BULGA OPTIMISATION PROJECT MODIFICATION 3 AND BULGA UNDERGROUND MODIFICATION 7

STATEMENT OF ENVIRONMENTAL EFFECTS

September 2019





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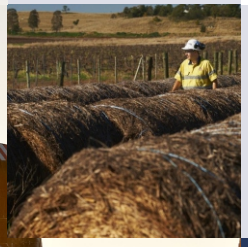
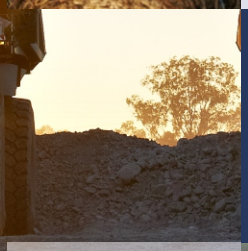
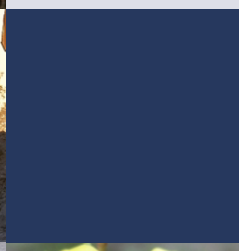
MANAGED OPERATION











BULGA COAL

GLENCORE

BULGA OPTIMISATION PROJECT MODIFICATION 3 AND BULGA UNDERGROUND MODIFICATION 7

Statement of Environmental Effects

Prepared by

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on behalf of

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Report No.	4100/R03
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Executive Summary

Bulga Coal Management Pty Ltd (BCM) operates the Bulga Coal Complex (BCC) on behalf of the Bulga Joint Venture, with mining operations occurring at the site for over 35 years. The BCC consists of open cut operations (Bulga Surface Operations) and underground operations (Bulga Underground Operations) that use shared coal washing and rail loading infrastructure as well as having an integrated water management system (WMS).

On 1 December 2014 BCM was granted approval for the Bulga Optimisation Project (BOP) (SSD 4960), which related to ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD 4960 has been modified twice since it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

The Bulga Underground Operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). The Bulga Underground Operations ceased mining in May 2018 and the mine was sealed in July 2018. The Bulga Underground Operations approvals are being retained and BCM is actively evaluating opportunities to recommence underground operations in the future.

The design of the BOP was developed having regard to potential environmental and social impacts associated with mining operations, with the aim of minimising project specific and cumulative impacts. A comprehensive Social Impact Assessment (SIA) was undertaken, informed by an extensive stakeholder engagement strategy. This process was implemented during the project design and Environmental Impact Assessment (EIA) phases to assist in refining the project design and identifying appropriate management and mitigation measures. A key feature of the BOP design was the development of a noise and visual bund along the western and southern edges of the open cut pit to manage noise impacts to nearby residences and tourist businesses, and to reduce visual impacts. The project design also included a number of features to reduce environmental and social impacts whilst enabling the efficient recovery of a valuable coal resource.

BCM is proposing a modification to maximise resource recovery within the approved Bulga Optimisation Project Area (Project Area). The modification proposes an extension of the open cut operations to the south east. Proposed mining will extend into a former open cut area occupied by the current Tailings Storage Facilities (TSFs) known as Deep Pit and Bayswater Pit. A revised mining sequence also allows the extraction of deeper coal resources beneath the floor of parts of the currently approved open cut mine (the Proposed Modification). The Proposed Modification also requires changes to infrastructure servicing both the Bulga Surface Operations and the Bulga Underground Operations, to accommodate the proposed extension to the mining area.

This Statement of Environmental Effects (SEE) has been prepared to assess the environmental and social impacts of the Proposed Modification and will accompany a modification application under section 4.55 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Proposed Modification requires modification to both SSD 4960 and the Bulga Underground Operations development consent DA 376-8-2003.

Project Overview

The Proposed Modification will maximise resource recovery within the approved Project Area through an extension of the open cut operations. The proposed extension of the open cut pit to the south east also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. An additional disturbance of 20.2 hectares (ha) is required to accommodate the proposed extension of the mining areas. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Million tonnes per annum (Mtpa) of run of mine (ROM) coal while enabling the extraction of an additional approximately 63 Mt of coal. The Proposed Modification will extend the life of the development consent by approximately four years until 2039.

The Proposed Modification will require the removal of the tailings material currently stored in the existing TSFs and relocation to the Main Pit TSF, which is located within the existing Main Pit mining area. The capacity of the currently approved Main Pit TSF will be increased to receive the relocated tailings by increasing the depth of the emplaced tailings within the in-pit facility, whilst maintaining a similar surface area. The Proposed Modification will also require the upgrade, relocation or removal of some components of the infrastructure servicing the Bulga Surface Operations as well as Bulga Underground Operations infrastructure including workshops, gas-fired power generation plant and associated gas infrastructure, electrical substation, fuel and oil storage.

The Bulga Open Cut (BOC) will continue to use BCC shared infrastructure approved to service both the open cut and the underground mining operations including the Coal Handling and Preparation Plant (CHPP), raw coal stockpiles and conveyors, train loading facilities, workshops, stores, offices and deployment areas, WMS, etc.

The Proposed Modification has been designed through a multi-disciplinary social and environmental risk-based approach aimed at maximising resource extraction efficiency and optimising the use of existing site infrastructure, while minimising impacts on the environment and community. As discussed in later sections of this SEE, the key learnings from the history of mining operations at the site; the stakeholder engagement program; the comprehensive BOP social impact assessment; and the detailed environmental studies undertaken for BOP, have all been considered in the project design.

Benefits of the Project

The Proposed Modification will extend the operational life of the Bulga Open Cut for approximately four years and provide for the economic recovery of available coal resources using the existing infrastructure, facilities and experienced personnel. The Proposed Modification is a logical continuation of the existing mining operations at the BCC and will provide the following key benefits:

- maximise efficient recovery of the States' coal resources
- provide for ongoing use of the existing BCC infrastructure
- provide ongoing employment opportunities for the Bulga Open Cut workforce of approximately 700 employees, as well as approximately 150 employees based at BCC shared infrastructure facilities
- ongoing opportunities for local businesses and service providers
- provide a net benefit of $81.3 million (M) to the region in net present value terms.
- provide a net benefit of $410.6 M to NSW over the life of the operation, in net present value terms

- generate $104.5 M in royalty revenue
- provide significant export earnings for Australia
- use the same leading practice environmental management approach and controls as the existing operation.

Through the implementation of the Proposed Modification, BCM believes it can contribute substantial economic benefits at local, regional and State levels whilst continuing to coexist with the local community.

Broad Overview of Environmental, Social and Economic Outcomes

This SEE includes a detailed assessment of the potential environmental, social and economic outcomes of the Proposed Modification and identifies the management, mitigation and offset measures that will be implemented as part of the Proposed Modification. A summary of the key findings of the assessment process is provided in **Table ES1**.

Table ES1 Summary of the Key Environmental, Social and Economic Impact Assessment Findings

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Air Quality	• Comprehensive air quality management controls have been incorporated into the operations to minimise the contribution to impacts on local and regional air quality. • Cumulative dust levels and other air quality parameters are predicted to comply with the relevant criteria at all surrounding private residences, with the exception of a single private residence due to the change in criteria. This residence has current noise acquisition rights for the adjacent Mount Thorley Warkworth (MTW) mine, and may be afforded acquisition rights from the Proposed Modification, in accordance with the Voluntary Land Acquisition and Mitigation Policy (VLAMP). • A proactive and reactive dust control strategy will be implemented to minimise dust emissions over the life of the operation.
Noise	• As part of the design of the Proposed Modification, BCM has incorporated a range of mine design changes and noise controls to minimise noise impacts. • Operational noise levels are predicted to meet the currently approved noise criteria for BCC at all surrounding private residences. • Noise impacts will be managed through the implementation of the ongoing real-time monitoring program combined with proactive and reactive noise management measures including adaptively managing mining operations as required.
Blasting	• Blasting activities will be managed so that relevant blast criteria are not exceeded at private residences or at blast sensitive infrastructure. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.
Land Use and Agriculture	• The primary existing land use of the Project Area is mining. No agricultural land will be disturbed by the Proposed Modification. • Much of the surrounding land is mine owned land significantly reducing the potential for impacts on private land uses. The existing mining operations have coexisted with the surrounding land uses since the 1980s without substantial land use conflict, and this is expected to continue. • The Proposed Modification will not result in any changes to surrounding land uses. • The Proposed Modification will have a minimal impact on surrounding land uses.

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Water Resources	• A comprehensive WMS has been designed for the Proposed Modification to manage water in accordance with legislative requirements and relevant guidelines. • The WMS for the Proposed Modification will be integrated with the existing WMS to maximise water recycling, reducing external water import and releases. • The Proposed Modification is not predicted to have significant impacts on downstream water quality, flows, flooding or water users. • A detailed groundwater impact assessment including modelling of the approved open cut and underground mining, in addition to the proposed activities was undertaken, indicating that the incremental groundwater impacts associated with the Proposed Modification are negligible.
Biodiversity	• The biodiversity impacts of the Proposed Modification are being assessed, managed and offset under the FBA. • The additional disturbance area of 20.2 ha is relatively minor, in the context of the currently approved BCC disturbance area of 3,786 ha. • Approximately 19.2 ha of native woodland/forest vegetation will be removed from the additional disturbance area associated with the Proposed Modification. • Approximately 16.2 ha of the Commonwealth listed Central Hunter Valley Eucalypt Forest and Woodland CEEC will be impacted by the Proposed Modification. • One State listed endangered ecological community will also be impacted by the Proposed Modification. • BCM has committed to a biodiversity offset strategy to offset the biodiversity impacts of the Proposed Modification.
Cultural Heritage	• A comprehensive Aboriginal Cultural Heritage Assessment (ACHA) was undertaken for BOP covering the Project Area. The assessment identified culturally significant features in the surrounding regional landscape context but not in the additional disturbance area. • A comprehensive ACHA process was completed for the Proposed Modification in consultation with the registered Aboriginal parties for the operations. • The Proposed Modification will impact on 6 sites (2 artefact scatters and 4 isolated finds) which were assessed as low scientific significance. • The ACHA found that the additional disturbance area did not contain any key cultural values. • BCM will update the Aboriginal Cultural Heritage Management Plan (ACHMP) to include the additional disturbance area and additional study area.
European Heritage	• A comprehensive assessment of the potential impacts of the Bulga Surface Operations on historic heritage values was prepared as part of the BOP EIS (Umwelt, 2013). • One item, PS7 – Post and Rail Fence, is located in the vicinity of the additional disturbance area. • Item PS7 will be impacted by the Proposed Modification and will consequently require removal, however it is considered to be of no significance to local heritage values.

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Visual	• Views of the existing mining operations are currently available from residences surrounding the Project Area. It should be noted that views of the approved and proposed mining operations are largely obscured by the approved noise and visual bund. • There will be either no increase or only minor changes to the visibility of the active and inactive overburden areas as a result of the Proposed Modification. • The progressive rehabilitation of emplacement areas and shaping of the final landform using natural landscape principles is expected to reduce the visual impact of emplacement areas.
Rehabilitation	• The overall rehabilitation strategy for the Proposed Modification is consistent with the Approved Operations. This design will include variable terrain which is profiled to effectively manage runoff to enhance long term landform stability and to be sympathetic to the profile of the adjacent landscape. • Approximately 200 Ha of mine rehabilitation will be re-disturbed and re-established as a result of the Proposed Modification. • The Proposed Modification will result in an extension of approximately four years to the Bulga Open Cut mine life and modified final landform to that currently approved. • Consistent with the Approved Operations, a single final void will remain, however the Proposed Modification will result in it being located approximately one kilometre (km) to the south east of the location contemplated for the Approved Operations.
Greenhouse Gas	• A range of energy and greenhouse gas management initiatives will continue to be implemented as part of the operations to improve energy efficiency and reduce greenhouse gas emissions.
Transport	• The Proposed Modification does not propose to increase operational employee numbers therefore it is not expected to change operating traffic volumes associated with the Bulga Coal Complex. • The Proposed Modification will extend the traffic generated by the Bulga Surface Operations for an additional four years. • The total approved maximum annual tonnage of coal transported by train will remain unchanged.
Social and Economic	• The Social Impact and Opportunities Assessment found that from a technical social perspective, it is unlikely that the Proposed Modification will result in significant change across any of the key community capitals (natural, economic, human, physical and social), thus affording a risk ranking of 'low' for impact on community sustainability. • A range of strategies will continue to be implemented to seek to minimise social impacts and maximise benefits. For example, to address the issues raised by stakeholders around the perceived concerns regarding end land use and rehabilitation (post mining), health and wellbeing and community sustainability and to enhance perceived positive economic impacts, BCM proposes to develop a Nature and Culture Trail - a Recreation and Tourism Strategy, for the landholders and residents residing in proximity to the BCC in the neighbouring villages of Bulga, Broke and Milbrodale. • The Project will provide significant ongoing benefits for local and wider communities through employment, local and regional expenditure and payment of royalties and taxes. • A cost benefit analysis indicates the Proposed Modification will provide a net benefit to NSW.

Further details of the predicted environmental and social impacts of the Proposed Modification are provided in the main text of this SEE and associated technical reports. This SEE includes commitments by BCM to the ongoing implementation of comprehensive management, mitigation and offset measures to minimise and counterbalance the predicted impacts of the Proposed Modification.

The development of a coal mine and associated infrastructure is limited, by its nature, to the location of the coal resource. For the Proposed Modification, the additional resource proposed to be extracted is located adjacent to an existing operating coal mine, on land owned by Glencore that is currently primarily used for mining purposes.

The additional disturbance area of 20.2 ha is relatively minor, in the context of the currently approved BCC disturbance area of 3,786 ha. The additional disturbance area generally consists of land with lower land capability which is surrounded by land being used for mining or mining purposes. In terms of land use, it would be reasonable to determine that mining is the preferred land use for the site for the duration of the BCC operations. Post mining, the area will be rehabilitated and whilst the predominant post mining land use is proposed as native vegetation, that land (outside the final void) would be capable of being used for other purposes.

The additional disturbance area currently has a range of biodiversity values and these values will be impacted by the Proposed Modification, however, BCM has developed an offset strategy that fully offsets these impacts in accordance with government policy and which will contribute to conservation and community outcomes in the local area and region.

The Proposed Modification has been assessed against the principles of ecologically sustainable development as required by the EP&A Act and NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). This assessment has indicated that while the Proposed Modification, like any large-scale development, will have impacts, these impacts can be managed, mitigated and offset and the development will result in significant economic benefits. The assessment therefore concludes that the Proposed Modification is consistent with the principles of ecologically sustainable development.

The focused SIA undertaken for this Proposed Modification builds on the detailed SIA undertaken for BOP, in the context of the strong relationships established between BCM and local community stakeholders. The continuation of operations at BCC through the Proposed Modification will allow for the ongoing employment of the local workforce, continued business to local suppliers and continued contributions to Singleton Shire Council and payment of royalties to the state of NSW.

The detailed Economic Impact Assessment, including a cost benefit analysis undertaken for the Proposed Modification following relevant NSW government guidelines has identified that the benefits of the Proposed Modification will outweigh the costs, including consideration of environmental and social costs.

With the implementation of the management, mitigation and offset measures proposed by BCM, the assessment has concluded that the Proposed Modification would result in a net benefit to the NSW community.

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Appendix 15 Economics Impact Assessment

1.0 Introduction

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located approximately 12 kilometres (km) south west of Singleton in the Hunter Valley, of New South Wales (NSW) (refer to **Figure 1.1**). Bulga Coal Management Pty Ltd (BCM) operates the BCC on behalf of the Bulga Joint Venture, with mining operations occurring at the site for over 35 years. The BCC consists of open cut operations (Bulga Surface Operations) and underground operations (Bulga Underground Operations) that use shared coal washing and rail loading infrastructure as well as having an integrated water management system (WMS).

On 1 December 2014, BCM was granted approval for the Bulga Optimisation Project (BOP) (SSD 4960), which related to ongoing operation of the Bulga Surface Operations until 31 December 2035. The approval was granted by the Planning and Assessment Commission (under delegation from the Minister for Planning). SSD 4960 has been modified twice since it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

The Bulga Underground Operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). The Bulga Underground Operations ceased mining in May 2018 and the mine was sealed in July 2018 including all accesses and ventilation shafts. Some Blakefield South goaf drainage infrastructure has been retained and is being operated to reduce leakage of methane to the atmosphere and or ingress of oxygen into the goaf. While underground mining is currently suspended, pre-drainage of gas from the Blakefield North mining area is ongoing. This process reduces gas levels in the Blakefield seam in preparation for future underground mining, and supplies gas to the approved gas fired power generator. The Bulga Underground Operations approvals are being retained and BCM is actively evaluating opportunities to recommence underground mining operations in the future.

The design of the BOP was developed having regard to potential environmental and social impacts associated with mining operations, with the aim of minimising project specific and cumulative impacts. A comprehensive Social Impact Assessment and stakeholder engagement program was implemented during the BOP project design and environmental assessment phases to assist in refining the project design and to identify appropriate management and mitigation measures.

A key feature of the BOP project design was the development of a noise and visual bund along the western and southern edges of the open cut pit to manage noise and visual impacts. The noise and visual bund creates a landform between the open cut operations and the Bulga, Milbrodale and Broke areas which reduces noise impacts and is in keeping with the natural surrounding landscape. The project design also included a number of features to reduce environmental and social impacts whilst enabling the efficient recovery of a valuable coal resource.

BCM is proposing a modification to the Bulga Surface Operations to maximise resource recovery within the approved BOP Project Area (Project Area). The modification proposes an extension of the open cut operations to the south east as well as some changes to existing open cut infrastructure. Proposed mining will extend into a former open cut area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit. A revised mining sequence also allows the extraction of deeper coal resources beneath the floor of parts of the currently approved open cut mine (the Proposed Open Cut Modification). The Proposed Modification has been designed to maintain the project specific and cumulative noise and air quality impacts from the BOP SSD 4960 within the existing criteria.

BCM is also proposing to relocate some of the infrastructure required for the Bulga Underground Operations, in order to accommodate the proposed extension to the Bulga Surface Operations open cut mining area.

This Statement of Environmental Effects (SEE) has been prepared to assess the environmental and social impacts of the proposed modifications to both the Bulga Surface Operations (BOP SSD 4960 Modification 3) and the Bulga Underground Operations (DA 376-8-2003 Modification 7) (collectively referred to as the Proposed Modification). This SEE will support a modification application under section 4.55 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for both these planning approvals. .



FIGURE 1.1

Locality Plan

1.1 Proposed Modification

The Proposed Modification will maximise resource recovery within the approved Project Area through an extension of the open cut operations. The proposed extension of the open cut pit to the south east also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 million tonnes per annum (Mtpa) run of mine (ROM) coal while enabling the extraction of an additional approximately 63 million tonnes (Mt) of coal.

The Proposed Modification will extend the life of the approved open cut operation by approximately four years until 2039. Bulga Surface Operations will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the need for any additional disturbance area.

To allow for the proposed extension of the open cut pit, the Proposed Modification includes changes to the infrastructure associated with the separately approved adjacent Bulga Underground Operations, including the gas fired power generation plant and associated infrastructure. The Proposed Modification does not prohibit the ability to access approved underground mining resources to the south and west of the proposed open cut pit in the future and does not preclude the ongoing use of the CHPP and train loading facilities for the future beneficiation and transportation of coal from potential Bulga Underground Operations.

Figure 1.2 illustrates the approved Bulga Surface and Underground Operations and **Figure 1.3** shows the Proposed Modification in relation to the currently approved open cut mining operations at BCC. The Proposed Modification will be undertaken within the existing approved Project Area while extending the open cut coal extraction area further to the south of the approved extent of mining.

The Proposed Modification generally comprises:

- extension of mining areas to the south and west to access an approximately 63 Mt of additional ROM coal by accessing deeper resources within the approved open cut pit and in the proposed extension area
- realignment of the western highwall to improve long term stability and allow access to additional coal resources
- an additional disturbance of 20.2 hectares (ha) to accommodate the proposed extension of the mining areas to the south and west
- re-disturbance and rehabilitation of approximately 200 ha of existing immature mine rehabilitation
- removal and relocation of the tailings material currently stored in the existing TSF to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure
- relocation and removal of infrastructure servicing the open cut and Bulga Underground Operations including workshops, gas infrastructure and power generator, electrical sub-station, fuel and oil storage
- continued use of the temporary mine infrastructure area (MIA) area known as East Pit Muster Area
- construction of new water management structures to manage changes to the site surface water catchments

- the use of all existing or approved infrastructure and mobile equipment with some additions to the existing mobile equipment fleet over the life of the Project
- reprocessing of tailings where practicable. Any reprocessed coal from tailings would form part of the 20 Mt of product coal approved from the BCC, and not included in the BOC annual limit of ROM coal mined.

The Proposed Modification has been designed through a multi-disciplinary social and environmental risk-based approach aimed at maximising resource extraction efficiency and optimising the use of existing site infrastructure, while minimising impacts on the environment and community. As discussed in later sections of this SEE, the key learnings from the history of mining operations at the site; the stakeholder engagement program; the comprehensive BOP Social Impact Assessment (SIA); and the detailed Environmental Impact Assessment (EIA) undertaken for BOP, have all been considered in the project design. The Proposed Modification has been designed to maintain the predicted project specific and cumulative impacts within the currently approved limits and criteria applying to the BOP as much as practicable, while also providing significant ongoing benefits for an additional four years.

1.2 The Applicant – Bulga Coal Management

Bulga Coal Management Pty Ltd, the applicant for the Proposed Modification and the operator of BCC, is owned by Oakbridge Pty Ltd. Oakbridge Pty Ltd is ultimately 77.999% owned by Glencore PLC. Oakbridge Pty Ltd, through its subsidiary Saxonvale Coal Pty Limited is the majority participant (87.5%) in the Bulga Joint Venture.

1.3 Brief History of Mining Operations at Bulga Coal Complex

1.3.1 Open Cut Mining

Open cut mining was approved at the BCC in 1981 and has been carried out since 1982 when the site was first operated as a truck and shovel open cut coal mine to the east of the earlier Broke Road alignment. This mine was known as Saxonvale Colliery. In 1990, development consent was granted for an expansion to the west of Broke Road. A dragline was acquired in 1996 to supplement the truck and shovel mining fleet.

