural Land Use (Grazing)	Rural Land Capability	Achieve Class V, VI or VII land dependent on the closure area being rehabilitated (such as Northern Void or Pit-top Area).
	Erosion and drainage	Minimal evidence of accelerated erosion; no active gullies. Continued viability of constructed surface drainage system.
	Species diversity and suitability	Predominantly improved pasture to consist of at least three grass and one legume species appropriate to the district and recognized as suitable for grazing
	Ground cover	Average 70% ground cover over a minimum of 95% of areas treated.
	Pests	Pest species to be controlled at a level such that Pasture cover / land stability is not significantly impaired. No declared or noxious species present.
	Water storage	Sufficient water storage or access to water so as to support low intensity grazing activities, ie. 3 DSE/ha.

Final Landuse Option	Aspect	Rehabilitation / Closure Completion Criterion
Native Woodland	Rural Land Capability	Achieve Class V, VI or VII land dependent on the closure area being rehabilitated (such as Northern Void or Pit-top Area).
	Erosion and drainage	Minimal visible evidence of accelerated soil erosion. No active gullies. Continued viability of constructed surface drainage system until sufficient vegetation cover has been achieved and is providing the required degree of erosion protection.
	Species diversity and community composition	At least 70% of the species within the rehabilitated vegetation community will be consistent with the native vegetation community in adjacent areas of the Ben Bullen State Forest.
	Health and recruitment	Monitored increase in plant size, with evidence of ongoing reproduction (eg. juvenile foliage, flowering, fruiting and seedpod discharge).
	Pedology	Evidence of litter accumulation (approximately 30% of soil surface cover), plus evidence of soil carbon accumulation and/or nutrient mineralisation.
	Habitat	The rehabilitated vegetation community to provide habitat for a suite of fauna species similar to immediately adjacent areas in the Ben Bullen State Forest.
	Canopy height or coverage	Minimum 30% of expected mature height of canopy species or minimum 50% of target community canopy cover.
	Pests	Pest species to be controlled such that vegetation communities are not significantly impaired. No declared or noxious species present.
Industrial Park Development	Redevelopment of domain for future use as an industrial park	Sale to external parties or establishment of consortium/alliance. Approval of rezoning and Development Consent applications.

13.5.3 Long Term Rehabilitation Monitoring Methodology

A Rehabilitation Monitoring Methodology and Program for Baal Bone has been prepared by DnA Environmental (in final draft August 2009). This program will incorporate and address the completion criteria and key performance indicators described above to assist all stakeholders to monitor rehabilitation performance and targets, to set benchmarks and milestones, to observe trends and rehabilitation trajectory, and to make an informed decision about the long term landscape/ecological function of the rehabilitation areas in the context of the local environment.

This will be achieved by establishing a series of replicated sample sites on completed rehabilitation areas, in addition to a selection of relevant analogue (reference) sites. Key performance indicators measured in the reference sites will be used to form both an upper and lower limit value by which rehabilitation sites can be assessed.

Simultaneous monitoring of both rehabilitation and reference sites can be used to demonstrate that selected performance indicators have reached their established completion criteria, and/or that a satisfactory trajectory has

been achieved within a five tier hierarchy of ecosystem succession (i.e. landform establishment, growth medium development, ecosystem establishment, ecosystem development and ecosystem sustainability).

Monitoring undertaken by DnA Environmental in August 2009 compared the performance of both native woodland and improved pasture reference sites to the relevant rehabilitation areas. Due to their relative immaturity none of the rehabilitation sites were yet equivalent to Landscape Function Analysis (LFA) indices for stability, infiltration or nutrients as obtained in the reference sites. However, other individual KPI's such as species diversity, vegetation composition, soil pH, cation exchange capacity, phosphorous and nitrate levels all indicated that rehabilitation areas were progressing well and that in a number of instances had either met or exceeded individual completion criteria targets.

13.5.4 Socio Economic Impacts

An assessment of socio-economic impacts resulting from mine closure at Baal Bone has previously been undertaken by Coakes Consulting Pty Ltd (2008). This assessment employed a range of mechanisms to identify potential closure impacts and to obtain the views and perceptions of key stakeholders. It is evident from this work that the TWCL's workforce at Baal Bone will be the most impacted by the closure of the Colliery, through a loss of, or interruption to, household income. The extent of this impact will be dependent upon the length of time it takes employees to find alternative employment or to even retrain for alternative employment if required.

Based on the identified preferences of employees, Coakes suggested that impacts on the Colliery's workforce could be addressed through the provision of a workforce support package. It was envisaged that this support would be in addition to any redundancy requirements of the company. The key elements of this package include:

- **Training and counselling**, including programs such as employee assistance through coaching workshops to assist with matters such job allocation and resume preparation, financial planning and household management, retirement planning, and other counselling to assist with adjusting to change.
- **Provision of information**, including development of a bulletin providing information on job opportunities in the region, and with other Xstrata operations, and provision of regular information on the mine closure planning process and associated timelines. These measures would be detailed as part of the Mine Closure Plan for the Colliery.

The potential socio economic impacts of mine closure are discussed in further detail in **Section 21.2**.

13.6 Post Mining Rehabilitation of Baal Bone

Once all mining and processing activities are completed and the site has been decommissioned, final rehabilitation of the outstanding areas is scheduled to commence. All infrastructure would be demolished and removed during decommissioning in accordance with the Demolition Closure Study. All mine entries, including ventilation shafts, would be sealed in accordance with the approved Mine Seal Design.

During the last 10 years, approximately 135 ha has been shaped to final landform and seeded with a range of native and improved pasture seed mixes; this includes 110 ha completed as part of the current campaign, plus an additional 25 ha completed previously. As stated in **Section 13.1**, the Surface Infrastructure Area would be the focus of the majority of future rehabilitation activities.

Figure 13-3 shows the conceptual final design landform for Baal Bone. **Table 13-3** shows the schedule of planned rehabilitation works for the remainder of the life of mine.

Table 13-3: Summary of Proposed Final Rehabilitation Activities

Area Disturbed/Rehabilitated (hectares)		
Location	**Current Total Area**	**At Mine Closure (anticipated)**
Disturbed Areas		
Surface Infrastructure Area (other disturbed areas to be rehabilitated at closure including facilities, roads)	71 ha	Nil
Active Surface Mining Area (excluding waste emplacement and tailings areas; remaining NOC highwalls)	6 ha	Nil

Area Disturbed/Rehabilitated (hectares)		
Location	**Current Total Area**	**At Mine Closure (anticipated)**
Waste emplacements (dozer push and dumps in the north and south)	44ha	Nil
Tailings emplacements (REA 5, 6) (active/ unshaped/uncapped)	10 ha	Nil
Shaped waste emplacement (awaits final vegetation)	6 ha	Nil
Total Disturbed Areas remaining	136 ha	Nil
Surface of Rehabilitated Land (Cumulative)		
Pasture and grasses	60 ha	89 ha
Native woodland	75 ha	181 ha

Additionally, a ventilation shaft, fan and power transmission line corridor within Ben Bullen State Forest would be rehabilitated. The ventilation shaft would be back filled with suitable material and capped with concrete, and the shaft footprint would be contoured and re-topsoiled to achieve the pre-disturbance landform. The area would be revegetated with a mixture of native seed and mulch material harvested during the initial clearing program.

13.6.1 Rehabilitation Materials and Land Shaping

The final rehabilitation and mine closure of all outstanding areas at Baal Bone requires materials to assist in both the shaping and covering of the final design landform.

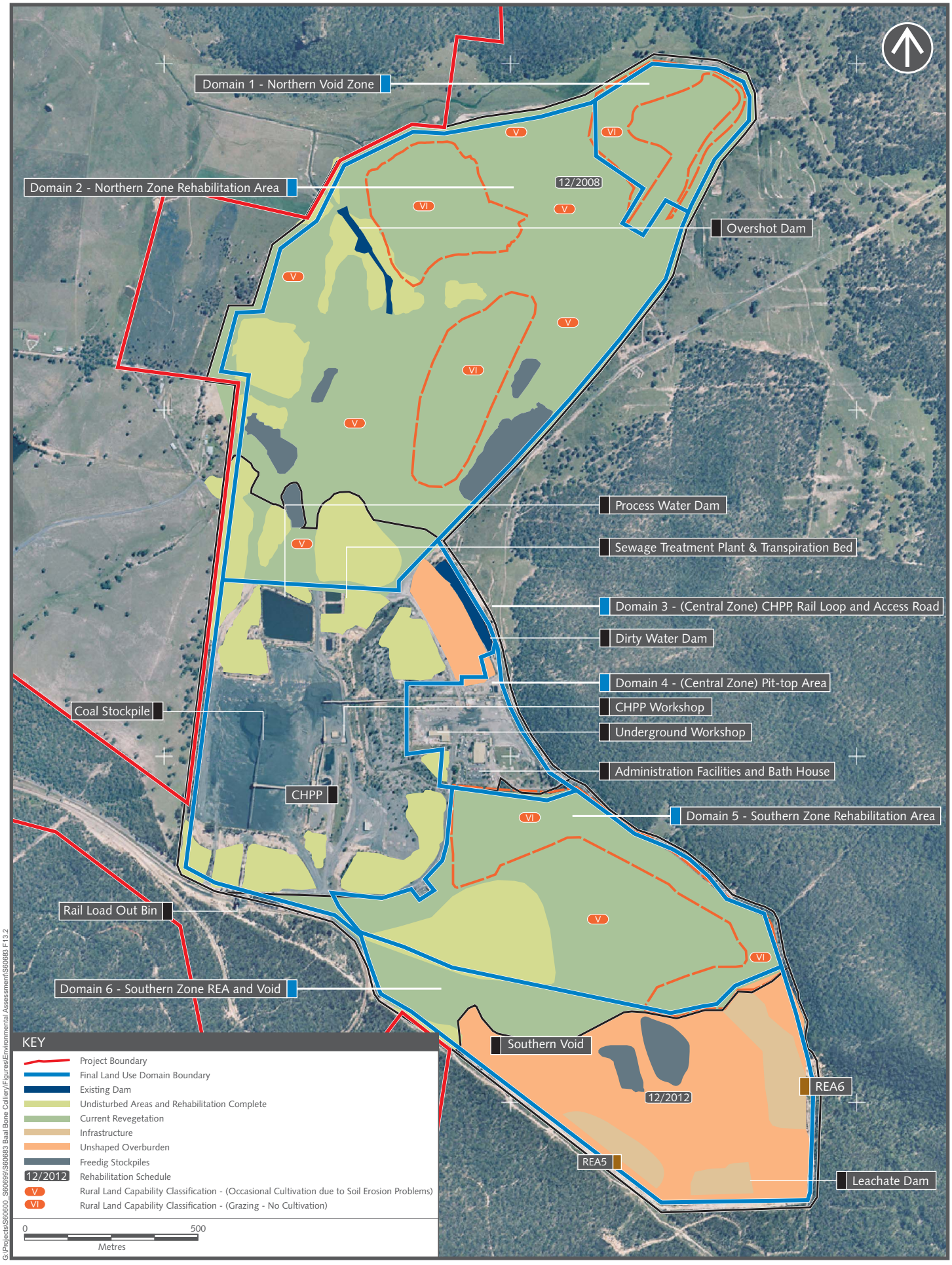
During 2008, approximately 450000m^3 of coarse reject from the CHPP was placed in and around the former southern open cut pit to assist in the creation of the final design landform. Drainage paths, contour drains, ridgelines and emplacement are currently being shaped in a manner consistent with the natural landforms of the surrounding environment, as shown in **Figure 13.3**.

Some course rejects will also be stockpiled to assist with final landform development in the Surface Infrastructure Area, although much of the shaping will be undertaken on a cut to fill basis. Regrading will be undertaken to produce slopes whose angles, lengths and shapes are compatible with proposed land capability classifications suitable for the proposed land use and not prone to an unacceptable rate of erosion. Integrated with will be a drainage pattern which is capable of conveying runoff from the newly created catchments whilst minimising risk of erosion and sedimentation.

Survey has confirmed that approximately 331,000 m^3 of freedig (clay loam) material has been stockpiled for capping and covering all areas following mine decommissioning. Three dimensional modelling indicates that approximately 150,000 m^3 is required to provide cover over the southern reject emplacement area and approximately 127,500 m^3 will be required to provide cover over the remaining central infrastructure area.

13.6.2 Stabilisation and Restoration of Ben Bullen Creek

The main water course affected by operations at Baal Bone is Ben Bullen Creek, which transects the Surface Infrastructure Area. Historically, Ben Bullen Creek dissected and meandered through the Surface Infrastructure Area and eventually flowed into the Jews Creek and Turon River to the north west of the site. Since commencement of the former Ben Bullen Open Cut Mine (prior to operation of Baal Bone Colliery), Ben Bullen Creek has been significantly impacted. More recently it has been diverted through the Surface Infrastructure Area to allow for the construction and operation of mining related facilities, such as the pit top area and mine entry adits. The final design landform of Baal Bone has allowed for the stabilisation and restoration of Ben Bullen Creek, in an alignment similar to its original location.



AECOM

FINAL LAND USE DOMAINS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 13.2

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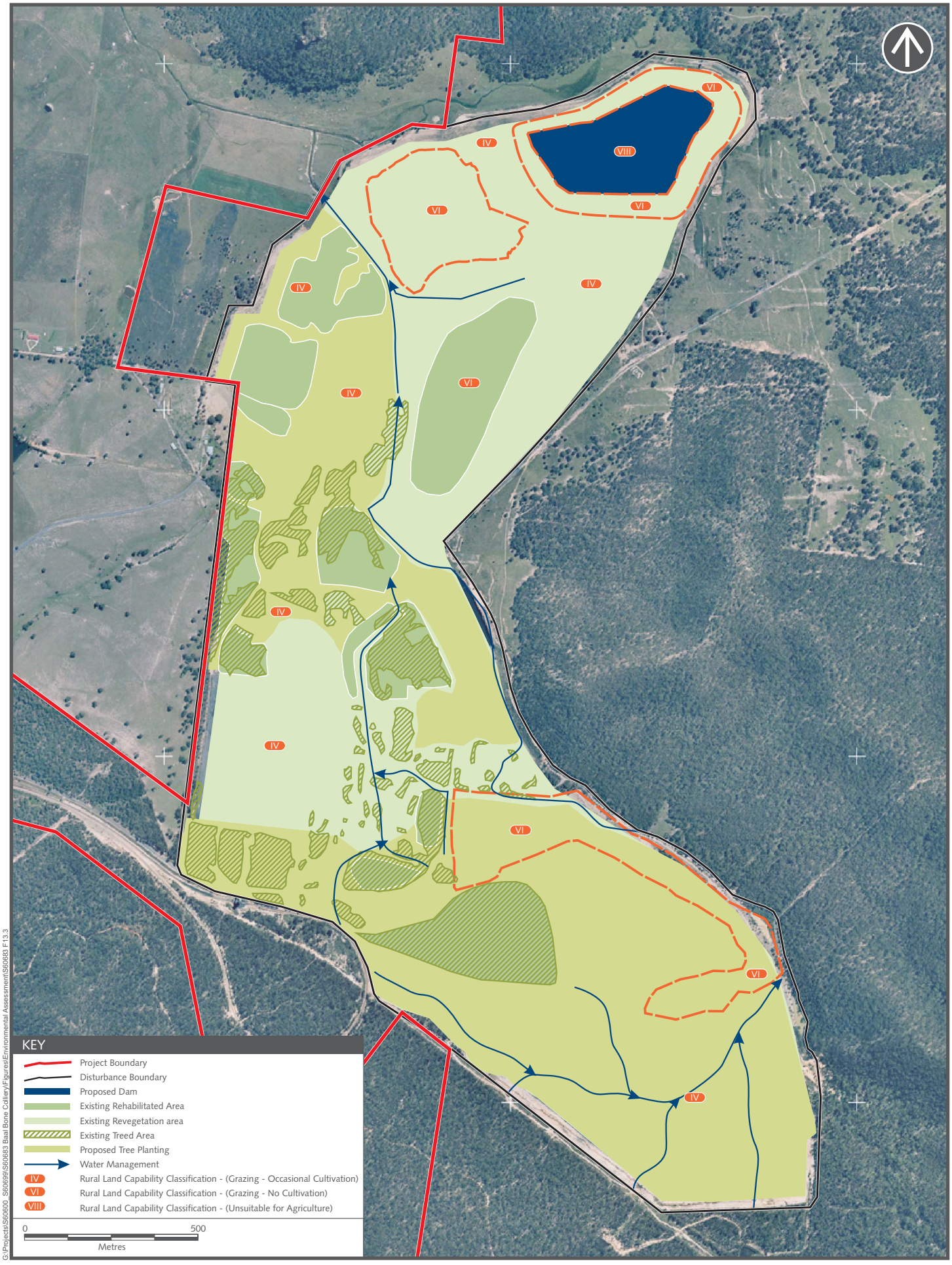

AECOM

FINAL LANDFORM OF SURFACE INFRASTRUCTURE AREA (AT MINE CLOSURE)

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 13.3

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As part of this process, in 2007 a Natural Channel Design and Restoration Plan was prepared for the Ben Bullen Creek; both DWE and DII (Fisheries) were consulted during the development of this plan. The design includes a series of pools and riffles, interconnected via a meandering flowpath. It also includes the design of two significant grade stabilisation structures within the Ben Bullen Creek. Two of the three stages of this work have been completed, with riparian tree planting to be undertaken in 2009. Upon commencement of final rehabilitation and closure activities, the last outstanding stage of work relating to the current pit top area would be initiated.

13.6.4 Soil Amelioration and Seeding

A comprehensive agronomic soil analysis of the freedig covering material has previously been undertaken through the Soil Conservation Service Soils Laboratory in Scone. The results confirm that the material is generally of a sandy clay loam texture, with high to spontaneous dispersion in most cases, as evidenced by EAT classes of 2(1) and 2(2). All samples exhibited a low to moderate cation exchange capacity, with a corresponding low level of chemical fertility. Aluminium toxicity has the potential to be problematic as the pH was in the range 5.5 – 6.7 and many samples returned a high level of exchangeable aluminium.

Following recommendations provided by the SCS gypsum will be incorporated at a rate of 5,000kg/ha across the site to ameliorate the high dispersion percentage and to reduce the erodibility of the freedig material. Agricultural lime will also been included in areas identified for pasture seeding at a rate of 2,500kg/ha to assist with both longer term dispersion amelioration and pH adjustment, thereby reducing potential for aluminium toxicity.

Ameliorants will be incorporated into the top 150 mm of planting media, generally by chisel ploughing or light ripping on the contour. The soil surface will be left in a roughened condition to maximise capture of runoff and to minimise the potential for erosion and surface crusting.

A Grower 12 type chemical fertiliser (20:20:40) at a rate of 250kg/ha will be applied on areas that are to be seeded with a predominantly exotic or improved pasture mix, and a low analysis organic type fertiliser (eg. Dynamic Lifter) at a rate of 250kg/ha to be applied on areas with a predominantly native mix.

Application of both seed and fertiliser will generally be via aerial (helicopter) and/or ground spreading directly into a freshly prepared and ameliorated seedbed. Some hydroseeding and straw mulching may be required on steep or otherwise inaccessible areas. Further detailed methodology will be provided in the *Detailed Mine Closure Plan* which is currently being finalised.

13.7 Future Detailed Mine Closure Planning and Activities

There are a number of future activities for Mine Closure required to be undertaken and these include:

- Completion of feasibility and cost-benefit analysis for the preferred Final Landuse Options;
- Refinement / finalisation of closure objective and completion criteria for approved Final Landuse Options;
- Finalisation of scientifically based Rehabilitation Maintenance and Monitoring Plan utilising the concept of Landscape Function Analysis (LFA);
- Development and collation of Detailed Mine Closure Plan document, which is to provide a summary of all physical site works required, social mitigation/communication strategies, implementation costs, monitoring requirements, ‘sign off’ and relinquishment procedures, closure indicators/milestones, timeline/critical path network.

13.8 Conclusion

Detailed Mine Closure Planning and site rehabilitation works are well progressed at Baal Bone, with around 130 ha of rehabilitation having been completed to a high standard. The Final Landuse has been determined and the post-mining landscape will be dominated by native woodland and grazing on both Class V and Class VI agricultural lands.

The Colliery has been stockpiling coarse rejects and freedig material to assist in the shaping and capping of the final design landform once mining activities have concluded and final rehabilitation activities on the remaining areas has commenced.

The continued operation of Baal Bone to allow the completion of Longwalls 29 to 31 and the identified Remnant Areas would not impact upon the mine closure planning and site rehabilitation activities.

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14.0 Traffic and Transportation

14.1 Existing Environment

Baal Bone is located approximately 25 km north west of Lithgow and 5 km north east of the village of Cullen Bullen which has a population approximately 300, as described in **Section 2**. Other townships in the surrounding area include Portland which is located approximately 6 km to the south west of Baal Bone along the Wallerawang-Gwabegar railway (population approximately 2000), and Wallerawang (population of approximately 1800), also on the Wallerawang-Gwabegar railway north west of Lithgow.

14.1.1 Road Network

Castlereagh Highway is a two lane two way arterial road providing connection between the Great Western Highway to the south and the Golden Highway to the north. It services towns including Cullen Bullen and Mudgee, and has strategic importance servicing the transportation of freight and services throughout the region.

Castlereagh Highway is signposted at 100km/h for the majority of the corridor, with reduced speed limits surrounding the Cullen Bullen village centre and the private colliery immediately south (50km/h and including a 40km/h school zone) and a speed limit of 80km/h from Duncan Street (Brays Lane) to immediately south of the Wallerawang Power Station coal truck entrance.

It is noted that the road corridor alignment includes steep upgrades and downgrades so that fully laden trucks can be observed to reduce speed to approximately 30km/h.

Overtaking lanes and opportunities are permitted along the corridor, with acceleration and deceleration lanes provided on some access points.

The Castlereagh Highway (State Route 86) provides access to Baal Bone and is situated to the west of the site, and runs approximately north-south. The Castlereagh Highway is an RTA approved B-double truck route. To the south of Baal Bone the Castlereagh Highway passes through the villages of Cullen Bullen, Blackmans Flat and Lidsdale before joining up to the Great Western Highway at Marrangaroo, north of Lithgow.

Residential receptors to traffic on the road transport route from Baal Bone include three residential properties located north west of the site, residents of Cullen Bullen and, to a lesser extent, residences of Blackmans Flat and Lidsdale.

14.1.2 Rail Network

To the west of the Castlereagh Highway runs the Wallerawang-Gwabegar railway. This line branches from the Main Western railway at Wallerawang and heads north to the townships of Kandos, Mudgee and Gulgong. Historically this rail line has been used primarily to transport coal from the Western Coal Fields and also for wool and livestock. A 7 km long spur line from the railway line services the site, terminating at a 200 m radius balloon loop (see **Figure 4-1**).

14.1.3 Walking and Cycling

A cycle lane is provided on the west side of the Castlereagh Highway carriageway, in the hard shoulder south of Main Street. The cycle lane continues south of the Wallerawang Power Station Coal Truck entrance. North of Main Street Cycle lane is not continuous and irregular shoulder widths would require cyclists to utilise the available traffic lanes.

Reduced speed zones are provided within the Cullen Bullen village centre at 50km/h. A school zone is also provided reducing speeds to 40km/h during school peak periods.

14.1.4 Public Transport

Lithgow to Mudgee Coonabarabran and Baradine, bus service operated by Countrylink (two services per day). Bus shelters were observed within the Cullen Bullen village centre adjacent to the Cullen Bullen Public School. A Bus shelter is also provided adjacent to the private colliery entrance towards the south of Blackmans Flat village.

Bus shelters are located within the Cullen Bullen village centre adjacent to the Cullen Bullen Public School. A bus shelter is also provided adjacent to a private colliery entrance towards the south of Blackmans Village. School bus routes are serviced by Jones Bros and include Route 1015 and Route 1014. Route 1015 services schools located within Lithgow, originating at Capertee and travelling to Lidsdale on the Castlereagh Highway via Cullen Bullen, Ben Bullen and Blackmans Flat. It collects students from View Street and then turns into Ian Holt Drive through Lidsdale, rejoining the Castlereagh Highway via Wogan Road and continues south to the Great Western Highway.

Route 1014 services schools located within Portland, Capertee and Cullen Bullen. The route travels between Portland and Capertee via Portland Cullen Bullen Road, Carson Siding Road and then north via the Castlereagh Highway. For both routes, students are collected at property gates and at designated bus shelters within Capertee, Ben Bullen and Cullen Bullen.

Typical school bus hours would be between 8 - 9.30 am and 2.30 - 4 pm, Monday to Friday. These hours generally do not coincide with typical employee shift times at Baal Bone.

14.2 .Coal Transportation from Baal Bone

14.2.1 Background

Historically, coal produced from the Colliery has been primarily transported by road and rail to various destinations. When the Colliery commenced operations in 1982 under the consent granted by the Minister, coal was solely transported by road until the rail loop was constructed and commissioned in 1985. Following this, rail was utilised as the major transportation option for the distribution of coal from the Colliery. The rail line would take coal product from the Colliery to Port Kembla for export.

The Colliery has utilised rail as the preferred option of transportation of coal for international export, whilst road haulage of coal has been limited to minor domestic short term contracts.

14.2.2 Road Haulage of Coal

Transport of coal by road has been occurring at Baal Bone since 1982, initially delivering to the CHPP and rail loading facility at the Wallerawang Colliery site at Blackmans Flat prior to the construction of the CHPP and rail loop at Baal Bone in 1985. Road transport has also been utilised more recently to supply coal to the nearby Mount Piper and Wallerawang Power Stations and a small quantity to some domestic clients. The amount of coal transported by road has varied over the years, with the contract between Baal Bone and the power stations the main determinant.

Table 14-1 below shows a summary of recent road coal transportation from Baal Bone.

Table 14-1: Road Coal Transportation Summary (2003 to 2008)

Financial Year	Road Haulage (Mt)[1]
2003	0.808
2004	0.482
2005	0.767
2006	0.628
2007	0.044
2008	0.003
2009	0

1. Includes the consented road haulage to the power stations as well as small road haulage contracts to other domestic locations.