In 1999, the Bulga Mine Open Cut Consent was granted, enabling open cut mining to continue until 2025. The Open Cut Consent consolidated the previous open cut development consents and allowed for a maximum production rate from the open cut mining operation of 12.2 Mtpa ROM coal.

In 2014, the BOP was granted development consent SSD 4960. This development consent authorises the current open cut mining operations at the BCC and was designed to replace the previous Open Cut Consent. Key components of the approved Bulga Surface Operations are shown in **Figure 1.2**

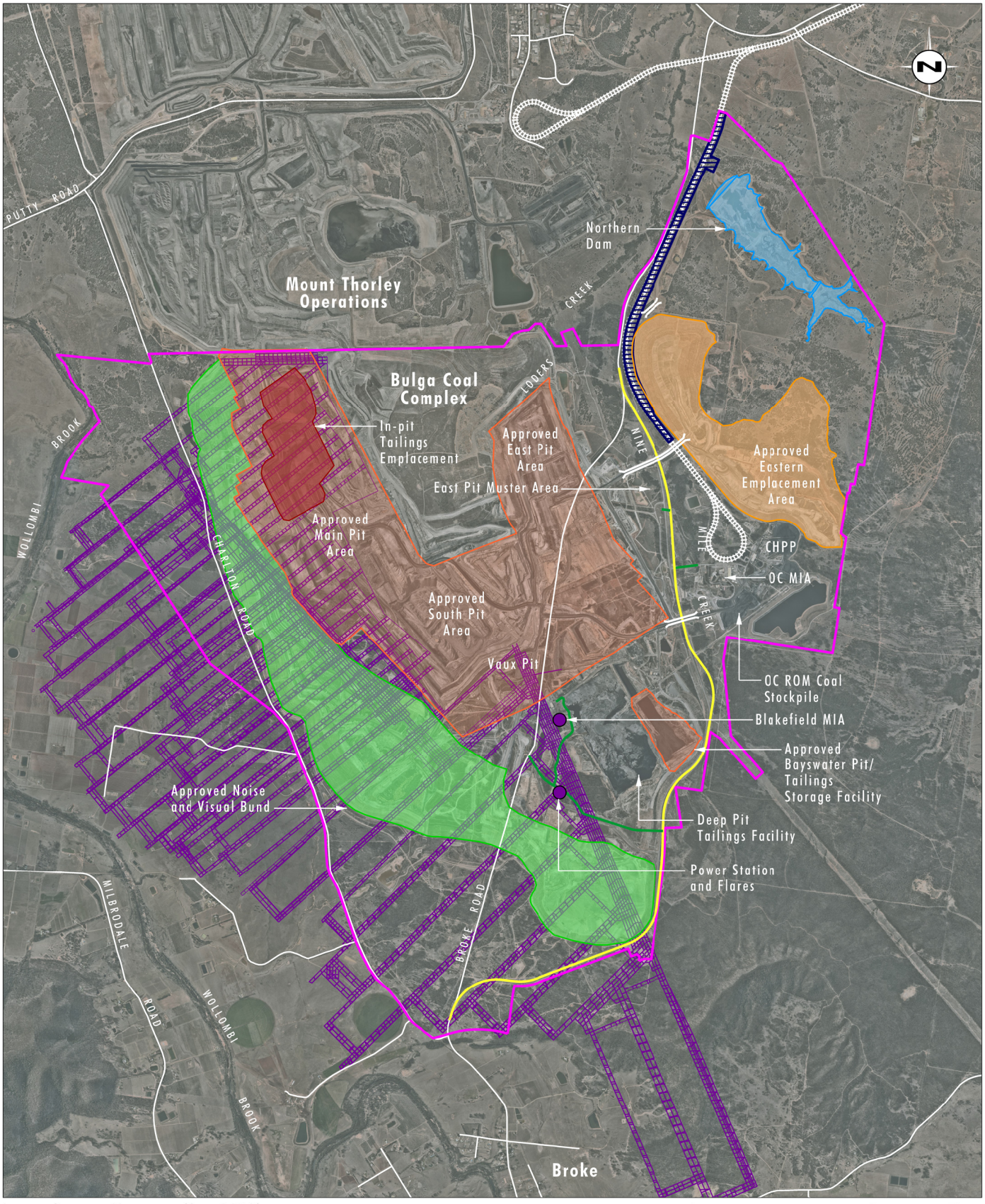

Image Source: Nearmap (Sep 2018)
Data Source: BCM (2019)

0 1 2 3km
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Legend

- Project Area
- Coal Extraction Area
- Approved Noise and Visual Bund
- Approved Eastern Emplacement Area
- Approved Northern Dam
- Approved Rail Siding
- Approved Broke Road Realignment
- Approved BCC Access Roads
- Existing Rail Line
- Approved Underground Mining Areas
- Existing Underground Facilities

FIGURE 1.2

Bulga Coal Complex Approved Operations Key Mining Features

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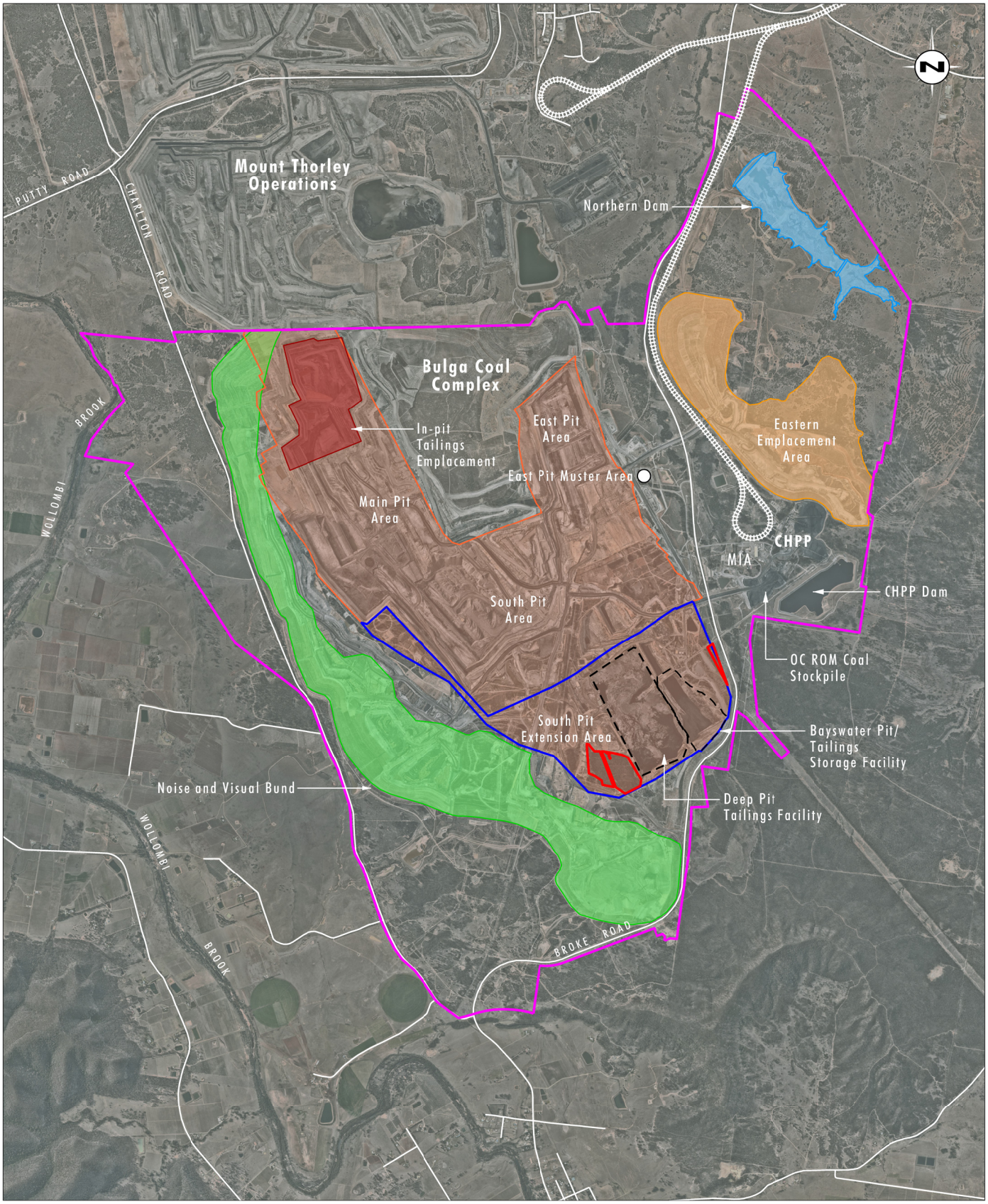


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

Legend

- Project Area
- Additional Disturbance Area
- South Pit Extension Area
- Mining Area
- Noise and Visual Bund
- Eastern Emplacement Area
- In-pit Tailings Emplacement
- Northern Dam
- Rail Line

FIGURE 1.3

Bulga Optimisation Project (SSD 4960)
Proposed Modification 3
Key Mining Features

File Name (A4): R03/4100_075.dgn
20190904 14.18

1.3.1.1 Bulga Optimisation Project

As outlined in **Section 1.0**, approval for the BOP (SSD 4960) was granted on 1 December 2014 which related to ongoing operation of the Bulga Surface Operations until 31 December 2035. The approval was granted by the then Planning and Assessment Commission (under delegation from the Minister for Planning).

The BOP was designed through a multi-disciplinary social and environmental risk-based approach that aimed to maximise resource extraction efficiency and optimise the use of existing mining infrastructure, whilst minimising impacts on the environment and community. To build on their existing knowledge, BCM implemented a comprehensive stakeholder engagement program for the BOP early in the project planning process to discuss potential future mining plans and alternatives with the community and other relevant stakeholders including government agencies, and Singleton Shire Council. This consultation assisted BCM to better understand how these plans could be adapted to minimise impacts and address issues raised by community and other stakeholders.

The key learnings from the history of mining operations at the site and the extensive stakeholder engagement program and comprehensive social impact assessment undertaken for the BOP were all considered in the project design. Through implementation of the BOP, BCM continued to contribute substantial economic benefits at local, regional, state and national levels whilst coexisting with the local community.

The detailed project planning and stakeholder engagement processes assisted BCM to develop the key objectives of the BOP. These key objectives of BOP were as follows:

- conduct mining in an environmentally responsible manner to minimise project-specific and cumulative environmental and social impacts
- reduce existing and potential environmental impacts of the Bulga Surface Operations by incorporating mitigation measures (such as noise and visual screening features) into the project design
- continue to develop the Bulga Surface Operations with a long term focus on:
    - maximising efficiency and coal resource recovery from the BCC
    - optimising the use of existing infrastructure
    - minimising additional mining disturbance footprint by maximising use of existing disturbed areas
- maintaining ongoing continuity of coal production from the surface operations over the approved lifespan of the underground operations
- extending the substantial employment opportunities provided by the surface operations
- developing comprehensive mitigation and management strategies that expand on existing commitments to mitigate and offset predicted impacts associated with the BOP
- co-existing with the local community, including the villages of, Bulga, Milbrodale and Broke
- establishing a final landform that is safe, stable and sustainable.

The BOP SSD 4960 has been modified twice since it was granted in 2014, as outlined in **Table 1.1** below:

Table 1.1 Bulga Optimisation Project Historic Modifications

Bulga Optimisation Project SSD 4960 Historic Modifications		
Modification Number	**Description**	**Approval Date**
Modification 1	Revised Eastern Emplacement Area and in-pit tailings storage	17 January 2017
Modification 2	Extend the period to complete the outer face of the Noise and Visual Bund till the end of September 2019	30 August 2018

The BOP was also approved by the Commonwealth Department of the Environment (DoE) (now Department of Energy and the Environment (DoEE)) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) 2012/6637.

1.3.2 Underground Mining

Underground operations commenced at BCC at South Bulga Colliery using longwall extraction methods in 1994. In 2004, the current Bulga Underground Mine Consent was granted (DA 376-8-2003), authorising ongoing underground longwall mining in the Whybrow, Blakefield, Glen Munro and Woodlands Hill seams. Multiple access locations are provided in the Bulga Underground Mine Consent (DA 376-8-2003) for accessing the approved underground mining areas, including access from a number of locations within the Bulga Surface Operations open cut. In addition, the BOP approval (SSD 4960) also provides a further option for underground access from the open cut. Key components of the approved Bulga Underground Operations are shown in **Figure 1.2**

There have been six modifications to the Bulga Underground Mine Consent since it was granted in 2003, outlined in **Table 1.2** below:

Table 1.2 Bulga Underground Mine Consent Historic Modifications

Bulga Underground Mine Consent DA 376-8-2003 Historic Modifications		
Modification Number	**Description**	**Approval Date**
Modification 1	Relocation of Men and Materials Drift	11 April 2006
Modification 2	Increased CHPP Throughput	25 October 2006
Modification 3	Southern Mining Area Longwall Realignment	01 October 2007
Modification 4	Blakefield South Power Generation and Methane Abatement	14 July 2010
Modification 5	Blakefield North Longwall and Gas Fired Power Plant	18 October 2013
Modification 6	Contemporising Criteria for Noise, Biodiversity and Auditing	8 December 2016

The Proposed Modification will require the relocation of the power station and associated infrastructure to accommodate the proposed extension of the open cut pit. The Proposed Modification does not preclude the ability to access approved underground mining resources to the south and west of the proposed pit in the future. The Proposed Modification will also not preclude the ongoing use of the CHPP and train loading facilities for the future beneficiation and transportation of coal from the Bulga Underground Operations.

The Bulga Underground Operations suspended coal extraction in May 2018 and the mine was sealed in July 2018. A reduced workforce has been retained for essential administrative and maintenance purposes, including functions such as statutory inspections, monitoring and reporting required under the Mining Act, the Environmental Protection Licence and Development Approval, electrical and mechanical maintenance, gas drainage, water management and administrative activities. The Bulga Underground Operations statutory approvals and mining tenements are being retained and BCM is actively evaluating opportunities to recommence underground operations in the future.

The Bulga underground mine also has a separate Commonwealth Approval 2002/773 which provides the necessary authorisation for the underground operations under the EPBC Act.

1.4 Overview of Existing Environment

1.4.1 Land Use and Ownership

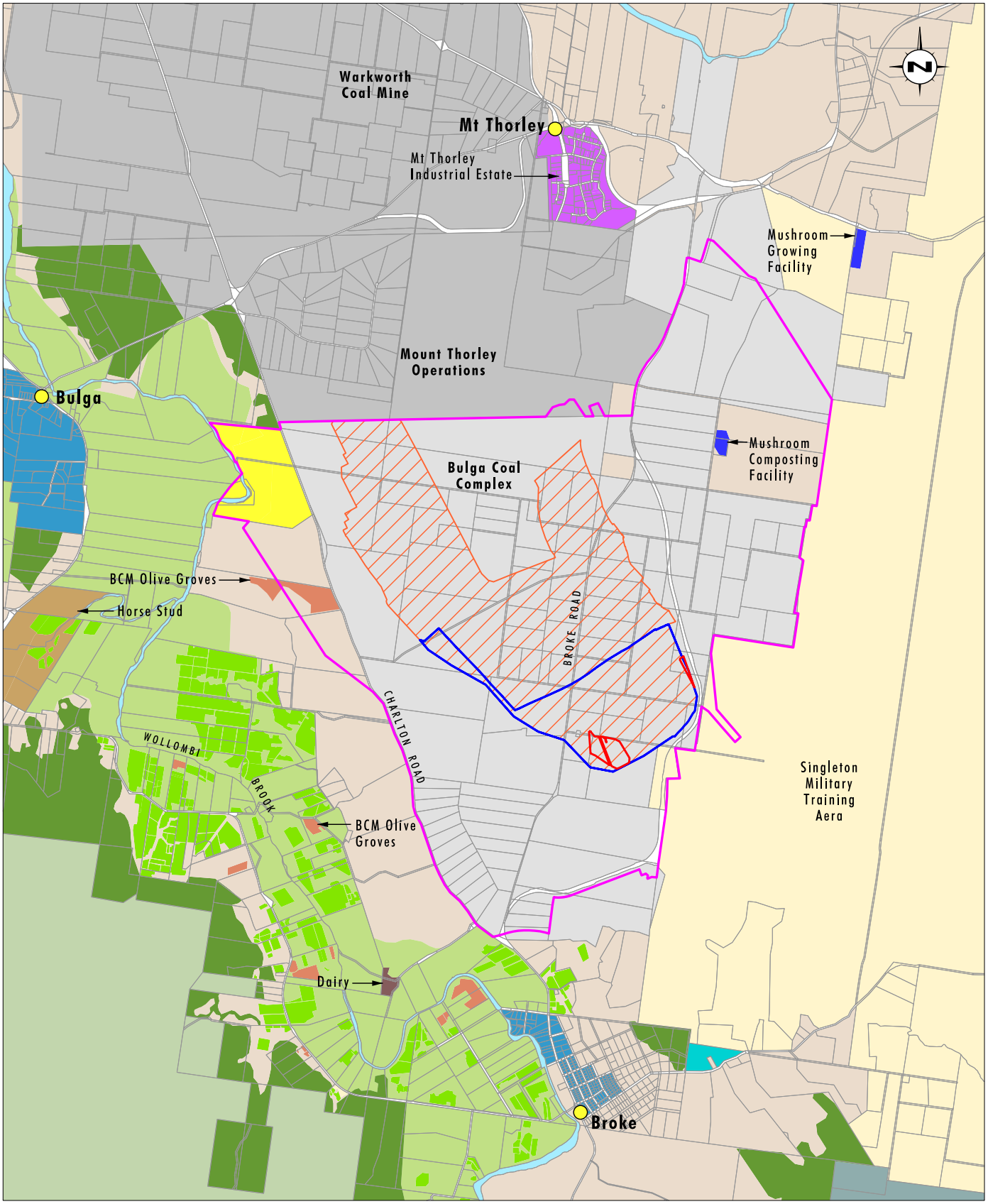
The Project Area including the additional disturbance area is located within a locality dominated by mining activities. A number of established mining and industrial operations are located within 10 km of the Project Area including:

- Mount Thorley Warkworth Mining Complex (MTW) which adjoins the northern boundary of the Bulga open cut
- Mount Thorley Industrial Area approximately 4 km to the north of the Project Area
- Wambo Mine is located approximately 9 km to the northwest
- Mushroom Composters adjacent to the northern boundary of the Bulga open cut eastern emplacement area.

The land uses surrounding the Project Area are dominated by open cut and underground coal mining operations, rural landholdings, grazing and cropping, olive groves, and viticulture (refer to **Figure 1.4**). In addition, tourist operations including short stay accommodation, winery cellar doors and specialist retail outlets also operate within the locality. The Singleton Military Training Area (SMTA) is located immediately to the east of the Project Area. The SMTA is used for defence training purposes and has large areas of planted, regenerating and remnant woodland as well as a live firing range and training areas.

All activities associated with the Proposed Modification will be undertaken on land owned by the Bulga Joint Venture and related corporate entities (hereafter also referred to as BCM). BCM also owns a number of properties surrounding the Project Area and has commercial arrangements regarding mining impacts with some of the other private landholders which are impacted by the BCC. The locations of private and mine owned residences around the Project Area are shown in **Figure 1.5**.

The remaining land surrounding the Project Area is owned by a variety of entities including other mining companies, State of NSW (Crown Land, including a former travelling stock reserve), the Commonwealth of Australia (including SMTA) and private land holders. A schedule of land located within the Project Area is included in **Appendix 1**.



Source: Google Earth (2010), LPMA

0 1 2 4km
1:80 000

Legend

- Project Area
- Additional Disturbance Area
- South Pit Extension Area
- Mining Area
- National Park
- State Forest
- Singleton Military Training Area
- Bulga Mining and Buffer Area
- MTW Operations
- Conservation - Private
- Forest/Woodland Area - Private Management
- Olive Grove
- Vineyards
- Mixed, Grazing and Cropping Land
- Grazing
- Dairy
- Village/Small Holdings
- Town/Village Centres

FIGURE 1.4

Surrounding Land Use

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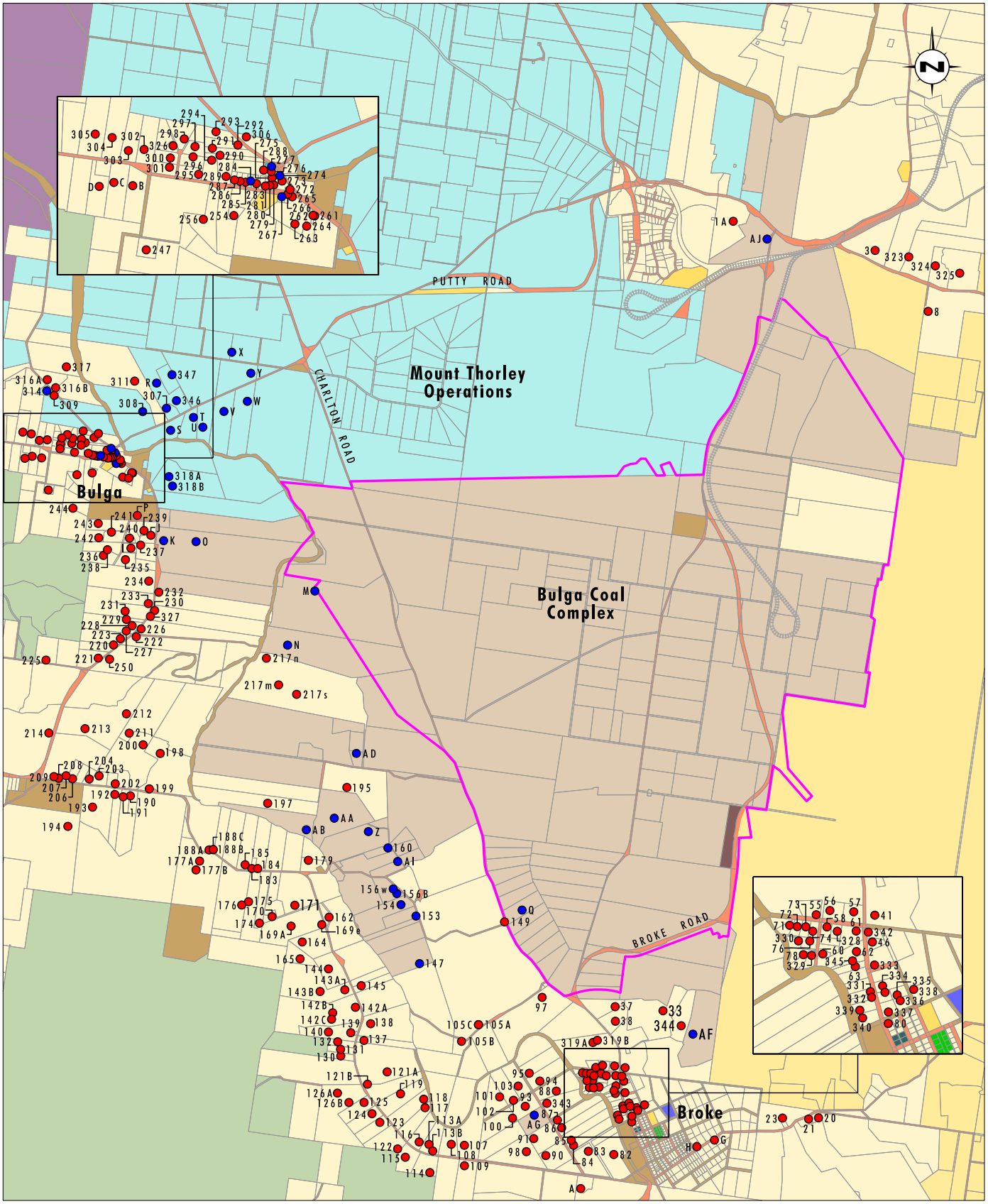
20190530 15.00



Legend

- Project Area
- Mine Owned Residence
- Private Residence
- AGL Energy
- Anglican Church Trustee
- Broke Public School
- Bulga Community Centre
- Crown Land
- Defence
- Glencore
- Private
- Singleton Council
- Telstra
- Wambo
- Yancoal
- National park
- Singleton Council leased to BCM
- Government Authority

FIGURE 1.5

Land Ownership

1.4.2 Environmental Context

The Proposed Modification requires the disturbance of an additional 20.2 ha within the Project Area (refer to **Figure 1.3**). Much of the land within and around the additional disturbance area has previously been cleared and modified for mining purposes. The 20.2 ha within the additional disturbance area currently comprises 19.2 ha of native vegetation surrounded by approved disturbance.

The Project Area is located within the catchments of Wollombi Brook, a tributary of the Hunter River, and Loders Creek. Loders Creek drains into the Hunter River downstream of the confluence of the Hunter River and Wollombi Brook (approximately 6.7 km upstream (south-west) of Singleton). The additional disturbance area is located within the existing surface water management system of the approved BCC.

The Greater Blue Mountains Area NSW World Heritage Property includes Wollemi National Park and Yengo National Park which are located approximately 4 km from the additional disturbance area.

1.5 Need for the Modification

The Proposed Modification will result in the efficient recovery of approximately 63 Mt of additional ROM coal resource at the BCC with minor changes to the currently approved environmental impacts.

Bulga Surface Operations will continue to utilise the existing BCC shared mining facilities, including the CHPP and train loading facilities, raw coal stockpiles and conveyors, train loading facilities, workshops, stores, offices and deployment areas, water management system, etc. for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas within the approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The Proposed Modification represents the most efficient method of extracting the additional 63 Mt of resources underlying the existing Deep Pit and Bayswater Pit TSF. The Proposed Modification represents a relatively small change to the currently approved mine layout and subsequently will result in relatively minor changes to the currently predicted impacts associated with the approved open cut operations.

Not proceeding with the Proposed Modification would significantly increase the cost of extracting the identified resources at a later date due to the efficiencies inherent in the continuation of the existing mine configuration, and the continued use of the BCC plant and infrastructure. The extraction of this additional coal resource now, while there is existing mining equipment operating at the site with available mining infrastructure, is substantially more efficient than seeking to mine the resource at some future date following closure of the existing operations. Such future operations may not be commercially viable. It is also unlikely that the deeper coal in the open cut area could be economically extracted if not undertaken as part of this Proposed Modification, as the completion of mining in this area without taking this coal (as currently approved) would likely sterilise this resource.

The operations at the BCC have provided substantial economic benefits at Federal, State, regional and local levels for many decades. The approved Bulga Surface Operations will continue to provide substantial economic benefits until approximately 2035. The Proposed Modification would extend the life of the Bulga Surface Operations until approximately 2039 which would result in the continued employment of approximately 700 Full Time Equivalent (FTE) positions at the BCC, with associated flow on effects for the local and regional communities. Not mining the additional coal resource would result in lower economic benefits including tax and royalty revenues and unrealised economic flow-on effects.

World energy demand is predicted to increase significantly over the next 20 years (International Energy Agency 2017). Meeting this increased energy demand into the future will require a mix of energy sources with thermal coal expected to be a key component of this energy mix into the foreseeable future.

Bulga Surface Operations is well positioned to contribute to meeting this expected demand in the short to medium term and will maximise coal recovery from within existing mining areas, whilst optimising the use of existing infrastructure and minimising the environmental impact associated with meeting this demand.

In order for the proposed expansion of the Bulga Surface Operations open cut mining area to be progressed, the Proposed Modification also includes the need to relocate the existing gas fired power generation plant and associated infrastructure required for the Bulga Underground Operations. The relocation and ongoing use of the existing gas fired power generator is required as a component of the ongoing removal of gas from the approved Blakefield North underground mining area ahead of future mining. This ongoing gas extraction process is approved and assists in providing improved safe mining conditions in future underground mining areas.

1.6 Alternatives

The main alternative to the Proposed Modification is the option of not proceeding.

The Proposed Modification would result in an additional 63 Mt of ROM coal. The impacts of supplying this coal from within an existing mining area are significantly reduced when compared to commencing a new 'greenfields' mine development. The extraction of this ROM coal now, while there is existing mining equipment operating at the site and available mining infrastructure, is substantially more efficient and would result in less environmental impacts compared to establishing a new "greenfield" mine elsewhere.

Not proceeding with the Proposed Modification would likely sterilise the coal resources as it would be difficult and significantly more expensive to access these resources once approved mining operations have ceased. As the coal is a multi-seam resource, the most efficient method of extraction requires that the seams must be extracted in sequence and in parallel with the same seams located in the adjacent approved mining area, as the adjacent mining is progressed. Any separate future operations would not be considered commercially viable as the benefits of being able to continue mining within an approved mining area and utilise existing infrastructure may not be available if the Proposed Modification does not proceed.

A further option of removing this additional coal resource by underground mining methods was considered and was rejected on technical grounds due to the steep dip of the seams which precludes efficient underground extraction, and would require a significant barrier of coal to remain unmined adjacent to the open cut mining area due to a range of safety factors including highwall stability, potential spontaneous combustion issues and mining underneath a significant tailings storage. Underground mining operations would only allow access to 1 to 2 coal seams whereas open mining will allow for greater recovery of the resource within the proposed mining footprint. In addition, the relatively small size and confined shape of the Proposed Modification area do not allow for the establishment of a viable longwall mine layout.

Variations to the proposed mine plan were also considered. The proposed mine plan aims to minimise additional disturbance as much as possible. As outlined in **Section 3.0**, it is proposed to increase the typical height of overburden emplacement areas from RL 150 mAHD to approximately 160 mAHD with selected areas emplaced to approximately 175 mAHD to accommodate the incorporation of micro-relief landform features. This minor increase in the height of the emplacement areas within the Project Area increases the available volume of the in-pit emplacement areas, resulting in reduced need for external emplacement of mine spoil. This enables the layout of the emplacement areas to remain generally consistent with the currently approved emplacement area footprint. If the height of the overburden emplacement areas was not increased, a greater area of additional disturbance would be required to accommodate the overburden from mining, estimated to be approximately 180 ha. A larger disturbance area would have additional impacts on biodiversity and the water management system as well as resulting in potential additional impact to noise, air quality, visual amenity and Aboriginal heritage. The minor increase to the overburden emplacement heights is considered a lesser impact on balance to an additional 180 ha of disturbance which would likely include threatened ecological communities.

Proceeding with the Proposed Modification will provide a range of ongoing economic and social benefits at local, regional and State levels.

As outlined in **Section 9.0**, the Proposed Modification has been assessed against the principles of ecologically sustainable development as required by the EP&A Act. This assessment has indicated that the Proposed Modification is consistent with the principles of ecologically sustainable development.

With the implementation of appropriate management, mitigation and offset measures as outlined in **Sections 6.0** and **7.0**, the assessment in this SEE has concluded that the Proposed Modification would result in a net benefit to the NSW community and will result in minimal incremental increase in environmental or social impacts. BCM therefore considers that not proceeding with the Proposed Modification is not an appropriate alternative.

2.0 Overview of Existing Operations

2.1 Bulga Surface Operations

The Bulga Surface Operations are approved to employ approximately 700 people and operate 24 hours per day, 7 days per week with approval to mine approximately 230 Mt of ROM coal. The Bulga Surface Operations have approval to mine up to 12.2 Mtpa ROM coal and to process up to 20 Mtpa ROM coal through the Bulga CHPP which receives coal from both the Bulga Surface Operations and Bulga Underground Operations. Bulga Surface Operations is currently approved to 2035 with further rehabilitation and closure works being carried out after the end of this period.

Bulga Surface Operations currently mine in a number of contiguous pit areas as outlined below:

- Main Pit, with extraction of coal to the base of the Woodlands Hill seam
- East Pit, with extraction of the steeply dipping seams in the Whittingham Coal Measures
- South Pit, which will ultimately mine down to the Broonie seam series
- Bayswater Pit, which mined shallow coal reserves and was subsequently used for tailings storage after the completion of mining.

Key approved mine infrastructure at BCC includes:

- open cut MIA
- underground MIA
- shared CHPP, stockpiles and train loading facilities
- water management infrastructure including the Surge Dam and Northern Dam
- TSF's.

The Bulga Surface Operations currently emplaces overburden in two out-of-pit emplacement areas. The noise and visual bund located generally west of the open cut mining area is designed to minimise the noise and visual impacts of the ongoing mining operations. The EEA enables overburden from the eastern side of the open cut operations to be handled efficiently and assists to reduce noise and air quality impacts to the majority of residents around the BCC. Overburden is also emplaced in pit.

The currently approved TSF include the Deep Pit, the Bayswater Pit and Main Pit. The Main Pit tailings emplacement was approved under SSD 4960 Mod 1, which included a revised tailings management strategy for the BCC and included an additional tailings emplacement area in the Main Pit active mine void. Coarse rejects and paste thickened tailings are co disposed with overburden.

2.1.1 Noise and Visual Bund

As outlined in **Sections 1.0** and **1.3.1.1** , a key feature of the BOP design was the development of a noise and visual bund along the western and southern edges of the open cut pit to manage noise and visual impacts (refer to **Figure 1.2**). The noise and visual bund creates a landform between the open cut operations and the localities of Bulga, Milbrodale and Broke which reduces noise impacts to sensitive receivers including residences and tourism businesses, and is more in keeping with the natural surrounding landscape.

BCM conducted community consultation regarding the noise and visual bund concept and held two 'In Focus' workshops with community members on visual aspects of the proposed bund. The concept of the noise and visual bund became a cornerstone of enabling long term coexistence with the community, whilst also being a key component of the BOP.

SSD 4960 was modified in August 2018 to extend the period to complete the outer face of the noise and visual bund. The noise and visual bund will remain in place as part of the Proposed Modification and has been considered in the impact assessment, including noise modelling. The construction and rehabilitation (topsoiling and seeding) of the outer face of the noise and visual bund was completed in August 2019.

2.2 Bulga Underground Operations

The Bulga Underground Operations consent, granted in 2003 under Part 4 of the EP&A Act, authorises the ongoing development of the underground mine and includes the following features:

- longwall mining of four seams (Whybrow, Blakefield, Glen Munro and Woodland Hill) at a rate of up to 14 Mtpa of ROM coal to 2031
- construction of amenities, offices, road intersections and overland conveyors, transfer stockpiles and associated infrastructure as well as ongoing use of existing infrastructure
- construction and operation of gas and ventilation management facilities, dewatering bores, and other ancillary surface infrastructure associated with underground mining
- continued joint use of the existing CHPP, with minor upgrades to allow processing of up to 20 Mtpa ROM coal from the BCC.

While the Bulga Underground Operations are currently suspended, there is an ongoing workforce employed to maintain underground mine facilities and supporting services such as gas drainage, electrical systems, statutory approval reporting, water management systems, as well as employees required for shared infrastructure such as the operation of the CHPP, train loading facilities, offices, stores, etc

The Bulga Underground Operations approvals are being retained and BCM is actively evaluating opportunities to recommence underground operations in the future.

3.0 Proposed Modification

The Proposed Modification relates to the extension of open cut mining at the Bulga Surface Operations within the currently approved Project Area following the relocation of tailings from the historical tailings storage facility, in addition to the relocation of some infrastructure associated with the adjoining Bulga Underground Operations. These activities will require the modification of both the open cut approval (Bulga Optimisation Project SSD 4960) (Proposed Modification 3) and the Bulga underground mining approval (Bulga Underground DA 376-8-2003) (Proposed Modification 7). The proposed changes to both current development approvals are described below.

3.1 Bulga Optimisation Project SSD 4960 Proposed Modification 3

The Proposed Modification will maximise resource recovery by extending the open cut operations approved under the BOP development consent (SSD 4960) to the southeast and west into a former open cut mining area currently occupied by two of the three approved TSF known as Deep Pit and Bayswater Pit. The extension of the open cut pit to the southeast and west also enables extraction of additional deeper coal resources both below parts of the currently approved BCC open cut, and also below the Deep Pit and Bayswater Pit TSF. The location of key mining features included in the BOP SSD 4960 Proposed Modification 3 are shown on **Figure 1.3**. The Proposed Modification will maintain the currently approved open cut coal extraction rate of up to 12.2 Mtpa ROM and will enable extraction of approximately an additional 63 Mt of coal.

The Proposed Modification includes the removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSF to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings from the Deep Pit and Bayswater Pit TSF.

The Proposed Modification generally comprises:

- extension of mining areas to the south east and west to access an additional 63 Mt of coal by accessing deeper resources within the approved open cut pit and in the proposed extension area
- realignment of the western highwall to achieve a more stable long term highwall and access the deeper resources
- an additional disturbance of 20.2 ha to accommodate the proposed extension of the mining areas to the south east and west
- re-disturbance and re-establishment of approximately 200 ha of existing immature mine rehabilitation
- removal and relocation of the tailings material currently stored in the existing TSF to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure
- relocation and removal of infrastructure servicing the open cut and underground operations including workshops, gas infrastructure and power station, fuel and oil storage
- continued use of the temporary MIA area known as East Pit Muster Area
- construction of new water management facilities to manage changes to the site surface water catchments

- the use of all existing or approved infrastructure and equipment with some additions to the existing mobile equipment fleet over the life of the project
- reprocessing of tailings where practicable. Any reprocessed coal from tailings would form part of the 20 Mt of product coal approved from the BCC, and not included in the BOC annual limit of ROM coal mined.

A comparison between the approved development under SSD 4960 and the BOP SSD 4960 Proposed Modification 3 is provided in **Table 3.1**. **Section 3.1** provides further detail of the aspects of the Proposed Modification which differ to the approved development.

Table 3.1 Comparison of SSD 4960 and Proposed Modification

Key Project Component	Approved Development (SSD 4960)	BOP Proposed Modification 3
Extraction rate limit	Extraction limit of 12.2 Mtpa of ROM coal.	No change.
Total Recoverable Resource (ROM)	162 Mt.	An additional approximately 63 Mt
Project life	Mining operations until 31 December 2035.	Extension to the life of mine until 31 December 2039 (an additional four years).
Project boundary/ Schedule of Lands	Per SSD 4960 **Appendix 1** .	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim.
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit. Mining undertaken within existing ML1547.	Extension of mining areas to the south east and west. Accessing deeper resources within the approved pit and the proposed extension area. Mining undertaken within existing ML1547.
Disturbance Areas	Approved mining disturbance footprint (3,786 ha).	Additional disturbance area of approximately 20.2 ha not currently part of the approved mining disturbance footprint.
Key Infrastructure	Realignment of Broke Road (Complete). Relocation of 330kV transmission lines (Complete). Construction of new water storage dam (Complete). Upgrade to CHPP to improve yield and plant efficiency (Ongoing). Relocation of sections of Broke-Fordwich Private Irrigation District pipeline and Telstra infrastructure (Complete).	Relocation of some mine owned open cut infrastructure . Demolition of some open cut infrastructure to accommodate proposed mining. Ongoing use of the existing East Pit deployment infrastructure Upgrade of the Bulga Surface Operations carpark and deployment infrastructure. Replacement/relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop. Installation of tailings relocation infrastructure (pumps and pipelines, power lines and access tracks).

Key Project Component	Approved Development (SSD 4960)	BOP Proposed Modification 3
Coal Handling and Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput.	Potential upgrade of CHPP to reprocess additional tailings. No changes to CHPP throughput, ROM or product stockpiles.
Coal Transport	20 Mt of product coal transported in any calendar year.	No change.
Equipment Fleet	Mining fleet as per BOP Amended Project Application Assessment (Umwelt 2013).	Minor increases to fleet numbers to provide flexibility for mining operations.
Overburden / coarse reject management	Overburden placed in-pit.	No change to overburden and coarse reject management.
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF. Main Pit TSF approved in SSD 4960 Mod 1.	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining. Increased capacity of Main Pit TSF to cater for relocated tailings and ongoing tailings production.
Final void	One void at the end of mining operations.	One void proposed to be of similar size to the approved void.
Rehabilitation and final landform	Conceptual final landform is shown in SSD 4960 and includes a final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use.	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing. Increases to typical overburden emplacement heights from 150 mAHD to 160 mAHD with selected areas emplaced to approximately 175 mAHD to accommodate the incorporation of micro-relief landform features Re-disturbance and re-establishment of approximately 200 ha of immature rehabilitation. Revised conceptual final landform includes 1 final void .
Employee Numbers	Approximately 700 FTE employees.	No change.

3.1.1 Conceptual Open Cut Mine Plan

Indicative mine plans for the BOP SSD 4960 Proposed Modification 3 representing the key stages of the development are shown on **Figures 3.1** to **3.4**. The proposed conceptual final landform is presented in **Figure 3.5**.

The proposed open cut mining area is largely within the existing open cut pit area and Bulga Coal Complex disturbance footprint. The open cut resources will continue to be mined in three main contiguous pit areas (refer to **Figure 1.2**) being the Main Pit and East Pit areas being consistent with the approved mining areas, and an extension to the South Pit area enabling additional deeper resources below the approved pit to be extracted.

Figures 3.1 to **3.5** provide representative mine plan stages that depict the proposed changes to the mine progression and form the basis of the detailed environmental assessments in **Section 6.0**. Cross-sections of

the open cut pit are presented in **Figure 3.6** which demonstrate the proposed deeper mining within the approved open cut pit and proposed extension. An iterative design and review process was undertaken to ensure that the mine layouts including overburden emplacements can be undertaken within the currently approved noise criteria provided in the existing BOP consent (SSD 4960).

As discussed, the BOP SSD 4960 Proposed Modification 3 requires the relocation of tailings from the Deep Pit and Bayswater Pit TSF to facilitate the extension of the South Pit mining further to the southeast and west. Where feasible, the tailings recovered from the tailings facilities will be reprocessed at the CHPP. Any product sourced from the reprocessing of the TSF will be included in the CHPP processing and transportation limit of 20 Mtpa. The reprocessing of tailings will not be included in the Bulga Surface Operations extraction limit of 12.2 Mtpa as the tailings is not considered to be ROM coal, having been mined and processed previously.

As shown on **Figures 3.1** to **3.4**, the areas disturbed by mining activities will be progressively rehabilitated throughout the life of the mine to achieve a suitable final landform. No change to the approved rehabilitation techniques is proposed however some changes will result to the final landform resulting from the Proposed Modification. The conceptual final landform for the BOP SSD 4960 Proposed Modification 3 is shown in **Figure 3.5**. The mine planning design principles adopted for the BOP SSD 4960 Proposed Modification 3 are consistent with those used for the approved open cut operations. The emplacement and capping of additional tailings within the Main Pit TSF will alter the final landform of the Main Pit emplacement area and mining further to the southeast and west will result in the final void moving to the southeast.

The conceptual mine plans which form the basis of this assessment have been designed in consideration of current mining techniques and technologies and are based on BCM's current understanding of local geology. Mining operations are, however, dynamic and the specific mine plan layout, timing and sequence shown in the indicative mine plans may be subject to changes due to, for example, economic conditions, technological advances and operational needs or as further geological and geotechnical data is gathered.