The table above shows that since 2007, road transportation of coal has tapered off significantly and is currently well under its approved limits. Based on 2007 – 2009 road haulage, it is assumed that an average of 16 000 tpa of coal is currently transported from the Colliery to domestic customers.

Since 1997, Baal Bone has modified its development consents with respect to coal haulage by road. The consents have been modified largely due to the volume of coal required within the contracts with the nearby power stations. A summary of the consents for road haulage by Baal Bone is provided in **Table 14-2**.

Table 14-2: Summary of Approvals for Road Haulage

Year	Consent	Summary of Details (Subject to Conditions)
1982 - 1992	Original DA	Up to 1 Mt of coal per annum for export purposes, from Baal Bone Colliery by road to the Wallerawang Colliery up to 30 September 1985.
1992 – 1997	Original DA Modification 31/12/92	Included provision to supply up to 300000 tpa by road to Mount Piper Power Station for a period of three years. Also included approval to supply an additional 150000 t of per annum by road for industrial purposes, where the destination can not otherwise be supplied by rail.
1997 – 1999	DA 197/97	Road haulage of 500000 t of coal per annum for domestic markets.
1999 – 2000	DA 164/98 19/08/1999	Consent for road haulage of 1.5 Mt of coal per annum to the Mount Piper and Wallerawang Power Stations, with a maximum daily rate of 6000 t to 30 December 2000. Consent required surrender of DA197/97.
2000 – 2003	DA 164/98 Modification 25/08/2000	Extension of timeframe to 31 December 2003, with a reduced maximum rate to 900000 tpa and retention of a maximum daily rate of 6000 t.
2003 - 2015	DA 164/98 Modification 23/12/2003	Extension of timeframe to 31 December 2015, with a maximum rate to 900000 tpa and retention of a maximum daily rate of 6000 t.

The Castlereagh Highway (State Route 86) is the approved road haulage route between Baal Bone and Mount Piper and Wallerawang Power Stations under the terms of the development consent (DA164/98; as modified). Annual road haulage of up to 900000 t of coal via this route has been approved, subject to detailed reviews of alternative coal haulage options every three years to be produced by Baal Bone and submitted to DoP (see **Section 3**). Whilst coal haulage by road from Baal Bone to Delta Electricity has ceased in recent times, there is the potential for contracts to be renewed in the future, which would result in the resumption of road haulage of coal from Baal Bone.

Transportation Route

The transportation route for road haulage of coal from Baal Bone requires that all trucks travel from the CHPP, where they are loaded, along the private Colliery access road to the intersection with the Castlereagh Highway. The trucks then turn left (towards the south) and travel along Castlereagh Highway to Boulder Road (for coal deliveries to Mt. Piper Power Station, 9.9 km from Baal Bone) or directly to the Wallerawang Power Station coal receival entry (18.3 km from Baal Bone). Coal is also periodically transported to other domestic customers by road beyond the local power stations as required.

Site Access

There is an acceleration/deceleration lane on the Castlereagh Highway from both approaches at the intersection with the private Colliery access road. The private Colliery access road comprises a 7.5 m wide sealed pavement with double centre lines. The speed limit is 60 kph and speed humps are positioned at several locations along the access road. Advisory speed and other warning signs are positioned along the road. Speed limits vary along the Castlereagh Highway with 50 kph speed limits applying in Cullen Bullen, followed by 80 kph, then 100 kph speed limits. The majority of the transport route is in a 100 kph speed limit zone.

Hours and Rates of Transport

Coal loading occurs between the hours of 7.30 am and 2.45 pm and 3.30 pm to 5.30 pm Monday to Saturday in accordance with the current Truck Management Plan (TMP). The transportation of coal from the Colliery is permitted between 7am and 7pm, Monday to Saturday. No coal is permitted to be loaded or transported on Sundays or public holidays.

The trucks involved with the haulage of coal from Baal Bone are operated principally by local haulage contractors. The types of trucks transporting coal from Baal Bone to the local power stations comprise approximately 50% truck and dog, 45% semi-trailer and 5% B-double (TWCL, 2003). These trucks on average carry a load of 25 t of coal.

Existing Traffic Management

In association with the Baal Bone Community Consultative Committee (CCC), Baal Bone has prepared and implemented a TMP in accordance with relevant consents which is implemented by the Colliery and haulage contractors. The TMP applies to all Baal Bone personnel, haulage contractors and truck drivers involved with the loading, dispatch and/or transportation of coal from the Baal Bone Colliery by road. The TMP includes procedures in relation to the following:

- Hours of haulage;
- Noise and speed restrictions;
- Truck operation and training and induction requirements at the Colliery;
- Truck operation on customer's sites;
- Inspection, maintenance and pollution control of vehicles;
- Emergency procedures; and
- Complaints management.

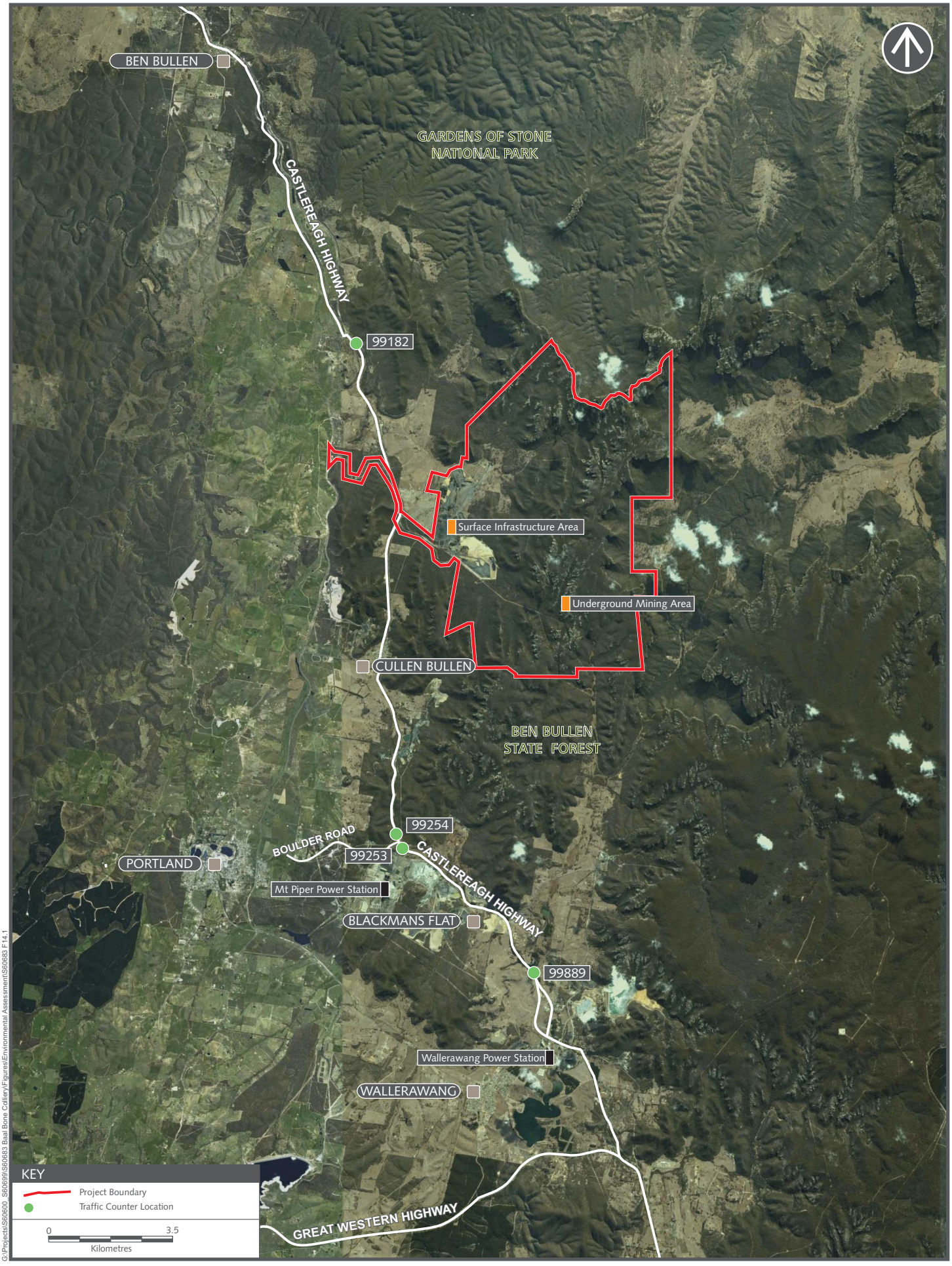
TWCL has historically received a very low level of public complaint regarding road haulage between the site and the power stations.

In accordance with the modification of DA 164/98 undertaken in 2003, a Road Haulage Management Plan (RHMP) was prepared. The key components of the RHMP included the assessment of noise impacts on dwellings associated with trucks travelling to and from Baal Bone and the implementation of reasonable noise mitigation works on properties adversely impacted by road haulage noise directly attributable to the Baal Bone operations. This RHMP has largely been implemented in the vicinity of Cullen Bullen due to the close proximity of residences to the Castlereagh Highway and their exposure to noise emanating from the coal haulage trucks from Baal Bone.

Traffic Volumes and Roadway Capacity

The primary road utilised for the transportation of coal by road from Baal Bone is the Castlereagh Highway. The Castlereagh Highway is a two lane road with a speed limit of 100 kph in the vicinity of the Colliery and a speed limit of 50 kph through Cullen Bullen to the south. There is also a 40 kph speed limit in Cullen Bullen during specified school hours. The roadway capacity of the Castlereagh Highway is estimated to be approximately 8,700 vehicles per day (RTA, 2002), which is based on a conservative assumption of a 15% contribution from heavy vehicles, a desired operational Level of Service (LOS) C and peak hour flows represent 10% of the daily traffic volumes.

The Annual Average Daily Traffic (AADT) count was obtained from the RTA at the traffic stations located in the vicinity of Baal Bone, and along the transport route. The AADT volumes on the Castlereagh Highway are shown in **Table 14-3**. The traffic count locations are shown on **Figure 14-1**.



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TRAFFIC COUNT LOCATIONS

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 14.1

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Table 14-3: Annual Average Daily Traffic (AADT) Volumes (Axle Pairs)

Station No.	Location	AADT (Percentage from Baal Bone)			
		1996	1999	2002	2005
Castlereagh Highway.					
99182	Ben Bullen Rail Crossing	2039	2116	2008	1959
99254	North of Boulder Rd	2652	3512	3028	3011
99253	South of Boulder Rd	3571	N/A	N/A	N/A
99889	Lidsdale, North of Newnes Rd	3864	4447	3526	3717
Great Western Highway					
99024	Marrangaroo, 0.3 km East of Castlereagh Hwy	13547	14411	N/A	N/A

* Data presented is axle pairs

The data presented above are raw data and comprise axle pairs. The data indicates that traffic volumes are relatively low and that traffic volumes have been decreasing over recent years. The table shows that the Castlereagh Highway is operating well below capacity and that the estimated contribution of traffic generated by Baal Bone due to the transportation of coal by road is minimal.

In recent years, the contribution of traffic to the local road network including the Castlereagh Highway from Baal Bone has been low, with transportation of coal in the order of 16 000 tpa equating to 12 return trips (or 24 truck movements) of coal per week.

14.2.3 Rail Transportation of Coal

In recent times, due to a number of market factors, the majority of product coal has been transported by rail to the coal terminal at Port Kembla to be exported to international markets. A smaller quantity of coal has also been transported by rail to Bluescope Steel, also located at Port Kembla.

The rail loop which services Baal Bone is a 7 km long spur line from the Wallerawang-Gwabegar line, terminating at a 200 m radius balloon loop. The rail loop at Baal Bone is equipped with a comprehensive signalling system for the purpose of advancing trains and to allow train passage beneath the 1000 t loading bin at a train loading station.

A train loading conveyor running from the stockpile discharges product coal into the rail loading bin. The bin is supported on columns over the railway line to facilitate the automatic loading of product coal from above. The train loading system is designed in a way so when each individual railroad car, or wagon, passes beneath the bin and approaches the loading chute, a charging gate is opened and a batch of coal is discharged. The train wagons have a capacity of between 57 and 77 t.

Current total volumes of coal being transported from Baal Bone are slightly less than 1.5 Mtpa. On average, eight to ten trains per week are utilised to transport coal from Baal Bone, although train movements are generally irregular and may occur for several days at a time, separated by extended periods where no coal is hauled via rail from the site. This is dependent on market requirements. There would be no increase to the approved quantity of coal transported from the site, and timing and frequency of train movements would continue as required.

The Wallerawang-Gwabegar Rail Line is non-electrified. From Baal Bone, trains travel along the Wallerawang-Gwabegar Rail Line to Lithgow and then to the coal terminal at Port Kembla via the Main Western Rail Line. This rail line is within an existing rail corridor that is subject to the provisions of ARTC's Environment Protection Licence for the rail corridor.

14.3 Predicted Traffic Generation

14.3.1 Road Haulage of Coal

Section 14.2 outlines the road and rail haulage volumes typically generated at Baal Bone for the distribution of coal product. The continued operation of Baal Bone would not result in volumes of traffic (either by rail or road) increasing beyond the approved volumes outlined. Furthermore, the Project does not involve an increase to the approved 2 Mtpa of prepared saleable coal from Baal Bone, therefore additional transport of coal would not be required.

Dependent upon future contracts (i.e. with local power stations) requiring the delivery of coal product by road, the proposed continuation of operations may potentially involve the resumption of road transport of coal up to a currently approved rate of 900 000 t per annum. As a worst case scenario (i.e. up to around 6000 t per day), the maximum number of truck movements would be up to 240 truck movements per day (120 return truck trips) to and from the Colliery. However, based on previous contracts with local power stations, it is more likely that truck movements would be in the order of 110 trucks movements per day (or 55 return truck trips), equating to an hourly average of 10 to 12 truck movements (or 5 to 6 return truck trips). Based on previous operations, during peak periods when the local power stations dictate above average deliveries of coal, up to 16 truck loads could be despatched per hour, equating to 32 truck movements per hour.

The maximum number of coal transport vehicles generated by Baal Bone for road haulage (up to 900000 tpa) is not expected to increase as a result of the continued operations of the Colliery. Whilst Baal Bone has not utilised the road transportation option in recent years, there is potential for coal despatch via this mode to be resumed in the future, depending on future contracts between Baal Bone and Delta Electricity and/or other domestic clients.

14.3.2 Rail Haulage of Coal

The existing operations currently transport approximately 1.5 Mtpa of coal by rail. The transportation of coal product via the existing rail loop would continue with the continuation of operations at Baal Bone. On average, eight to ten trains per week are utilised to transport coal from Baal Bone, although train movements are generally irregular and may occur for several days at a time, separated by extended periods where no coal is hauled via rail from the site. This is dependent on market requirements. There would be no increase to the approved quantity of coal transported from the site, and timing and frequency of train movements would continue as required. Rail transportation rates would likely decrease in the case that coal haulage by road is resumed.

14.3.3 Employee Vehicles

TWCL currently employs approximately 190 full time equivalent staff, including contractors at Baal Bone. The project would not result in the employment of additional staff. As Baal Bone is not serviced by a public transport network, it is assumed that all employees would travel to and from work in private vehicles with one person travelling per vehicle. Trips would generally occur prior to and following each shift. Typical shift times are detailed in **Table 14-4**. These are the typical shift times currently operating at Baal Bone, however are subject to change depending on operational requirements.

Table 14-4: Typical Baal Bone Employee Shift Times

Shift	Shift Time	Total Staff per Shift
Monday to Thursday		
Day Shift	7 am to 4 pm	85
Afternoon Shift	3 pm to 12 am	60
Night Shift	11 pm to 8 am	50
Friday		
Day Shift	7 am to 3 pm	85

Shift	Shift Time	Total Staff per Shift
Afternoon Shift	3 pm to 11 pm	60
Night Shift	11 pm to 7 am	50
Saturday and Sunday		
Day Shift	6 am to 6 pm	< 30
Late Evening Shift	6 pm to 6 am (and 6 am to 11 pm Sunday night)	< 30

Traffic movements are predominantly generated in the half hour prior to the commencement of a shift and in the half hour following a shift. Therefore it is expected that 135 vehicle movements are currently generated between 6.30 am and 8.30 am, 145 vehicle movements between 2.30 pm and 4.30 pm, and 110 vehicle movements between 10.30 pm and 11.30 pm.

The Social Impact Assessment (SIA) undertaken for mine closure at Baal Bone (Coakes Consulting Pty Ltd, 2007) indicated that the majority of employees working at the Colliery resided south of Baal Bone, with 58% residing in Lithgow, 15% in Wallerawang and 15% in Portland. Only 7% of residents indicated they lived in areas that would require travel north along the Castlereagh Highway from Baal Bone (Bathurst, Dubbo, Mudgee). Therefore it is assumed that the majority of employees would travel to and from the Colliery along the portion of the Castlereagh Highway south of Baal Bone.

As these traffic movements are existing, the AADT data for 2005 presented in **Table 14-3** are considered to conservatively incorporate these traffic movements, given the Colliery was operational during this period. No changes to operational hours or shift times are proposed as part of continued operations at Baal Bone, and as such, no additional traffic would be generated.

14.4 Road Safety Assessment

A road safety assessment, provided in **Appendix I**, has been undertaken to enable consideration of the existing approved coal haulage using the public roads between Baal Bone and Mount Piper and Wallerawang Power Stations, should haulage resume. The scope of the assessment is limited to the road corridor from Baal Bone, south to Mount Piper Station coal receival entrance on Boulder Road (9.9km) and from Baal Bone to Wallerawang Power Station coal receival entry, located 18.3km south of Baal Bone on Castlereagh Highway.

The road safety assessment provides a review of existing conditions observed during a site inspection undertaken by AECOM for this EA. The purpose of the review was to identify possible safety issues under the existing network related to potential coal haulage between Baal Bone and local power stations (Mount Piper and Wallerawang). Various elements of the road environment such as line marking and delineation, directional signage, road alignment, visibility, speed limits, presence of overtaking lanes and intersection layout have been included in the assessment. The assessment is based on observations undertaken during day time conditions.

14.4.1 Crash Analysis

An analysis of historical crash rates on Castlereagh Highway near Baal Bone Colliery has been undertaken based on historic crash data provided by NSW Roads and Traffic Authority (RTA) Western Region. Crash data relating to all types of crashes on Castlereagh Highway between Marrangaroo and Ben Bullen was reviewed. The data included crash statistics between 1996 and 2008.

The RTA uses performance measures to enable assessment of current and future performance levels of network corridors. Performance benchmarks enable the RTA to focus on progressively working toward achieving its network objectives. Benchmarks are calculated for each road 'class' and are defined as the average value for each measure over all roads contained in that class. Castlereagh Highway is classified as class 2R in the rural network hierarchy, which is defined as follows:

> *(Average Annual Daily Traffic – 1,500[3], Heavy Vehicles – 250, Speed Limit – 60km/h – 110km/h) Class 2R roads provide inter-regional and intra-regional connectivity and strategic needs of freight. They are typified by low levels of traffic volumes including freight, commercial vehicle and public transport travel. They provide a reasonable standard of travel and serve intra-regional and inter-regional functions. Typically they have undivided carriageways with 2 lanes.*

In assessing the safety of rural road networks, casualty crashes per kilometre per year are measured and averaged over a five year period. This is then compared against the average casualty crash rate for that road class. The average casualty crashes per kilometre per year (2001-05) for a class 2R road is 0.16.

Crash analysis on Castlereagh Highway has been undertaken for two five year analysis periods. The first is during between years 1999 and 2003 (Baal Bone road haulage of up to 1.5Mt per annum) and the second 2004 to 2008 (Baal Bone road haulage of 0.003 to maximum of 0.767Mt per annum). Analysis indicates that all sections experience casualty crash rates comparable to the national average (0.16) for a class 2R road, with the exception of Blackmans Flat where five crashes were recorded during the five year period from 1998 to 2003. Data analysis indicates several head-on collisions, and off-carriageway collisions surrounding Blackmans Flat. Within the Blackmans Flat cluster, the majority of collisions involve class 1 vehicles (car, 4WD, station wagon).

It is noted, that a high incidence of crashes has been recorded at the entrance to Mount Piper Power Station at the Boulder Road / Castlereagh Highway intersection during reduced operations at Baal Bone. This indicates that this area is prone to collisions, independent of operations at Baal Bone. The average casualty crash rate near Boulder Rd / Castlereagh Hwy intersection reaches 0.8 (equivalent to four casualty crashes) in the post 2003 period.

During the five year analysis period under full operation of the Baal Bone Colliery (pre 2003), one crash was recorded at the Colliery entrance. This collision involved a right turning vehicle (sedan) into the colliery, and semi-trailer following in the same northbound lane. No southbound collisions were reported at this location.

Review of the complete study area, reveals a total of 10 casualty crashes in the five year period 1998 to 2003, and 12 casualty crashes in the five year period 2004-2008. Over a corridor of 19.4km, this equates to average annual casualty crash rates of 0.10 and 0.12 casualty crashes per kilometre per year for the two time periods respectively. The casualty crash rate per kilometre per year is below that of the state average of 0.16 for the 2R road class.

14.4.2 Road Safety Assessment Findings

An assessment of the road corridor has been undertaken on the coal haulage routes between Baal Bone Colliery and Delta Electricity Power Stations, Mount Piper and Wallerawang. This assessment does not constitute a comprehensive road safety audit, but a general overview of potential safety issues identified throughout the corridor is provided.

A number of road safety issues were identified along the corridor, however only one issue was found to be specifically related to an increase in road haulage from Baal Bone. This issue relates to potential conflict between trucks exiting the Colliery and high speed vehicles on the Castlereagh Highway. This exit is located on an upgrade which would result in increased time for a fully laden truck to accelerate to a 100km/h speed environment. As there is no acceleration lane travelling southbound, trucks are required to merge directly into the single lane 100km/h carriageway.

Minimal signage exists at the colliery notifying the presence of entering truck movements. This may contribute to limited driver appreciation on the highway, which may in turn lead to rear end collisions or vehicles running off the road in order to avoid collisions.

To understand the implication of the increased coal haulage by road, historical crash data was reviewed within study area, as described in **Section 14.4.1** above. The analysis indicated crash cluster areas within the corridor and overall crash rates are below that of the state average for the road class.

Consideration of the crash cluster location and characteristics, together with safety issues identified in Chapter 5, indicates that a decrease in the likelihood of vehicle conflict could be achieved by increasing driver awareness of issues such as:

- The road environment and characteristics;
- Trucks exiting and decelerating to enter the Baal Bone Colliery entrance;
- Required speed reductions; and
- Potential for over tipping (adverse camber at sharp corners).

It is anticipated that increased driver awareness could be achieved by installation of for example, increased signage. Monitoring could be undertaken to determine the effectiveness of signage, with review of other mitigation measures as appropriate. Provided appropriate mitigation measures are implemented, the level of impact on road safety generated by resumption of haulage from Baal Bone Colliery is not anticipated to be significant.

The remaining findings of the road assessment (refer **Appendix I**) are associated with pre-existing road conditions along the corridor.

14.5 Potential Impacts

14.5.1 Road Haulage of Coal

Generally, the AADT volumes along the Castlereagh Highway in the vicinity of Baal Bone have been decreasing over recent years (refer to **Table 14-3**) indicating that the surrounding road network is likely to operate well in future years as the background traffic is not increasing.

The proposed continuation of operations may potentially involve the resumption of road transport of coal up to a currently approved rate of 900 000 t per annum. This would be dependent upon future contracts with local power stations requiring the delivery of coal product by road. The maximum number of truck movements would be up to 240 truck movements per day (120 return truck trips) to and from the Colliery (i.e. up to 6000 t per day). However, based on previous contracts with local power stations, it is more likely that truck movements would be in the order of 110 trucks movements per day (or 55 return truck trips), equating to an hourly average of 10 to 12 truck movements (or 5 to 6 return truck trips). Based on previous operations, during peak periods when the local power stations dictate above average deliveries of coal, up to 16 truck loads could be despatched per hour, equating to 32 truck movements per hour.

Baal Bone has historically held approval (up to 2000) for the transport of up to 1.5 Mtpa of coal per annum by road, which was previously assessed as acceptable for the existing road network along the road transport route. As such, the resumption of transport of up to the currently approved 900 000 t of coal per annum by road is expected to have minimal effect on the traffic flows along the Castlereagh Highway.

Baal Bone's coal loading occurs between 7.30 am and 2.45 pm and then from 3.30 pm to 5.30 pm Monday to Saturday. The existing consent allows road haulage of coal from Baal Bone from 7am to 7pm, Mondays to Saturdays.

The low incident and low compliant history of road transportation from Baal Bone indicates that the existing site access to and from the Castlereagh Highway is suitable for resumption of road transport for up to 900 000 t per annum.

14.5.2 Employee Traffic Generation

The AADT data for 2005 presented in **Table 14-3** are considered to incorporate the existing traffic movements generated by employees travelling to and from Baal Bone. As no changes to operational hours or shift times are proposed as part of continued operations, and the existing level of service along the Castlereagh Highway is considered adequate, there is not expected to be a significant impact associated with the existing employee vehicle movements from the Colliery.

14.5.3 Rail Haulage of Coal

It is expected that rail would still provide the majority of coal transport from Baal Bone, and the volumes and rates of transport are unlikely to change significantly from existing operations. It is considered that the continued operation of rail transportation of coal product from Baal Bone would not create adverse environmental impacts due to the existing management measures and procedures already in place between Australian Rail Track Corporation (ARTC) and TWCL.

14.6 Cumulative Road Traffic Impacts

An assessment of cumulative road traffic impacts has been undertaken for developments approved since the most recent AADT traffic count data (refer **Table 14-3**) which utilise the section of the Castlereagh Highway between Baal Bone and Wallerawang Power Station (refer **Figure 14-1**).