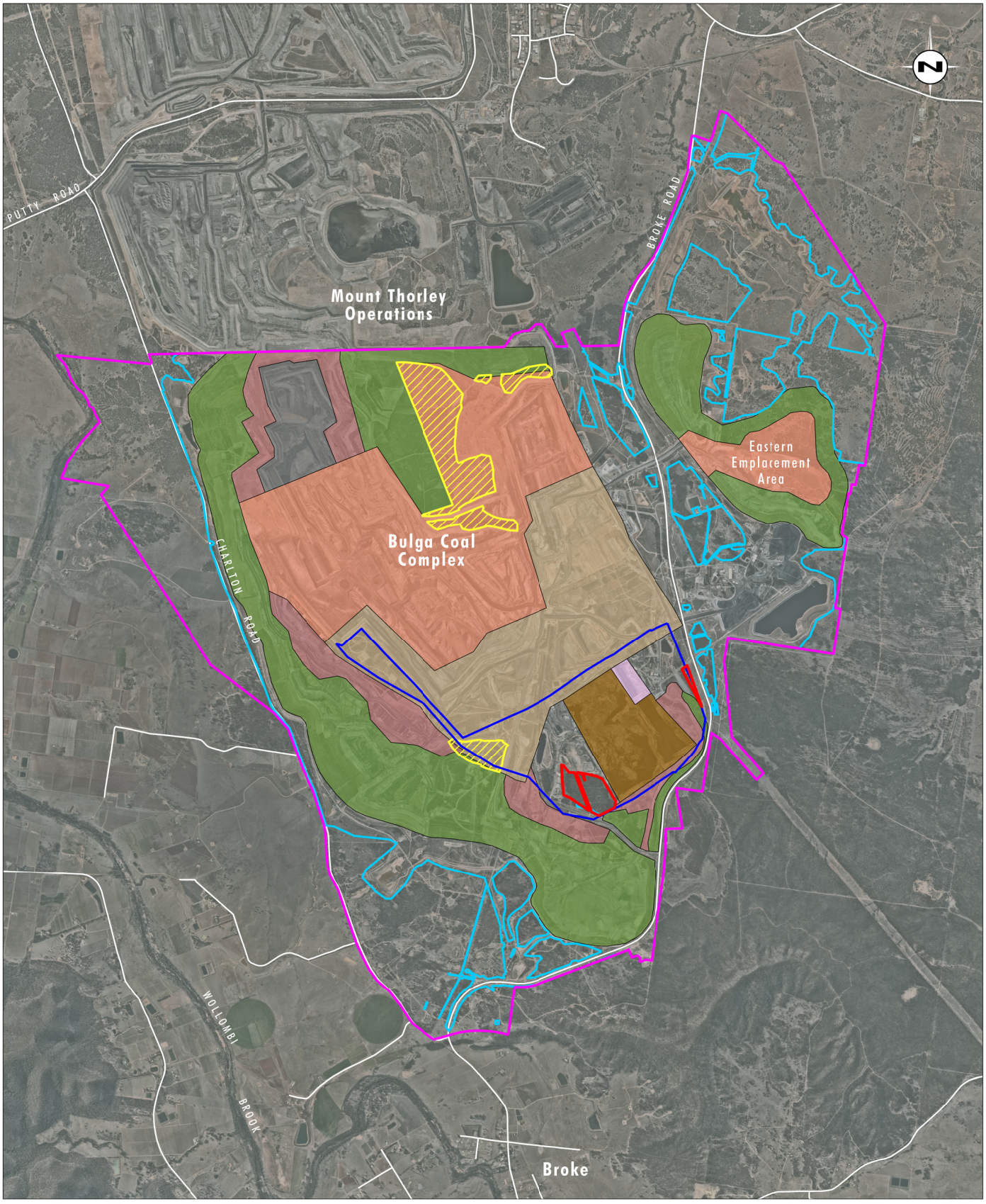


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- South Pit Extension Area
- Active Overburden
- Inactive Overburden
- Active Pit
- Inactive Pit
- Rehabilitation
- Tailings Storage Facility
- Tailing Storage Facility - Mining
- Rehabilitation Re-disturbance Area

FIGURE 3.1

Bulga Optimisation Project Modification 3
Conceptual Mine Plan 2022

File Name (A4): R03/4100_057.dgn
20190904 14.06

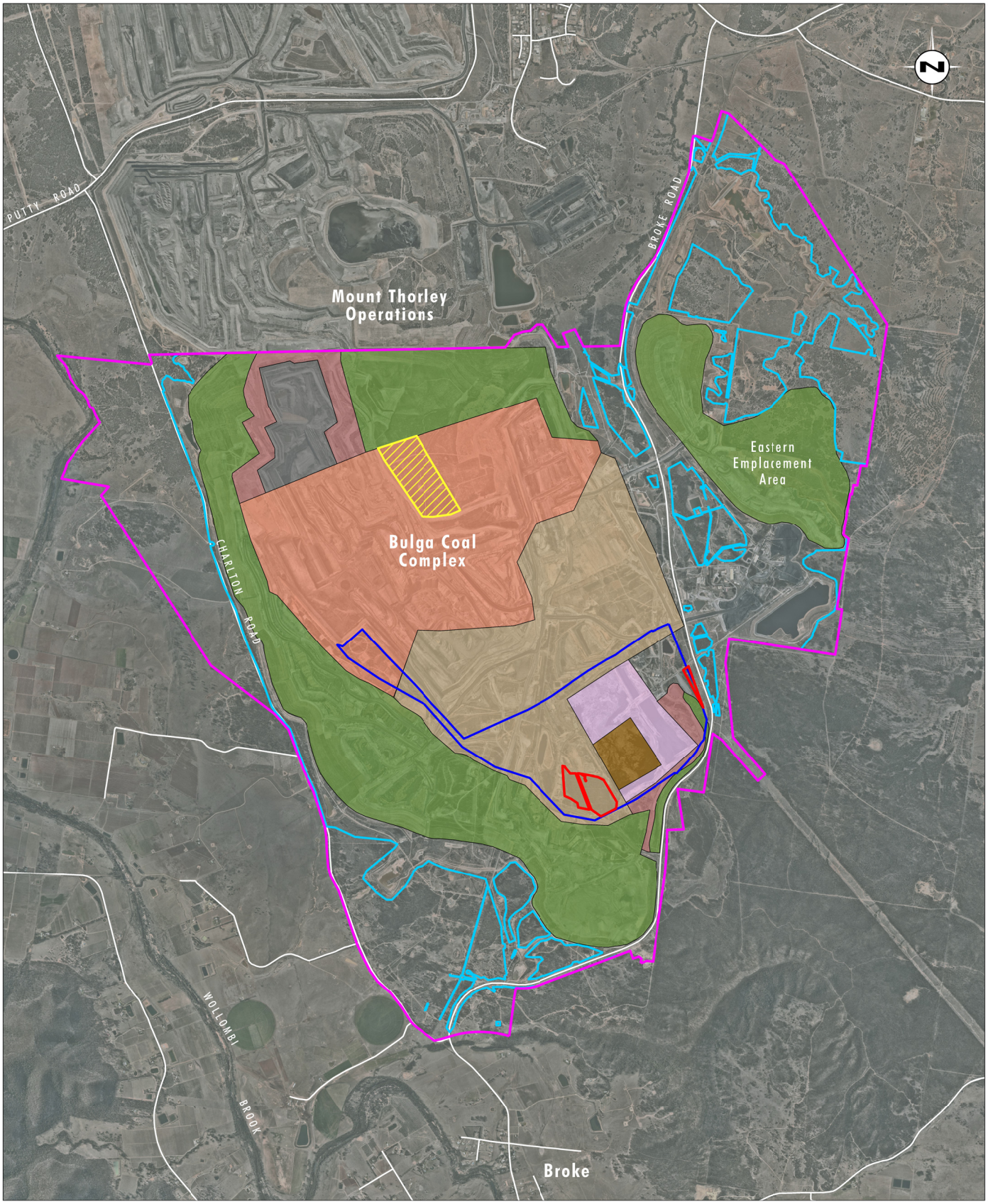


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- South Pit Extension Area
- Active Overburden
- Inactive Overburden
- Active Pit
- Inactive Pit
- Rehabilitation
- Tailings Storage Facility
- Tailing Storage Facility - Mining
- Rehabilitation Re-disturbance Area

FIGURE 3.2

Bulga Optimisation Project Modification 3
Conceptual Mine Plan 2026

File Name (A4): R03/4100_058.dgn
20190904 14.08

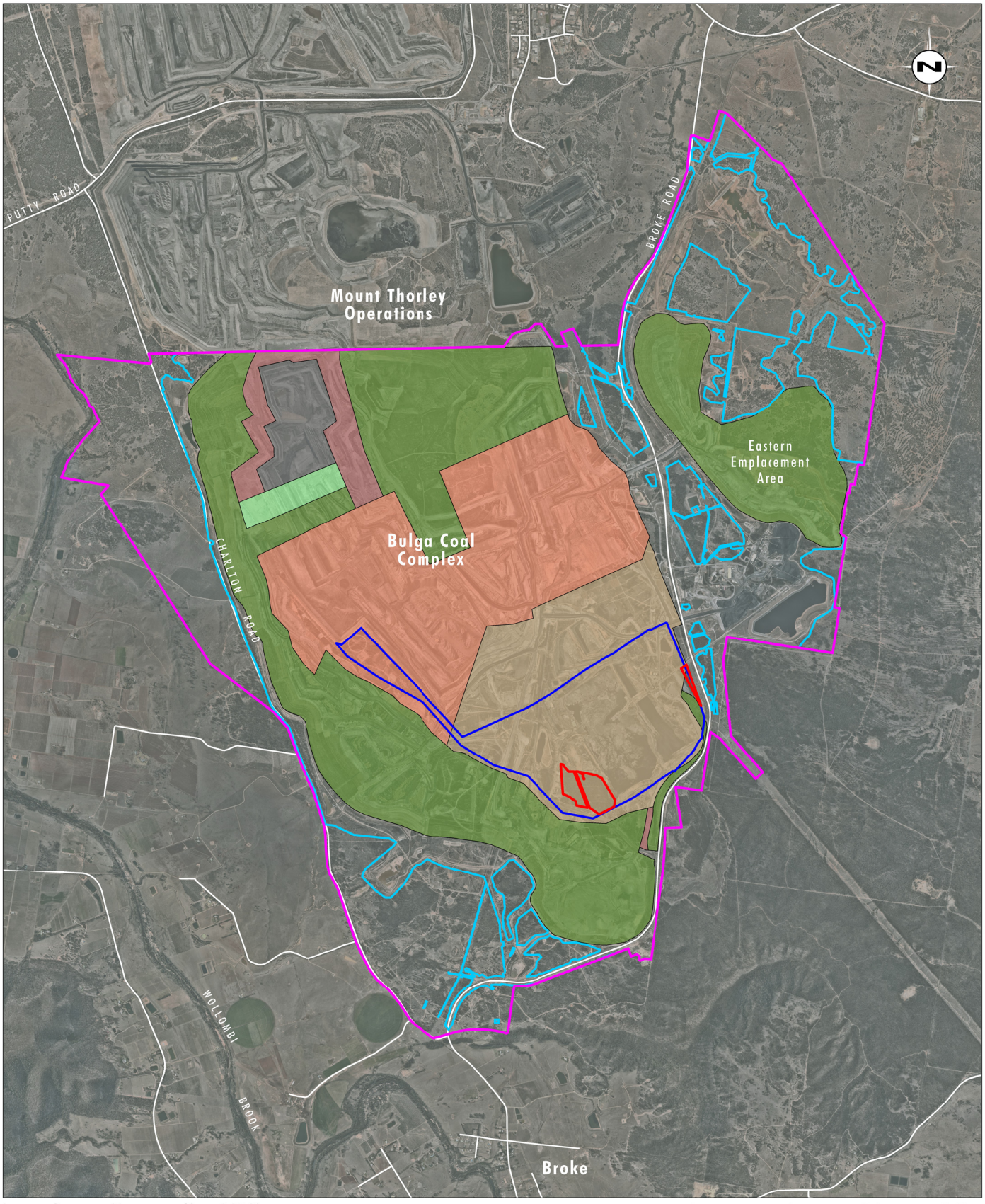


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- South Pit Extension Area
- Active Overburden
- Active Pit
- Temp Rehabilitation
- Rehabilitation
- Tailings Storage Facility

FIGURE 3.3

Bulga Optimisation Project Modification 3
Conceptual Mine Plan 2031

File Name (A4): R03/4100_059.dgn
20190529 16.43

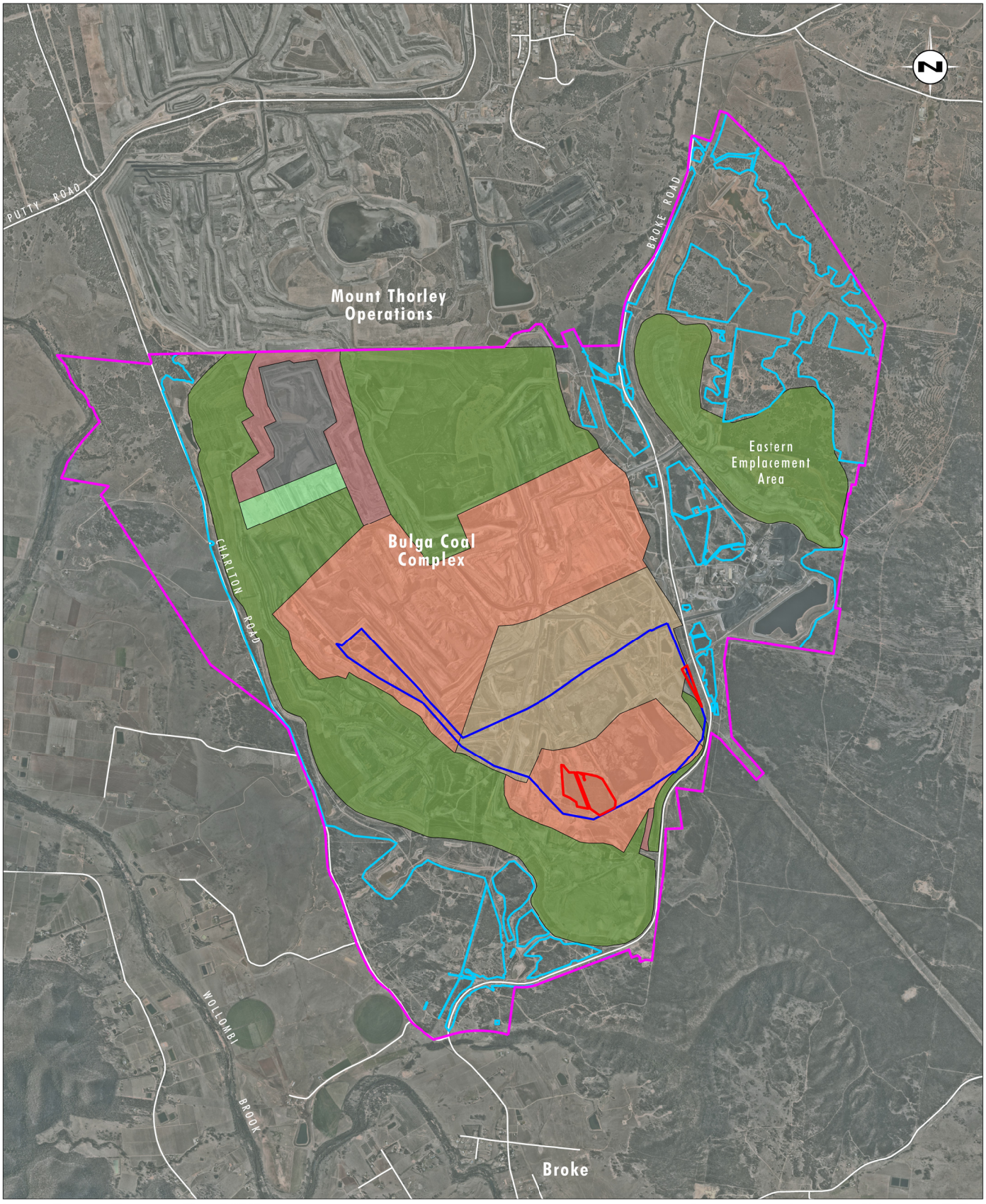


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- South Pit Extension Area
- Active Overburden
- Inactive Overburden
- Active Pit
- Temp Rehabilitation
- Rehabilitation
- Tailings Storage Facility

FIGURE 3.4

Bulga Optimisation Project Modification 3
Conceptual Mine Plan 2035

File Name (A4): R03/4100_060.dgn
20190529 16.44

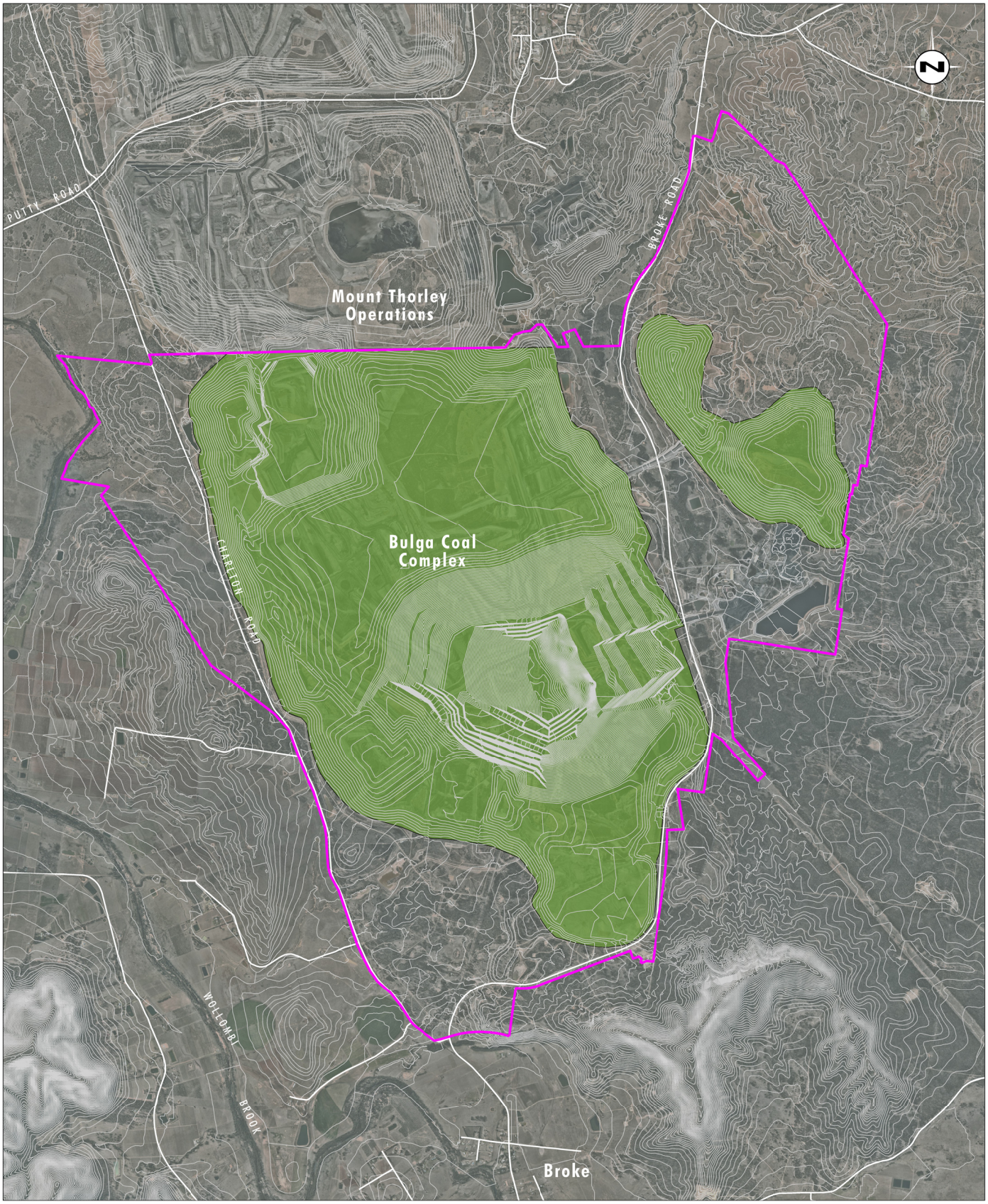


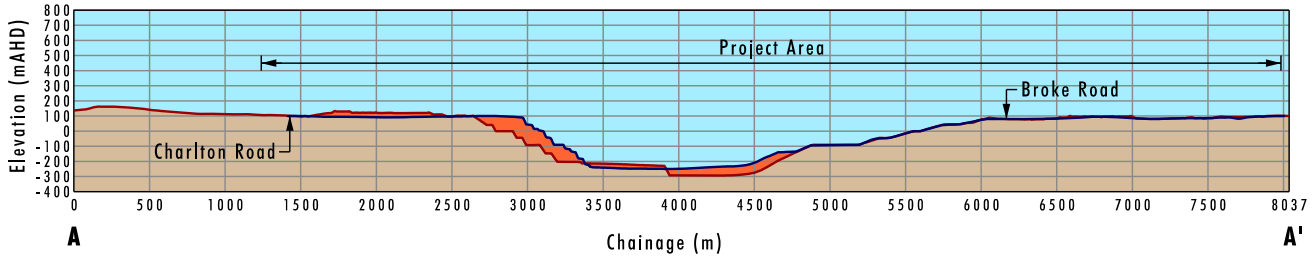
Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)
Note: 5m Contour Interval

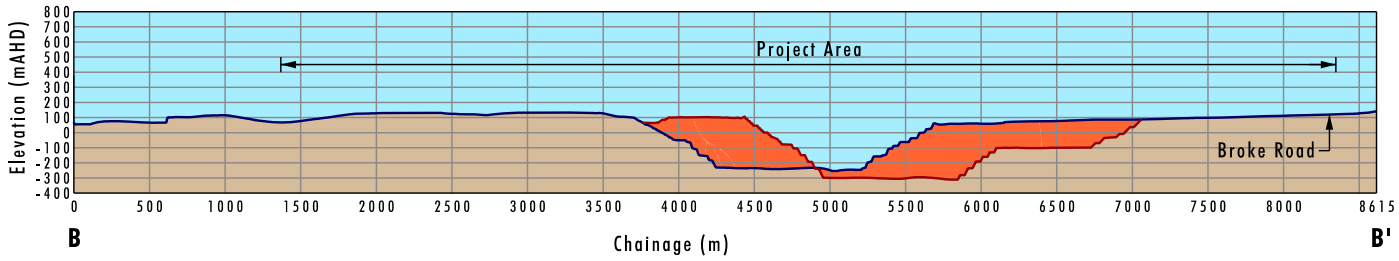
0 1.0 2.0 3.0km
1:60 000

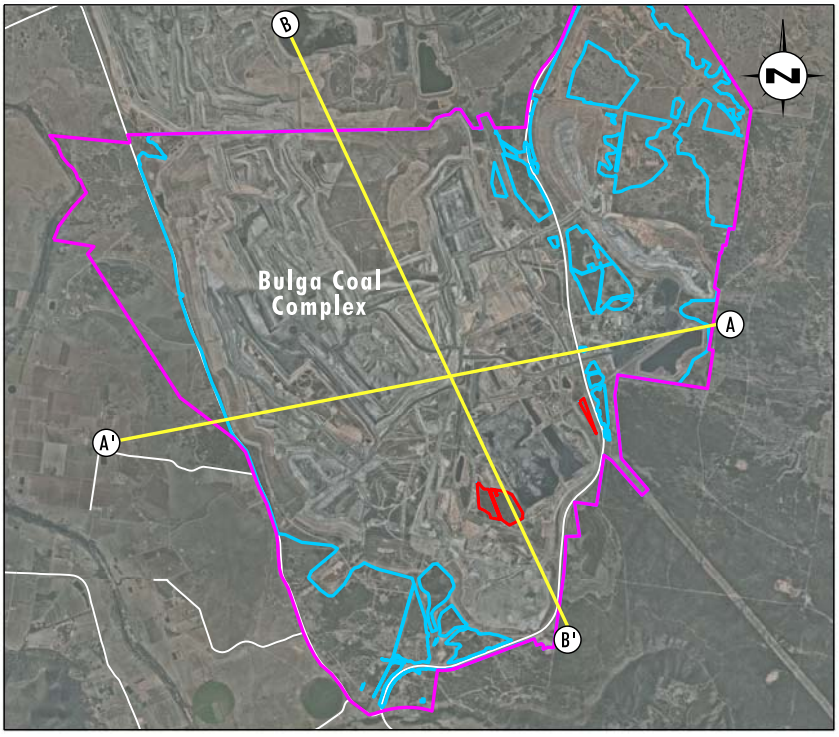
Legend
- Project Area
- Rehabilitation

FIGURE 3.5

Bulga Optimisation Project Modification 3
Conceptual Final Landform







0 0.5 1.0 1.25km
Inset 1:25 000

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- BOP Pit Shell
- BEP Pit Shell

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

FIGURE 3.6

Depth of Extraction Cross-section

3.1.1.1 Overburden Emplacement Heights

Overburden will be emplaced in either out-of-pit emplacement areas (Noise and Visual Bund and Eastern Emplacement Area) or in-pit, filling previously mined areas, including the common landform area between the BCC and the adjoining Mount Thorley operations (Yancoal).

The location of overburden emplacement activities will be generally dependent on the source of the overburden, minimisation of haul distances and prevailing weather conditions, and will be actively managed through the mine dispatch centre to minimise noise, dust and visual impacts. This system is currently in place at BCC, and consistent with current practices, the proposed mine plan has been designed to provide flexibility in the placement of mining equipment in order to manage environmental impacts, in particular noise and dust.

The overburden emplacement areas (in-pit and out-of-pit) are approved to be developed progressively over the life of the mine to a typical height of approximately RL 150 mAHD (typical emplacement heights over the last 20 years at BCC) with selected areas emplaced to approximately RL 165 mAHD. As part of the BOP SSD 4960 Proposed Modification 3, BCM is seeking to increase the typical height of overburden emplacement areas to approximately 160 mAHD with selected areas emplaced to approximately 175 mAHD to accommodate the incorporation of micro-relief landform features.

This minor increase in the height of the in-pit emplacement areas increases the available volume of the in-pit emplacement areas, resulting in reduced need for external emplacement of mine spoil. This enables the layout of the emplacement areas to remain generally consistent with the currently approved emplacement area footprint. If the height of the overburden emplacement areas was not increased, a greater area of additional disturbance would be required to accommodate the overburden from mining, estimated to be approximately 180 ha. The project design has attempted to minimise additional impacts as much as practicable. The minor increase to the overburden emplacement heights is considered a lesser impact compared to an additional 180 ha of disturbance which would likely include threatened ecological communities.

3.1.1.2 Re-disturbance of mine rehabilitation

In addition to the proposed additional disturbance area of 20.2 ha, the BOP SSD 4960 Proposed Modification 3 will result in the re-disturbance of approximately 200 ha of existing mine site rehabilitation located on the current in-pit overburden emplacement area, in order increase the height of the existing in-pit overburden emplacement area. The rehabilitation will be disturbed in stages and progressively re-planted. Conceptual progressive rehabilitation re-disturbance and re-establishment is shown in **Figures 3.1** to **3.4**.

The re-disturbance of areas of rehabilitation is proposed in order to limit the need to expand the footprint of the overburden emplacement area, which would otherwise result in further areas of new disturbance.

The areas of rehabilitation to be re-disturbed have been established in accordance with the currently approved BOP Rehabilitation Management Plan. The rehabilitation is currently in various states of establishment covering a range of planting timeframes and has not been finalised for relinquishment. Further details are provided in **Section 6.12.3**.

All existing rehabilitation obligations and commitments will be maintained including types of vegetation to be established, establishment of habitat type and areas, revegetation establishment techniques and biodiversity monitoring requirements. Topsoil will be retrieved and re-used, where practicable.

The currently approved BOP Rehabilitation Management Plan will be revised to reflect the rehabilitation activities required for BOP SSD 4960 Proposed Modification 3 following development consent.

3.1.1.3 Access to Underground Workings

The Proposed Modification will mine through key infrastructure associated with the current Bulga Underground Operations including the Blakefield South entry portal, MIA and some ventilation equipment. The Proposed Modification allows the development of alternative entry points for mining the Bulga Underground Operations similar to the in-pit portal previously approved as part of the BOP, and in the original Bulga Underground DA 376-8-2003.

Details of the Proposed Modification to the Bulga Underground DA 376-8-2003 are provided in **Section 3.2**.

ROM coal from underground operations would be hauled to the CHPP via truck or conveyor.

3.1.2 Mining Process and Fleet

There will be no change to the mining process as part of the Proposed Modification.

Mining as part of the BOP SSD 4960 Proposed Modification 3 will continue to use similar types of mining fleet to the approved operations. Some of this fleet will be replaced or upgraded, as required, over the life of the operation. Truck and shovel/excavator mining method provides flexibility for multi-seam mining operations and is also suited to the progressive backfilling and rehabilitation of pit areas behind the active working areas as the mining activities advance. Conceptual progressive rehabilitation is shown in **Figures 3.1** to **3.4**.

As currently approved, highwall mining into suitable seams exposed in the lowwalls and highwalls will be undertaken to maximise resource extraction where it is safe and efficient to do so. Any such mining will be opportunistic and will heavily depend on the ability to time the highwall mining operations with the scheduling of the open-cut mine plan which is based around the truck and shovel operations.

Trucks will be utilised to haul overburden to emplacement areas and extracted coal to the CHPP. Trucks used for hauling coal to the open cut ROM stockpiles will also be used to transport coarse and thickened reject material from the CHPP to overburden emplacement areas for co-disposal with the overburden material.

The typical mining fleet will be subject to technological advances in mining equipment which may alter the composition of the fleet over time. The make-up of the mining fleet will vary from time to time throughout the life of the project. To provide for greater operational flexibility, additional mining fleet is proposed. The typical mining fleet proposed in modelling undertaken for noise and air quality impact assessments for the approved mining operations is provided in **Table 3.2**, along with the indicative equipment fleet numbers required for the Proposed Modification.

Table 3.2 Typical Mining Equipment

Equipment Type	Indicative Number Modelled for BOP Proposed Modification 3
Electrical Dragline	0
Excavator/shovel	8
Rear dump truck (Overburden)	50
Rear dump truck (Coal)	10
Dozers (including both tracked and rubber tyred)	17
Drill	4
Grader	4
Water cart	4
Front End Loaders	3

3.1.3 Coal Handling and Processing

The BOP SSD 4960 Proposed Modification 3 will continue to utilise the existing CHPP infrastructure located in the eastern extent of the Project Area (refer to **Figure 1.2**). The CHPP currently has an approved throughput capacity of 20 Mtpa ROM coal. The CHPP will continue to process ROM coal from both the Bulga Surface Operations and the Bulga Underground Operations. No change is proposed to the currently approved maximum operating capacity of 20 Mtpa ROM coal and the CHPP will continue to operate up to 24 hours per day, seven days a week. The CHPP will continue to operate for the additional years of operation associated with the Proposed Modification.

Consistent with current mining practices, ROM coal from the BOP SSD 4960 Proposed Modification 3 area will be hauled by trucks via haul roads to the open cut ROM stockpile area adjacent to the existing CHPP. Haul trucks will typically unload coal directly into a hopper which will deliver the coal either directly to the CHPP for washing or to the raw feed stockpile. Some coal may be temporarily stockpiled at the ROM coal stockpile area to improve stockpile management. Stockpiling will allow blending of a range of seams to meet market requirements, and to achieve maximum coal recovery from the CHPP to improve efficiency.

3.1.4 Product Coal Transportation

Export coal processed from the Bulga Surface Operations will continue to be transported to the Port of Newcastle via the existing rail spur onto the main Newcastle Line.

There are no proposed changes to the existing train loading system. The product coal will be loaded into trains and transported off site via the current rail spur and train loading facilities. No additional rail or port capacity allocation is required for this Proposed Modification.

3.1.5 Tailings Management

3.1.5.1 Revised Tailings Management Strategy

Tailings are currently approved for disposal in the Deep Pit, Bayswater Pit, the Main Pit (refer to **Figure 1.2**) and in the underground workings. Deep Pit and Bayswater Pit have been used as the primary tailings facilities for the Bulga Coal Complex to-date, with the Main Pit in-pit TSF being approved in SSD 4960 Modification 1.

The approved tailings emplacement strategy for the BCC includes the disposal of tailings in underground workings. Since SSD 4960 was granted in December 2014, mining operations at the Bulga Underground Operations have been temporarily suspended. As a result of this temporary suspension, underground mining will not be sufficiently advanced to implement the previously planned and approved underground placement of tailings as part of BOP in the quantities previously envisaged, although underground placement of tailings may still be used through the life of the project. A further consequence of the temporary suspension of underground mining is that the placement of tailings in the existing underground mining areas (i.e. those areas currently mined) would prevent the future underground mining of the underlying seams. This would therefore sterilise part of the coal resource to be mined by underground methods in the future.

As part of SSD 4960 Modification 1, BCM developed a revised tailings management strategy for the BCC and in addition to the existing approved in-pit tailings emplacement areas included an additional tailings emplacement area in the Main Pit within the confines of the in-situ mine void as shown in **Figure 1.2**.

As discussed, the BOP SSD 4960 Proposed Modification 3 will mine through the existing Deep Pit and the Bayswater Pit TSF which will no longer be available for tailings storage. Tailings currently located in the Deep Pit and the Bayswater Pit will be extracted utilising dredging (or similar) techniques to recover the tailings which will be pumped to the Main Pit in-pit TSF for disposal as described below.

The Main Pit in-pit TSF will be the primary TSF for the ongoing BCC open cut and underground mining operations (refer to **Figures 3.1** to **3.4**). The Main Pit in-pit TSF has an approved storage capacity of 7.5 Mm^3. As part of the BOP SSD 4960 Proposed Modification 3, the capacity of the Main Pit in-pit TSF will increase to approximately 70 Mm^3 to accommodate the relocated tailings and ongoing mining operations. The revised design of the Main Pit in-pit TSF will achieve the required additional capacity primarily through increasing the depth of the stored tailings whilst maintaining a similar surface area.

The Main Pit in-pit TSF will be managed to optimise water recovery and improve drying which will assist in the timely rehabilitation of the facility. Tailings emplacement employs:

- multiple discharge points to enhance the beaching angle to promote dewatering and consolidation of the tailings
- maximised liberation and recovery of water through processes such as secondary thickening and/or flocculation where required
- effective removal and reuse of the tailings decant water.

Water recovered from the tailings thickening and the Main Pit in-pit TSF will be returned to the BCC integrated WMS for storage and re-use, in a similar manner to that deployed for the current tailings emplacement areas.

Tailings management infrastructure will be located in previously disturbed or approved disturbance areas where possible.

3.1.5.2 Tailings Relocation

In order to extract the tailings from the existing TSF, tailings recovery and relocation equipment will be utilised. This equipment will include a combination of dredges (or similar), pumps, pipelines and associated power and control infrastructure. Tailings thickening equipment may also be utilised to improve efficiency of the tailings pumping and emplacement processes. Tailings recovered from the TSF will be pumped to the Main Pit in-pit TSF for storage. Over the life of the mine, alternative strategies may be employed in response to technological advances.

Fine coal contained in the tailings proposed to be recovered from the TSF may be extracted from the tailings subject to the quality and particle size distribution characteristics of the tailings. Should sufficient fine coal be recoverable from the tailings being relocated, additional fine coal recovery processes may be installed to further maximise efficiencies. These additional fine coal recovery processes may include cyclones, spirals or other suitable processes designed specifically to suit the characteristics of the fine coal being recovered or reprocessed. Any reprocessed coal extracted from tailings would form part of the 20 Mt of product coal approved from the BCC, and not included in the Bulga Surface Operations annual limit of ROM coal mined.

3.1.5.3 Ongoing Rejects and Tailings Management

The Proposed Modification will result in production of fine tailings and coarse reject from the processing of the additional ROM coal resource. Tailings produced from the processing of the additional ROM coal will be stored in accordance with the revised tailings strategy outlined in **Section 3.1.5.1**.

The residual tailings will be pumped to the Main Pit in-pit TSF where further water extraction and thickening processes can be utilised if the tailings characteristics are suitable. The mine also disposes of fine fraction tailings via disposal to the Main Pit in-pit TSF as paste thickened reject. Paste thickened tailings (i.e. reduced water content) may also be co-disposed with coarse reject in the overburden emplacement areas.

3.1.6 Other Infrastructure

To accommodate the Proposed Modification, some additional changes will be required to the Bulga Surface Operations infrastructure, including:

- relocation or demolition of existing open cut mining infrastructure
- changes to the water management infrastructure
- associated power supply and control systems
- continued use of the temporary MIA known as the East Pit Muster Area
- use of the underground infrastructure, including the underground overland conveyor to transport open cut coal
- access roads.

BCM are proposing to upgrade the existing BOP MIA as part of the BOP SSD 4960 Proposed Modification 3 to accommodate future needs. The upgrade will be located within the MIA and Office Upgrade Area approved under BOP SSD 4960 (refer to **Figure 3.7**). Additional office buildings and workshops will be constructed to house administrative staff and service the Bulga Surface Operations and Bulga Underground Operations. Buildings will be constructed to relevant design standards.

A light vehicle workshop and fuel and oil storage facility will also be relocated to accommodate the BOP SSD 4960 Proposed Modification 3 (refer to **Figure 3.8**). The replacement workshop and fuel and oil storage facility will be located within the BOP approved disturbance area.

3.1.7 Water Management Infrastructure

As part of the BOP, significant upgrades to the BCC integrated WMS were completed to accommodate the future mining within the Project Area. Changes included:

- construction of fresh water diversion structures and sediment control structures
- construction of the Northern Dam
- modifications to the CHPP Surge Dam
- increases to the total maximum allowable discharge capacity from the site.

The existing integrated WMS has been designed to accommodate the approved mine plan. The BOP SSD 4960 Proposed Modification 3 will result in relatively minor changes including the removal of some of the existing water storage facilities, a minor increase to the mining area catchment, and construction of new water management facilities.

The proposed mining operations, including changes to emplacement areas and infrastructure changes, will result in changes to the site surface water catchments. This will require modification of fresh water diversion structures and sediment control structures to manage runoff and to minimise the impacts of erosion from disturbed areas.

The changes to the water management system are discussed further in **Section 6.7**.



Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2017)

0 100 250 500m
1:10 000

Legend

- Project Area
- Approved MIA and Office Upgrades (2014)
- Infrastructure Upgrade Area

FIGURE 3.7

Bulga Surface Operations MIA and CHPP Area Upgrades (Indicative Plan)

File Name (A4): R03/4100_111.dgn
20190606 14.47

3.1.8 Additional Disturbance Area

The approved disturbance area for BOP is 3,786 ha, as shown in **Figure 3.9**.

The BOP SSD 4960 Proposed Modification 3 is seeking approval for additional disturbance of 20.2 ha to accommodate the proposed extension of mining, referred to as the additional disturbance area. The additional disturbance area is a disconnected island of vegetation located within the currently approved disturbance area.

The proposed additional disturbance area is shown on **Figure 3.9**. The additional disturbance area is a minor increase in the context of the approved disturbance area.

3.1.9 Operational Workforce and Hours of Operation

The Proposed Modification does not propose any changes to the approved employee numbers of approximately 700 at the Bulga Surface Operations. The Bulga Underground Operations has approval for approximately 530 employees, providing for a total of 1230 employees at the BCC.

While the Bulga Underground Operations are currently suspended, there is an ongoing workforce required to maintain underground facilities and supporting services such as gas drainage, electrical systems and water management systems, as well as employees required for shared infrastructure such as the operation of the CHPP, train loading facilities, offices, stores, etc. As a result, the number of employees at the BCC, covering open cut operations and the suspended operations at the Bulga Underground Operations will be less than 1230 at any one time.

The proposed mining operations will be undertaken 24 hours per day, seven days per week. Consistent with existing operations at the BCC, blasting will be restricted to 9.00 am to 5.00 pm Monday to Saturday inclusive, except where approved otherwise by the Secretary.

3.2 Bulga Underground DA 376-8-2003 Proposed Modification 7

Bulga Underground Operation infrastructure will be relocated to accommodate the extension of open cut mining as part of the Proposed Modification. The Proposed Modification will not preclude the ongoing use of the CHPP and train loading facilities for the future beneficiation and transportation of coal from the Bulga Underground Operations. DA 376-8-2003 Proposed Modification 7 relates only to those items outlined in **Sections 3.2.1** to **3.2.4** below.

DA 376-8-2003 Proposed Modification 7 generally includes:

- demolition and relocation of the Bulga Underground Operations MIA
- allowance for the relocation of underground mine ventilation, as required
- relocation of the Gas Power Generation Plant and Gas Flare Station
- relocation of the Bulga Underground Operations electrical substation
- upgrading, relocation, construction and decommissioning of mine owned power transmission lines and associated access tracks.

A comparison between the approved development under the Bulga Underground DA 376-8-2003 and the Proposed Modification 7 is provided in **Table 3.3**. **Section 3.2** provides further details of the aspects of the Proposed Modification which differ to the approved development.

Table 3.3 Comparison of the Bulga Underground DA 376-8-2003 and Proposed Modification

Key Project Component	Approved Development (DA 376-8-2003)	Proposed Modification 7
Extraction rate limit	Extraction limit of 14 Mtpa of ROM coal per year	No change
Total Recoverable Resource (ROM)	212 Mt (per Modification 3)	No change
Project life	Mining operations until 23 February 2031	No change
Project boundary / Schedule of Lands	Per DA 376-8-2003 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim
Underground Access	Various portal and adit entries to seams exposed through the Bulga open cut, drift access to Blakefield South workings, service bores for materials	No change
Ventilation	Ventilation through upcast and downcast shafts, drifts and/or portals	No change
Mining Areas	Underground extraction of coal from the Whybrow, Blakefield, Woodlands Hill and Glen Munroe Seams in accordance with an approved Extraction Plan	No change
Mining Method	First workings development and longwall extraction	No change
Key Infrastructure	• workshop and stores • offices • car parking • bathhouse • ventilation shafts • gas extraction and management infrastructure • gas fired power generation plant	Relocation of mine owned ancillary infrastructure (power lines, electrical sub-station, etc) Relocation of the gas fired power generator, associated infrastructure and underground equipment surface storage area
Surface Disturbance	Total of around 34 ha approved for disturbance	No additional disturbance area required
Operational Workforce	530 full time employees at BUO including the CHPP.	No change

3.2.1 Underground Mining Infrastructure Area

The Bulga Underground Operations administration buildings and workshop will be demolished to accommodate the proposed mining operations. To allow for potential ongoing operation of the approved Bulga Underground Operations under DA 376-8-2003, a new MIA site will be required. The key elements of the proposed new MIA will include:

- workshop and stores
- offices

- car parking
- bathhouse
- Ancillary infrastructure and services as required

The proposed MIA facilities will be relocated to within the approved disturbance area and will require the augmentation of existing ancillary services such as power, water supply, waste systems and telecommunications facilities. BCM will consult with relevant service providers where required during detailed design and construction of the proposed infrastructure facilities.

3.2.2 Underground Access and Ventilation Infrastructure

To allow for future access and ventilation of the Bulga Underground Operations, new entries and ventilation site may be required. Options for the location of in-pit underground mine entries are approved in the existing Bulga Underground Consent (DA 376-8-2003) and in Bulga Optimisation Project SSD 4960. Alterations to the location of underground mine ventilation infrastructure were also approved in the SSD 4960 development consent providing a combination of in-pit access via the open cut mining area, and out-of-pit locations for ventilation and service bores. Further changes to the underground mine ventilation system will be required as a result of the Proposed Modification.

Auxiliary ventilation and/or access infrastructure may also be required to be established within the open cut mining area in the future when access to a suitable location can be coordinated with the progress of the open cut operations. This approach is consistent with the in-pit infrastructure and access arrangement originally assessed and approved in the Bulga Underground Mine DA 376-8-2003 approved in 2004. No changes to the approved accesses are proposed as part of the Proposed Modification, however future access to the underground mine will be assessed as required, and modifications to DA 376-8-2003 will be sought if required.

The Proposed Modification does not preclude the ability to access approved underground mining resources in the future.