Average daily traffic movements for traffic generating developments are listed in **Table 14-5**. Traffic movements for collieries are based on either saleable coal production, or limitations identified in Project Approvals or development consents for respective developments.

Table 14-5: Average Daily Traffic Movements for Developments Utilising the Castlereagh Highway

Development	Average Daily Traffic Movements (Monday to Saturday)	Comment
Invincible Colliery	144	900000 tpa saleable coal
Springvale Colliery	24	50000 tpa saleable coal
Cullen Valley Mine	256	1 Mtpa saleable coal
Ivanhoe North	100	300000 tpa ROM coal
Proposed Charbon	64	250 000 tpa saleable coal
Blackmans Flat Waste Management Facility	260	Development approved by Lithgow City Council. Traffic movements based on information provided in the Environmental Impact Statement for the proposal.
Total	**848**	

The AADT data for 2005 presented in **Table 14-3** indicates that daily traffic movements are in the order of 3011 north of Boulder Road (entrance to Mount Piper Power Station), and in the order of 3717 at Lidsdale north of Newnes Road before the entrance to Wallerawang Power Station. During 2005 (calendar year), Baal Bone transported approximately 0.7 Mt. As such, traffic movements from Baal Bone are already included in the 2005 AADT, and have not been listed separately in **Table 14-5**.

As discussed in **Section 14.2.2** the roadway capacity of the Castlereagh Highway is estimated to be approximately 8,700 vehicles per day (RTA, 2002) with a desired operational Level of Service C. The estimated 848 daily traffic movements generated by other developments would result in an increase of daily traffic movements of approximately 18% to around 4560, which is well below the roadway capacity of 8700 for the Castlereagh Highway

14.7 Environmental Safeguards

Correspondence between TWCL and DoP in 2003 regarding the most recent modification to the existing development consent regarding road haulage concluded that the DoP considered that the existing traffic safety and amenity management plans associated with Baal Bone's road haulage of coal product were sufficient for addressing potential impacts.

Therefore, should TWCL resume road haulage of coal from Baal Bone, TWCL would utilise the current TMP and RHMP. The current TMP and RHMP outline a number of safeguards to minimise traffic impacts during the transportation of coal by road. The safeguards would be reviewed upon resumption of road haulage.

- The finalisation of all outstanding noise mitigation works to the remaining four residences identified in the RHMP prior to recommencement of road haulage to Mount Piper or Wallerawang Power Stations. Baal Bone would meet all reasonable costs required to implement these works; and
- Coal would be able to be hauled by road from 7am to 7pm Monday to Saturday. No coal would be loaded or transported on Sundays or public holidays.

- Potential mitigation measures suggested in **Table 14.9** should be reviewed in conjunction with Baal Bone's TMP and RHMP, as well as in consultation with other relevant authorities (Lithgow City Council and RTA) and road users such as Delta Electricity and other colliery operators.

Truck operators are to comply with the rules outlined in the current TMP whilst operating within Baal Bone, within customer's sites and when commuting to and from Baal Bone. The TMP includes:

- Immediately report all emergencies, accidents, incidents or complaints via the procedure identified in the TMP; and
- Ensure they adhere to RTA speed limits and noise restrictions at all times.

Consideration of the crash cluster location and characteristics, together with general safety issues identified along the corridor, indicates that a decrease in the likelihood of vehicle conflict could be achieved by increasing driver awareness of certain issues including road environment, trucks entering and accelerating / decelerating, and potential for overtipping. It is anticipated that increased driver awareness could be achieved by installation of for example, increased signage. Monitoring could be undertaken to determine the effectiveness of signage, with review of other mitigation measures as appropriate. Provided appropriate mitigation measures are implemented, the level of impact on road safety generated by resumption of haulage from Baal Bone Colliery is not anticipated to be significant.

14.8 Conclusion

The continued operations at Baal Bone would not create additional traffic impacts. No additional traffic movements, other than what has already been approved previously for Baal Bone, would be generated.

Baal Bone currently utilises the existing rail infrastructure to transport coal to Port Kembla with some minor road haulage of coal on an as needs basis, depending upon contracts with domestic customers. Should Baal Bone resume transportation of coal by road at the currently approved rate of 900000 tpa, as per the current development consent, the RHMP would be reviewed and any required outstanding noise mitigation works would be implemented.

The continued use of rail infrastructure for the transportation of coal product to Port Kembla for export is not expected to create adverse environmental impacts. The continued implementation of the existing management measures and procedures between Baal Bone and ARTC would minimise identified impacts associated with the use of the Baal Bone Rail Loop.

A road assessment has been undertaken for the road corridor from Baal Bone, south to Mt Piper Station coal receival entrance on Boulder Road and from Baal Bone Colliery to Wallerawang Power Station coal receival entry. The assessment has identified a number of issues along the corridor. It is noted that a majority of these issues exist independent of TWCL's operations at Baal Bone, but would not create unacceptable safety issues for coal haulage from Baal Bone.

It is considered that existing management plans and measures outlined in **Section 14.7** would acceptably mitigate the potential traffic impacts created by the continued operations at Baal Bone.

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15.0 Air Quality

15.1 Existing Environment

The Baal Bone Surface Infrastructure Area is situated on a plateau with an elevation of approximately 860 m, surrounded to the north, east and south by steep forest with elevations over 1000 m. The current air quality environment is influenced by the existing operations at Baal Bone, which include underground coal mining and coal processing and handling activities at the surface infrastructure and facilities. Two mine ventilation shafts operate at Baal Bone, one being located within the Surface Infrastructure Area at an elevation of approximately 860 m, and another located within densely forested hills to the south east at an elevation of 1036 m. This has been constructed to provide additional ventilation facilities for the approved Longwalls 29 to 31. The location of the Surface Infrastructure Area, including the location of ventilation facilities is provided in **Figure 15-1**. The air quality environment at Baal Bone is currently monitored by four dust deposition gauges, also shown in **Figure 15.1**.

A number of sensitive receptors are located proximate to Baal Bone. A sensitive receptor is defined by DECCW as anywhere someone works or resides or may work or reside, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar. **Table 15-1** presents the discrete sensitive receptor locations proximate to Baal Bone, which have been selected to represent the local community. The sensitive receptor locations assessed for potential air quality impacts are identified in **Figure 15.1**.

Table 15-1: Discrete Representative Sensitive Receptor Locations

Receptor Number	Distance from Nearest boundary of Surface Infrastructure Area (m)	Type	Base Elevation (AHD m)
R1	60	Residence	861
R2	180	Residence	862
R3	266	Residence	862
R4	1300	Residence	844
R5	1100	Residence	844
R6	4800	Residence	705
R7	5000	Residence	700
R8	5300	Residence	680
R9	1300	Residence	920
R10	1100	Residence	895
R11	1400	Residence	915
R12	1900	Residence	931
R13	2300	Residence	912

It should be noted that there is an additional receptor positioned close to the Baal Bone Surface Infrastructure Area, receptor R3. Receptor locations R1 and R2 are considered to be representative of receptor R3 due to their close proximity, and as such measurements from R3 are not considered further in relation air quality. The receptors listed in **Table 15-1** are considered to be representative of the local community for the purposes of this assessment.

15.2 Method of Assessment

In order to assess the potential air quality impacts of current and continued operations a Baal Bone an Air Quality Impact Assessment (AQIA) was undertaken which included the following scope of works:

- Identification of pollutants of concern and development of an emissions inventory containing air quality emissions information from current operations at the site;
- Preparation of an AUSPLUME atmospheric dispersion model in accordance with DECCW guidelines, using emissions from surface infrastructure and facilities and mine ventilation shafts; and
- Assessment of predicted air quality emissions against assessment criteria using the DECCW Approved Methods (DEC, 2005).

The AQIA is presented in **Appendix J**.

15.2.1 Pollutants of Concern and Emissions Inventory

Sources of pollutants of concern from Baal Bone are predominantly from the Surface Infrastructure Area and mine ventilation shafts, and include:

- Coal and ROM stockpile;
- CHPP;
- Coarse reject emplacement area;
- Coal train loader;
- Coarse reject truck loader;
- Haulage road;
- Mine Ventilation Shaft – Forest; and
- Mine Ventilation Shaft – Adit 5.

The locations of the pollutant sources identified above are provided in **Figure 15-1**.

An emissions inventory containing air quality emissions information for pollutants of concern from current operations at the site was established and encompassed previous mine shaft exhaust data, operational information and the emission factors supplied in the National Pollution Inventory (NPI) Emissions Estimation Technique Manual (Commonwealth of Australia, 2001). The primary pollutants of concern resulting from current and continued operations include particulate matter (total suspended particulates (TSP) and particles less than 10 µm in diameter (PM_{10})) and odour. These are described below. The emissions inventories for each of these pollutants of concern are included in **Appendix J**.

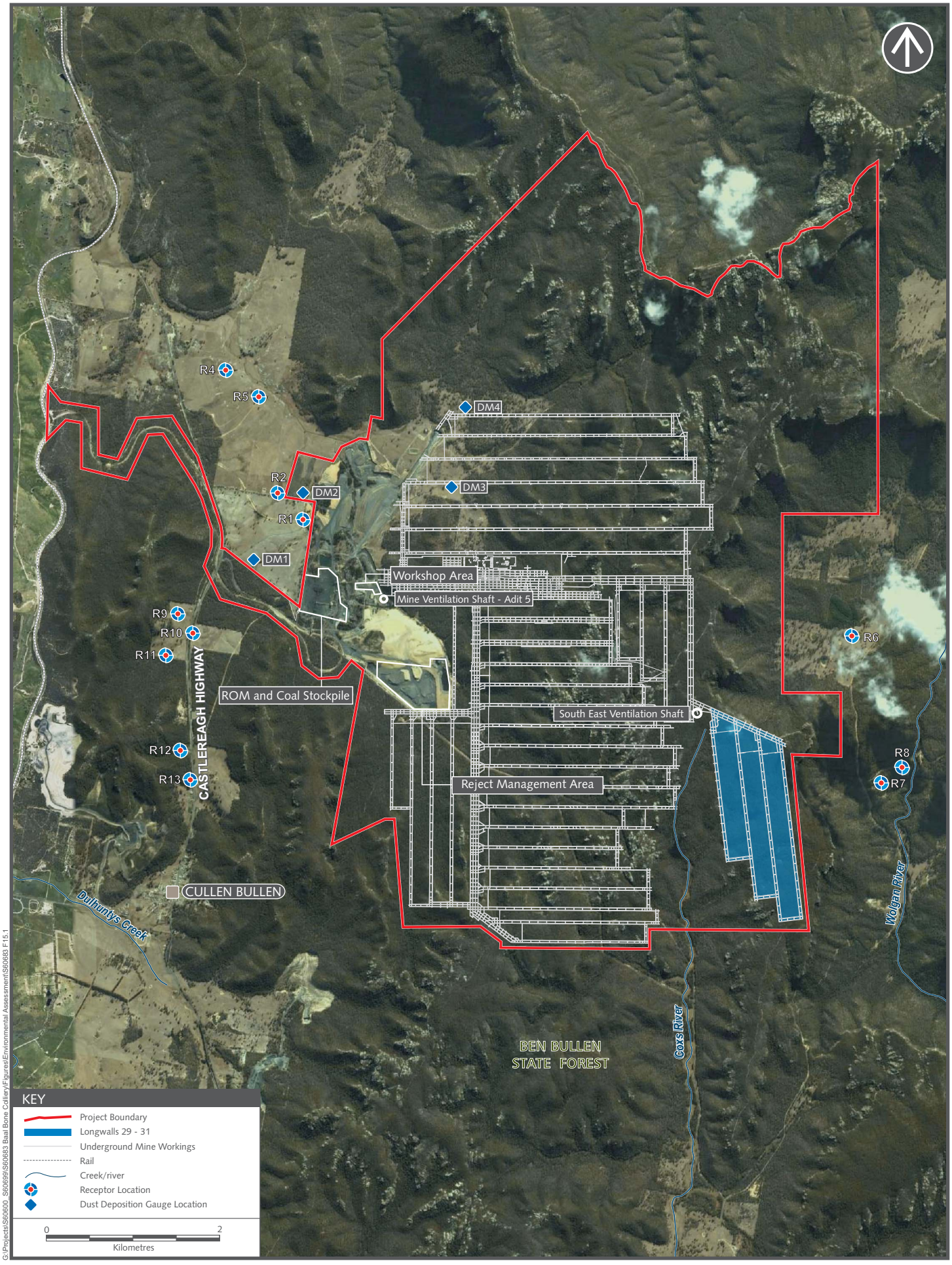
Particulate Matter

Particulate matter refers to solid or liquid particles in the air as a result of the mechanical break-up of larger solid particles from sources such as dust from roads, agricultural processes, uncovered soil or mining operations, as well as non-combustible materials released when burning fossil fuels. The smaller or fine particulates are largely formed by the oxidation of primary gases. Particulate matter is assessed in terms of nuisance effects, due to deposited dust and coarser fraction of TSP, and health effects, due to PM_{10} and particles less than 2.5 µm in diameter ($PM_{2.5}$).

Larger dust particles are generally responsible for nuisance (amenity) effects including vegetation damage and surface soiling. Depending on its physical or chemical characteristics, dust may also cause surface deterioration of materials due to its abrasive or corrosive properties. If the dust composition is dangerous then it is considered a hazardous air pollutant (and may contain toxic material).

Odour

Odour is a sensory response to the inhalation of one or more chemicals in the air we breathe. A person's perception of an odour can vary significantly depending on the sensitivity of the person, the acuteness of the person's sense of smell and the connotations that the odour bestows on that person. Odour primarily affects a person's quality of life and can have a large range of adverse effects including stress and other physical symptoms.



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AECOM

LOCATION OF SENSITIVE RECEPTORS AND AIR QUALITY POLLUTANT SOURCES

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 15.1

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15.2.2 Meteorological Conditions

Meteorological data required by AUSPLUME includes wind speed, wind direction, temperature and an estimation of the stability class and mixing height for the area surrounding the subject site. Preferably, meteorological data is sourced from on-site dedicated meteorological stations which have recorded data over a number of years.

For the sake of consistency, meteorological data included in the air dispersion modelling was sourced from the Mount Piper Power Station monitoring station for the period of 2004 as provided by TWCL from a previous air quality study (Heggies, 2007). Meteorological quality checks were conducted during the previous assessment and the data is considered acceptable for use in this AQIA. The monitoring site is approximately 10km to the south of the Baal Bone Colliery site at an elevation of 950 m. The station measures wind speed, wind direction, ambient temperature, relative humidity and rain fall.

Wind roses analysing wind direction and wind speed were produced from the meteorological data to compare seasonal trends for 2004 and are provided in **Appendix J**. The wind patterns for the station throughout the year are dominated by winds from the southwest and to a lesser extent the northeast. The annual average wind speed for the year was 2.33 m/s with 2.4% calm conditions and an annual wind vector (the mean wind direction and frequency count for that direction) of 226 degrees (south west).

15.2.3 Background Monitoring of Pollutants of Concern

Meteorological data was obtained from Mount Piper Power Station for the year 2004 for background conditions such as wind speed and direction as it is located in close proximity to Baal Bone (i.e. approximately 10km). However, the background TSP and PM_{10} measurements recorded at Mount Piper were relatively low. Therefore, it was considered that Bathurst DECCW monitoring station provided a more appropriate and conservative background concentrations of TSP and PM_{10} than Mount Piper given the Bathurst monitoring station is located in a more built up area than that of Baal Bone.

Therefore, the pollutant concentrations from the Bathurst DECCW monitoring station for the year 2004 (provided in the previous assessment (Heggies, 2007)) were used to calculate background PM_{10} and TSP concentrations. No background odour concentrations were available.

The Bathurst DECCW monitoring station measures daily averaged PM_{10} concentrations. The calculated annual average PM_{10} concentration was applied as the background value for the PM_{10} annual average dispersion modelling. No background concentration has been applied to the 24 hour average dispersion modelling as the measured data showed that the short term impacts measured at the monitoring station were unrealistic for the Baal Bone and unsuitable for application in the short term PM_{10} 24 hour average modelling.

To allow an estimation of likely impacts due to TSP, the daily TSP concentrations were assumed from a typical PM_{10} to TSP ratio for the Hunter Valley (an area with a concentration on mining activities and has been conservatively applied to the Western Coalfields) of 40% and applied to the daily PM_{10} concentrations measured at the Bathurst DECCW monitoring station for 2004. The resulting TSP annual average concentration was applied in the assessment.

Dust deposition has been monitored at four locations surrounding the Baal Bone using dust deposition gauges, sampled monthly according to Australian Standard AS3580.1, and analysed for insoluble solids and ash residue. The 2008 Baal Bone AEMR (TWCL, 2009) was used to calculate the background dust deposition level. As the solid particles provided in the AEMR have been applied instead of insoluble particles (as stated in the DECCW assessment criteria) the background deposition rate and subsequent cumulative deposition rates (impact of the Baal Bone and background deposition rates) are considered conservative.

15.2.4 Dispersion Modelling

Atmospheric dispersion modelling was conducted using the AUSPLUME model in accordance with the guidelines published by Australian regulatory authorities (DEC, 2005).

The model uses the Gaussian dispersion model equation to simulate the dispersion of a plume from point, area or volume sources. Mechanisms for determining the effect of terrain on plume dispersion are also provided. AUSPLUME operates on an hourly time step, and, therefore, requires hourly wind speed, wind direction and other dispersion parameter data. The dispersion of each pollutant plume is determined for each hour using conventional Gaussian model assumptions. It should be noted that Gaussian models are best used to identify pollutant concentrations at receptor locations close to emissions sources, as they can overestimate concentrations at longer distances.

The model utilised the following input data:

- Meteorology:
  - Data, such as wind speed and direction, included in the air dispersion modelling was sourced from the Mount Piper Power Station monitoring station for the period of 2004 as provided by TWCL from a previous air quality study (Heggies, 2007).
  - The monitoring site is approximately 10km to the south of the Baal Bone site at an elevation of 950m and the station measures wind speed, wind direction, ambient temperature, relative humidity and rain fall.
  - Wind roses analysing wind direction and wind speed were produced to compare seasonal trends for 2004
- Terrain effects:
  - a terrain file was generated for the region surrounding both the surface activities and the mine ventilation shaft covering an area of 33km by 25km and applied in the AUSPLUME model
- Building wake effects:
  - Due to the nature of the odour and dust sources, no building wake effects were included in the dispersion modelling
- Modelling scenarios:
  - Dispersion modelling for the Baal Bone was performed for one scenario which considered emissions from surface activities combined with emissions from the mine ventilation shafts.
  - Background PM10 and TSP concentrations were considered in the model predictions
- Source characteristics:
  - Area source characteristics included:
    - Coal and ROM stockpile;
    - Surface Infrastructure Area; and
    - Coarse reject emplacement area.

The dimensions and areas of the sources were chosen to represent the active surface sections of the mine where dust would potentially be generated and did not include revegetated areas or sealed roads. Assumptions from the Emissions Inventory were also utilised.

- Volume source characteristics included:
  - Coal Train Loader;
  - Coarse Reject Truck Loader;
  - Haulage Road;
  - Mine Ventilation Shaft – Forest; and
  - Mine Ventilation Shaft – Adit 5.

The dust emissions caused by the movement of coarse reject haulage trucks on the site were modelled as volume sources spread out every 150m on the road (line source). The initial lateral and vertical dimensions were calculated from the ISC3 air dispersion model Users Guide (US EPA 1995). Ten (10) volume sources were chosen for the Baal Bone coarse reject haulage road.

- Emissions inventory (refer to Section 15.2.1)

- The evaluation of odour impacts required the estimation of short or peak concentrations on the time scale of less than one second. The ratio of 1 second average concentrations to mean 1 hour average concentrations (P/M60) are provided in the Approved Methods were applied in the AQIA for the mine shafts.
- The input emissions file used in the model designates hourly varying dust emission rates to reflect the surface operations of the Colliery.

Comments and assumptions made in relation to generating the emissions inventory and modelling inputs for the Baal Bone Colliery included:

- The operational process description, operational time frames and the volume of material excavated were supplied by TWCL;
- Where possible conservative assumptions have been applied;
- Mine ventilation shaft parameters were gained from a previous air quality report (Heggies, 2007);
- The mine ventilation shafts were modelled as volume sources;
- Emission factors used to calculate TSP and PM_{10} emission rates were gained from the NPI manual for mining (Commonwealth of Australia, 2001);
- The watering of the haul road, infrastructure surfaces and coal and ROM stockpiles was assumed to be conducted at less than 2 L/m2/hr and the appropriate reduction applied to PM_{10} and TSP emissions as stated in the NPI manual (50%);
- The TSP background concentration data was generated on the assumption that 40% of TSP is PM_{10}.
- The kilometres travelled by the haulage trucks were calculated from the distance of the unsealed road between the centre of the coarse reject emplacement and the coarse reject truck loader;
- Bulldozers were not included in the emission calculations;
- Truck haulage off site was not included in the emission calculations;
- A coal yield value of 75% was used in the calculation of coarse reject volume; and
- Sealed roads, infrastructure, dirt roads that are not often used, vegetated or rehabilitated soil, water/liquid bodies were not included in the calculated potential dust generating areas:

15.2.5 Assessment Criteria

Assessment of the predicted dust and odour concentrations and deposition rates for the Baal Bone was performed using assessment criteria and methodology defined in the DECCW Approved Methods (DEC, 2005). The method states that the criteria must be applied at the nearest existing or likely future off site sensitive receptor. Assessment criteria are presented for TSP, PM_{10}, and dust deposition.

The relevant impact assessment criteria specified by the DECCW Approved Methods for the AQIA is presented in **Table 15-2**. The Approved Method provides for dust impact assessment as PM_{10}, TSP and deposited dust concentrations in ug/m^3 and odour concentrations in OU. The relevant averaging periods for each pollutant is provided. The assessment compares the impact assessment criteria to the predicted isolated ground level concentration (GLC) impact (predicted impacts due to the Baal Bone alone) as well as the predicted cumulative GLC impact (predicted isolated impacts plus the background concentration).

Table 15-2: Assessment Criteria

Pollutant	Units	Assessment Criteria	Averaging Period	Percentile
TSP	$\mu g/m^3$	90	Annual	100^{th}
PM_{10}	$\mu g/m^3$	30	Annual	100^{th}
	$\mu g/m^3$	50	24 hours	100^{th}
Deposited Dust	g/m^2.month	4	Annual	100^{th}
Odour	OU	5	1 Second	99^{th}

The odour criterion for the AQIA was selected from the Approved Methods (DEC, 2005) as 5 OU nose- response time average at the 99^{th} percentile. The method provides for the selection of assessment criteria based upon the population of the affected community. The community surrounding the Baal Bone within the zone of affectation

has been estimated to be approximately 36 people; 12 residences multiplied by an average of three residents per residence. The method states that for a population around 30 people that an impact assessment criterion of 5 OU be applied.

15.3 Potential Impacts

The maximum predicted dust and odour concentrations in isolation from the background concentrations at each discrete sensitive receptor have been presented in **Table 15-3**. The predicted cumulative pollutant concentration (which includes the predicted concentration form the Project plus the background concentration) is also included (refer to **Section 15.2.2**). Note that deposited dust results are expressed as deposition rates and not concentrations.

Table 15-3: Maximum Predicted Pollutant Results at the Discrete Sensitive Receptors

Receptor Number	TSP ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)			Deposited Dust (g/m^2.month)		Odour (OU)
	Annual	Cumulative	Annual	Cumulative	24 Hour	Annual	Cumulative	1 Second
1	13.5	58.5	5.0	23.0	36.2	0.7	3.3	2.6
2	7.4	52.4	2.6	20.6	23.2	0.4	3.0	1.8
4	3.3	48.3	1.2	19.2	12.5	0.2	2.8	1.0
5	4.2	49.2	1.5	19.5	16.1	0.2	2.8	0.9
6	4.5	49.5	1.7	19.7	13.2	0.2	2.8	2.1
7	2.5	47.5	0.9	18.9	13.6	0.2	2.8	1.3
8	2.6	47.6	1.0	19.0	16.4	0.2	2.8	1.8
9	5.2	50.2	1.7	19.7	26.5	0.4	3.0	1.1
10	5.4	50.4	1.8	19.8	19.4	0.4	3.0	2.5
11	3.8	48.8	1.3	19.3	13.0	0.2	2.8	0.7
12	3.3	48.3	1.1	19.1	18.5	0.2	2.8	1.5
13	2.8	47.8	0.8	18.8	10.6	0.2	2.8	0.7
Criteria	**90 $\mu g/m^3$**		**30 $\mu g/m^3$**		**50 $\mu g/m^3$**	**4 g/m^2.month**		**5 OU**

No exceedences of the relevant criteria are predicted. The predicted dust deposition rates were compared to the measured data to assess the relative contribution of the Baal Bone to existing deposition levels. The results show that predicted dust deposition rates and odour concentrations are relatively low to very low (**Table 15-3**). It was concluded that potential impacts are unlikely to be significant due to the success of existing operations in mitigating the effects on air quality.

The AQIA (**Appendix J**) predicted that ground level concentrations and deposition rates for all modelled parameters, TSP, PM_{10}, deposited dust and odour, were comfortably below the DECCW assessment criteria at the nearest representative sensitive receptor (**Table 15-3**). Based on the use of Bathurst DECCW pollutant data as the background concentration for TSP and PM_{10} annual average, the cumulative GLCs provided in the AQIA for these parameters are considered to be conservative and likely to over-predict the actual impacts of the Colliery at sensitive receptors. Applying the measured deposited dust deposition rate as the background deposition rate is also considered conservative and likely to over predict the actual impacts of the Colliery.

Due to the existing operations and known overall air quality of the area through previous assessments of mining operations, the potential impact on air quality of current and continued operation of the Surface Infrastructure Area and Underground Mining Area (including the Remnant Areas) is well understood. Potential impacts to air quality are not expected to be significant provided the continued implementation of current successful mitigation and design measures on site.