3.2.3 Gas Fired Power Generator and Flare Infrastructure

The Bulga Underground Operations operate an approved gas fired power generation plant, gas flares, goaf plant, associated pipelines, water extraction bores and ancillary service infrastructure to manage the methane production from gas drainage. It is proposed to relocate the existing gas fired power generation plant, flare installation and associated infrastructure as part of DA 376-8-2003 Proposed Modification 7 to accommodate the proposed extension of the open cut operations. Disturbance required for the relocation of the gas fired power generation plant, gas flare installation and associated infrastructure will be managed in accordance with the Bulga Underground Consent (DA 376-8-2003) approved disturbance area. The locations of the existing and proposed gas fired power generation plant are shown on **Figure 3.8**.

3.2.4 Ancillary Infrastructure and Services

Other ancillary infrastructure and services required to support future underground mining activities may require relocation to accommodate the Proposed Modification. The relocation of any ancillary infrastructure or services required will be constructed within the approved disturbance area and/or follow existing road alignments where possible to reduce the vegetation disturbance associated with the clearing required along the transmission line easement for safety purposes.

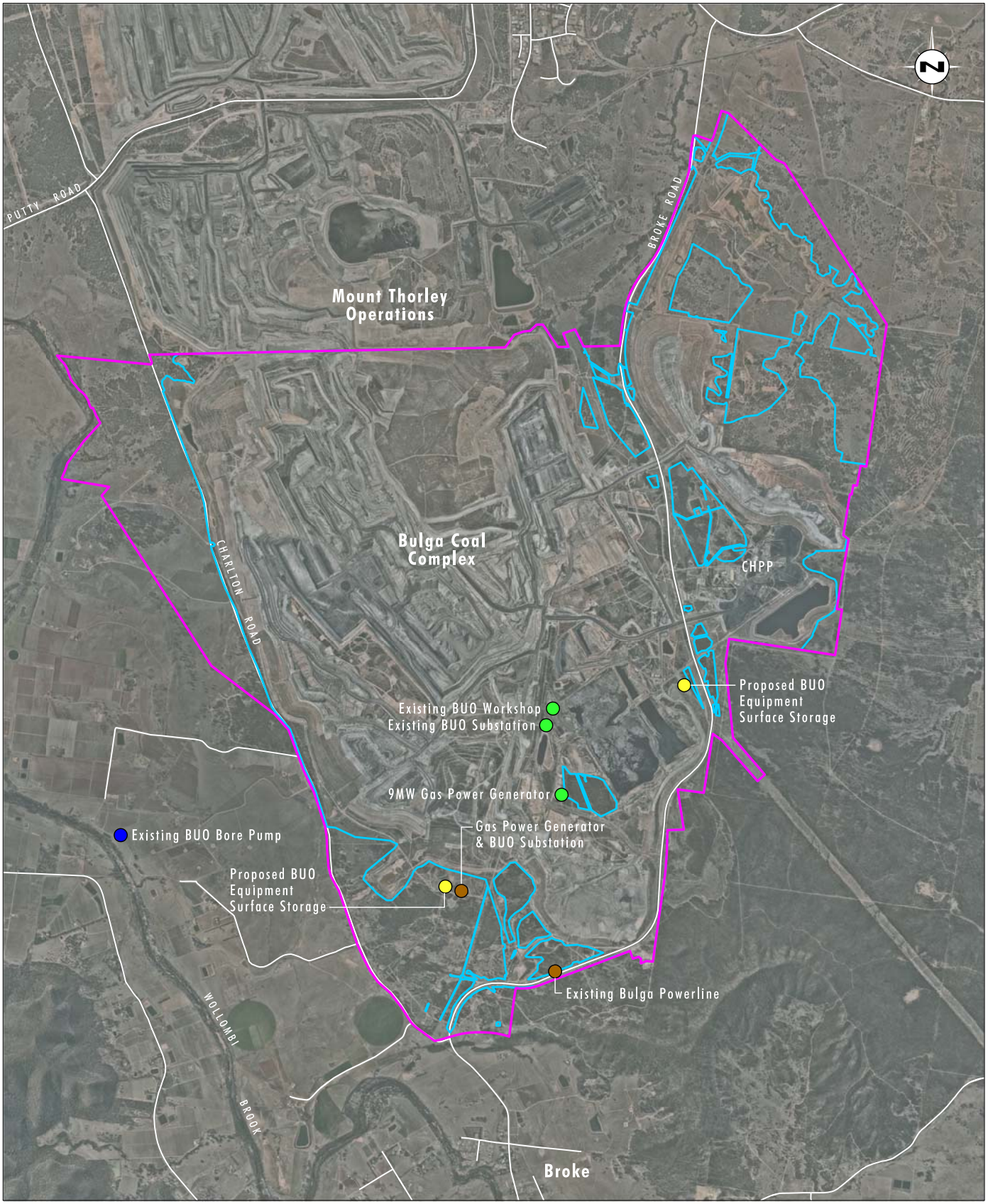


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2017)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Current Disturbance Footprint - BOP (SSD 4960)
- New Facility
- Existing Facility to be Demolished
- Relocated Facility
- Existing Facility Proposed to be Upgraded

FIGURE 3.8

Bulga Underground (DA 376-8-2003)
Modification 7
Infrastructure Relocations and Upgrades

File Name (A4): R03/4100_062.dgn
20190905 13.35

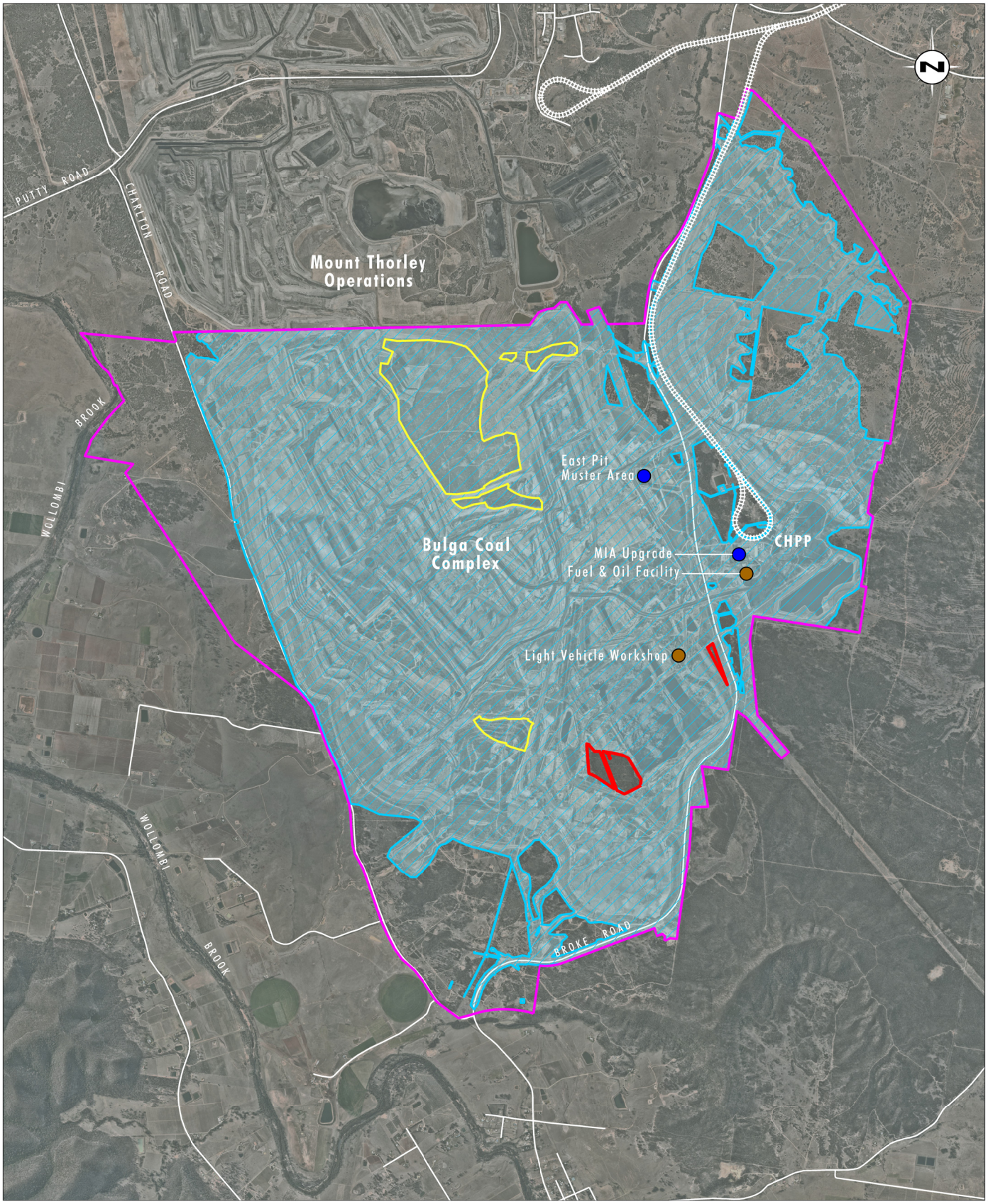


Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2017)

0 1 2 3km
1:60 000

Legend

- Project Area
- Current Disturbance Area
- Additional Disturbance Area
- Rehabilitation Re-disturbance Area
- Relocated Facility
- Existing facility Proposed to be Upgraded

FIGURE 3.9

Bulga Optimisation Project (SSD 4960)
Proposed Modification 3
Infrastructure Changes and Additional Disturbance Area

File Name (A4): R03/4100_081.dgn
20190904 14.34

4.0 Stakeholder Engagement

To support BCM's aim of designing and developing a project to coexist with the local community and surrounding land uses, BCM implemented a comprehensive stakeholder engagement and SIA program for the BOP. BCM's aim for the BOP engagement program was to:

- inform and involve stakeholders during the development of the project design
- identify key issues of interest or concern
- work together with stakeholders to mitigate or address those issues.

The key perceived issues identified during the initial phases of the BOP consultation program included:

- air quality
- noise
- visual impacts
- community sustainability
- vibration from blasting
- general environmental issues.

BCM worked with the community to develop a project which seeks to coexist with the local community and built on the existing engagement program and relationships with the community. The BOP team considered community feedback in refining the project design, with some key elements of the BOP being amended to address issues. This included:

- alternative mine designs were not progressed by BCM due to the potential impacts of air quality and noise in Broke, Milbrodale and Bulga. This included not progressing alternatives that advanced open cut coal extraction to Charlton Road and looked at opportunities and options for mining to the east and deeper seams
- the BOP proposed the development of the Noise and Visual Bund. This feature was designed to mitigate noise emissions resulting in the reduction of noise impacts in the nearby villages and rural residences over time and shield the view of the operations for a number of sensitive receivers
- the BOP was designed to progressively move away from Bulga village over the life of the project, and progressively rehabilitate the north and western extents of the Project Area early in the project. This results in the predicted reduction of visual and dust impacts from the BOP in this area over the life of the development
- implementation of a range of controls and monitoring to mitigate potential impacts.

The Proposed Modification aims to build from the project design and management commitments made as part of the BOP. BCM has sought to minimise additional environmental and social impacts as part of the design of the Proposed Modification, including commitments to meeting existing noise and air quality criteria.

4.1 Community Consultation

BCM has an ongoing community engagement program which includes regular engagement with both individuals and groups from the local and regional communities via a range of mechanisms including:

- regular newsletters to update the community on operations and BCM initiatives
- face to face meetings with individuals and/or groups as required/requested, including any meetings required in response to complaints
- community BBQs as an alternative mechanism to provide updates regarding operations and BCM initiatives, providing the opportunity for real time feedback from the community and to further strengthen relationships between the community and operations staff
- regular meetings (two per year) with the BCC Community Consultative Committee (CCC). The CCC is made up of four community representatives (one position is currently vacant), one Singleton Shire Council representative and BCM representatives.

A comprehensive stakeholder engagement program was undertaken by BCM and Umwelt specifically in relation to the Proposed Modification as outlined in **Table 4.1**. The stakeholder engagement program for the Proposed Modification utilised many of the existing BCC consultation mechanisms in addition to specific activities focused on the Proposed Modification, as outlined below:

Table 4.1 Community Consultation

Activity	Date	Details
Bulga Open Cut Development Consent Modification - Community Newsletter	9 November 2017	Overview of the Proposed Modification was distributed via a double-sided A4 insert outlining the proposal, the environmental assessment requirements and expected timeframes Contact details for mine personnel provided Newsletter letterbox dropped to all households in Broke, Milbrodale and Bulga and mailed to the newsletter mailing list Newsletter posted on the home page of the Bulga Coal website
CCC meeting	19 October 2017	Initial briefing on the Proposed Modification
Community BBQ	7 and 9 November 2017	Initial briefing on the Proposed Modification
Meeting – Hunter Valley Protection Alliance	17 November 2017	Initial briefing on the Proposed Modification
CCC meeting	9 May 2018	Update on the Proposed Modification
CCC meeting	17 October 2018	Update on the Proposed Modification
Community BBQ	30 October and 1 November 2018	Provided update on the Proposed Modification and included a community survey as part of SIA for Proposed Modification.
Community BBQ	27 and 28 March 2019	Provided an update on the Proposed Modification including a summary of results

Activity	Date	Details
Face to Face with local stakeholders (Broke, Bulga, Milbrodale etc.)	April/May 2019	Provided individualised update on the Proposed Modification with particular attention to stakeholder location and concerns
Community Information Session (Broke Hall)	15 May 2019	Introduced stakeholders to the Proposed Modification, provided studies update on the Proposed Modification and approval process
Phone interviews with potentially impacted residents in close proximity	May 2019	Umwelt conducted phone consultation with six residents in closest proximity to BCM's existing operations, to better understand perceptions relating to the Proposed Modification and mitigation measures currently in place.

Broader community consultation processes undertaken by Umwelt on behalf of Glencore and also integrated into the SIA include the 2018 community attitude survey and survey of indigenous groups and service providers in 2019.

4.2 Government Consultation

BCM has also undertaken a range of Government consultation related to the Proposed Modification as detailed in **Table 4.2** below.

Table 4.2 Government Consultation

Agency	Date	Activity	Details
DPE	29 September 2017	Meeting	Discussion regarding the Proposed Modification and the approval pathway.
DPE	13 October 2017	Letter	BCM provided a letter to DPE outlining the Proposed Modification seeking confirmation of the proposed approval pathway and scope of technical studies.
DPE	16 October 2017	Letter	BCM provided a letter to DPE regarding the Biodiversity Assessment pathway for the Proposed Modification.
DRG	18 October 2017	Meeting	BCM introduced Proposed Modification to DRG.
DPE	4 December 2017	Letter	Letter sent to DPE Compliance Officer introducing the Proposed Modification.
DPE	15 December 2017	Letter	BCM received a letter from DPE indicating that DPE was satisfied that BCM had undertaken substantial environmental assessment prior to the commencement of the new *Biodiversity Conservation Act 2016* and could therefore continue to undertake the assessment under the former biodiversity framework.
Department of Defence (Defence)	1 March 2018	Letter	Introduced Proposed Modification and aspects of studies that would impact Defence land.

Agency	Date	Activity	Details
Singleton Shire Council	20 March 2018	Meeting	Discussed Proposed Modification and studies also discussed offset strategy.
OEH	7 June 2018	Meeting	A meeting was held with OEH to present preliminary findings of the biodiversity assessment and confirm approach to offsetting for the Proposed Modification.
DoEE	3 July 2018	Meeting	Discussed Proposed Modification referral position and presented groundwater results and discussion to Office of Water.
DRG	12 July 2018	Conceptual Project Development Plan meeting	A meeting was held with representatives from the Division of Resources and Geoscience at BCC. The Conceptual Project Development Plan meeting aimed to demonstrate that the proposal is a responsible and sustainable mining development.
DSC	20 December 2018	Meeting	Introduction to the Proposed Modification and presentation on the TSF for consideration as part of the approval process.
DPE	10 January 2019	Meeting	Provided update on Proposed Modification SEE and assessments.
Singleton Shire Council	5 April 2019	Meeting	Provided update on the Proposed Modification including summary of results to Singleton Shire Council Planning Department.
Singleton Shire Council	16 April 2019	Meeting	Provided update of Proposed Modification including a summary of results with a focus on water to the Singleton Shire Council Water Resources Department.
DPE	27 May 2019	Meeting	An update on the Proposed Modification presented to DPE (Sydney).
Singleton Shire Council – Councillors	3 June 2019	Meeting	Provided overview of the Proposed Modification and summary of assessment results.

4.3 Aboriginal Community Consultation

Aboriginal community consultation has followed the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*. In the evaluation of the cultural values of the additional disturbance area for the Proposed Modification, the assessment has also utilised the extensive consultation for the BOP that includes the landforms of the Project Area.

The consultation for the ACHA for the Proposed Modification was undertaken with 56 individuals/groups who are regarded as Registered Aboriginal Parties (RAP). Further discussion regarding the consultation process with the RAP for the Project is included in **Section 4.3.1**.

In addition, as outlined in **Section 6.13.4**, to further inform the SIA, interviews were also undertaken with local indigenous groups in the Upper Hunter across the Singleton and Muswellbrook local government areas (LGA). A total of 15 indigenous stakeholders participated in the interview process that held representative roles in Aboriginal service provision in Government, NGOs and the private sector. This included representatives from Hunter New England Health (HNEH), Hunter Valley Aboriginal Corporation and the NSW Indigenous Chamber of Commerce as well as other more locally based group representatives and service providers. Further details are provided in **Section 6.13.4**.

4.3.1 Previous Aboriginal Cultural Heritage Assessments

As an outcome of the extensive consultation for BOP, the Aboriginal stakeholders identified the BOP Project Area to be of high social, cultural and spiritual significance, because it has spiritual and ceremonial associations to highly significant sacred creation and ceremonial places located within the region. The BOP Project Area contains a number of specific archaeological sites of high cultural significance.

Consultation for the BOP was undertaken in accordance with OEH Guidelines and involved:

- identification and RAP with an interest in BOP
- information provided to all RAP including field visits
- development of a methodology for the assessment of Aboriginal cultural heritage in the BOP Project Area that included a consultation framework and consultation protocols
- Archaeological surveys undertaken with RAP including discussion of cultural significance values, and to identify management measures, care and control arrangements and intergenerational equity suggestions
- Agreed management measures, care and control arrangements and intergenerational equity proposals were presented to the RAP and comments on their content sought
- RAP reviewed and commented on the BOP ACHA report and Archaeological values assessment report.

5.0 Planning Considerations

This section discusses the application of the various Commonwealth and State environmental and planning legislation and policies that are relevant to the Proposed Modification.

5.1 Commonwealth Legislation

The EPBC Act is the primary environmental and planning regulatory instrument relevant to the Proposed Modification at a Commonwealth level. The operation of the EPBC Act and its application to the Proposed Modification is discussed in **Section 5.1.1** below.

The *Native Title Act 1993* is not directly relevant to the approval process for the Proposed Modification. The *Native Title Act 1993* has potential implications for the granting of mining leases under the *Mining Act 1992* where native title has not been extinguished within the lease application area. No new mining leases are required for the Proposed Modification.

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

Under the EPBC Act, approval from the Commonwealth Minister for Environment is required for any action that may have a significant impact on Matters of National Environmental Significance (MNES).

MNES are identified in the following categories:

- World Heritage Properties
- National Heritage Places
- Wetlands of International Importance (listed under the Ramsar Convention)
- Threatened Species and Ecological Communities
- Migratory species protected under international agreements
- Nuclear Actions (including uranium mines)
- The Great Barrier Reef Marine Park
- Commonwealth land, marine areas and reserves
- A water resource, in relation to a coal seam gas development and large coal mining development.

If an 'activity' is likely to have a significant impact on a MNES then it may be a 'controlled action' and require approval from the Commonwealth Minister for the Environment. To obtain approval from the Minister, a proposed action must be referred to the Minister via the Commonwealth DoEE. The purpose of a referral is to enable the Minister to decide whether the proposed action will need assessment and approval under the EPBC Act.

BCM currently operates under two EPBC approvals 2002/773 and 2012/6637. The EPBC Act approval relevant to the Bulga Surface Operations is EPBC 2012/6637. The components of the Project Modification that are not covered under EPBC 2012/6637 have been referred under the EPBC Act. The referral specifically covers:

- extension of mining areas to the south east and west by to access an additional 63 Mt of coal within the proposed extension area
- additional disturbance of 20.2 ha to accommodate the proposed extension of the mining areas to the south east and west within the proposed extension area
- accessing deeper resources beneath part of the currently approved open cut.

On 17 December 2018, the Proposed Modification, as referred under the EPBC Act, was determined to be a controlled action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on the following MNES:

- Central Hunter Eucalypt Forest and Woodland – Critically Endangered
- Regent Honeyeater (*Anthochaera Phrygia*) – Critically Endangered
- Swift Parrot (*Lathamus discolour*) – Critically Endangered
- a water resource, in relation to coal seam gas development and large coal mining development.

A copy of the determination of the controlled action is provided in **Appendix 2**. The assessment path for the Proposed Modification is under the bilateral agreement between the Commonwealth and NSW Governments and DoEE has issued its assessment requirements (refer to **Table 5.1**). This SEE addresses the assessment requirements, with a summary of the assessment findings related to MNES is included in **Section 7.0**.

Table 5.1 DoEE Assessment Requirements

Requirement	Relevant SEE Section
On 17 December 2018, a delegate of the Federal Minister for the Environment and Energy determined that the above project is a controlled action under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act controlling provisions for the proposed action are: i. listed threatened species and communities (sections 18 and 18A); and ii. a water resource, in relation to coal seam gas development and large coal mining development (section 24D and section 24E). The delegate also confirmed that the proposed action will be assessed under the State's accredited assessment process under Part 4 of the *NSW Environmental Planning and Assessment Act 1979* in accordance with the bilateral agreement between the two governments. These guidelines provide specific information on MNES environmental assessment requirements.	

Requirement	Relevant SEE Section
The Applicant must undertake an assessment of all protected matters that may be impacted by the development under the controlling provisions identified in paragraph 1. The Commonwealth Department of the Environment and Energy (DoEE) considers that there is likely to be a significant impact on the following: i. listed threatened species and communities (sections 18 and 18A); a) Central Hunter Valley Eucalypt Forest and Woodland - Critically Endangered; b) Regent Honeyeater (Anthochaera phrygia) – Critically Endangered; and c) Swift Parrot (Lathamus discolor) - Critically Endangered; and ii. a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).	
The Applicant must consider each of the protected matters under the triggered controlling provisions that may be impacted by the action. Note that this may not be a complete list and it is the responsibility of the Applicant to undertake an analysis of the relevant impacts and ensure all protected matters that are likely to be impacted are assessed for the Commonwealth Minister's consideration.	
General Requirements	
The Statement of Environmental Effects (SEE) must address the matters outlined in Schedule 4 of the EPBC Regulations and the matters outlined below in relation to the controlling provisions.	Refer to SEE
The title of the action, background to the action of the action and current status.	Refer to **Sections 1.0**, **2.0** and **3.0**
The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Refer to **Section 3.0**
How the action relates to any other actions that have been, or are being taken in the region affected by the action.	Refer to **Sections 1.0**, **2.0** and **3.0**
How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	Refer to **Section 3.0**
The SEE must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including: i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts; ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; iii. analysis of the significance of the relevant impacts; and iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Refer to **Sections 7.2.1**, **7.2.2** and **Appendix 8**

Requirement	Relevant SEE Section
For each of the relevant matters protected that are likely to be significantly impacted by the action, the SEE must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: i. a description, and an assessment of the expected or predicted effectiveness of the mitigation measures, ii. any statutory policy basis for the mitigation measures; iii. the cost of the mitigation measures; iv. an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; v. the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Refer to **Sections 7.2.2**, **6.6** and **6.7**
Where a significant residual adverse impact to a relevant protected matter is considered likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	Refer to **Section 7.2.4**
For each of the relevant matters likely to be impacted by the action the SEE must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: i. conservation advice or recovery plan for the species or community, ii. relevant threat abatement plan for a process that threatens the species or community iii. wildlife conservation plan for the species iv. any strategic assessment. [Note: the relevant guidelines and policy statements for each species and community are available from the Department of the Environment Species Profiles and Threats Database http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl]	Refer to **Section 7.2**
Biodiversity (threatened species and communities and migratory species)	
The removal of 16.4 ha of EPBC Act listed Central Hunter Valley Eucalypt Forest and Woodland will result in a reduction in the amount of this ecological community and a reduction in foraging habitat for the EPBC Act listed Regent Honeyeater and Swift Parrot.	Noted
For each of the EPBC Act listed species predicted to occur in the project site, and each of the EPBC Act listed ecological communities likely to be significantly impacted, the SEE must provide: a. survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements and/or the NSW Framework for Biodiversity Assessment (FBA); b. a description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices and recovery plans, threat abatement plans and wildlife conservation plans; and	Refer to Sections 2.0 and 3.0 of **Appendix 8** Refer to **Section 7.2.1** and Appendix E of **Appendix 8**

Requirement	Relevant SEE Section
c. maps displaying the above information (specific to each EPBC protected matter) overlaid with the proposed action. [Note - it is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the FBA as the basis for identifying EPBC Act-listed species and communities. The SEE must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act listed species or community and provide individual maps for each species or community.]	Refer to **Figures 6.4** and **6.5**
The SEE must describe the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act listed species and communities. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act listed species or community.	Refer to **Section 7.2.2** and **Appendix 8**
For each of the EPBC Act listed species and communities likely to be impacted by the development, the SEE must provide information on proposed avoidance and mitigation measures to deal with the impacts of the action, and a description of the predicted effectiveness and outcomes that the avoidance and mitigation measures will achieve.	Refer to **Section 7.2.3** and **Appendix 8**
The SEE must identify each EPBC Act listed species and community likely to be significantly impacted by the proposed action. Where a significant impact is likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit, how offsets will be secured, and timing of protection. [Note - not all of the offset options under the *NSW Biodiversity Conservation Act 2016* are endorsed under the EPBC Act for approval purposes. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same EEC or habitat being impacted, or funding to provide a direct benefit to the matter being impacted i.e. threat abatement, breeding and propagation programs or other relevant conservation measures.]	Refer to **Section 7.2.4** and **Appendix 8**
Water resource, in relation to coal seam gas development and large coal mining development	
The Applicant provided hydrological information that is insufficient for an adequate assessment of the impacts of the proposed action on a water resource. DoEE understands that the Applicant has commissioned detailed groundwater modelling specifically for the proposed modification to the Bulga Optimisation Project. This modelling will be available in late January 2019 and should allow a detailed assessment of the potential impacts on the proposed action on groundwater at, and in the vicinity of the site, to be undertaken.	Refer to **Section 6.7**, **Appendices 9** and **11**
The SEE must provide a description of the location, extent and ecological characteristics and values of the identified water resource potentially affected by the project.	Refer to **Appendix 11**
The assessment of impacts should include information on: i. any substantial and measurable changes to the hydrological regime of the water resource, for example a substantial change to the volume, timing, duration or frequency of ground and surface water flows; ii. the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected; and iii. substantial and measurable change in the water quality and quantity of the water resource— for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland; or water temperature that may adversely impact on biodiversity, ecological integrity, social amenity or human health.	Refer to **Section 6.7**, **Appendices 8**, **9** and **11**
The SEE should specifically consider potential impacts on private groundwater users, groundwater and surface water quality, groundwater dependent ecosystems, surface water catchments, surface water flows and flooding and water licencing arrangements. In particular, consideration must be given to potential impacts on Wollombi Brook, Loders Creek and the Hunter River.	Refer to **Section 6.7**, **Appendices 9** and **11**

Requirement	Relevant SEE Section
The SEE must provide adequate information to allow the project to be reviewed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, as outlined in the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC, October 2015).	Refer to **Section 6.7**, **Appendices 9** and **11**
Other approvals and conditions	
Information in relation to any other approvals or conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations 2000.	Refer to **Section 5.0**
Environmental Record of person proposing to take the action	
Information in relation to the environmental record of a person proposing to take the action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.	Refer to **Section 7.4**
Information Sources	
For information given in a SEE, the SEE must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	References are provided in **Section 10.0**

5.2 New South Wales Legislation

5.2.1 Environmental Planning and Assessment Act 1979

It is proposed to modify SSD 4960 and DA 376-8-2003 pursuant to Section 4.55(2) (previously Section 96(2)) of the EP&A Act. As a State Significant Development (SSD), the Independent Planning Commission (IPC) will be the consent authority.

Modifications sought under section 4.55(2) must be substantially the same development for which the original consent was granted. The Proposed Modification is considered to be substantially the same development as that approved under SSD 4960 and DA 376-8-2003 as:

- the overall nature of the development remains unchanged
- there is no proposed change in annual production rates
- the majority of the key project components remain unchanged from that which is currently approved, as outlined in **Table 3.1**
- as outlined in **Section 6.0** there are no substantive changes to environmental impacts. The Proposed Modification can be undertaken in accordance with the approved environmental impact criteria contained in the current SSD 4960 and DA 376-8-2003.

Furthermore, consultation with DPE confirmed that section 4.55(2) of the EP&A Act is the appropriate approval pathway for the Proposed Modification (refer to correspondence from DPE in **Appendix 3**).

Permissibility

The Bulga Surface Operations, including the additional land subject to the Proposed Modification, are located wholly within the area to which the *Singleton Local Environmental Plan 2013* (LEP) applies. The land on which the revised mine plan is located is zoned RU1 – Primary Production and in accordance with the Singleton LEP, open cut mining is permissible with consent.

5.2.1.1 Assessment Requirements

Under section 4.55(3) of the EP&A Act in determining an application for the modification of development consent, the consent authority must take into consideration such of the matters referred to in section 4.15(1) as of relevance to the development the subject of the application. These matters for consideration by the consent authority and the sections where they are addressed in this SEE are provided in **Table 5.2**. **Section 6.0** includes an assessment of relevant environmental impacts associated with the Proposed Modification to determine the level of assessment completed to support the SEE.

Table 5.2 Section 4.15 Matters for Consideration

Matters for Consideration	Relevant SEE Section
(i) any environmental planning instrument	**Section 5.2.2**
(ii) any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Secretary has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and	**Section 5.2.2**
(iii) any development control plan,	Not Applicable based on SSD provisions
(iiia) any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under section 7.4	**Section 6.0**
(iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph),	Not applicable
(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality	**Section 6.0**
(c) the suitability of the site for the development,	**Sections 1.4** , **6.0** and **9.2**
(d) any submissions made in accordance with this Act or the regulations	N/A
(e) the public interest	**Sections 4.0** and **6.0**

This SEE has also been prepared in consideration of the factors identified in Section 4.55 of the EP&A Act and Clause 115 of the *Environmental Planning & Assessment* (EP&A) *Regulation*.

5.2.2 Environmental Planning Instruments

The environmental planning instruments applicable to the Proposed Modification are discussed in the following section.

5.2.2.1 Singleton Local Environmental Plan 2013

The Proposed Modification is located within the Singleton LGA and is subject to the Singleton LEP 2013. As discussed in **Section5.2.1,** the Proposed Modification is within the RU1 Primary Production zone. The objectives of this zone are as follows:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

The Proposed Modification is considered to be consistent with the objectives of the Primary Production zoning through its:

- focus on maximising resource extraction efficiency and optimising the use of existing mining infrastructure
- avoidance of future possible sterilisation of the coal resource.

5.2.2.2 State Environmental Planning Policies

The following State Environmental Planning Policies (SEPP) are relevant to the consideration of the Proposed Modification.

State Environmental Planning Policy (State and Regional Development) 2011

The *State and Regional Development SEPP* (SRD SEPP) identifies development to which the SSD assessment and determination process under Part 4 of the EP&A Act applies. The Proposed Modification is for the purpose of coal mining and is SSD as defined by the provisions of the SRD SEPP and requires development consent under Part 4 of the EP&A Act.

The Independent Planning Commission is the consent authority for SSD where certain objections and disclosures referred to in subclause 8A (1) of the SRD SEPP are made in respect to an application. For SSD where such objections and disclosures are not made the Minister for Planning is the consent authority (section 4.5(a) of the EP&A Act).

State Environmental Planning Policy – Mining, Petroleum Production and Extractive Industries

State Environmental Planning Policy – (Mining, Petroleum Production and Extractive Industries) (the Mining SEPP) regulates the permissibility and assessment requirements for mining, petroleum production and extractive industries and related development.

Part 3 of the Mining SEPP requires specific matters to be considered in relation to development applications for mining development or applications that will affect existing or proposed mining operations. Clause 12AB of the Mining SEPP identifies non-discretionary development standards for mining and provides that the consent authority cannot impose more onerous standards in any approval in relation to the matters covered by the development standard. The prescribed criteria are summarised in **Table 5.3** with the relevant assessment outcomes noted for each criteria.

Table 5.3 Non-discretionary development standards for mining under the Mining SEPP

Matter	Non-discretionary Standard	Assessment Outcomes
Cumulative noise level	The development does not result in a cumulative amenity noise level greater than the acceptable noise levels, as determined in accordance with Table 2.2 of the Noise Policy for Industry, for residences that are private dwellings.	The cumulative noise impact assessment indicated that cumulative amenity noise levels are predicted to exceed acceptable levels at one receptor in the Mount Thorley area, consistent with the approved operational noise criteria. This receptor has acquisition rights with MTW, which was primarily responsible for the predicted cumulative noise level.

Matter	Non-discretionary Standard	Assessment Outcomes
Cumulative air quality level	The development does not result in a cumulative annual average level greater than 25 µg/m³ of PM_{10} for private dwellings.	Detailed air quality modelling found that one property is predicted to experience cumulative annual PM_{10} concentrations that exceed 25 µg/m³ in 2022, 2026 and 2031. It is noted that the exceedance is due to the change in criteria rather than an increase to predicted impacts. It is anticipated that this property would be entitled to mitigation and acquisition rights.
Airblast overpressure	Airblast overpressure caused by the development does not exceed: 120 dB (Lin Peak) at any time, and 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	The blast assessment found that airblast overpressure exposure can be managed effectively to ensure that relevant criteria at all private residences and potentially sensitive receivers are not exceeded. Any impacts in excess of these criteria would be the subject of a negotiated agreement with the owner of the residence or sensitive receivers.
Ground vibration	Ground vibration caused by the development does not exceed: 10 mm/sec (peak particle velocity) at any time, and 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	Detailed blast assessment confirms that ground vibration levels can be managed effectively within the given criteria. The estimated maximum vibration exposure for the residences using proposed charge masses of 26 to 2,810 kg is in the order of 0.1 to 5.5 mm/s. To achieve vibration values below the specified criteria, lower charge masses will be used.
Aquifer interference	Any interference with an aquifer caused by the development does not exceed the respective water table, water pressure and water quality requirements specified for item 1 in columns 1, 2, 3 and 4 of Table 1 of the Aquifer Interference Policy for each relevant water source listed in column 1 of that Table.	Based on the groundwater modelling, predicted impacts associated with the Proposed Modification are considered less than the Level 1 minimal impact considerations.

Clause 12 of the Mining SEPP, extracted below, requires the consent authority to consider the compatibility of proposed mining developments with existing land uses in the area.

12 Compatibility of proposed mine, petroleum production or extractive industry with other land uses

Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must:

(a) consider:

(i) the existing uses and approved uses of land in the vicinity of the development;

(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

(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses.

(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii); and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).

The Project Area, in which the Proposed Modification is situated, is dominated by the existing mining operation, including the open cut mining area and associated infrastructure, along with areas of rehabilitated land and native vegetation.

The surrounding land use is largely dominated by other mining operations and the Proposed Modification has been designed with consideration of maintaining minimal environmental impact and compatibility with surrounding land uses. The compatibility of the approved operations and the Proposed Modification with the surrounding land uses is considered in more detail in **Sections 6.0** and **9.2**.

Clause 12A of the Mining SEPP, extracted below, requires the consent authority to have regard to the VLAMP.

12A Consideration of voluntary land acquisition and mitigation policy

(2) Before determining an application for consent for State significant development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider any applicable provisions of the voluntary land acquisition and mitigation policy and, in particular:

(a) any applicable provisions of the policy for the mitigation or avoidance of noise or particulate matter impacts outside the land on which the development is to be carried out, and

(b) any applicable provisions of the policy relating to the developer making an offer to acquire land affected by those impacts

It is considered that the air quality and noise impacts associated with the Proposed Modification are consistent with the approved operations. The relevant air quality criteria have changed since SSD 4960 was determined. As a result of the new air quality criteria, one additional residence (1A) may now be afforded acquisition rights under the VLAMP.

Clause 13 of the Mining SEPP requires the consent authority to consider the potential impact of proposed mining developments on other mining, petroleum production or extractive industry projects or potential resources. MTW adjoins the northern boundary of the Bulga open cut while the Wambo Mine is located approximately 9 km to the northwest. The geology in the Project Area is well understood and the mine design aims to optimise resource recovery and to minimise the potential sterilisation of known coal resources in the area, without adversely impacting on the adjoining mining operations.

The Proposed Modification will not adversely impact on the MTW mining operations. BCM will continue to consult with MTW regarding matters such as any interaction issues and management of cumulative impacts.

The Proposed Modification will not adversely impact on any other extractive industry operations or known extractive material resources.

Clause 14 of the Mining SEPP requires the consent authority to consider the impact of a proposed mining project on the natural resources and whether specific environmental management conditions (relating to water resources, biodiversity and greenhouse gas emissions) should be imposed on the development if approved. The Proposed Modification's potential impact on natural resources is dealt with in detail in **Section 6.0** (specifically, **Section 6.7** (water), **Section 6.6** (biodiversity) and **Section 6.5** (greenhouse gas)) and specific commitments regarding the management of potential environmental impacts are contained in **Section 8.0**.

Clause 14(3) of the Mining SEPP requires that the consent authority must consider any certification by OEH for measures to mitigate or offset the biodiversity impact of the Proposed Modification. As discussed in **Section 6.6**, the biodiversity impacts of the Proposed Modification are being assessed in accordance with the NSW Framework for Biodiversity Assessment (FBA). BCM (and its parent company Glencore) has had ongoing consultation with OEH regarding the approach to biodiversity assessment and offsetting for the Proposed Modification.

Clause 15 of the Mining SEPP requires the consent authority to have regard to the efficiency of a proposed mining development in terms of its ability to optimise extraction of the target resources. A key outcome of the Proposed Modification is the optimisation of the recovery of coal resources from within the existing lease areas held by BCM.

Clause 16 of the Mining SEPP requires the consent authority to consider whether or not the mining development under consideration should be subject to conditions restricting the use of public roads for product transport or other mining related traffic. All product coal from the Proposed Modification will be transported to markets by train.

Clause 17 of the Mining SEPP requires a consent authority determining a development application for a mining development to have regard to whether or not to impose specific conditions regarding the rehabilitation of land affected by the proposed mining development. The mining and overburden emplacement areas will be progressively rehabilitated as the operation progresses and the Project Area will be fully rehabilitated as part of the closure process following completion of mining. Progressive rehabilitation is discussed in further detail in **Sections 3.0** and **6.12**.

Gateway Process

Part 4AA of the Mining SEPP, together with Clause 50A of the EP&A Regulation, provides for the implementation of the NSW Government's Strategic Regional Land Use Plan (SRLUP). The gateway process applies for projects located within Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Clusters (CIC) (as defined by the regional mapping presented in the Upper Hunter SRLUP) outside of existing mining lease areas.

The Proposed Modification area is covered by appropriate existing mining lease areas and new mining leases are not required. As a result, the gateway process does not apply to the Proposed Modification.

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44)

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44) applies to the extent that Proposed Modification is in LGAs listed in the SEPP and a council is restricted from granting development consent for proposals on land identified as core koala habitat without the preparation of a plan of management. Singleton LGA is listed in Schedule 1 of the SEPP and therefore the SEPP needs to be considered in regard to the Proposed Modification.

A biodiversity assessment (refer to **Section 6.6**) has been conducted for the Proposed Modification. The Project Area, including the additional disturbance area, does not contain core koala habitat. Consequently, the requirement for preparation of a koala plan of management does not apply.

State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33)

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) requires a consent authority to consider whether an industrial development is a potentially hazardous industry or a potentially offensive industry. A hazard assessment is completed for potentially hazardous developments to assist the consent authority to determine acceptability.

The Proposed Modification does not constitute a hazardous or offensive development and accordingly a preliminary hazard analysis is not required.

State Environmental Planning Policy 55 – Remediation of Land (SEPP 55)

State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) aims to provide a state-wide planning approach to the remediation of contaminated land and to reduce the risk of harm to human health and the environment by consideration of contaminated land as part of the planning process. Under SEPP 55, a consent authority must not consent to the carrying out of development on land unless it has considered any potential contamination issues. A review of the contaminated land register undertaken for the SEE confirmed that there are no known or registered contamination sites with the additional disturbance area.

5.2.3 Approvals required under other State legislation

If the Proposed Modification is approved under Section 4.55(2) of the EP&A Act, the approvals outlined in **Table 5.4** will also be required.

Table 5.4 Environmental Approvals Required for the Proposed Modification

Act	Approval	Authority
Coal Mine Subsidence Compensation Act 20174	An approval under section 15 for development within a mine subsidence district.	Subsidence Advisory NSW
Mining Act 1992	All of the land on which mining and associated activities will occur is covered by a current mining lease and therefore no additional mining leases are required. An amendment to the Mining Operations Plan will also be required to be approved under this Act.	Department of Planning and Environment – Division of Resources and Geoscience (DRG)
Dams Safety Act 2015	The Dams Safety Act requires that Dam Safety NSW ensure that any risks that may arise in relation to dams (including any risks to public safety and to environmental and economic assets) are of a level that is acceptable to the community. Dams Safety NSW may, by order published in the Gazette, declare a dam or proposed dam to be a declared dam for the purposes of this Act. Any dams required to be constructed as part of the Proposed Modification will be subject to assessment in accordance with the Dam Safety NSW requirements to determine if any of these dams will be declared dams. Subject to the detailed design process, approvals under this Act may be required for water storage dams.	Dam Safety NSW

5.2.4 Relevant Strategic Policies

5.2.4.1 Upper Hunter Strategic Regional Land Use Plan 2012

The Upper Hunter SRLUP requires the assessment of impacts from mining and coal seam gas development on land identified as being strategic agricultural land. There are two types of strategic agricultural land identified in the Upper Hunter SRLUP, BSAL and CICs. The additional disturbance area is subject to an existing Mining Lease and no further mining leases are required in relation to the Proposed Modification, therefore no further assessment is required.

The Upper Hunter SRLUP also requires all development applications for mining development that is State Significant Development, and which would potentially impact on agricultural resources and industries, to be accompanied by an Agricultural Impact Statement (AIS). The additional disturbance area (20.2 ha) is wholly contained within the Project Area which was assessed as part of the BOP. It is therefore considered that the Proposed Modification will not have a significant impact on agricultural land uses relative to the approved operations and no further assessment is warranted.

5.2.4.2 NSW Aquifer Interference Policy

The AIP clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation, and establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The AIP requires that, where mining will result in a loss of water from an overlying source covered by a water sharing plan (WSP), a water access licence is required under the *Water Management Act 2000* (WM Act) to account for this loss of water. In addition, the AIP requires proponents of mining projects seeking development consent under Part 4 of the EP&A Act to provide estimates of all quantities of water likely to be taken from any water source during and following cessation of the activity, and all predicted impacts associated with the activity. Potential groundwater impacts associated with the Proposed Modification are discussed in **Section 6.7**.

The AIP requires that potential impacts of the Proposed Modification on groundwater sources, including groundwater users and groundwater dependent ecosystems (GDEs), be assessed against the minimal impact considerations. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable.