15.4 Environmental Safeguards

Mitigation measures are currently employed as part of Baal Bone operations to manage potential impacts on air quality. Previous assessment recommendations for the Surface Infrastructure Area would continue to be utilised including management practices such as the following:

- Conveyors and transfer points are either fully or partially enclosed on the sides of the prevailing winds;
- Spraying of stockpiles to minimise dust;
- Watering of haul road to minimise dust;
- Regular cleaning of areas that may generate dust; and
- Appropriate ventilation of operational mine shafts.

Monitoring for potential impacts to air quality would continue to be undertaken and reported according to Xstrata protocols and EPL requirements for the existing operations. Environmental safeguards would be inclusive of the existing management measures outlined in the MOP.

15.5 Conclusion

The AQIA undertaken for this EA predicted that ground level concentrations and deposition rates for all modelled parameters, TSP, PM_{10}, deposited dust and odour, met all regulatory assessment criteria at the nearest representative sensitive receptor. Continued operations at Baal Bone are not expected to generate significant impacts to air quality as has been demonstrated by the existing operations. The continued operations and remnant mining at Baal Bone are not expected to adversely impact the air quality of the local community around the Colliery.

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16.0 Greenhouse Gas

A Greenhouse Gas (GHG) Assessment was undertaken for this EA in order to estimate the annual GHG emissions associated with the operation of the Colliery. AECOM has undertaken an assessment of Scope 1, 2 and 3 GHG emissions (as defined in **Section 16.1**) for operations at Baal Bone using the *National Greenhouse Accounts Factors* (NGA) (DCC, 2008) and the *Xstrata Coal Estimation of Scope 3 Emissions SEE Version December 2008* (Xstrata Coal, 2008) document and excel spreadsheet originally developed by Energetics for Xstrata. The Greenhouse Gas Assessment is presented in **Appendix K** and summarised in the following sections.

16.1 Greenhouse Assessment Policy Context and Methodologies

In NSW, there are a number of policies in place that outline the methodologies for undertaking greenhouse gas assessments. Primary policies include:

- World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) Greenhouse Gas Protcol 2004 (GHG Protocol); and
- National Greenhouse Accounts (NGA) Factors, Australian Government Department of Climate Change (DCC), June 2009.

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions by entities. Under the GHG Protocol, operational boundaries are established by identifying emissions associated with an entity's operations, categorising them as direct or indirect emissions, and identifying the scope of accounting and reporting for indirect emissions. This methodology divides emissions into three broad scopes referred to as Scopes 1, 2 and 3.

Scope 1 emissions are direct emissions from sources within the boundary of an operation including fuel combustion, manufacturing processes and onsite waste disposal. These emissions are controlled by the operation. Scope 1 emissions or the Project include:

- Fugitive methane (CH_4) and carbon dioxide (CO_2) emissions from underground workings. These emissions are likely to be released into the atmosphere through the ventilation shafts. Baal Bone mining operations are typically of non-gaseous underground nature and were therefore assessed as a 'non-gassy mine' in the GHG assessment.
- CO2 emissions from the combustion of fuel by diesel powered equipment and vehicles. This would include surface operation equipment such as bulldozers, on-site haul trucks, and other vehicles under the control of the Colliery.

Scope 2 covers indirect emissions from the consumption of purchased electricity during normal operation of the Colliery.

Scope 3 includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the operation. Scope 3 emission sources which arise from Baal Bone's operation but are not directly emitted by the Colliery include:

- Transport of products from the site; and
- Emissions due to the end use of the coal product itself.

The procedures specified in the *NGA Factors* (DCC, 2009) have been used to estimate the Scope 1 and 2 GHG emissions. The Workbook (DCC, 2009) is consistent with internationally applied methods. The Xstrata Coal Estimation of Scope 3 Emissions document (Xstrata Coal, 2008) has been used to estimate the Scope 3 GHG emissions.

The methodology identifies the primary greenhouse gases as follows:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O); and
- Synthetic Gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF)).

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (potentials) and emission factors take into account the global warming potentials of the reaction products or chemicals.

16.2 Emission Calculation

Baal Bone has provided information including production rate, diesel use, electricity use, consumable rates, transport information and product end use to allow the estimation of future production rates of the Colliery.

An annual average ROM coal production value of 2.2 Mtpa has been used in calculating GHG emissions as a best estimate of the annual average coal production based on the remaining life of the mine, although it is noted that the Colliery has an approved ROM coal production up to 2.8 Mtpa.

16.2.1 Scope 1 – Direct

The total tonnage of CO_2-e for direct process GHG emissions are provided in **Table 16-1** as estimated using the *NGA Factors* (DCC, 2008).

Table 16-1: Direct Process GHG Emissions Summary

GHG Emission Source	GHG Emission (tonnes CO_2-e/annum)
Fugitive Emissions	17 600
Diesel Use	3 910
Total CO_2-e	**21 510**

Fugitive Emissions

Fugitive emissions from underground mines involve the release of methane and carbon dioxide during the mining process due to the fracturing of coal seems, overburden and underburden strata. Due to the non-gaseous underground nature of the mining operation, the Baal Bone Colliery is assessed as a 'non-gassy mine' under the NGA Factors method. The emission factors for non-gassy underground mines are substantially lower than those for gassy mines. The total ROM coal extracted is estimated to be 2.2 Mtpa with an emission factor of 0.008 tonnes CO_2-e/tonne of coal. This results in GHG emissions of **17 600 t CO_2-e/annum**.

Diesel use

Diesel equipment would include bulldozers, forklifts, and other vehicles under the control of TWCL. The total annual diesel usage is estimated to be 1,449 kL. This results in GHG emissions of **3 910 t CO_2-e/annum** for the full fuel cycle in producing the diesel.

16.2.2 Scope 2 – Indirect

The total tonnage of CO_2-e for energy related (indirect) GHG emissions are provided in **Table 16-2** as estimated using the *NGA Factors* (DCC, 2008).

Table 16-2: Energy Related (Indirect) GHG Emissions Summary

GHG Emission Source	GHG Emission (tonnes CO_2-e/annum)
Electrical Energy Consumption	46 489
Total CO_2-e	**46 489**

The electricity generation emission factor for New South Wales of 0.89 kg CO_2-e/ kWh has been applied.

Electricity

The estimated annual electricity consumption of the Ball Bone Colliery for continued operations is 52,234,921kWh. The electricity generation emission factor for New South Wales of 0.89 kg CO_2-e/ kWh is applied, resulting in total equivalent CO_2 emissions due to electricity consumption of **46 489 t CO_2- e/annum**. This includes the emission for the full fuel cycle in generating the electricity.

16.2.3 Scope 3

Emission sources which arise from the Baal Bone Colliery operation but are not directly emitted by the Colliery are determined in this section. Sources include consumable material transportation, transport of products from the site, and emissions due to the use of the coal product itself.

The Scope 3 GHG emissions have been estimated using the Xstrata Scope 3 Assessment excel spreadsheet – SEE Version December 2008 (Xstrata Coal, 2008). The total tonnage of CO_2-e for associated external GHG emissions are provided in **Table 16-3**.

Table 16-3: Associated External GHG Emissions Summary

GHG Emission Source	GHG Emission (tonnes CO_2-e/annum)
Product Transportation	157 425
Product End Use	4 150 300
Total CO_2-e	**4 307 725**

Product Transportation

Coal product is exported to overseas customers by train and ship and delivered domestically to customers by trucks. The Xstrata Scope 3 Assessment provides the following emission factors for transportation in kg CO_2-e per tonne km; road transport 0.138, rail transport 0.0054, and ship transport 0.0126. The Xstrata Scope 3 Assessment excel spreadsheet calculates the GHG emissions from transport using these emission factors and transport distance. The Xstrata excel spreadsheet calculates the GHG emissions from transport using identified emission factors and transport distance. Table 16-4 details the equivalent CO_2 emissions due to product transportation.

Table 16-4: Product Transportation GHG Emissions Summary

GHG Emission Source	GHG Emission (tonnes CO_2-e/annum)
Road Transportation	102
Rail Transportation	1 865
Ship Transportation	155 457
Total CO_2-e	**157 424**

Emission factors for transportation in kg CO_2-e per tonne km; road transport 0.138, rail transport 0.0054, and ship transport 0.0126.

The road transport value in **Table 16-4** has been calculated using a best estimate of the annual operations of the colliery. However, the Baal Bone Colliery is licensed to domestically transport 900,000 tpa of coal by road. If this license value was used to calculate the tonnes of CO_2-e per annum, the resulting road transport GHG emission would be **18 630 t CO_2-e/annum,** however this was would result in a reduction of GHG emissions from rail and ship transportation, as coal transported by road would be used locally at nearby power stations.

Product End Use

Coal product in NSW is generally used for either electricity production (thermal coal) or steel production (coking coal). The coal product exported overseas and delivered domestically to customers from the Baal Bone Colliery is thermal coal for electricity generation. The total coal product is estimated to be 1,650,000 t/annum for the continued operations of Baal Bone. It is assumed that 100% of the coal extracted will be used for electricity generation. The carbon in coal content is assumed to be 70%. The emission factor for electricity generation as provided by the Xstrata document (2008) is 2.52 t of CO_2 per tonne of carbon in the coal. The resulting equivalent CO_2 emissions due to product end use is **4 150 300 t CO_2-e/annum**.

16.2.4 Total Emissions

The total annual GHG emission from the continued operations of Baal Bone for Scope 1, 2 and 3 emission sources is provided in **Table 16-5**.

Table 16-5: Total GHG Emissions Summary

GHG Emission Source	GHG Emission (tonnes CO_2-e/annum)	Percentage of NSW GHG Emissions
Scope 1 GHG emission	21 510	0.01
Scope 2 GHG emission	46 489	0.03
Scope 3 GHG emission	4 307 725	2.65
Total CO_2-e	**4 375 724**	**2.69**

As reported in the Department of Climate Change publication *State and Territory Greenhouse Gas Inventories 2007* (Commonwealth, 2009), Australia's GHG emissions for the year 2007 are estimated to be 597.2 Mt (million tonnes) CO_2-e. New South Wales (NSW) GHG emissions were 162.7 Mt CO_2-e for 2007, a contribution of 27.3% to the total national emissions. Scope 1 and 2 emissions from the operation of the Colliery comprise a total of 0.04% of NSW GHG emissions. Total GHG emission contributions (including Scope 3) from Baal Bone to the NSW GHG emissions is approximately 2.7%, with a contribution of 0.73% towards the total national GHG emission.

16.3 Greenhouse and Energy Mitigation Management

As Baal Bone is a Xstrata operation, TWCL is committed to the Xstrata Coal Climate Change Position Statement (Xstrata Coal 2008). Xstrata is committed to playing its part in the international collaborative effort to implement solutions to the challenge of climate change.

TWCL is currently preparing an Energy Savings Action Plan (ESAP) for Baal Bone as part of its requirements under the NSW Government's ESAP legislation. The purpose of the ESAP is to review energy usage, identify energy savings opportunities and implement ongoing energy management activities.

Some of the energy savings opportunities and management activities implemented at Baal Bone include:

- Reporting, feedback and control systems;
- Review of standard operating and maintenance procedures to ensure that they address energy efficient operation of major equipment;
- Regular monitoring the energy use of all major facilities, metering and recording of electricity and diesel usage at CHPP;

- Auditing process comprising of a formal, in-house review each year to review of all aspects of energy management (targets, plans, processes etc) and compare energy savings results against original projections;
- Upgrade of Diesel engines to Tier 2 with cleaner burns and greater power output; and
- Conveyor Sequencing - Conveyor shut downs during down shift.

Xstrata's climate change strategy for reducing GHG emissions from the extraction and use of coal in power generation is focused on policy, management of emissions, carbon markets, technology and communication. Xstrata actively supports research and development into low emission technologies and developing a portfolio of options to reduce GHG emissions. Baal Bone has a number of GHG and energy management systems in place. And is committed to the Xstrata Coal Climate Change Position Statement (Xstrata Coal, 2008a) and participates in the Energy Efficiency Opportunities (EOO) Program (Xstrata Coal, 2008b).

Xstrata participates in the Carbon Disclosure Project which is a global initiative that aims at encouraging private and public sector organisations to measure, manage and reduce emissions and climate change impacts of their business. Baal Bone therefore publically reports on its actions to reduce its greenhouse footprint and the potential impacts of climate change.

Baal Bone would continue to contribute to initiatives and programs such as the National Greenhouse and Energy Reporting System (NGERS), EEO Program and the proposed Carbon Pollution Reduction Scheme (CPRS).

Baal Bone would continue to seek to provide maximum resource extraction with maximum efficiency. Baal Bone would also assess and consider implementation, where feasible, of GHG and energy management and mitigation initiatives during the design, operation and decommissioning of the mine.

16.4 Conclusion

Continuation of operations at Baal Bone would result in the continuation of greenhouse gas emissions. Scope 1 2 and 3 GHG emissions associated with the operation of the Colliery based on a coal production value of 2.2 Mt of coal per year were assessed. Baal Bone's GHG emissions relating to the proposed continuation of mining operations and mining of Remnant Areas have been calculated to be a total of 4 375 724 t CO_2-e per annum, which represents approximately 2.7% of the NSW GHG emissions, and approximately 0.73% towards the total national GHG emission.

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17.0 Geology and Soils

17.1 Existing Environment

17.1.1 Landform

As discussed previously, the landscape encompassing and surrounding Baal Bone is varied with both gently undulating forested plateaus and steep escarpments and valleys. Ben Bullen State Forest, the Gardens of Stone National Park and Wolgan State Forest lie in close proximity to the north, east and west of the site. These features provide significant and high local visual amenity to the area.

17.1.2 Geology

Setting

Baal Bone lies geologically in the Western Coalfield of the Permo-Triassic Sydney Basin. The Western Coalfield is generally free of major faults, and igneous intrusions are uncommon. The area overlying Longwalls 29 to 31 at Baal Bone form part of the western edge of the Newnes Plateau. This area is known for its unusual sandstone rock formations and considered to have unique environmental significance (Umwelt, 2007).

At Baal Bone no igneous dykes or sills have been detected in the mine workings to date with minor faults occurring infrequently (JDS Mining, 2008). Baal Bone mines from the Lithgow Coal Seam (LCS) from within the Illawarra Coal Measures. The stratigraphical profile of the area is shown in **Figure 17-1**.

Narrabeen Sandstone

The geological landscape at the surface is largely defined by rock outcrops and underlying strata of Narrabeen Group sandstones, which are interbedded with shale and siltstone bands. Weathering has eroded some of the upper parts of the Group and exposed some of the underlying subgroups at the surface.

Illawarra Coal Measures

The Illawarra Coal Measures overlie marine sediments of the Shoalhaven Group and were deposited in lower delta plain conditions interrupted by a marine incursion known as the Erins Vale Formation. Coal measure development was terminated by rapid climate change and renewed basin uplift at the end of the Permian age. The Illawarra Coal Measures are comprised of shale, quartz-lithic sandstone, conglomerate, chert, sporadically carbonaceous mudstone, coal and torbanite seams of late Permian age. The LCS is located within this sequence.

Lithgow Coal Seam

The LCS is within a subgroup of the Illawarra Coal Measures and is mainly dull, medium volatile and generally non-swelling bitumous coal with moderate ash content. It ranges in thickness between 1.9m and 2.5m but averages approximately 2.4m, with overlying shale and inter-laminated sandstone and siltstone. The overlying Triassic sandstone sequence generally ranges between 100m and 120m in thickness and consists mostly of sandstones belonging to the Narrabeen Group. The general dip of the bedding is to the north east at about 1 degree.

From various exploration drilling and inspections it has been determined that, in unmined areas, the profile overlying the Lithgow Seam consists of sequences of clays, traces of the Irondale Seam, interbedded fine to medium grained gravel, light grey to dark grey sandstone and siltstone, and dark grey and thinly laminated shale bands overlying the Lithgow Seam. For most of the Baal Bone area, overburden and cover ranges from 100m to 200m; however, the LCS has been noted as shallow as 30m and as deep as 300m (JDS Mining, 2008). The lithological profile of the seam is shown in **Figure 17-1** and includes the estimated height of each stratum above the roof of the LCS.

History of exploration

Exploration drilling has been undertaken since Baal Bone was acquired by Coalex in 1979 when reserves at the existing Wallerawang operation were nearing depletion. Exploration drilling of the LCS was undertaken for sampling and analysis by different operators in the periods from 1979 to 1991, during the 1990's, and more recently from 2001 to 2007 by Xstrata. Data gained from the exploration and confirmation drilling holes includes analyses, downhole geophysical logs, lithological logs and core photos.

17.1.3 Soil Landscapes

A review of the Soil Conservation Service maps was undertaken to determine the distribution of soil landscapes within the area. Based on the Wallerawang Soil Landscape Series Map Sheet, six soil groups apply to the study area, including Longwalls 29 to 31 and proposed mining of Remnant Areas, the characteristics of which are summarised in **Table 17-1** below.

Table 17-1: Soil Characteristics

Soil Group	Characteristics
Newnes Plateau (np)	• Landscape is described as gentle undulating partially cleared low open-forest with infrequent rock outcrops and the general fertility of the soils low. • Soil is loose quartz-rich sand (topsoil), contains sandstone fragments and is strongly to moderately acidic. Subsoil consists of earthy sandy clay loam and is moderately to slightly acidic. • Erodibility is low to moderate but is susceptible to erosion following bushfire or logging.
Medlow Bath (mb)	• Landscape is described as narrow crests and moderately inclined sideslopes on Narrabeen Group sandstones with localised rock outcrop and partially cleared open-forest and woodland. • Characterised by both loose black organic-rich sand, and earthy loamy sand (topsoil) containing sandstone fragments and ranges from strongly to slightly acidic. Subsoil consists of clayey sand and is moderately to slightly acidic.
Hassans Walls (hw)	• The landscape is described as cliffs derived from Narrabeen Group sandstones and steep sideslopes. Open-forest and open-woodland. • Characterised by topsoil of brownish black loamy sand with abundant sandstone gravel and boulders. Subsoils consist of yellowish brown pedal clays. • Severe erosion is common throughout this landscape.
Cullen Bullen (cb)	• Landscape is described as rolling low hills with localised rock outcrop and extensively cleared open-woodland and forest. • Earthy, slightly to moderately acidic soils. Subsoil usually contains sandstone fragments at depth • High water erosion hazard.
Wollangambe (wo)	• Landscape is described as rounded convex crests and moderately to steep inclined sideslopes on Narrabeen Group sandstones. Localised rock outcrop is common with largely uncleared open-woodland and forest. • Soils are generally acidic with low nutrient status. • High water erosion hazard.
Long Swamp (ls)	• Landscape is described as level to gently inclined swamps on recent alluvium overlying the Illawarra Coal Measures. Contains closed-sedgeland and closed-heath with open-forest on swamp margins. • Highly organic acid soils with low fertility and permeability.

The soil types that characterise the area generally have low fertility and have a moderate to high erosion potential.

PERIOD	STRATIGRAPHY			GRAPHIC LOG	LITHOLOGY	DIST. OF BASE OF ROCK UNIT ABOVE SEAM ROOF (M)
	Group	Subgroup	Formation			
Tertiary			Basalt		Basalt	
Triassic	Wiannamatta		Ashfield shale			
		Hawkesbury Sandstone				
	Narrabeen Group	Grose Subgroup	Burralow Formation			Surface 150-220m
			Banks Wall Sandstone			
			Mt York Claystone			
			Burra-Moko Head Sandstone			112-118m
			Caley Formation			98-100m
Permian	Illawarra Coal Measures	Wallerawang Subgroup	Farmers Creek Formation		Coal, sandstone, claystone, siliceous claystone (includes Katoomba and Middle River Seams)	76-77m
			Gap Sandstone		Sandstone	
		Charbon Subgroup	State Mine Creek Formation		Coal, mudstone, claystone	
			Watts Sandstone		Sandstone	
			Denman Formation		Interbedded mudstone/ sandstone, claystone, mudstone	
			Glen Davis Formation		Coal and claystone bands	
			Newnes Formation		Coal, sandstone	
			Irondale Coal		Coal	27-28m
			Long Swamp Formation		Interbedded sandstone and siltsone	
		Cullen Bullen Subgroup	Lithgow Coal		Coal and claystone bands	TARGET SEAM
			Marrangaroo Formation		Sandstone, conglomerate	
		Nile Subgroup	Gundangaroo Formation		Coal, sandstone, claystone	
			Coorongooba Creek Sandstone		Sandstone	
			Mount Marsden Claystone		Claystone	
	Shoalhaven Group		Berry Siltstone			
			Snapper Point Formation			

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STRATIGRAPHY OF THE WESTERN COALFIELD

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 17.1

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Potential Impacts

Potential impacts on geology and soils are largely associated with soil erosion of hardstand areas and surface infrastructure; however, other potential impacts have also been considered. Potential impacts associated with longwall mining include:

- Surface cracking;
- Soil erosion;
- Soil slumping (although no previous occurrence at Baal Bone);
- Sub-surface deformation; and
- Land degradation associated with subsidence.

Impacts on soil are expected to be minimal given the limited ground surface disturbance associated with the continued operations and that no new construction of surface facilities is proposed.

Due to the existing operations and known geology and soils of the area through previous assessments and mining operations, the potential impact of proposed mining activities, such as the Remnant Areas, on geology and soils is well understood and is not expected to be significant given the continued implementation of current successful mitigation measures and design.

17.2 Environmental Safeguards

Mitigation measures are currently employed as part of Baal Bone operations in order to manage potential impacts on geology and soil. The SMP approval for Longwalls 29 to 31 includes a Land Management Plan which addresses the potential impacts on soils and geology of the area through regular inspections of the surface features. These inspections would assist in the identification of soil erosion and surface cracking due to longwall mining in this area and ensures that appropriate mitigation measures are implemented where impacts are identified. As discussed in **Section 8**, the Land Management Plan contains a Trigger Action Response Plan (TARP), which enables identification of incidents and provides for corrective action and ongoing mitigation and management of subsidence impacts affecting the Project Area.

Also detailed in **Section 8**, potential mining activities associated with the Remnant Areas would be subject to an Extraction Plan which would be submitted to the Department of Planning prior to commencement of works. The Extraction Plan would detail the proposed mining activities and its design measures which have incorporated potential impacts upon the landform, including soils and geology.

Previous assessment recommendations for the Surface Infrastructure Area would continue to be utilised including management practices of surface flows into stockpiled areas to prevent the disturbance and erosion of washed product. Soil disturbance activities would cease during heavy rain, when surface runoff is occurring, or when there is evidence of soil saturation.

17.3 Final Rehabilitation

Concurrent rehabilitation techniques have been utilised to ameliorate soil and maintain and enhance disturbed areas to its natural and surrounding state (see **Section 13** and **20**). The sandstone escarpments would be preserved as they are unlikely to experience significant potential impacts.

TWCL is currently stockpiling clay loam freedig material and course reject in preparation for future rehabilitation and reshaping of the landform. Further details on final rehabilitation and safeguards are outlined in **Section 13**.

17.4 Conclusion

The continued operations of the Baal Bone surface infrastructure, mining of approved Longwalls 29 to 31, and mining of Remnant Areas are not likely to result in additional geological or soil impacts given continuation of current Land Management Plan, TARPs and successful mitigation techniques. Soil and geology would be considered as part of rehabilitation practices leading to the Final Landform.

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18.0 Ecology

18.1 Flora

18.1.1 Existing Environment

As described previously, the Surface Infrastructure Area is bordered to the north and east by the Capertee and Wolgan Valleys respectively. The Gardens of Stone National Park is situated to the north west of the site as is the Wolgan Gap. Ben Bullen State Forest surrounds most of the site and the Wolgan State Forest is located to the east of the site. The Underground Mine Area is situated beneath parts of Ben Bullen and Wolgan State Forests.

Biodiversity Monitoring Services was engaged to prepare an ecological assessment to assess the potential impacts of the Project on vegetation and habitat within the Project Area. The report is presented in **Appendix L**.

Nine vegetation types have been identified for the Baal Bone site, based on the field survey and relating the results of that survey to descriptions of vegetation map units (VWBM) reported by DEC (2005). The vegetation types with their respective VWBM units are shown below:

- Sandstone Plateau and Ridge Scribbly Gum – Silvertop Ash Scrubby Forest (28);
- Sandstone Slopes Sydney Peppermint Shrubby Forest (29);
- Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Scrubby Woodland (30);
- Tableland Hills Scribbly Gum – Narrow-leaved Stringybark Shrubby Open-Forest (32);
- Tableland Gully Mountain Gum – Broad-leaved Peppermint Grassy Forest (35);
- Coxs River Permian Red Stringybark – Brittle Gum Woodland (37);
- Pagoda Rock Sparse Shrubland (43);
- Sandstone Plateaux Tea Tree – Dwarf Sheoak – Banksia Rocky Health (44); and
- Mountain Hollow Grassy Fen (53).

The Mountain Hollow Grassy community corresponds to Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions endangered ecological community (EEC) listed under the NSW TSC Act.. It does not correspond to the EPBC listed Temperate Highland Peat Swamps on Sandstone endangered ecological community. An assessment of significance in relation to this EEC has been undertaken in **Appendix L**.

A search of the DECCW's *Atlas of NSW Wildlife* was undertaken on 13 May 2009 to identify records of threatened flora species known to occur within 5 km of the Project Area. A total of six species were identified. In addition, a further two known species were subsequently identified during field surveys. The full list of species is presented in **Appendix L** and is summarised in **Table 18-1** below.

Table 18-1: Threatened Flora Species of the Baal Bone Area

Species	TSC Status	EPBC Status
Derwentia blakelyi	Vulnerable (V)	Not listed
Eucalyptus cannonii	Vulnerable (V)	Vulnerable (V)
Genoplesium superbum	Endangered (E1)	Not listed
Grevillea obtusiflora ssp. fecunda	Endangered (E1)	Not listed
Persoonia marginata	Vulnerable (V)	Not listed
Prostanthera cryptandoides	Vulnerable (V)	Not listed
Prostanthera hindii	Not listed	Not listed
Prostanthera howelliae	Not listed	Not listed

The Capertee Stringybark (*Eucalyptus cannonii*) was the only threatened species found to occur at the Baal Bone site listed under both the TSC and EPBC Act as vulnerable. In addition, Coxs River Swamp, located some 350 m to the west of Longwall 29 and extending south (refer **Figure 18-1**), supports vegetation which corresponds to the EEC Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions. This community, whilst listed under the TSC Act does not correspond to communities listed under the Commonwealth EPBC Act. No other EPBC listed threatened species or ecological communities have been identified within the study area.

18.1.2 Method of Assessment

A literature review was conducted of ecological assessments and surveys undertaken within the Project Area. A total of nine previous flora surveys and assessments were utilised for the purpose of this flora assessment. The surveys have been used to characterise the vegetation patterns and flora species of the continued operations study area. An additional subsequent field survey was also undertaken for the purpose of this EA.

The surveys were conducted over several years and a range of seasons which has allowed for detection of plants such as flowering annuals, lilies and orchids. Seasonal conditions have been favourable for detection of cryptic species which flower in response to rainfall. The collection of literature identifies:

- Patterns of vegetation across the study area, including influence of past natural and man-made disturbance;
- Presence of threatened flora or other species of conservation significance;
- The condition of vegetation; and
- The presence of invasive exotic and non-local plant species.

Survey techniques utilised the draft Threatened Biodiversity Survey and assessment guidelines (DECC 2004) and Threatened Species Assessment Guidelines (DECC 2007).

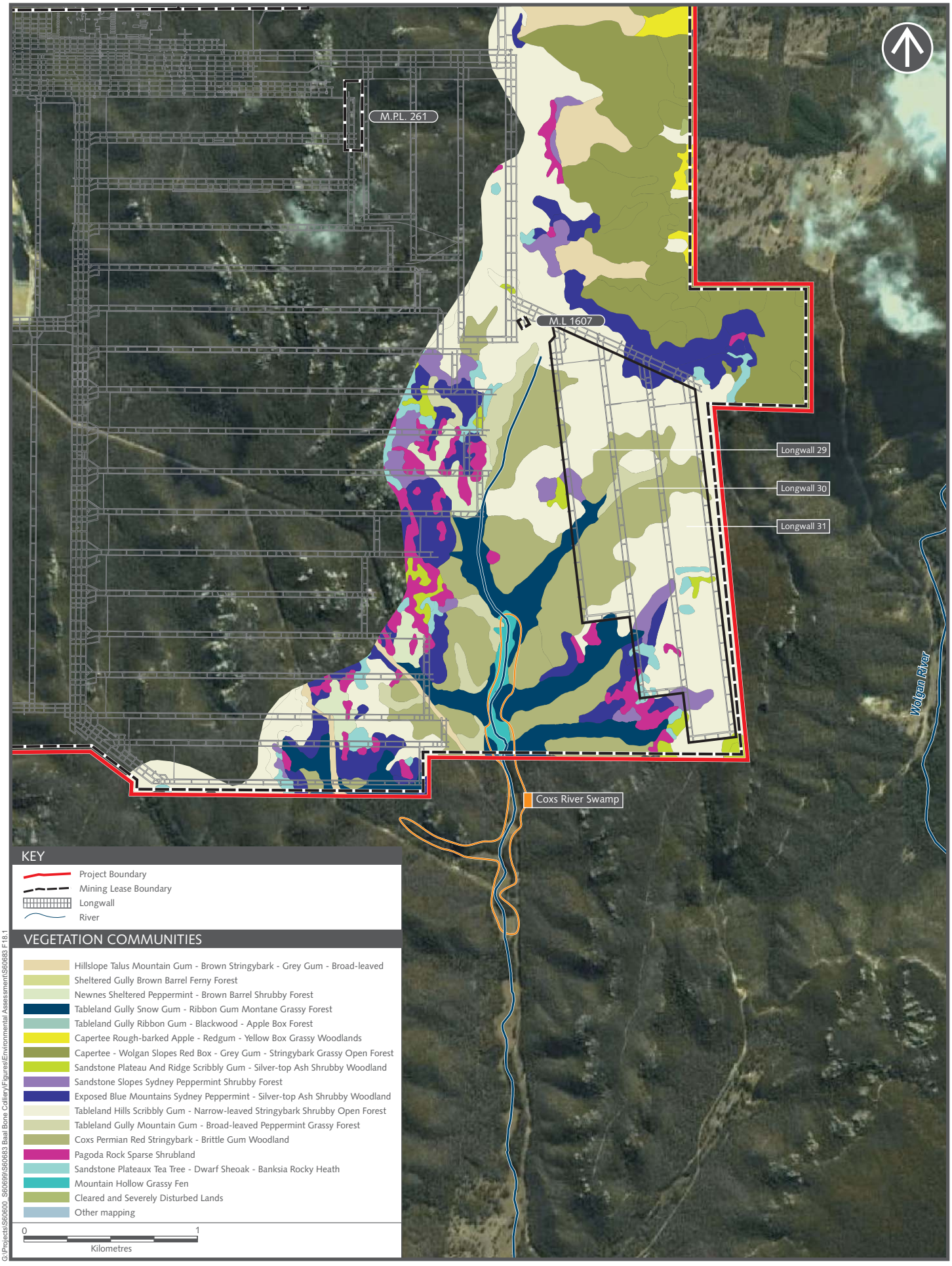
18.1.3 Potential Impacts

Longwalls 29 to 31 are adjacent to areas where mining has previously occurred, and over the history of mining at Baal Bone there is considerable information related to the levels of subsidence covering land of similar nature and with similar geological conditions, as they relate to coal mining and subsidence. The level of subsidence associated with extraction from Longwalls 29 to 31 is anticpated to be similar to that which has previously occurred at Baal Bone.

The arrangement of longwall panels has been deliberately planned to avoid impact on the Wolgan Valley escarpment and on cliffs and rock formations in the upper Coxs River catchment. Accordingly, it is expected that impacts on vegetation types which may be more sensitive to subsidence (communities associated with pagodas, rock platforms and escarpments) would be avoided.

Experience from mining of longwalls 25 to 28 indicates that surface expression of subsidence is likely. This may take the form of surface cracks extending 5m to 20m in length, 30cm to 2m in depth and 5cm to 20cm in width. This degree of cracking typically has relatively minor impact on vegetation with sporadic death or dieback of individual plants including ground cover plants, shrubs and trees. The degree of cracking typically experienced at Baal Bone is not expected to have a significant impact on plant species.

The Coxs River Swamp (also known as Long Swamp), located in the south east of the site, supports vegetation which corresponds to the EEC *Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions*, listed under the TSC Act. The proposed continued operations at Baal Bone including operation of the Surface Infrastructure Area and mining within the Underground Mining Area is not expected to directly impact on the EEC. The proposed development will not directly impact on this endangered ecological community and there is an extremely low likelihood of a localised and temporary impact due to indirect impact associated with changes in groundwater (Connell Wagner 2006, refer **Appendix G**). The flora monitoring program includes two sites in Long Swamp. This program is designed to enable detection and mitigation of impacts of longwall mining on vegetation within the Swamp.



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VEGETATION COMMUNITIES - LONGWALLS 29 TO 31

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Data Source:
Department of Environment and Conservation (2006)

Figure 18.1

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A seven part test under the TSC Act was conducted for both the Capertee Stringybark and the Montane Peatlands and Swamps EEC and can be found in **Appendix L**. A seven-part test involves consideration of seven factors of assessment which are to be considered when determining whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats. The aim of the test is to focus consideration of likely impacts in the context of the local rather than the regional environment as the long-term loss of biodiversity at all levels arises primarily from the accumulation of losses and depletions of populations at a local level.

A separate EPBC assessment was also undertaken for the Capertee Stringybark (**Appendix L**). The conclusion of the tests and assessment found that continued operations at Baal Bone are unlikely to have a significant impact and that an EPBC referral was not required.

The EPBC Protected Matters Search also identified that the Project Area is located within the same catchment of a listed Ramsar wetland, the Macquarie Marshes Nature Reserve located some 250 km from the Project Area. As discussed in **Section 10,** the project would not result in significant offsite water quality impacts. Additionally, the Project is unlikely to affect water supply to the wetland. As such the Macquarie Marshes Nature Reserve is unlikely to be affected either directly or indirectly by the project.

Extraction of coal from the Remnant Areas is likely to result in surface subsidence similar to levels experienced elsewhere at Baal Bone. This may cause cracking or minor rock falls which may result in localised death or dieback of individual or groups of plants. Seasonal monitoring undertaken for previous longwall mining at the site has not identified significant impacts to flora. **Section 8** outlines subsidence protection zones for the Remnant Areas based on identified sensitive surface features. As detailed in **Section 8**, potential mining activities associated with the Remnant Areas would be subject to an Extraction Plan which would be submitted to the Department of Planning prior to commencement of works. The Extraction Plan would detail the proposed mining activities and its design measures which have incorporated potential impacts upon the landform, including flora.

The continued operation of the existing Surface Infrastructure Area would not result in the removal or fragmentation of vegetation, and is not likely to result in a significant impact to flora.

18.1.4 Environmental Safeguards

The current monitoring strategy, as outlined in the Biodiversity and Land Management Plan would be continued. This Plan includes the following measures:

- Twice yearly monitoring of six vegetation quadrats as follows:
  - Four quadrats in woodland and forest areas over Longwalls 29-31;
  - Two quadrats within Coxs River Swamp (Long Swamp);
- Excessive clearing and proliferation of tracks is to be avoided with access tracks, and survey lines planned to minimise habitat fragmentation;
- Where feasible, revegetation works should be planned to link areas of existing fauna habitat;
- Prevention and control measures for weeds that may displace native species are to be implemented; and
- Land management procedures to ensure that grazing does not impact identified ecological values of the site shall be followed.

The scale of monitoring has been established based on predictions of the level and likely impact of subsidence, risk assessment and the recommendations that were outlined in the SMP. The current scale of monitoring, as outlined in the Biodiversity and Land Management Plan is considered appropriate and allows for attention to be drawn to the issues, such as weed or pest animal species invasion, which may impact on health of vegetation across the area.

18.1.5 Conclusion

A flora assessment was conducted and has identified ecological communities and threatened species within the Project Area. Two threatened species were identified which are listed under the TSC Act as vulnerable, with one also being listed under the EPBC Act. Two seven part tests and an EPBC assessment were undertaken and concluded the impact on these communities and species as a result of the continued operations at Baal Bone were not significant, and an EPBC referral would not be required.

18.2 Fauna

18.2.1 Existing Environment

The forested areas within the Project Area support a range of fauna species and habitat. Gingra Ecological was engaged to prepare an ecological assessment to assess the potential impacts of the Project on fauna and fauna habitat within the Project Area. The report is presented in **Appendix M**.

Desktop reviews and acquisition of baseline data have been used to identify fauna likely to occur within the Project Area. Previous records and baseline studies indicate that the following types of species are known to occur within the Project Area:

- 31 mammal species (20 Protected, three Vulnerable, eight Unprotected);
- 99 bird species (92 Protected, four Vulnerable, three Unprotected);
- 13 reptile species (13 Protected); and
- Five amphibian species (five Protected).

Analysis of records for threatened species derived from the DECCW online Atlas of NSW Wildlife returned 36 threatened species known to occur within 20km of the Project Area and included the following:

- 12 mammal species (12 Vulnerable);
- 17 bird species (15 Vulnerable, two Endangered);
- Three reptile species (one Vulnerable, two Endangered);
- Two amphibian species (two Vulnerable); and
- Two invertebrate species (two Vulnerable).

The full list of species identified as known to occur are listed in Table 2 and Table 3 of **Appendix M**.

18.2.2 Method of Assessment

The fauna assessment for the continued operations and mining of Remnant Areas involved three stages as follows:

Stage 1 – Gap and Constraints Analysis

A desktop review was undertaken of previous assessments and surveys undertaken within the Project Area, as well as databases including DECCW's Atlas of NSW Wildlife, State Forests and Australian Museum. The desktop review identified fauna species known to occur within the Project Area, as well as species known to occur within 20 km of the Colliery.

The full list of fauna species with the potential to exist within the Project Area is provided in the Fauna Assessment in **Appendix M** of this EA.

Data on the distribution of fauna within Baal Bone was used in assessment within the area and provides information on the known and potential threatened species that may occur. This list of threatened species has also been used in an Assessment of Significance in order to assess potential impacts on species listed under the TSC Act and EPBC Act. The results of this analysis are described in **Section 18.2.3**.

Stage 2 – Baseline Data Acquisition

Fauna surveys were undertaken in parts of the Project Area. Areas of land not currently approved to be mined were surveyed for fauna and habitat condition in March 2009. Detailed descriptions of these surveys are given in a separate report (Biodiversity Monitoring Services, 2009) but were utilised for the purpose of this EA where relevant.

Stage 3 – Impact Assessment

The information obtained from Stages 1 and 2 was used to assess the potential impacts on identified fauna species within the Project Area, including potential impacts from underground mining on critical habitats and threatened fauna.

18.2.3 Potential Impacts

Current potential impacts on fauna are largely limited to impacts on habitat as a result of subsidence, which as discussed in **Section 8**, is not expected to be significant. Rocky formations sensitive to subsidence could result in the loss of preferred habitat for some fauna species; however, there is a likelihood of the creation of new preferred habitat such as cracks. Regular ongoing monitoring has been conducted over the area and indicates that the likely extent of subsidence from the mining of these longwalls would be similar to that which has previously occurred at Baal Bone and is not expected to result in significant impacts to fauna species. It is therefore unlikely that continued operations within the Underground Mining Area would result in significant impacts on the viable local population of identified or potential fauna species. Potential impacts on threatened species listed under the TSC Act and EPBC Act have been discussed below.

Threatened Species Conservation Act 1995

A search of the DECCW online Atlas of NSW Wildlife returned 36 threatened species which have previously been recorded in the Baal Bone area. A seven-part test was conducted for each of the threatened species in accordance with the TSC Act.

Although listed for the locality (i.e. within 20km of Baal Bone), not all of the threatened species are likely to occur within the area of woodland habitat in the Colliery, nor are all likely to be affected by subsidence effects from underground mining.

The major impacts from underground mining are upon sensitive habitats such as wetlands, watercourses, wet gullies (dells), cliff lines and rocky outcrops. The project area for continued mining does not contain these sensitive habitats and therefore it is unlikely threatened species would be affected. However, to ensure a complete assessment was undertaken, the listed species were subject to an Assessment of Significance. Of the 36 species known to occur within the Baal Bone area, seven of these have not been assessed as there is no preferred habitat in the areas affected by the project. Seven-part tests were undertaken for 29 species.

The fauna assessment (refer **Appendix M**), concluded that threatened species are not likely to be significantly affected by the continued operations at Baal Bone, and a Species Impact Assessment is not required.

From the results of the detailed assessment of potential impacts upon the threatened species listed under the NSW TSC Act likely to occur within Baal Bone Colliery (refer Appendix 1 of **Appendix M**) it is unlikely that threatened species would be significantly affected by the operation of the existing surface infrastructure area or coal haulage via road and rail from the site.

Environment Protection and Biodiversity Conservation Act 1999

Under the EPBC Act it is necessary to assess whether an action is likely to have a significant impact on a matter of National Environmental Significance (NES) as described in **Section 5**.

Criteria are used for assessing whether an impact upon a threatened species or ecological community is significant and would trigger an approval under the Act. There is also a requirement for approval under the EPBC Act if an action has a significant impact upon a listed species. The criteria are outlined in **Appendix M** and must be applied to all listed species or communities that may occur within the area affected by the project.

An EPBC Protected Matters Report (**Appendix M**) was generated using the online database provided by DEWHA. The report identified 12 migratory species, 20 threatened species and 12 listed marine species (11 of these are species that overfly marine areas during migration) known from an area of 50 km radius surrounding Baal Bone and have been listed in **Table 18-2:** EPBC listed species

The listed species were then assessed in terms of their likelihood to occur within the Project Area, and the likelihood of a significant impact from the development should the species occur. The results are presented in **Table 18-2**.

Table 18-2: EPBC listed species

Species (Common Name)	Likelihood of Occurrence	Likelihood of Potential Impact
Migratory Species		
White-bellied Sea-Eagle	Unlikely within the Remnant Areas, no preferred habitat.	Low
White-throated Needletail	Known to occur on the Newnes Plateau (one occasion)	Low
Satin Flycatcher	Not known within Remnant Areas and unlikely to occur, no preferred habitat.	Low
Rufous Fantail	Not known within Remnant Areas and unlikely to occur, no preferred habitat.	Low
Lathams Snipe	Not known within Remnant Areas and unlikely to occur, no preferred habitat.	Low
Painted Snipe	Low at site as not preferred vegetation within Remnant Areas.	Low
Rainbow Bee-eater	Not known within Remnant Areas but could occur during summer foraging	Low
Black-faced Monarch	Not known within Remnant Areas but could occur	Low
Great Egret	Not known within Remnant Areas and unlikely to occur, no preferred habitat.	Low
Cattle Egret	Not known within Remnant Areas and unlikely to occur, no preferred habitat.	Low
Fork-tailed Swift	Not known within Remnant Areas but likely to occur as a summer migrant.	Low
Threatened Species		
Swift Parrot	Likely when sufficient trees flower	Low
Regent Honeyeater (also migratory)	Could occur, only occasionally recorded from Newnes State Forest	Low
Superb Parrot	Possible, but at its eastern edge of distribution	Low
Australian Painted Snipe	Possible (within range, but no suitable habitat)	Very low
Spotted-tail Quoll	Possible but not recorded in recent years, not found in Remnant Areas.	Very low
Brush-tailed Rock-wallaby	Low within site, no preferred habitat	Very low
Large-eared Pied Bat	Found at adjoining coal mines but known at Remnant Areas	Low
Eastern Long-eared Bat	Could occur	Very low
Grey-headed Flying-fox	Low	Very low
Southern Brown Bandicoot	Low	Very low
Long-nosed Potoroo	Low	Very low
Blue Mountains Water Skink	Low, no preferred habitat.	Low

Species (Common Name)	Likelihood of Occurrence	Likelihood of Potential Impact
Broad-headed Snake	Could occur within Remnant Areas as there is preferred habitat available	Low
Giant Burrowing Frog	Low, no preferred habitat.	Low
Stuttering Frog	Low, no preferred habitat.	Low
Heath Frog	Low as possibly outside range	Low
Purple Copper Butterfly	Possible but limited preferred habitat	Low
Murray Cod	Extremely low, no preferred habitat	Very low
Macquarie Perch	Extremely low, no preferred habitat.	Very low
Australian Grayling	Extremely low, no preferred habitat.	Very low

Table 18-2 indicates that, whilst there is potential for some threatened and migratory species to occur within the Project Area, the potential for impact on these species impact is generally low to very low due to no preferred habitat within the Project Area, or preferred habitat not being affected by continued operations, including activities within the Surface Infrastructure Area and Underground Mining Area. It was concluded that an EPBC referral was not required as matters of NES would not be significantly affected by the project.

18.2.4 Environmental Safeguards

The existing monitoring and management measures currently in place at Baal Bone are suitable for the continued operations including mining of Longwalls 29 to 31 and Remnant Areas. Measures currently in place to mitigate impacts on fauna are outlined in the Colliery's Biodiversity and Land Management Plan which forms part of the EMS. Environmental safeguards employed at the site include:

- Monitoring three times per year of four quadrats for fauna as follows:
  - Three quadrats in woodland and forest areas over Longwalls 29-31;
  - One quadrat within Coxs River Swamp (Long Swamp);
- Continued monitoring of four long term fauna monitoring sites located within the Longwalls 29 to 31 and Coxs River Area. These surveys would be undertaken three times per year at appropriate times to obtain seasonal information on fauna in this area;
- Prevention of the invasion of weeds that may displace native species; and
- Periodic monitoring of feral animals, as part of an Annual Pest Audit.

18.2.5 Conclusion

The fauna assessment has demonstrated that the potential for threatened species to be significantly affected is low to very low and the effects from activities within the Underground Mining Area are likely to be low. The proposed project is therefore not likely to result in significant impacts upon threatened fauna species or populations.

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19.0 Heritage

19.1 Existing Environment

The landscape of the Project Area comprises gently undulating forested plateaux and steep escarpments and valleys. The topography of the area presents a range of landforms that may have been utilised by traditional Aboriginal groups. The valley floors contained within the area would have offered shelter and food resources, swamps found in the valleys would have encouraged foraging, escarpment cliffs and plateaux would have provided temporary shelter and areas of ceremonial significance.

A number of Indigenous heritage assessments have been undertaken within the Project Area since operations at Baal Bone commenced in 1982. A review of these heritage assessments was undertaken by OzArk for the continued operations at Baal Bone. The heritage assessment Study Area within the Project Area relevant to continued operations include:

- The Surface Infrastructure Area;
- Remnant Areas; and
- Longwalls 29 to 31 within the Underground Mining Area.

The Surface Infrastructure Area has been almost completely impacted by present and historical open cut mining activities, road and rail infrastructure, coal processing and handling infrastructure and storage areas. The Northern Rehabilitation Area includes former open cut areas which have been highly disturbed, and have now been partially or fully rehabilitated. The Southern Rehabilitation Area and Reject Management Area contain former open cut areas, and Reject Emplacement Areas, some of which are currently in use and others which have been partially rehabilitated.

The other regions of the Project Area including the approved Longwalls 29 to 31 and Remnant Areas have had relatively low disturbance as the mining activity is underground and potential subsidence impacts have not been significant. As the Project Area forms part of the Ben Bullen State Forest, some parts of the Project Area have been subject to logging activities, with access tracks and fire trails constructed; however, ground surface impacts have been minor and the area has the potential to contain intact archaeological deposits.

The Longwalls 29 to 31 area and associated ventilation shaft compound and transmission line corridor have been the subject of detailed Aboriginal heritage assessments prepared by Ozark (2007a and 2007b) which included consultation with Indigenous stakeholders in accordance with relevant DECCW guidelines.

19.2 Previous Surveys

Numerous surveys have been conducted throughout the Project Area. Key surveys include:

- Brayshaw and Haglund surveys from (Stone 1989) Brian Stone Environmental Services, *Environmental Impact Statement, Baal Bone Colliery*. Report to Wallerawang Collieries.
- Kohen (1992 a). Archaeological Survey of the Proposed Open Cut extension to the Baal Bone Colliery. Report to Coalex.
- Kohen (1992 b). The impact of longwall mining on Aboriginal sites. The southeast extension to the Baal Bone Colliery. Report to Coalex.
- Kohen (1995). Archaeological Survey of the Proposed Open Cut extension to the Baal Bone Colliery. Report to Coalex.
- Kohen (1996). Archaeological Survey of the Proposed Northern extension to the Baal Bone Colliery. Report to Wallerawang Collieries.
- OzArk (2007 a). Indigenous Heritage Assessment for Subsidence Management Plan over three proposed longwalls (29–31), Baal Bone Colliery Ben Bullen State Forest, Cullen Bullen, NSW. Report for Xstrata Coal.
- OzArk (2007 b). Indigenous Heritage Assessment for Proposed 1.7 km, 11kV powerline easement and ventilation fan compound, Baal Bone Colliery Ben Bullen State Forest, Cullen Bullen, NSW. Report for Umwelt Pty Ltd.

- OzArk (2009) Indigenous and non-Indigenous Heritage Assessment of areas within and adjacent to Baal Bone Colliery, Western Blue Mountains (Cullen Bullen) NSW. Report for AECOM Pty Ltd.

The Project Area has had varying degrees of assessment. The surveys boundaries for key heritage surveys undertaken by Brayshaw (1989), Kohen (1992), Kohen (1995), Kohen, (1996) and Ozark (2007a and 2007b) are provided in **Figure 19-1**. In general, the following comments can be made in relation to these survey areas and assessments:

- The Surface Infrastructure Area has had a small representative sample previously surveyed, although the northeast corner has been subjected to three surveys (Brayshaw 1989, Kohen 1995 and Kohen 1996).
- Of the Remnant Areas, approximately 40% has been previously surveyed (Brayshaw 1989, Kohen 1992, Kohen 1995 and Kohen 1996). In addition, the remaining Remnant Areas have had heritage surveys occur in close proximity, and in identical landscapes (for example the Remnant Area to the south of Longwalls 24 and 25 has had two surveys along its northern border (Brayshaw 1989, and Kohen 1996) in a contiguous landform).
- Longwalls 29 to 31 has been the subject of a complete heritage survey (OzArk 2007a) which was undertaken for the Longwalls 29 to 31 SMP. This survey also includes the electricity easement and ventilation fan compound (OzArk 2007b). These assessments included consultation with Indigenous stakeholders in accordance with relevant DECCW guidelines.

A search of the DECCW Aboriginal Heritage Information Management System (AHIMS) database shows the presence of 20 recorded sites located within a 10 km x 10km area of the Project Area. It is noted that two sites were recorded on the database twice, erroneously; Site ID 45-1-2664 was also recorded as 45-1-2666, and Site ID 45-1-2665 was also recorded as 45-1-2667. As such, a total of 18 sites have been identified.

Figure 19-2 shows the location of previously recorded Aboriginal sites in relation to the Project Area. A breakdown of these sites into their site types shows the most frequent site type recorded in the vicinity of the Study Area is open sites, comprising 50% of all site types. Thirty nine percent of all site types are shelters with deposits. One shelter with art has been recorded in the vicinity of Longwalls 29 to 31, and is managed in accordance with an Aboriginal Heritage Management Plan. One axe grinding groove site has been recorded in the immediate vicinity of the Study Area (5.5%).The escarpment country in the east of the Study Area, along with the watered and undulating landscape in the west of the Study Area, provide the requisite geological landforms and environmental niches for these site types.

Table 19-1 provides information on the 12 sites recorded within the Project Area.

Table 19-1: Previously recorded sites within the Project Area

Site ID	Site name	ASR[1] types	Located Within Heritage Assessment Study Area? [2]
45-1-0080	Morenmore Shelter	Shelter with Deposit	No
45-1-0097	Gardiners Hill; Baal Bone Creek; Ben Bullen State Forest	Shelter with Deposit	No
45-1-0118	Baal Bone 1	Open Camp Site	No
45-1-0119	Baal Bone 2	Open Camp Site	No
45-1-0120	Baal Bone 3	Open Camp Site	No
45-1-0121	Baal Bone 4	Open Camp Site	No
45-1-0122	Baal Bone 5	Open Camp Site	No
45-1-0123	Gardners Gap 1	Shelter with Deposit	No
45-1-0124	Baal Bone Lease 2	Shelter with Art	No
45-1-0125	Baal Bone Pagoda 1	Shelter with Art	No
45-1-0126	Unknown site (Blue Mountains, Ben Bullen State Forest)	Shelter with Deposit	No

Site ID	Site name	ASR[1] types	Located Within Heritage Assessment Study Area? [2]
45-1-0240	Ben Bullen Creek 10	Open Camp Site	Yes - Remnant Areas
45-1-2542	Forest Lodge (FL:66:1) Forest Lodge	Axe grinding groove	No
45-1-2579	CB-OS-1	none	No
45-1-2580	CB-S-1	none	No
45-1-2664 / 45-1-2666	BBC-IF1	none	Yes - Longwalls 29 to 31
45-1-2665 / 45-1-2667	BBC-RS1	none	Yes - Longwalls 29 to 31
45-1-2668	Invincible OS1	none	No

1 – Archaeological Survey Report

2 – Study Area for this assessment includes the Surface Infrastructure Area, Remnant Areas, and Longwalls 29 to 31.

During a heritage survey undertaken within northern and southern portions of the Project Area in 2009 (OzArk, 2009), eight additional Aboriginal sites or Sensitive Archaeological Landforms (SAL) were recorded. These included five open sites, two isolated finds and one SAL. Site cards for these recordings have been submitted to DECCW; to date, none appear on the AHIMS database. The areas surveyed in the 2009 assessment are not located in the heritage assessment Study Area, however further details are provided in the Heritage Assessment presented in **Appendix N**.

Three previously recorded sites, as shown in **Table 19-1** above are located within the areas considered within the Heritage Assessment. The remaining sites are not located within areas affected by underground mining of the Remnant Areas and Longwalls 29 to 31, or activities within the Surface Infrastructure Area, and as such are not likely to be affected by the project.

19.3 Method of Assessment

19.3.1 Background studies

A desktop assessment involved a search of relevant data bases to determine the nature and findings of pervious heritage assessments within the Project Area. Databases searches included:

- DECCW AHIMS database;
- State Heritage Inventory and State Heritage Register;
- Australian Heritage Database;
- Native Title Claims; and
- Lithgow City LEP 1994.

19.3.2 Predictive Modelling

Predictive modelling aims to establish a theoretical model for site location/distribution of artefacts within a given area. This type of modelling provides a comparative situation against which the results of the investigation can be discussed, taking into account the effects of post formation processes, such as ground surface visibility and past land use.

A review of archaeological surveys in the region concluded that permanent water supplies and large shelters were clearly preferred as occupation sites. The large numbers of open sites in the region indicated that there was intensive and repeated use of the area by traditional Aboriginals, with many large sites appearing to be base camps. Open sites were often found in association with hanging swamps. A model of Aboriginal site distribution based on all earlier studies was proposed as a result of this review.

The predictions of the model included:

- On major creek lines and rivers, archaeological evidence would tend to indicate more permanent or repeated occupation. Sites may be complex, with a range of lithic activities represented, and may even be stratified. Proximity to resource rich zones also indicates a higher likelihood of the presence of complex occupation sites.
- Further from permanent water, sites are likely to be smaller, less complex and more likely to be the result of one-off occupation episodes. The Study Area is considered to fall into this category. Consequently, small sites may be located on appropriately elevated, well drained areas near ephemeral water.

In escarpment country or upper hill slopes where appropriate, habitable sandstone overhangs and caves are present, occupation sites are likely and their size would be determined by the extent of available space in the shelters. The Study Area comprises little high country and sandstone escarpments. Depending on the presence, condition and aspect of available overhangs, rock shelter sites with or without art and/or deposits may be recorded.

From the known sites previously listed in **Table 19-1**, and the landform potential as detailed in the predictions above, the most likely type of sites to be encountered in the Project Area are:

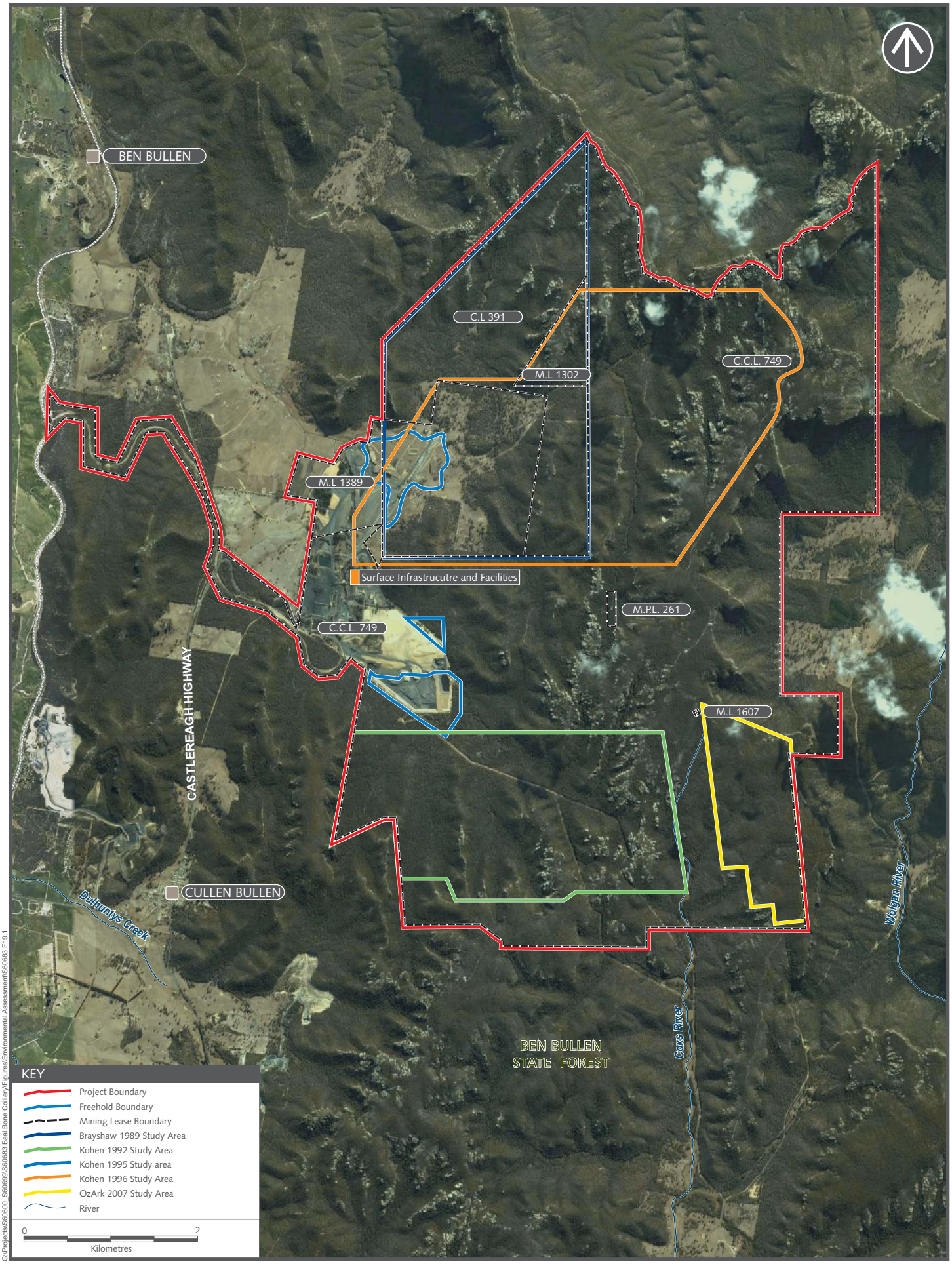
- Rock shelter sites may occur wherever there are suitable overhangs/caves. The quality and extent of such features will determine the nature and type of potential occupation.
- Open camp sites (on elevated terraces and low spurs close to water). Due to the ephemeral nature of the watercourses within the study area and the significant slope of the landform, such sites may be unlikely, but if present may be the result of one-off occupation episodes.
- Culturally modified trees (i.e. scarred trees) are located frequently close to creeks and rivers but also found further afield. Few mature trees of an age to bear cultural scars are likely to remain in the study area (due to logging: see Section 3.5), although some remnant individuals may be present.
- Grinding grooves may occur where exposed sandstone is evident.
- Natural mythological or cultural/ceremonial sites may occur anywhere, although are less likely on significant slopes.
- Isolated finds may occur anywhere, especially in disturbed locations near water sources or in areas close to ephemeral water – i.e. headwaters.

The Project Area is comprised of areas that have undergone varying degrees of disturbance and heritage assessment.

The Surface Infrastructure Area has had the most invasive disturbance to the ground surface. This area occupies landforms that may have been more conducive to Aboriginal occupation than adjoining landforms to the east. The original ground surface has been substantially altered from its original form due to open cut mining and the presence of other infrastructure. While the area may have once held potential for locating Aboriginal sites, the extensive disturbance is likely to have diminished or destroyed the context and integrity of archaeological deposits that once may have existed.

The Remnant Areas have low levels of ground surface disturbance. One Aboriginal site has previously been recorded in this area (Site ID 45-1-0240). There is potential for the Remnant Areas to contain further Aboriginal sites, although the overall area is relatively small and the landscape would indicate that sites would be less complex than those located further west. As this area is devoid of escarpments that are located further east of the Project Area, it is predicted that disturbance to currently undetected Aboriginal sites (if present) in this area would be minimal, as the primary type of landform containing sites potentially affected by subsidence (sites located within shelters located along escarpments) is not located with the Remnant Areas.

Longwalls 29 to 31 had complete survey coverage (OzArk 2007a, 2007b) and contains two previously recorded Aboriginal sites (Site ID 45-1-2664 and ID 45-1-2665 – refer **Table 19-1**). Disturbance in this area has been low apart from the ventilation shaft compound which has had high levels of disturbance.



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AECOM

ALL HERITAGE ASSESSMENT BOUNDARIES ARE APPROXIMATE ONLY

PREVIOUS HERITAGE ASSESSMENTS IN RELATION TO THE STUDY AREA

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 19.1

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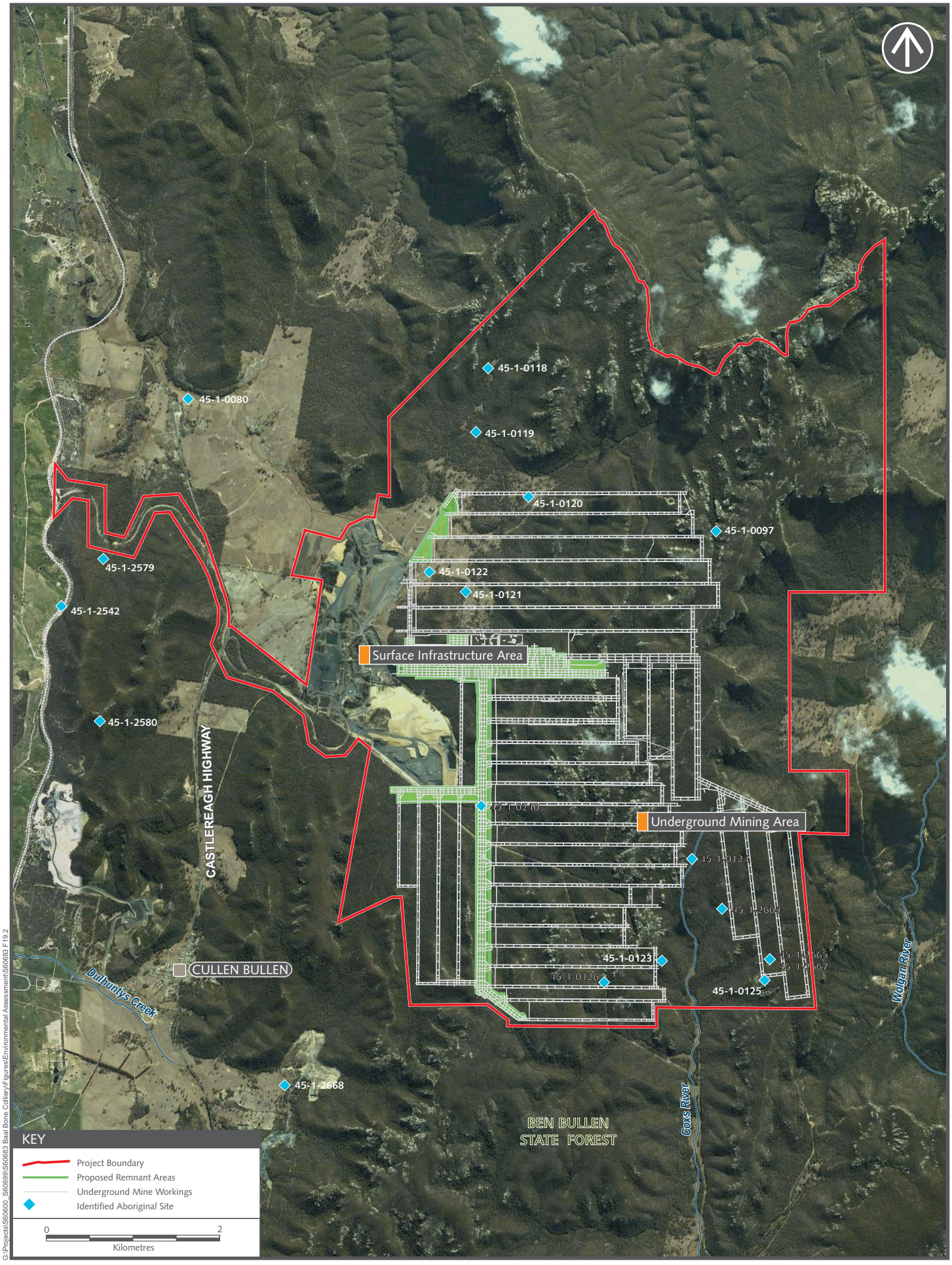

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AECOM

PREVIOUSLY RECORDED ABORIGINAL SITES IN THE VICINITY OF THE PROJECT AREA

Environmental Assessment

Baal Bone Colliery, Cullen Bullen NSW

Figure 19.2

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19.3.3 Assessment of Heritage Significance

The appropriate management of cultural heritage items is usually determined on the basis of their assessed significance as well as the likely impacts of proposed developments. Scientific, cultural and public significance are currently identified as baseline elements of this assessment, and it is through the combination of these elements that the overall cultural heritage values of a site, place or area are resolved.

The assessment of heritage significance is further described in the Heritage Assessment provided in **Appendix N** of this EA. Previously recorded sites within the Study Area were assessed to determine the heritage significance to the aforementioned categories.

Cultural

The two sites recorded by previous surveys within the area affected by Longwalls 29 to 31 were assessed for their cultural significance through conversations held on site with Aboriginal representatives. The isolated find (Site ID 45-1-2664) was assessed as having moderate cultural significance to the local Aboriginal people. The Aboriginal community representatives considered the artefact to be *in situ*, and it was assessed as most likely to have a been a 'drop' artefact, left as someone moved through the landscape rather than as an indicator of an occupation site. It was difficult to determine the significance of the second site, a rock shelter (Site ID 45-1-2665), due to the lack of evidence of Aboriginal occupation present. Notwithstanding, this site is being managed in accordance with an Aboriginal Heritage Management Plan (AHMP).

The other site recorded within the Project Area, Ben Bullen Creek 1 (Site ID 45-1-0240) located within the Remnant Areas, was recorded during Kohen's 1995 survey (Kohen 1995). No assessment of cultural significance is recorded for this site.

Scientific

The isolated find (Site ID 45-1-2664) within the Longwalls 29 to 31 area is considered to potentially be of Aboriginal origin and the report notes that the likelihood of there being associated artefacts or intact, sub-surface deposits related to this artefact was considered to be very low (OzArk 2007a). The site was assessed as having low scientific significance.

No direct evidence of Aboriginal occupation of the rock shelter (Site ID 45-1-2665) near Longwalls 29 to 31 was recorded by previous surveys and a significant degree of collapse had occurred in the main portion of the shelter. An assessment of the scientific significance of this rock shelter was challenging due to the lack of surface information available. OzArk (2007a) noted that there was some potential that the roof collapse overlies evidence of prior human habitation and this evidence may continue to the currently overgrown drip line of the shelter and hence be accessible through test excavation. As a result the site was assessed as holding moderate scientific significance.

It has been previously noted that there is the possibility of further undetected archaeological deposits in the area. The exact nature of potential scientific significance would need to be determined through further survey of the site.

Kohen (1995) does not assign scientific significance to the site, Ben Bullen Creek 1 (45-1-0240). He notes, however, that the site displayed a relatively rich array of stone artefacts that included cores and backed tools (Kohen 1995: 17). On the basis of the tool forms, Kohen determined that the site belongs to the Australian Small Tool Tradition. Kohen noted a range of raw materials present at the site including different types of cherts and milk quartz (Kohen 1995: 18).

Although Kohen (1995) states that the site is typical of open sites in the area, it is noted that there is the possibility of further undetected archaeological deposits in the area.

Although this site has not been re-located to determine its present condition and integrity, if it retains the features noted by Kohen (1995), then it would hold scientific significance.

Public

All sites previously recorded within the Project Area are not located within easily accessible areas and nor are the stone artefacts easily identifiable by the lay person as being Aboriginal in origin. Consequently, the sites previously recorded within the Project Area are assessed to have overall low to moderate public significance.

19.4 Potential Impacts

As the Surface Infrastructure Area has already been heavily impacted, it is considered that it is extremely unlikely that intact archaeological deposits remain in this area. Evidence of Aboriginal heritage in this area is likely to have already been lost, and the continued operations at Baal Bone would not result in further impacts cultural heritage in this area.

The Remnant Areas and Longwalls 29 to 31 not only contain previously recorded sites, but have had low disturbance to the ground surface in the past. Mining of Longwalls 29 to 31 and the Remnant Areas is underground, and the main impact will be possible subsidence. The impact of subsidence has been assessed (SCT 2009) for the mining of Longwalls 29 to 31, and mining is being undertaken in accordance with an approved Subsidence Management Plan.

Although a Subsidence Management Plan and detailed subsidence assessment has not yet been undertaken for the Remnant Areas, the impact to cultural heritage of any potential subsidence in this area is assessed as low. This is due to the fact that this area does not contain escarpment country which is often impacted by subsidence and, while subsidence may occur, it is unlikely it impact currently undetected Aboriginal sites such as open sites.

Potential impacts to Aboriginal heritage in the Longwalls 29 to 31 area have been assessed in previous surveys (Ozark 2007a). No significant impacts are expected in this area, provided the rock shelter BBC-RS1 (Site ID 45-1-2665) is managed in accordance with an Aboriginal Heritage Management Plan (AHMP), which has been prepared for the site.

The AHMP has been prepared for the rock shelter BBC-RS1 (Site ID 45-1-2665) in accordance with Longwalls 29 to 31 SMP approval conditions. The relevant condition required TWCL to consult with the local Aboriginal community regarding the ongoing management of the rock shelter BBC-RS1. Consultation was undertaken with the Bathurst Local Aboriginal Land Council (BLALC), the Warrabinga Native Title Claimants Aboriginal Corporation (WNTCAC) and the North East Wiradjuri Native Title Party (NEWNTP) as part of the assessment undertaken for the Longwalls 29 to 31 SMP. The rock shelter BBC-RS1 (Site ID 45-1-2665) was identified during this survey. Consultation in respect of the AHMP was undertaken with BLALC, NEWNTP, and WNTCAC as well as with the Gundungurra Tribal Council Aboriginal Corporation (GTCAC). An Aboriginal Heritage Working Group meeting was then held in September 2008 with BLALC, NEWNTP, and WNTCAC, as well as two DECCW representatives, to discuss the management of the rock shelter BBC-RS1. GTCAC could not be contacted and did not attend this meeting.

The AHMP was developed on the basis of the outcomes of the Working Group meeting. The AHMP contains a protocol for the ongoing management of the rock shelter BBC-RS1. The Aboriginal stakeholders BLALC, NEWNTP, GTCAC and WNTCAC would be contacted for further consultation in the event one of the following occurs:

- Inadvertent impacts to rock shelter BBC-RS1 occur.
- Previously unrecorded Indigenous sites are located in the vicinity.
- Areas which have not yet been surveyed for the presence of Indigenous site are to be impacted.

19.5 Environmental Safeguards

Potential impacts to cultural heritage from continued operations at Baal Bone is considered overall to be low in the Surface Infrastructure Area due to the complete alteration of the ground surface within this area. Therefore, there are no cultural heritage management recommendations for continued operations in this area.

In the Remnant Areas, the potential impacts from continued operations are limited to potential impacts associated with subsidence. As this area has not been subjected to a full heritage assessment and is known to contain previously recorded sites, management options would include:

- Prior to the mining of the Remnant Areas, undertake a further heritage survey for the identified Remnant Areas;
- Prior to the mining of the Remnant Areas, undertake an inspection of the previously recorded site (Site ID 45-1-0240), which is located within the identified Remnant Areas, to assess its present condition and implement management measures if required; and
- Implement the current Aboriginal Heritage Management Plan for the rock shelter BBC-RS1 (Site ID 45-1-2665) in the vicinity of Longwalls 29 to 31. This Plan would be updated with indigenous sites requiring management, if identified during heritage surveys of the Remnant Areas.

The nature of the impacts in the proposed Remnant Areas and Longwalls 29 to 31 would be relatively minor as there would be no ground surface altering works and subsidence is predicted to be low. Should subsidence occur, it is unlikely to have a great impact on existing cultural heritage as this area does not contain escarpment country (which can be affected by subsidence), has been previously logged (potentially removing sites such as culturally modified trees) and although it may contain further Aboriginal sites such as open sites, these site types are unlikely to be greatly affected by subsidence. Further, the Remnant Area is relatively small and heritage surveys in contiguous landforms have recorded a generally low density of Aboriginal sites. Therefore it is predicted that the possibility of locating further Aboriginal sites in this area that require management is low.

19.6 Conclusion

The Surface Infrastructure Area has diminished potential for heritage value and it is unlikely that the continued operations in this area would have further impacts to Aboriginal heritage. Due to predicted modelling and previous background surveys it was concluded that impacts to potential and existing heritage sites in the Longwall 29 to 31 area and proposed Remnant Areas would be minimal provided the management measures in **Section 19.5** above are implemented.

The desktop heritage assessment conducted for this EA determined that although there are some existing sites of cultural significance, potential impacts are not expected to be significant.

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20.0 Land Use

20.1 Background

As discussed in **Section 2.1**, Baal Bone is one of numerous operating mines within the Western Coalfields of NSW. A description of the Project Area and land uses within and surrounding the Project Area is provided in **Section 2.4**.

The following sections consider the potential impacts of the continuation of operations at Baal Bone on surrounding land uses, as well the mitigation and management measures that would be implemented following mine closure.

20.2 Potential Impacts

A large portion of the Project Area encompasses land which is managed (at the surface) by NSW Forests, and is utilised by the public for a range of recreational activities, management of potential impacts in these areas which could affect the safety or amenity of users, particularly the public.

As mining activities at Baal Bone are underground operations, potential impacts on the surface land uses are largely focussed on subsidence. Surface cracking, due to subsidence associated with longwall mining, has the potential to affect activities undertaken in the overlying Wolgan and Ben Bullen State Forests, including forestry, bushwalking, camping and other recreational activities. Subsidence impacts also have the potential to alter the surface landscape as a result of indirect effects such as changes in surface water flow and increased surface instability.

Underground mining at Baal Bone is undertaken in accordance with the SMP for Longwalls 29-31, which was prepared in consultation with Forests NSW as Landowners and was approved by DII. The SMP contains a number of management plans for the management of surface impacts resulting from underground mining that may affect land use, including:

Public Safety Management Plan. As described in **Section 8.4**, the Public Safety Management Plan provides a management program which identifies risks, nominates triggers, and provides an appropriate level of management action or response for the management of public safety in all surface areas affected by subsidence. The scope of the Public Safety Management Plan includes subsidence related impacts on forest roads and access tracks, surface rock pagoda formations, the Wolgan Escarpment, watercourses and an Aboriginal rock shelter located within Longwalls 29 to 31.

Land Management Plan. As described in **Section 8**, the Land Management Plan provides a management program that allows identification of impacts, nominates triggers, and provides management actions and responses for remediation and mitigation of surface features that might be affected by mining induced subsidence. Forest roads and access tracks, and surface rock formations including the Wolgan Escarpment are monitored and managed under the Land Management Plan. The monitoring schedule with the Land Management Plan includes inspection frequencies and responsibilities for various types of monitoring including visual, photographic, video and surveying.

Environmental Monitoring Program. The Environmental Monitoring Program describes the environmental monitoring and reporting program for features including surface and groundwater, and flora and fauna.

Subsidence Monitoring Program. The Subsidence Monitoring Program includes the requirements for detailed survey and scientific monitoring of a range of subsidence parameters within the Project Area. This program has been developed in consultation with DPI-MR (now DII).

The continued operations at Baal Bone would include ongoing implementation of the management and monitoring plans contained within the SMP in order to minimise, manage and mitigate impacts that may affect land use within the Project Area.

Potential impacts on surrounding residential land uses are not expected to be signficant. Potential impacts to residential land uses and amenity may result from noise emissions from the Surface Infrastructure Area. The operations may impact the closest rural residential receivers R1, R2 and R3 located to the north west of the Surface Infrastructure Area, however as discussed in Section 9, these receivers were constructed after the commencement of the mine and complaints in relation to noise associated with typical operations at the site are minimal. Given there would be no significant change to operations, potential impacts are considered to be acceptable. A Site Noise Reduction Program (SNRP) would be prepared to investigate potential options to reduce noise emissions from the site, and to maintain noise at acceptable and reasonable levels.

The township of Cullen Bullen is located along the road haulage transport route to Wallerawang and Mount Piper Power Stations. Should the Colliery recommence haulage along this road transport route as part of continued operations, outstanding mitigation measures contained within the current Road Haulage Management Plan would be implemented to minimise potential noise impacts on sensitive receivers.

20.3 Mitigation Measures

20.3.1 Continued Operations

Whilst current land use is unlikely to be significantly affected by continued operations, current mitigation measures would be updated where necessary and implemented for the duration of the mining operations.

Current mitigation measures employed by Baal Bone as part of the Land Management Plan include:

- Monitoring of surface cracking and erosion / cracking on forest roads and access tracks;
- Remediation including grading and back filling of surface cracks on forest roads and access tracks;
- Signage to inform public about potential mine subsidence, surface cracking, and in some areas, rockfall; and
- Public Safety Management Plan, which is part of the SMP for Longwalls 29 to 31.

Additional measures would be implemented should there be a resumption of coal resources transport via road transport routes to local power stations. The Colliery, in compliance with consent conditions for road haulage (DA 164-98), would revise and update a Road Haulage Management Plan and provide procedures for ongoing assessment of noise impacts (see **Section 14**).

20.3.2 Final Landform and Rehabilitation

Current levels of disturbance within the Surface Infrastructure Area have been reduced due to rehabilitation works carried out in conjunction with, and following conclusion of open cut mining previously undertaken at the site. Rehabilitation materials, such as freedig (clay loam) and coarse rejects, have been stockpiled in the Reject Emplacement Area to be used during final rehabilitation and mine closure activities (see **Section 13**).

Other past rehabilitation activities contributing to the final landform added to those mentioned above and in **Section 20.3.1** includes the restoration and revegetation of areas of the Ben Bullen State Forest. Further tree planting and revegetation is proposed for future rehabilitation of the site.

Proposed tree planting surrounding existing treed (Native Woodland) areas would also ensure compatibility with existing habitat and restore biodiversity across the site. The proposed final landform including rehabilitation areas is shown in **Figure 13-3**. The future use of rehabilitated land has been determined by what land use would be most beneficial and can be sustained in view of the range of limiting factors. The proposed end land use for the site includes a combination of grazing and native vegetation bushland. The end land use would be compatible with adjoining lands.

20.3.3 Compatibility

The land uses within the Project Area overlying underground mining operations are largely unaffected by underground operations. Future compatibility of the Surface Infrastructure with surrounding land uses has been considered, and appropriate Rural Land Capability Classifications have been designated to current and future rehabilitation areas. The future landscape would be dominated by Class IV (grazing – occasional cultivation) and Class VI (grazing – no cultivation) lands (**Figure 13-3**). This classification as well as other rehabilitation works including native woodland revegetation (mentioned above) would ensure that no conflict of future land use would occur.

Given the rehabilitation activities as part of the final landform, future land uses are unlikely to be affected by the operations. The project is generally considered to be compatible existing and preferred uses in the vicinity of the Colliery.

20.4 Conclusion

Potential impacts on land use are limited to those arising from subsidence and potential noise as a result of transport movements. It is expected that continued operations of Baal Bone would have no significant impact on current or future land use, provided management of the Project Area continues in accordance with the SMP and EMS and relevant management plans contained within.

In order to mitigate impacts to land use, a range of mitigation measures and plans are currently implemented as described in **Section 20.3**. Provided these mitigation measures continue to be implemented, the project is not likey to result in a significant impact to surrounding land uses.

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21.0 Social and Economic

21.1 Existing Environment

TWCL is one of the oldest and longest operating coal mine operators in the Western Coalfields, having conducted operations in some form at Wallerawang and Baal Bone since the early 1900's. It has been an integral part of the social and economic environment of the region.

21.1.1 Social Profile

Population

The Lithgow LGA has had a steadily declining population profile over the last decade, currently with approximately 20 600 persons living in the LGA (ABS, 2008). Cullen Bullen is the closest township to Baal Bone, located 5 km south of the Colliery. It has a population of some 300 and is largely sustained by the local coal mines and power stations.

Other townships in the surrounding area include Portland which is located approximately 6 km to the south west of Baal Bone along the Wallerawang-Gwabegar railway (population approximately 2000), and Wallerawang (population of approximately 1800), also on the Wallerawang-Gwabegar railway north west of Lithgow.

The Department of Infrastructure, Planning and Natural Resources (DIPNR) forecast data (released in 2004) has been used to provide population projections up to 2031 and expects that the population for Lithgow is not expected to undergo significant changes reflecting a nil average annual growth rate (Coakes, 2008).

Age Structure

The 2006 Census data for the region, the median age of the LGA is 40, slightly older than the NSW median of 37. The data shows that 19.5% of the population were children aged between 0-14 years, 11.9% aged 15-29 years, 39.5% of the population between the ages of 25 and 54, and 29.1% of people aged 55 years and over (ABS, 2006).

The population is aging and there has been a notable drift of young people to other nearby areas, in part due to the changing economic environment and the growth of the town of Bathurst for new industry and educational opportunities (Coakes, 2008).

Other Considerations/Characteristics

The region is rich in Indigenous local history with Lithgow largely encompassed within the largest Aboriginal language group in NSW, the Wiradjuri Aboriginal nation. 3.1% of the Lithgow LGA population are Indigenous Australians, higher than the national average of 2.3% (ABS, 2006).

21.1.2 Economic Profile

Employment and Workforce

The Lithgow LGA has a large proportion of employees of which the majority are technicians and trades workers, machinery operators and drivers, clerical workers and labourers. Coal mining is one of the main industries of employment for the LGA with 9.1% of people employed working in the sector, whereas only 0.3% of Australia's workforce are employed in coal mines.

Approximately 775 people were employed in the mining industry in Lithgow in 2006 with only retail trade having a higher employment contribution. Baal Bone currently employs a full-time workforce of approximately 190 people, some 30 of these being contractors, thus highlighting the significance of coal mining for employment in the local community.

Unemployment levels have been substantially higher in Lithgow LGA than that of the national average. Australia's 2006 unemployment rate was at 5.2% opposed to Lithgow's 8.5%.

Regional and Local Economy

The Central West Regional NSW economy is largely supported by manufacturing and agriculture (wool, cattle, wheat), as well as mining (coal, copper, gold), food processing, tourism and retail.

Mining is one of the main industries in the region, mainly extracting gold, copper and coal resources. Lithgow is the centre of a coal mining district, with a number of collieries in proximity to the town. Baal Bone mines black coal primarily for export and is utilised for thermal energy generation and supply.

Mining of black coal is one of Australia's most important industries, creating significant employment in regional Australia. Australia is the world's biggest coal exporter, and black coal is Australia's largest export, worth around $A24.4 billion in 2007-08 (ACA, 2008). Although the Baal Bone operations are relatively small compared to other mines across the country, it is significant in providing employment and other direct and indirect economic benefits to the local community and greater Lithgow area through the extraction and production of recoverable coal product.

Other economic influences in the area include contributions from:

- Energy – Thermal power generation at Wallerawang and Mount Piper Power Stations;
- Confectionary industry – Ferrero Australia major manufacturing facility;
- Retail Trade – well established retail service centre;
- Transport and Tourism – Lithgow lies across major road and rail corridors including the tourist attraction Zig Zag railway. Tourist Wilderness areas such as the Greater Blue Mountains World Heritage Area are also in close proximity;
- Manufacturing – small base of light manufacturing and engineering enterprises;
- Agriculture – wool and beef industries as well as forestry and other growing industries; and
- Water – enterprises engaged in the bottled water industry in the area.

21.1.3 Colliery Contributions

Baal Bone currently provides grants to the local community through a community contributions program. An estimated total of $19 500 was made to the community in the 2007/2008 financial year, a large portion being directed to local schools including Cullen Bullen Public School and Capertee, Cullen Bullen and Wallerawang Primary Schools. Other sectors receiving contributions in the past include the health system, arts and culture as well as other community uses.

Baal Bone has recently contributed to the Lithgow City Council Cultural Plan which included a feasibility study into the proposed development of a Cultural Centre comprising the Hoskins Memorial Institute, Union Theatre and Lloyds Copper Smelter Building. Baal Bones contributed $50 000 and also contributed to the development of Conservation Management Plans for the Eskbank House and Museum and Blast Furnace Park.

21.2 Potential Impacts

21.2.1 Continued Operations

The continued operations of Baal Bone would generate positive social and economic benefits for Lithgow, the Central West region and NSW through providing sustained income, ongoing employment and positive flow on effects.

With unemployment in the area already high, and with a significant percentage of the community employed by the mine, earlier than expected mine closure has the potential to increase unemployment rates resulting in both direct and indirect impacts. Smaller towns such as Cullen Bullen, Portland and Wallerawang that are highly reliant on employment from the mine are likely to experience the greatest impacts.

The presence of the workforce maintains positive impacts for the local economy due to the demand for goods and services sourced from a range of other industries including hospitality, accommodation, rental, hiring and real estate services, construction and retail trade. If mining operations were to cease ahead of the schedule outlined in the current MOP, the demand on local resources generated by the mine workers would decline and may also lead to closure of services in these other industries.

The mine injects approximately $77 million into the NSW economy on an annual basis, of which $13 million goes directly to the Lithgow LGA (Coakes, 2008). Taking into account multiplier effects, the early discontinuation of the

mine would have a noticeable impact on the local and State economy as well as businesses invested with the mining services. This impact is estimated as an overall reduction of $141 million in State output.

Social concerns relate to the future of the community, with early closure having the potential to negatively impact the community's condition. Continued operations of Baal Bone would ensure the following social benefits to the community are maintained:

- People's way of life – ensuring jobs, economic stability;
- Culture – Lithgow traditionally a mining, manufacturing and service hub; and
- Community – character, services and facilities, stability.

If TWCL ceased operations at Baal Bone early, community contributions would also be terminated, having the potential to reduce the quality of education, health, and other sectors previously receiving contributions.

21.2.2 Mine Closure

An assessment of socio-economic impacts resulting from mine closure at Baal Bone has previously been undertaken by Coakes Consulting Pty Ltd (2008). This assessment employed a range of mechanisms to identify potential closure impacts and to obtain the views and perceptions of key stakeholders. It is evident from this work that the TWCL's workforce at Baal Bone will be the most impacted by the closure of the Colliery, through a loss of, or interruption to, household income. The extent of this impact will be dependent upon the length of time it takes employees to find alternative employment or to even retrain for alternative employment if required. In addition, early mine closure will not allow for adequate planning and transition into alternative employment.

Based on the identified preferences of employees, Coakes suggested that impacts on the Colliery's workforce could be addressed through the provision of a workforce support package. It was envisaged that this support would be in addition to any redundancy requirements of the company. The key elements of this package include:

- Training and counselling
  - Engagement of an appropriate job search / placement / training providing company to assist with the transition towards closure and in particular deliver training workshops and coaching on:
    - preparation of job applications and resumes
    - development of interviews skills
    - household financial planning and options for investment of redundancy
    - retirement planning
    - other relevant counselling on livelihoods and adjusting to change / transition
  - Identification of local training service providers and development of a contact list of providers for those that are interested in pursuing additional and changing industry of employment
- Information provision
  - Development of an Xstrata Coal company wide intranet site / bulletin that provides information about all other operations and available employment opportunities throughout the broader company to allow for the transfer of appropriate skilled and experienced personnel within Xstrata Coal
  - Identification of potential opportunities with other mines in the Lithgow area and subsequent development of a list of relevant contacts within nearby mining operations for follow up by employees.
  - Regular distribution of an employee newsletter / bulletin that provides a mechanism for the ongoing provision of information to the workforce on the closure planning process and associated timelines of closure activities
  - Facilitate access to an on-site computer(s) for preparation of resumes and for searching Internet-based job prospects.

21.3 Community Management

Management measures would be implemented as part of the Mine Closure Plan as described in **Section 21.2.2** above to ensure that negative social and economic impacts of the closure of Baal Bone are minimised.

Should the Colliery close ahead of the current schedule, potential impacts would be mitigated and managed to ensure a minimum degree of disruption to the employees, as well as the community. The final Mine Closure Plan would consider the potential impacts upon the employees, their families and the wider community when determining appropriate management measures.

21.4 Conclusion

The proposed continuation of mining operations at Baal Bone is anticipated to provide numerous social and economic benefits for Lithgow and the greater region through continued employment, revenue and community support.

With an extension of the life of the mine, social and economic benefits would continue to filter throughout the local and wider community and promote ongoing stability for the regional population. The proposed continued operations at Baal Bone are therefore considered to have ongoing beneficial impacts on the local community and wider region.

22.0 Statement of Commitments

22.1 Introduction

The continued operation of Baal Bone would largely involve the continued implementation of the existing EMS and other reporting requirements as part of existing development consents with DoP and SMP approval for Longwalls 29 to 31 with DII. As described in **Section 4.7**, the EMS has been designed to address environmental management associated with the site's mining operations and to comply with conditions of approval for the operation of Baal Bone.

This EA has assessed the continued operation of Baal Bone with respect to the mining of Longwalls 29 to 31, the operation of the Surface Infrastructure Area, the transportation of coal product and the potential mining of the Remnant Areas. **Section 22.2** presents the existing mitigation and management measures that are to be maintained for the continued operation of Baal Bone as well as new measures proposed be implemented by Baal Bone following approval of the Project.

22.2 Statement of Commitments

22.2.1 Introduction

In accordance with the EA requirements under Part 3A of the EP&A Act, the following Statement of Commitments (SoC) is provided. The SoC sets out Baal Bone's environmental commitments and details on the environmental management and monitoring of the proposed project during its continuation of operations.

Table 22-1: Draft Statement of Commitments

Issue	Commitment	
General	1.	The Proponent shall carry out the project generally in accordance with the EA and the Statement of Commitments.
	2.	Within 12 months of Project Approval, subject to confirmation that Project Approval conditions provide for feasible implementation of the project and ongoing operations at the Colliery, the Proponent shall surrender all redundant development consents that relate to activities in the Project Area, other than Project approval MP 07_0035 granted by the Minister for Planning on 24 October 2007 relating to the construction and operation of the ventilation shaft and power line corridor associated with Longwalls 29 to 31.
	3.	The Project will be in operation for up to 24 hours a day, seven days per week. The Proponent may load coal for road haulage between the hours of 7:30am and 2:45pm and 3:30pm to 5:30pm Monday to Saturday in accordance with the current Truck Management Plan. The hours of road haulage of coal, including initial and final laden journeys of the haulage vehicles to the Colliery and from the power stations, are to be limited to the hours of 7.00am to 7.00pm, Mondays to Saturdays. No road haulage is to take place on Sundays or Public Holidays.
	4.	The Proponent shall not: (a) extract more than 2.8 million tonnes of ROM coal from the Project area in a calendar year; or (b) transport more than 2.0 million tonnes of product coal from the Project area in a calendar year.
Environmental Management and Monitoring	5.	The Proponent shall adhere to the environmental management, monitoring and reporting requirements contained in Baal Bone's existing and revised monitoring programs contained within the EMS and in the SMP approval for Longwalls 29 to 31 dated 7 December 2007 which includes the following plans: • Subsidence Management Plan; • Public Safety Management Plan

Issue	Commitment	
		• Community Consultation Process; • Environmental Monitoring Program • Land Management Plan; • Underground Water Make Monitoring Program; • Subsidence Monitoring Program; • Wolgan Escarpment Management Plan; and • Aboriginal Heritage Management Plan (BBC-RS1).
	6.	Within 12 months of project approval, the Proponent will review and update Baal Bone's Environmental Management System to incorporate relevant aspects of the environmental management of the Project including a review of the following environmental management plans: • Biodiversity and Land Management Plan; • Cultural Heritage Management Procedure; • Social Involvements Plan; • Community Complaints Management Procedure; • Conflict Resolution Procedure; • Hydrocarbon Management; • Mine Closure Plan; • Product Stewardship Management Plan; • Subsidence Management Plan; • Public Safety Management Plan; • Land Management Plan; • Aboriginal Heritage Management Plan; • Truck Management Plan; • Waste Management Plan; • Water Quality Management Plan; and • Training and Competency Management Plan • Following a review of these plans, the Proponent will implement the revised plans in carrying out the Project.
	7.	The Proponent shall prepare and lodge with the Director-General an Annual Environmental Management Report (AEMR) for the Project containing all Report monitoring data including an analysis of that data, and providing an assessment of the effectiveness or otherwise of all environmental control measures. The first of such reports for the Project shall be completed within 12 months of the date of the Project approval
Subsidence – Performance Measures	8.	In carrying out its mining operations within the Project area, the Proponent shall implement appropriate mining methods that seek to achieve the objectives contained in Table 8-2 of the Environmental Assessment for the Project.

Issue	Commitment	
Subsidence - Remnant Areas	9.	Prior to commencing second workings in the Remnant Areas, the Proponent shall prepare and implement an Extraction Plan for all second workings in the Remnant Areas to the satisfaction of the Director-General. This plan must: (a) be prepared by a team of suitably qualified and experienced experts whose appointment has been endorsed by the Director-General; (b) include a detailed plan for the second workings, which has been prepared to the satisfaction of DII, and provides for adaptive management (for the identified Remnant Areas); (c) include detailed plans of associated surface construction works; (d) include the following to the satisfaction of DII: • a coal resource recovery plan that demonstrates effective recovery of the available resource; • revised predictions of the conventional and non-conventional subsidence effects and subsidence impacts of the extraction plan, incorporating relevant information that has been obtained since this approval; and • a Subsidence Monitoring Program to: - validate the subsidence predictions; and - analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and ensuing environmental consequences.
	10.	The Proponent must: • protect the three cliff formations and Ben Bullen Creek from being directly mined under by an angle of draw of 26.5 degrees of greater as shown in **Figure 8.2**; and • develop a management strategy in consultation with independent archaeologists to manage the subsidence impacts of the archaeological site (Site ID 45-1-0125).
Subsidence – Longwalls 29 to 31	11.	The Proponent shall implement the Subsidence Management Plan and associated monitoring programs for Longwalls 29 to 31. The monitoring program will include detailed survey and scientific monitoring which must be undertaken prior to, during and following the mining of Longwalls 29 to 31. Survey and monitoring will include the following: • Three-dimensional subsidence monitoring; • Horizontal stress changes in the cliff forming sandstones of the Wolgan Escarpment using stress change monitoring instruments; • Temperature changes in the rock formation at the northern pinch point as a basis for understanding thermal stress changes experienced on the Wolgan Escarpment; and • Implementation of the Land Management Plan which addresses management of surface impacts in the vicinity of the Wolgan Escarpment and pagoda formations and surface cracking in other general surface areas. Visual inspections, plus photographic and video monitoring would be conducted over the surface area at regular intervals during mining of the longwall panels.

Issue	Commitment	
Noise	12.	Within twelve months of receiving Project Approval, the Proponent shall prepare a Site Noise Reduction Program (SNRP), which would include a Strategy for the reduction of noise generated from the Project area. The SNRP will include investigation of the following items to seek to reduce noise generated from the Project area where feasible: • Replacement of damaged insulation installed in Washery Building; • Closure of façade openings in the Washery to Stockpile Transfer and/or Washery buildings; • Options to assess the feasibility and possibility of reducing noise emissions from the Bradford breaker; • Options to reduce noise emissions from the tracked dozer during night hours; and • A program for regular inspections of site plant including the dozer to ensure that the installed noise suppression controls are functioning and require no maintenance. The SNRP will review and/or develop procedures to manage noise complaints from residents: • Procedures for residents to contact the site environmental manager in regard to noise complaints or requests for information; • Procedures to inform residents of actions implemented following receipt of noise complaints; and • Procedures for the recording, investigation and follow up of noise complaints, and if required, site attended noise audits to identify additional procedures to minimise noise emissions from the Project area.
Groundwater	13.	The Proponent shall monitor groundwater in the vicinity of Longwalls 29 to 31 in accordance with the Surface and Groundwater Response Strategy and Underground Mine Water Make Monitoring Program to provide an ongoing assessment of the impact of mining works on the groundwater regime, enable early detection of potential adverse impacts, and to monitor the recovery of the groundwater system following completion of mining.
	14.	In the event that the monitoring of ground or surface water indicates an exceedance of trigger levels, procedures contained within the Surface and Groundwater Response Strategy would be implemented.
	15.	prior to mining of the Remnant Areas, the Proponent shall review and update the Surface and Groundwater Response Strategy and Underground Mine Water Make Monitoring Program for implementation upon commencement of mining in these areas.
Mine Closure and Rehabilitation	16.	The Proponent shall progressively rehabilitate the site over the life of the mine, rehabilitate all disturbed lands within the Project Area in accordance with the reasonable requirements of DII prior to relinquishment of mining leases.
	17.	The Proponent shall prepare and implement a Rehabilitation Monitoring Methodology and Program for the Project within 12 months of project approval.

Issue	Commitment	
	18.	The Proponent shall prepare a Mine Closure Plan which will include the following: • Objectives for the site following cessation of mining operations under this approval; • Investigation of options for the future use of the site;
		• Investigation of ways to minimise the adverse socio-economic effects associated with the conclusion of Baal Bone, including reduction in local and regional employment levels; and • Description of measures that would be implemented to minimise or manage the on-going environmental effects of Baal Bone.
Tailing and Reject Management	19.	The Proponent will implement the following operational controls to mitigate potential impacts associated with the Reject Emplacement Area: • Regular visual inspections of the emplacement area including specific attention to the structural integrity of the embankment and the flow of leachate; • All dams and associated pipelines at Baal Bone will be inspected on a daily, weekly and monthly basis as required; and • Operation of transport in the vicinity according to regulations.
	20.	Prior to constructing any future dams with a catastrophic or high risk ranking, the Proponent will ensure that the following actions have been undertaken in relation to the dam: • the dam has undergone an appropriate engineering design (e.g. relevant dam safety committee concurrence); or • the dam has a specific management plan including operational requirements and monitoring program. The monitoring program may be incorporated into the regular inspection checklists, however, the person who is to inspect the catastrophic or high risk dams must be competent to do so.
Traffic - Coal Road Haulage	21.	Haulage of coal from Baal Bone by public road will not exceed 900,000 tonnes per annum (tpa) with a maximum daily rate of 6,000 tonnes.
	22.	Prior to resumption of haulage of coal by road to the power stations from the Colliery, the Proponent shall undertake a review of the existing Road Haulage Management Plan and update the plan as required, for implementation. Once implemented the Road Haulage Management Plan is to be reviewed annually and updated as required.
	23.	Prior to resumption of haulage of coal by road to the power stations from the Colliery, the Proponent shall undertake a review of the existing Truck Management Plan, and update the plan as required, for implementation. Once implemented, the Truck Management Plan is to be reviewed annually and updated as required.

Issue	Commitment	
	24.	Prior to resumption of haulage of coal by road to the power stations from the Colliery, the Proponent shall seek RTA approval to install additional signage on the Castlereagh Highway to aim to increase driver awareness of issues including: • the road environment and characteristics; • trucks existing and decelerating to enter the colliery; • required speed reductions; and • potential for over tipping (adverse camber at sharp corners).
		Following the installation of road signage, the Proponent shall undertake an annual review of road accident statistics along the Castlereagh Highway between Baal Bone Colliery and Mount Piper and Wallerawang Power Stations to monitor the effectiveness of road signage and review the implementation of other mitigation measures as appropriate.
	25.	The Proponent shall finalise all outstanding noise insulation works to the remaining four residences in Cullen Bullen identified in the Road Haulage Management Plan, being 2541 Castlereagh Highway, 42 Castlereagh Highway, 46 Castlereagh Highway, 2508 Castlereagh Highway, prior to resuming road haulage of coal to the power stations. The Proponent shall meet all reasonable costs required to implement these works.
Air Quality	26.	The Proponent shall implement the following existing operational practices in the Surface Infrastructure Area to minimise air quality impacts to the surrounding environment as contained in the Mine Operations Plan: • Conveyors and transfer points are either fully or partially enclosed on the side of the prevailing winds; • Spraying of stockpiles to minimise dust; • Watering of haul road to minimise dust; • Regular cleaning of areas that may generate dust; and • Appropriate ventilation of operational mine shafts.
	27.	The Proponent will monitor potential impacts to air quality resulting from dust in accordance with the Environment Protection Licence (EPL) applying to the Project area and report any potential impacts according to the requirements of the EPL.
	28.	The Proponent shall operate the premises to seek to avoid exceedences of air quality impact assessment criteria identified in **Section 15.3** the EA.
Greenhouse Gas	29.	The Proponent will continue to seek to provide maximum resource extraction with maximum efficiency and will assess and consider implementation, where feasible, of GHG and energy management and mitigation initiatives during the design, operation and decommissioning of the mine.
Geology and Soils	30.	The Proponent shall continue to undertake regular inspections of the surface features in accordance with the Land Management Plan for Longwalls 29 to 31 to address potential impacts on soils and geology.
Flora and Fauna	31.	The Proponent shall continue to implement ongoing monitoring and management of quadrats in the vicinity of Longwalls 29 and 31 and Coxs River Swamp in accordance with the Environmental Monitoring Program contained within the SMP.

Issue	Commitment	
	32.	Prior to and during mining of the Remnant Areas, the Proponent shall implement ongoing monitoring of fauna populations and wildlife habitats within and in the vicinity of the Remnant Areas. The details of the monitoring requirements are to be developed in accordance with the SMP for the Remnant Areas.
	33.	The Proponent shall use best endeavours to incorporate Capertee Stringybark in its future rehabilitation works.
Indigenous Heritage	34.	The Proponent shall continue to manage the Aboriginal rock shelter (45-1-2665) in the vicinity of Longwalls 29 to 31 in accordance with the current Aboriginal Heritage Management Plan. If further sites are identified during the heritage surveys of the Remnant Areas, the Proponent will update the Aboriginal Heritage Management Plan to include any additional Indigenous sites requiring management.
	35.	Prior to the mining of the Remnant Areas, the Proponent shall undertake a further full heritage survey to: • ascertain the present condition of the site known as Ben Bullen Creek 1 (Site ID 45-1-0240); • properly assess this region for its heritage significance; and • develop a management strategy in consultation with the stakeholders to manage the subsidence impacts of the mining of the Remnant Areas on any cultural heritage items identified in the heritage survey.
	36.	During the course of mining, if any 'relics' or other Aboriginal sites are identified, work in that area will cease and the DECC and respective Aboriginal community organisations or Local Aboriginal Land Council will be contacted to discuss how to proceed.
Land Use	37.	The Proponent shall continue to implement the current Land Management Plan and Public Safety Management Plan which form part of the SMP for Longwalls 29 to 31.

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23.0 Residual Risk Analysis

The Residual Environmental Risk Analysis for the proposed continued operations is based on a process adapted from Australian Standard AS 4360:2004 Risk Management. The process is qualitative and is based on the Residual Risk Matrix shown below.

Residual Environmental Risk is assessed on the basis of the significance of environmental effects of the proposed project and the ability to confidently manage those effects to minimise harm to the environment.

The significance of environmental effects is given a numerical value between 1 and 5 based on the receiving environment, the level of understanding of the type and extent of impacts and community response to the environmental consequences of the project. This enables both the actual and perceived impacts to be considered. The manageability of environmental effects is similarly given a numerical value between 1 and 5 based on the complexity of mitigation measures, the known level of performance of the safeguards proposed and the opportunity for adaptive management. The numerical value allocated for each issue is based upon the following considerations.

Significance of Effects

5. Extreme	Undisturbed receiving environment; type or extent of impacts unknown; substantial community concern.
4. High	Sensitive receiving environment; type or extent of impacts not well understood; high level of community concern.
3. Moderate	Resilient receiving environment; type and extent of impacts understood; community interest.
2. Minor	Disturbed receiving environment; type and extent of impacts well understood; some local community interest.
1. Low	Degraded receiving environment; type and extent of impacts fully understood; uncontroversial project.

Manageability of Effects

5. Complex	Complicated array of mitigation measures required; safeguards or technology are unproven; adaptive management inappropriate.
4. Substantial	Significant mix of mitigation measures required; limited evidence of effectiveness of safeguards; adaptive management feasible.
3.Straight forward	Straightforward range of mitigation measures required; past performance of safeguards is understood; adaptive management easily applied.
2. Standard	Simple suite of mitigation measures required; substantial track record of effectiveness of safeguards; adaptive management unlikely to be required.
1. Minimal	Little or no mitigation measures required; safeguards are standard practice; adaptive management not required

The numbers are added together to provide a result which provides a ranking of potential residual effects of the project when the safeguards identified in this EA are implemented.

Table 23-1: Residual Risk Matrix

Significance of Effects	Manageability of Effects				
	5 Complex	4 Substantial	3 Straightforward	2 Standard	1 Minimal
1 Low	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)	3 (Low)	2 (Low)
2 Minor	7 (High/Medium)	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)	3 (Low)
3 Moderate	8 (High/Medium)	7 (High/Medium)	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)
4 High	9 (High)	8 (High/Medium)	7 (High/Medium)	6 (Medium)	5 (Low/Medium)
5 Extreme	10 (High)	9 (High)	8 (High/Medium)	7 (High/Medium)	6 (Medium)

23.1 Analysis

The analysis of residual environmental risk for issues related to the proposed project is shown in **Table 23-2**. This analysis indicates the environmental risk profile for the proposed project based on the assessment of environmental effects, the identification of appropriate safeguards, and the SoC included in this EA.

Table 23-2: Risk Profile

Issue	Significance	Manageability	Residual Risk
Subsidence	2	2	4 (Low/Medium)
Noise	2	2	4 (Low/Medium)
Water Balance	1	1	2 (Low)
Groundwater	1	1	2 (Low)
Tailings	1	1	2 (Low)
Mine Closure and Rehabilitation	2	1	3 (Low)
Traffic and Transport	2	1	3 (Low)
Air Quality	1	1	2 (Low)
Greenhouse Gas	2	1	3 (Low)
Geology and Soils	1	1	2 (Low)
Ecology	2	1	3 (Low)
Heritage	2	1	3 (Low)
Land Use	1	1	2 (Low)
Socio Economic	1	1	2 (Low)
Cumulative Impacts	1	1	2 (Low)

The residual risk analysis indicates that the proposal presents an overall low to medium risk in relation to each of the identified environmental issues, provided that the recommended mitigation, management and monitoring measures are implemented.

23.2 Cumulative Impacts

23.2.1 Cumulative Impact of the Continued Operations of Baal Bone

The cumulative impacts of Baal Bone have been considered in relation to each of the identified environmental issues in **Section 8** to **Section 21** of this EA. Cumulative impacts of the continued operations at Baal Bone, particularly with respect to land use, noise, water use and air quality have been considered in each of the technical studies undertaken in respect of this project.

Rehabilitation and Mine Closure Planning have been employed to ensure the final landform would be compatible with adjoining lands. The principal objective for the rehabilitation of mined land at Baal Bone is to return the site to a condition where its landforms, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land fabric. Given the proposed rehabilitation activities, future land uses are unlikely to be affected by the operations, and therefore adverse cumulative impacts on land use of the surrounding environment are also considered to be unlikely.

As stated in **Section 9**, the continued operation of the Baal Bone surface infrastructure would not result in additional noise generating activities and current noise impacts are generally acceptable. As Baal Bone is an existing mining operation and existing coal production levels would not be increased, the operation of these components is not expected to result in an increase in the overall noise profile for the area. Similarly, air quality (see **Section 15**) is not expected to result in an increase in emissions as the coal handling infrastructure and stockpiles and the approved production and handling capacity of the Colliery would not be altered as result of the proposal. Current air quality impacts are generally acceptable.

The potential cumulative impacts for each of the environmental factors were considered to be acceptable provided the prescribed mitigation measures and safeguards are implemented.

23.2.2 Cumulative Impact with other developments

The cumulative impacts of the continued operation at Baal Bone must also be considered taking into account other existing and recent developments and operations, as well as major projects planned in the local area. These include:

- Existing coal mining operations including Cullen Valley, Angus Place, Pinedale, Lamberts Gully, Springvale, Charbon, Airly and Clarence Collieries (see **Figure 1-1**).
- Existing power station operations including Mount Piper and Wallerawang Power Station;
- Ivanhoe North Rehabilitation Project (MP 05_0103);
- Invincible Coal Mine (MP07-0127) Project;
- Charbon Open cut and Underground Expansion Project (MP08_0211);
- Mount Piper Power Station Extension (currently seeking Concept Approval (MP09-0119)); and
- Proposed Blackmans Flat Waste Management Facility (approved, construction not yet commenced).

Given that these existing and proposed developments are located greater than 5 km from the Surface Infrastructure Area at Baal Bone cumulative amenity impacts including air quality and noise are not considered to be significant. As such, the primary potential cumulative impact which has been considered is heavy vehicle traffic generation along the Castlereagh Highway. A cumulative traffic assessment has been undertaken in **Section 14** of this EA, which considers average daily traffic movements from Invincible, Springvale, Cullen Valley and Ivanhoe North Collieries, the proposed Charbon open cut and underground extension, and the approved Blackmans Flat Waste Management Facility. Other collieries including Angus Place, Pinedale, Lamberts Gully and Airly were not considered as these operations primarily transport coal via rail or conveyor. The cumulative traffic assessment determined that significant traffic impacts are not anticipated.

The Invincible Coal Mine is expanding its operations and would increase its saleable coal production from 500000 to 900000 tpa. The expansion would result in an increase of road traffic on the Castlereagh Highway from trucks hauling coal south from the Mine to the nearby Mount Piper Power Station. It is proposed that truck movements would increase from 80 to up to 180 vehicles per day.

The Invincible Coal Mine also concluded that exceedances of noise criteria are likely during certain meteorological conditions and there is potential for further dust generation as a result of truck movements. Generally, these impacts have the potential to interact with minor noise and dust emissions generated from Baal Bone operations (see **Section 9** and **15**); however, it is considered unlikely to result in unacceptable cumulative impacts given the distance between Invincible Colliery, Baal Bone and Baal Bone's closest residential receivers to the north west of the Surface Infrastructure Area (approximately 10km).

The nearby Mount Piper Power Station is currently proposing to extend its power generation capacity. If the proposed power station uses coal-fired turbines in lieu of gas fired turbines, an increased coal supply is required to support the increased generation. This coal supply is most likely to be sourced from the surrounding coal mines. No commencement date has yet been provided and it is therefore uncertain whether potential cumulative impacts would be generated by continued operations at Baal Bone. However, given underground mining operations for Longwalls 29 to 31 and the Remnant Areas at Baal Bone have an expected operational mine life of approximately four to five years, unacceptable cumulative impacts of the Mount Piper Extension are unlikely.

Given the continued operations at Baal Bone would not result in an increase in coal production and approved transportation of coal to domestic destinations, traffic and other potential impacts from the Colliery are unlikely to create cumulative impacts with other proposed projects and existing nearby collieries and power generating operations.

23.2.3 Conclusion

The cumulative impacts of the proposal have been considered with respect to impacts associated with the proposed continued mining operations, in addition to impacts associated with other projects and developments in the region. The cumulative impact assessment concluded that the continued operations of Baal Bone would have negligible cumulative impacts given the remaining lifespan of operations.

24.0 Project Justification

24.1 Ecologically Sustainable Development

The term ESD was introduced by the Commonwealth Government in June 1990, defined as:

> *Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased. (ref: Ecologically Sustainable Development: A Commonwealth Discussion Paper)*

ESD Working Groups were subsequently established and involved representatives of government, industry, environment, union, welfare and consumer groups. The ESD Working Groups developed a series of policy directions and recommendations which provided the foundation for development of the *National Strategy for Ecologically Sustainable Development*.

The *National Strategy for Ecologically Sustainable Development* was endorsed by the Council of Australian Governments in December 1992. In addition, the *Intergovernmental Agreement on the Environment* (IGAE) was signed in 1992 by Federal and State Governments, Territories and the Australian Local Government Association, promoting intergovernmental cooperation.

ESD is a concept firmly entrenched in NSW environmental legislation and government policy. The concept of ESD has been given legal definition in NSW by the *Protection of the Environment Administration Act 1991* (NSW). Section 6(1)(a) of that Act requires the NSW DEC (formerly Environmental Protection Agency) which was established by the Act, in its role in protecting, restoring and enhancing the quality of the environment in NSW, to have regard to the need to maintain ESD requiring the effective integration of economic and environmental considerations in decision making processes.

Schedule 2 of the EP&A Regulation clearly establishes four guiding principles to assist in achieving ESD, as follows:

- **The precautionary principle** – namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- **Inter-generational equity** – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- **Conservation of biological diversity and ecological integrity** – namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.
- **Improved valuation and pricing of environmental resources** - namely, that environmental factors should be included in the valuation of assets and services, such as polluter pays, full life cycle costing, and utilising incentive structures/market mechanisms to meet environmental goals.

The EPBC Act also identifies a fifth principle for consideration in environmental impact, namely:

> *Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations.*

These five principles are interrelated and need to be considered both individually and collectively as part of determining whether or not a project would be consistent with the principles of ESD in Australia.

24.1.1 Precautionary Principle

This EA has considered the proposed development in terms of potential impacts to the environment, and in particular, the extent to which potential impacts may pose a significant risk to the environment. Specialist impact assessments have been undertaken in areas where potential impacts were uncertain or unable to be quantified otherwise.

A number of alternatives have been considered for the continuation of operations at Baal Bone (see **Section 3**). The currently approved Longwalls 29-31 included design features in recognition of the precautionary principle. This primarily involved employing an additional barrier at identified 'pinch points' with the Wolgan Escarpment for Longwall 31. This provided the Escarpment with a higher level of confidence with avoidance of potential subsidence as the Escarpment is well outside the angle of draw (see **Section 8**).

The identification of subsidence zones (see **Section 8**) for the Remnant Areas should they be mined in the future would enable Extraction Plans to be developed with the precautionary principle in mind. The design within these Extraction Plans would demonstrate the measures undertaken to ensure the avoidance of potential subsidence within the Remnant Areas.

The EA has been undertaken on the basis of the most recent and accurate scientific data relating to the project area. Where uncertainty in the data used in the assessment has been identified, a conservative worst-case scenario analysis has been undertaken and contingency measures have been identified to manage the uncertainty.

Environmental safeguards and mitigation measures recommended in this EA have been developed in accordance with current and accepted best management practice to achieve a neutral or beneficial effect on the environment.

24.1.2 Intergenerational Equity

The principle of 'intergenerational equity' requires that decisions made by the present generation would not result in a degradation of the environment for future generations.

The objectives of the project are to continue existing mining operations at Baal Bone beyond the expiry of its existing consent. The project would provide access to coal resources in a manner that achieves the best practical safety, environmental, social and economic outcomes, maximising the use of existing infrastructure and minimising surface disturbance and associated environmental impacts.

Potential environmental implications of the project in terms of greenhouse gases and climate change impacts are discussed in **Section 16**. Other potential impacts which have the capacity to potentially affect the health, diversity or productivity of the environment have been assessed as part of this EA. Environmental safeguards identified for specific issues, and the Statement of Commitments in **Section 23** of this EA form a fundamental part of the project to minimise the impact on the environment to the greatest extent reasonably possible.

24.1.3 Biological Diversity and Ecological Integrity

The principle of 'biological diversity and ecological integrity' requires a full and diverse range of plant and animal species to be maintained and conserved.

Consideration of the impacts of the proposed project on flora and fauna has been undertaken as part of development of the project through environmental investigations. A flora and fauna assessment was undertaken as part of the EA (**Appendix L** and **M**) which concluded that the proposed project would not significantly impact upon threatened species or ecological communities. The continuation of operations at Baal Bone would not result in additional areas of disturbance other than those previously assessed and approved for the extraction of Longwalls 29 to 31.

The ecological assessment found that there is very limited potential for the proposed works to have a significant impact on threatened ecological communities, important fauna habitats or movement corridors or potentially present threatened flora or fauna species or populations. In order to maintain biological diversity and ecological integrity on surrounding areas, the assessment concluded that ecological impacts are not expected as a result of the continued operations of Baal Bone.

Additionally, TWCL is committed to return the site to a condition where its landform, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land fabric through the rehabilitation of disturbed land (see **Section 13**). There are continued rehabilitation activities occurring at Baal Bone relating to previous mining operations, including the stabilisation and restoration of Ben Bullen Creek. The Baal Bone footprint, including the footprint of existing infrastructure, would be rehabilitated upon the closure of the mine to ensure that the biological diversity and ecological integrity of the area is maintained and conserved.

24.1.4 Valuation and Pricing of Environmental Resources

The IGAE and POEO Act require improved valuation, pricing and incentive mechanisms to be included in policy making and program implementation. In the context of environmental assessment and management, this would translate to environmental factors being considered in the valuation of assets and services.

Integration of environmental and economic goals is a key principle of ESD, which can be measured undertaking a cost-benefit analysis, that is, by measuring the costs of proceeding with a project against the benefits arising from the project.

Given the different values placed on the environment, and the various components of an environment, it is difficult to assign a monetary value against the environmental costs and benefits associated with the project. Given this, the approach adopted for this project is the management of environmental impacts through appropriate safeguards, and to include the cost of implementing recommended safeguards, including the cost associated with providing compensatory habitat on site, in the total cost of the project.

The project optimises the valuation and pricing of the coal resources with minimal impact by:

- Optimising available use of the existing coal processing and transportation facilities to handle, process and transport product coal to existing markets; and
- Maximising the efficient extraction of the coal resource and avoiding the isolation and sterilisation of coal through effective mine planning.

The value of the environment is also managed through the legislative process by imposing financial penalties or requirements to rehabilitate on persons responsible for polluting the environment.

Baal Bone would implement the safeguards and monitoring requirements outlined in this EA to minimise potential environmental and social impacts from the proposed project, and to minimise the potential for pollution to occur.

24.1.5 Decision Making Process

The proposed project requires approval under Part 3A of the EP&A Act 1979.

An assessment of the short, medium and long term impacts of the proposed project, taking into account the principles of ESD is described in this EA. The Statement of Commitments, provided in **Section 23**, forms the environmental mitigation, management and monitoring requirements for the project and its proposed operations.

The project approval process prescribed under Part 3A of the EP&A Act and subsequent environmental management frameworks ensure that decision making and monitoring of the project would be undertaken in an integrated manner, having regard to relevant issues associated with the project within its context.

Additionally, transparency throughout the decision making process for the design, impact assessment and development of management measures has been carried out through consultation with Government authorities, community groups, Aboriginal groups and other stakeholders during the preparation of the EA (see **Section 6**). This has allowed comment and discussion regarding potential environmental impacts and concerns and proposed environmental management procedures.

Baal Bone has operated successfully since its commencement of operations in 1982. Baal Bone currently submits AEMRs annually to the DII and DOP as part of their ongoing compliance with the existing development consents. The Colliery has an existing EMS that would continue to operate for the remainder of mining activities, including mine closure activities. The continued implementation of this EMS and annual reporting to the relevant departments would assist in the continued management of the local environment to Baal Bone.

24.2 Conclusion

The proposed continuation of operations at Baal Bone has been considered in the context of the principles of ESD and considered to be consistent with these principles. The project is not expected to result in significant environmental impacts provided the current environmental management is maintained at the site and recommended additional safeguards and mitigation measures are implemented.

25.0 Summary of Findings

The proposed continuation of operations at Baal Bone involves the following primary components:

- Continuation of underground mining within the Underground Mining Area, including Longwalls 29 to 31;
- Continued operation of the Surface Infrastructure Area, and associated prepared saleable coal production of up to 2.0 Mtpa (equating to up to 2.8 Mtpa ROM coal);
- Continued transport of prepared saleable coal to markets in accordance with current approvals; and
- Mining of Remnant Areas within the existing workings in the Underground Mining Area.

The continuation of operations at Baal Bone does not involve activities that would require additional processes at the site; therefore this EA has assessed the potential environmental management and impacts of the current operations. This EA concludes that the current operations at Baal Bone are not resulting in significant impacts to the environment. The existing environmental management measures are therefore considered to be adequate for the current operations at the site. This EA recommends the preparation of additional environmental monitoring and management requirements for the potential mining of the Remnant Areas, which form part of the Statement of Commitments for the project.

The project would result in benefits to the local community and economy associated with the continued employment of some 190 full time equivalent employees. The project has been considered in respect of biophysical, economic and social grounds and is considered to be consistent with the principles of ESD.

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26.0 References

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council, Canberra.

Australian Bureau of Statistics (ABS) (2006/7) 2006 Census QuickStats : Lithgow (C) (Local Government Area), available online at http://www.censusdata.abs.gov.au accessed: 7/05/09

Australian Coal Association (ACA) (2008). The Australian Coal Industry - Industry Overview. Accessed Electronically on 8 May 2009 http://www.australiancoal.com.au/

Australian Coal Association (2009). The Australian Coal Industry. Accessed Electronically on 12 March 2009 (http://www.australiancoal.com.au/the-australian-coal-industry.aspx)

Australian Mines Atlas (2009). Australian Atlas of Minerals Resources, Mines and Processing Centres – Black Coal. Accessed electronically: http://www.australianminesatlas.gov.au/aimr/commodity/black_coal.jsp

Barnson Pty Ltd (2006). Traffic and Transportation Assessment – Ivanhoe North Rehabilitation Project Environmental Assessment, Mudgee.

Bureau of Meteorology (2009). Climate Statistics for Australian Locations – Lithgow (Birdwood Street). Accessed electronically 10/3/2009: http://www.bom.gov.au/climate/averages/tables/cw_063224.shtml

Coakes Consulting (2008). Baal Bone Colliery Social Impact Assessment. Prepared by Coakes Consulting for Baal Bone Colliery / Xstrata Coal, May 2008

Commonwealth of Australia (2001). *National Pollution Inventory Emissions Estimation Technique Manual*.

Connell Wagner (2006). Baal Bone Colliery Longwalls 29 to 31 SMP Hydrologeological Assessment Xstrata Coal. Prepared by Connell Wagner Pty Ltd on behalf of Xstrata.

Craven Elliston & Hayes (2009). *Baal Bone Colliery Rehabilitation Survey*, May 2009 (drawing number BBREH09)

CWCMA (2009). Central West Catchment Management Authority – Water Catchment Summary. Accessed electronically 17/3/09: http://www.cw.cma.nsw.gov.au/cwcma_ourcatchment.htm

DCC (2008). National Greenhouse Accounts (NGA) Factors. Australian Government Department of Climate Change, November 2008.

DEC (2004). *Threatened biodiversity survey and assessment: guidelines for developments and activities (working draft)*. Department of Environment and Conservation, Hurstville, NSW.

DEC (2005). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. Department of Environment and Conservation of NSW.

DEC (2006) *The Vegetation of the Western Blue Mountains including the Capertee, Coxs, Jenolan and Gurnang Areas*. Department of Environment and Conservation, Hurstville, NSW.

DECC (2007) *Threatened species assessment guidelines: The assessment of significance*. Department of Environment and Climate Change, Hurstville, NSW.

DPI-MR (2003). Guidelines for Applications for Subsidence Management Plan Applications. NSW Department of Primary Industries - Mineral Resources.

HMS (2006). Longwall Mining Subsidence Risk Assessment. Hawcroft Miller Swan Consultants Pty Ltd. Prepared for Xstrata Coal.

HNCMA (2009). Hawkesbury-Nepean Catchment Management Authority – Water Catchment Summary. Accessed electronically 17/3/09: http://www.hn.cma.nsw.gov.au/topics/2042.html

Heggies (2007). Baal Bone Colliery Ventilation Shaft Installation and Operation Air Quality Assessment, Prepared for Umwelt Pty Ltd, Sydney on behalf of The Wallerawang Collieries Limited.

Hesse, P., Humphreys, G.S., Selkirk, P.M., Adamson, D.A., Gore, D.B., Nobes, D.C., Price, D.M., Schwenninger, J.L., Smith, B., Tulau, M., and Hemmings, F. (2003). Later Quaternary Aeolian dunes on the presently humid Blue Mountains, Eastern Australia. *Quaternary International,* 108: 13-32.

Hughes, L (2005). NSW Scientific Committee – Final Determination – Key threatening process declaration: Alteration of habitat due to subsidence following longwall mining. Department of Environment and Conservation website NSW Government Gazette No 90, p 3731: Sydney, Government Printer.

JDS Mining (2008), Conceptual Study Northwest Area Baal Bone Colliery. Report to Xstrata Coal.

Kay, D. (1991) Effects of Subsidence in Steep Topography and Cliff Lines. Commonwealth Government's National Energy Research End of Grant Report Number 1446.

Kohen (1992 a), Archaeological Survey of the Proposed Open Cut extension to the Baal Bone Colliery. Report to Coalex P/L.

Kohen (1992 b). The impact of longwall mining on Aboriginal sites. The southeast extension to the Baal Bone Colliery. Report to Coalex P/L.

Kohen (1995). Archaeological Survey of the Proposed Open Cut extension to the Baal Bone Colliery. Report to Coalex P/L.

Kohen (1996). *Archaeological Survey of the Proposed Northern extension to the Baal Bone Colliery*. Report to Wallerawang Colliers P/L.

Mackie (1998). Baal Bone Colliery Groundwater Management Studies.

OzArk (2007 a). Indigenous Heritage Assessment for Subsidence Management Plan over three proposed longwalls (29–31), Baal Bone Colliery Ben Bullen State Forest, Cullen Bullen, NSW. Report for Xstrata Coal P/L.

OzArk (2007 b). Indigenous Heritage Assessment for Proposed 1.7 km, 11kV powerline easement and ventilation fan compound, Baal Bone Colliery Ben Bullen State Forest, Cullen Bullen, NSW. Report for Umwelt Pty Ltd.

OzArk (2009). Indigenous and non-Indigenous Heritage Assessment of areas within and adjacent to Baal Bone Colliery, Western Blue Mountains (Cullen Bullen) NSW. Report for AECOM Pty Ltd.

Parsons Brinkerhoff (2007). Baal Bone Colliery Review of Road Haulage Options. Prepared by Parsons Brinckerhoff on behalf of The Wallerawang Collieries Limited.

RTA (2002). Traffic Volume Data for Western Region 2002. Roads and Traffic Authority, NSW.

SCT (1992). Surface Subsidence Behaviour at Baal Bone Colliery. Longwalls 1 – 8. SCT Operations Pty Ltd Report BBO0306/2.

SCT (2007a). Subsidence Assessment for Longwalls 29, 30 and 31 Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3248.

SCT (2007b). Review of Subsidence Monitoring and Impacts of Mining on Sandstone Cliff Formations at Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3259.

SCT (2008). Protection of Wolgan Escarpment from Longwall 31 Mining Subsidence. SCT Operations Pty Ltd Report BBO3432.

SCT (2009). Subsidence Zones in Remnant Areas at Baal Bone Colliery. SCT Operations Pty Ltd Report BBO3559.

Stone (1989). Brian Stone Environmental Services, *Environmental Impact Statement, Baal Bone Colliery*. Report to Wallerawang Collieries.

Corkery (2003). Statement of Environmental Effects to accompany application for a Proposed Modification to DA 164/98 related to Extension of the duration of coal haulage by public road from Baal Bone Colliery. Prepared by R.W. Corkery & Company Pty. Limited on behalf of the Wallerawang Collieries Limited.

TWCL (2009). *Baal Bone 2008 Annual Environmental Management Report*. The Wallerawang Collieries Limited prepared for Xstrata Coal.

Umwelt, 2005. Construction and Operation of Reject Emplacement Area 5 (REA5) at Baal Bone Colliery, Baal Bone Colliery Rehabilitation Survey, May 2009.

Xstrata Coal (2008). *Xstrata Coal Estimation of Scope 3 Emissions – SEE Version December 2008*. Energetics Pty Ltd. Prepared for Xstrata Coal.

Umwelt (2007). Review of Environmental Factors Longwalls 29-31, May 2007

Umwelt, (2008). *Construction and Operation of Reject Emplacement Area 6 (REA6) at Baal Bone Colliery*

US EPA (1995). *ISC3 Users Guide*. United States Environmental Protection Agency.

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