5.2.4.3 Dark Sky Planning Guideline

The Dark Sky Planning Guideline (DPE, 2016) is required to be considered for planning approval applications for State Significant Development within 200 km of the Siding Springs Observatory and is not required to be considered for planning approval applications within the Singleton Shire LGA. The Proposed Modification is not within 200 km of the Siding Springs Observatory.

6.0 Environmental Assessment

6.1 Agriculture, Soils and Land Capability

An AIS was undertaken for the BOP in 2013 (Umwelt, 2013) with the assessment presenting a focus on land and soil capability and physical resources. The previous assessment covered the entire BOP Project Area which includes the additional disturbance area required for this Proposed Modification.

6.1.1 Soil Landscapes

The soil types and landscape associations occurring within the Project Area are mapped on the Singleton 1:250,000 Soil Landscapes Map Sheet and described in Kovac and Lawrie (1991) (refer to **Figure 6.1**). Soil landscapes identified as being present in the Project Area include Branxton (bx), Rothbury (ro), Saxonvale (sx), Warkworth (ww) and Wollombi (wo) (Kovac and Lawrie 1991) (Umwelt, 2013). The Branxton soil landscape covers the additional disturbance area (refer to **Figure 6.1**).

The soil types within the soil landscape have a low fertility; are rapidly to poorly drained and have a low to moderate available water-holding capacity. Typical soil pH varies between 5.5 and 6.5 and mass movement hazard is nil.

6.1.2 Previous Soil Sampling

As part of the AIS (Umwelt, 2013), soil sampling was undertaken in December 2011 and February 2012 to confirm the existing soil landscape information. Topsoils and subsoils were sampled and tested to assist in determining their current land and soil capacity and to assess the suitability of soils for topsoil stripping and rehabilitation (Umwelt, 2013). The soils within the Project Area (including the additional disturbance area) conform with the Branxton soil landscape and generally have low to moderate fertility and are moderately to highly erodible and generally not suitable for cropping (Umwelt, 2013).

6.1.3 Land and Soil Capability Classes

As part of the AIS undertaken for the BOP (Umwelt, 2013), the land and soil capability classes were mapped for the entire Project Area. Land and soil capability is the ability of the land to sustain a range of land uses and land management practices in the long term without degradation of soil, land, air and water resources (OEH 2012, drawing on Dent and Young 1981, Emery 1986 and Sonter and Lawrie 2007).

The land and soil capability classes identify limitations on the type and intensity of use as a result of the severity constraints related to the physical attributes of the soil and the extent to which intensive management is required to prevent on and off site degradation under varying land uses. The classification does not necessarily reflect existing land uses; rather, it indicates the potential of the land for different agricultural purposes, while maintaining the quality of natural assets.

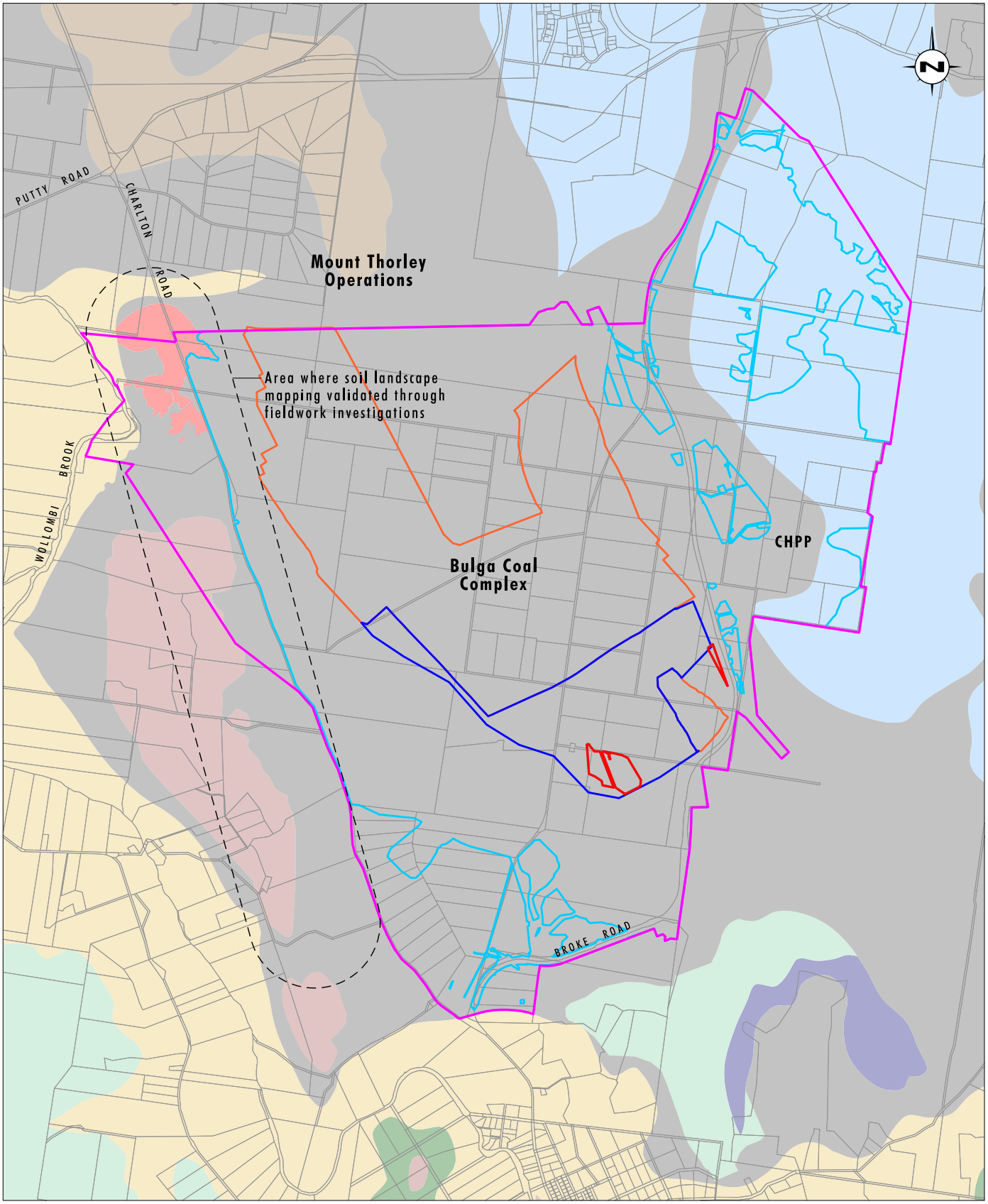
Table 6.1 presents the rationale and definitions for the eight Land and Soil Capability (LSC) classes currently used in NSW and their presence in the Project Area based on broad scale (1:250,000 scale) mapping undertaken for the Upper Hunter SRLUP. The land within the Project Area, including the additional disturbance area, as classified in LSC classes according to OEH (2012), is presented on **Figure 6.2**.

Table 6.1 LSC Classes

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

The land within the additional disturbance area is currently classified in LSC Class 4, which has high limitations if used for agricultural land uses more intensive than grazing with limited cultivation.

No LSC Classes 1 or 2 have been mapped within the Project Area, including the additional disturbance area, in the mapping prepared by OEH 2012 (refer to **Figure 6.2**).



Data Source: Bulga (2018), Kovac and Lawrie (1991), Department of Finance, Services & Innovation (2018)

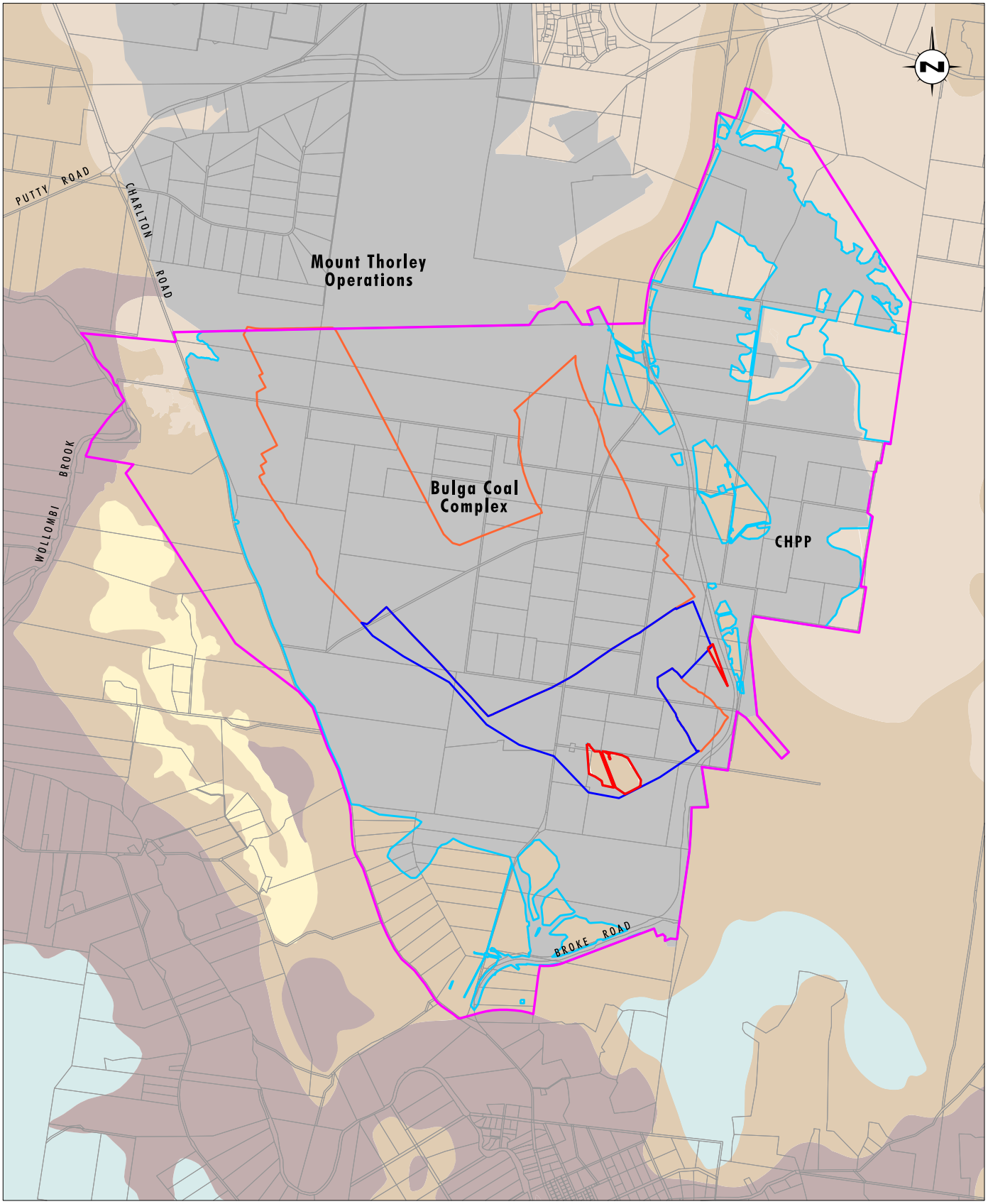
0 1 2 3 km
1:60 000

Legend

- Project Area
- Coal Extraction Area
- Current Disturbance Area
- Additional Disturbance Area
- South Pit Extension Area
- Saxonvale Soil Landscape
- Rothbury Soil Landscape
- Lees Pinch Soil Landscape
- Bulga Soil Landscape
- Branxton Soil Landscape
- Jerrys Plains Soil Landscape
- Ogilvie Soil Landscape
- Warkworth Soil Landscape
- Wollombi Soil Landscape

FIGURE 6.1

Soil Landscapes (Kovac & Lawrie 1991)



Data Source: Bulga (2018), OEH (2012)
Department of Finance, Services & Innovation (2018)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Coal Extraction Area
- Current Disturbance Area
- Additional Disturbance Area
- South Pit Extension Area
- 3 - High Capability Land
- 4 - Moderate Capability Land
- 5 - Moderate-Low Capability Land
- 6 - Low Capability Land
- 7 - Very Low Capability Land
- Mining

FIGURE 6.2

Existing Land and Soil Capability (OEH 2012)

File Name (A4): R03/4100_110.dgn
20190529 16.17

6.1.4 Agricultural Resources

The AIS (Umwelt, 2013) discussed the potential impact on the existing agricultural enterprises within the Project Area which is approximately 4,879 ha in total. The outcomes of the assessment noted that the majority of the land within the Project Area is either not currently used for agriculture or is used for low intensity cattle grazing. The additional disturbance area is surrounded by existing mining activities or other surface disturbance activities and not currently used for agricultural purposes. The assessment concluded that the generally marginal nature of the agricultural land being impacted by the BOP, the Project's overall contribution to the reduction in agricultural productivity in the region is considered to be low (Umwelt 2013).

The additional disturbance area represents an additional 20.2 ha of disturbance within the Project Area. The additional disturbance area is not currently utilised for agriculture and it would not be practicable for the area to be used for agriculture as it surrounded by mining activities, and comprises mostly native vegetation with limited grazing potential unless significantly modified. The Proposed Modification will not have any additional significant impacts on the agricultural resources within the Project Area.

6.2 Noise

A comprehensive Noise Impact Assessment (NIA) has been prepared by Global Acoustics Pty Ltd for the Proposed Modification and is contained within **Appendix 4**.

As outlined in **Section 4.0**, noise was a key community issue as part of the BOP. Consultation with local residents during the development of this SEE and SIA identified the potential for increased noise impacts due to the Proposed Modification to be a key area of concern. BCM has engaged closely with local residents as part of the development of BOP and subsequently since the approval of the BOP in 2014, to ensure that the management of noise impacts from the ongoing mining operations has complied with the currently approved noise criteria.

As outlined in **Section 2.1.1**, a key feature of the BOP was the noise and visual bund which was included in the project design to manage noise impacts. BCM also operates a comprehensive noise management system on site, as outlined in the approved Noise Management Plan (NMP), which uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of mining operations, and the implementation of both proactive and reactive noise mitigation measures. BCM will continue to operate under the approved NMP which will be updated for the Proposed Modification as required.

The key objectives of the NIA were to evaluate any difference in noise emissions from the Proposed Modification relative to the approved development, and to determine whether BCC can continue to operate in accordance with approved noise criteria. A key driver of the approach for this NIA has been to ensure that the results of this NIA can be directly compared to the criteria in the recently approved development consent (SSD 4960), to assist in improved community understanding of the outcomes.

Whilst the Proposed Modification relates to the extraction of coal from a relatively small area, the extraction of the additional coal in the most efficient manner requires a revision of the proposed future mine plans. BCM have prepared revised integrated conceptual mining stage plans which have been used in the NIA, along with an associated production schedule and proposed mining equipment fleet.

6.2.1 Assessment Methodology

To allow comparison of 'like with like', as many assessment parameters as possible were retained from the Bulga Revised and Amended Project NIA (Global Acoustics 2013). The currently approved noise impact criteria in SSD 4960 were also retained and applied to this Proposed Modification. This is seen as important in the context of the BOP Consent SSD 4960 being relatively recent (2014), in order to provide consistency to potentially affected residents, to whom BCM has made significant commitments regarding noise mitigation and control measures. In this way, any differences in predicted noise emission are due to changes to the mine progression, and not due to changes to assessment parameters.

The Bulga Revised and Amended Project NIA was prepared in accordance with the EPA's Industrial Noise Policy (INP) (2000), which predated the current Noise Policy for Industry (NPfI). The INP and NPfI are considered relatively equivalent in so far as they apply to this assessment. Primary differences between the INP and NPfI, as applicable to this assessment, pertain to setting of assessment noise levels and consideration of residual noise impacts. These differences have been resolved in this assessment through the following:

- Existing criteria set out in SSD 4960 have been adopted in lieu of establishing new assessment noise levels. Should new assessment noise levels be established in accordance with the NPfI, higher allowable noise levels than currently approved could result for the day period, and, for maximum noise event levels at night.

- Residual noise impacts are evaluated in accordance with the VLAMP (2018), which is more recent than the NPfI (evaluation of residual noise impact was not included in the INP).

- The cumulative distribution of results methodology was employed in lieu of the prevailing meteorological conditions method outlined in the NPfI. The cumulative distribution method provides assessment of impact for a far more comprehensive set of meteorological conditions, and is the same method used for the Revised and Amended Project NIA.

- Modifying factors have been assessed in accordance with Fact Sheet C of the NPfI, as required by NPfI transitional arrangements.

Four staged operational scenarios were assessed for the Proposed Modification, representing the updated progression of mining operations over the proposed modified life of mine, with emphasis on targeting the highest noise impact and maximum extraction periods. Each stage represents realistic worst case operating conditions for that period of operations, due to the proposed configuration of the mine and the location of the mining equipment fleet during those years. The stages nominally relate to Year 3 (nominally 2022), Year 7 (nominally 2026), Year 12 (nominally 2031) and Year 16 (nominally 2035).

In addition to intrusive operational noise from the Proposed Modification, the NIA also takes into consideration cumulative noise impacts due to concurrent operation with the adjacent MTW mine. Road traffic noise and rail noise impacts were not assessed as there is no change to road traffic or rail volumes as a result of the Proposed Modification. Similarly, construction noise was not assessed in the NIA as noise emissions associated with tailings relocation are included in the operational noise assessment and no other significant construction tasks are proposed. As such, it was considered highly unlikely that construction noise from any minor onsite construction activities would be audible over and above the noise generated by the open cut mining operation; therefore construction noise was not quantitatively assessed. Noise associated with minor construction activities required for the Proposed Modification will be managed to comply with the approved operational noise criteria and will therefore be treated as an operational noise source for compliance purposes.

6.2.2 Model Setup

Noise levels were predicted using RTA Technology's Environmental Noise Model (ENM), a computer based environmental noise model, to determine the acoustic impact of operational activities. ENM is approved by the DPE and EPA as suitable for prediction of industrial noise involving large propagation distances and is currently the industry standard for NIA of this nature. The model takes into account geometric spreading, atmospheric absorption, and, barrier and ground attenuation.

Noise sources such as mining equipment fleet and fixed noise sources such as fixed plant were located on each Proposed Modification mine stage plan at appropriate locations to reflect a typical mine setup. Mobile equipment types and numbers used in the model reflect a conservative mining fleet of current equipment types using noise levels sourced primarily from noise monitoring undertaken on current operating equipment. Whilst the mining fleet used in the NIA for modelling purposes is representative of current mining practices, it is acknowledged that mining equipment types and available technology will change throughout the life of the Proposed Modification. BCM may review and utilise alternative mining equipment or techniques from time to time and will manage noise emissions from the BCC to comply with the approved criteria for the BCC.

Potential impacts were evaluated using the cumulative distribution of results methodology. This method determines a noise level that is likely to be exceeded no more than 10% of the time in each of the four seasons. A range of results is calculated for a comprehensive set of meteorological conditions, and frequency of occurrence of each of these meteorological conditions is calculated from historical meteorological data. The cumulative distribution of these results is analysed to establish a single value for comparison with the limiting criterion. Modelled meteorological conditions and frequency distributions are the same as those used for the Bulga Revised and Amended Project NIA. All known private residential receptors that may be noise impacted by the Proposed Modification were assessed and their locations are shown in **Figure 1.5**.

6.2.3 Operational Noise Assessment

Table 6.2 provides a summary of compliance for the Proposed Modification against existing noise criteria prescribed in SSD 4960. Compliance for any given receptor is demonstrated where 90th percentile predictions for an indicative scenario with a feasible and reasonable level of noise mitigation applied is less than or equal to the relevant criterion.

Table 6.2 Summary of Predicted Compliance

Receptor ID[1]	SSD-4960 Criteria [1]	90th Percentile Prediction Complies with Criteria[2]			
	LAeq,15minute dB	2022	2026	2031	2035
95, 142A, 143B, 164, 165, 195, 217s	36/36/36	Y	Y	Y	Y
All other privately-owned residences	35/35/35	Y	Y	Y	Y

Notes:
[1] Receptor ID and Criteria (in format day/evening/night) are sourced from the table in Appendix 6 of BOP consent (SSD 4960).
[2] Y indicates 90th percentile prediction for relevant feasible and reasonable mitigated scenario complies with SSD 4960 criteria.

As indicated in **Table 6.2**, the Proposed Modification will comply with approved noise limits at all receptor locations throughout the mining progression with an appropriate level of noise mitigation applied to the mining operations during periods of adverse meteorological conditions.

Mitigation controls applied to demonstrate compliance in this NIA are applicable to the stage plans assessed, and provided to demonstrate that the Proposed Modification will be able to achieve compliance with the currently approved noise criteria contained in SSD 4960. The actual degree of mitigation controls required will vary throughout the life of the mine as the degree of exposure changes.

Residual noise impacts

BCM will continue to afford voluntary mitigation rights to receptors currently afforded these rights in accordance with Table 2 (Condition 2 of Schedule 3) of SSD 4960. It is again noted that these receptors would no longer be entitled to mitigation rights in accordance with either the NPfI or the VLAMP, as noise emissions from the Proposed Modification will be managed to comply with noise limits prescribed in Appendix 6 of SSD 4960, which are less than the noise mitigation level of LAeq, 15_{minute} 38 dB in all cases.

BCM will continue to afford voluntary acquisition rights to receptors currently afforded these rights in accordance with Table 1 (Condition 1 of Schedule 3) of SSD 4960. These are receptors 149 and 150, which are contiguous lots (effectively one property) and have the same owner.

Private land assessment

The VLAMP requires assessment of operational noise impacts over privately owned land. With regard to private landholdings, the VLAMP states that a consent authority should only apply voluntary land acquisition rights where, even with the implementation of best practice management:

> *The noise generated by the development would contribute to exceedances of the acceptable noise levels by 5dB in Table 2.2 of the NPfI on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.*

Table 2.2 of the NPfI is replicated in **Table 6.3** below.

Table 6.3 Amenity noise levels

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A) Recommended amenity noise level
Residential	**Rural**	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	**See column 4**	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A) Recommended amenity noise level
School classroom – internal	All	Nosiest 1-hour period when in use	35 (see notes for table)
Hospital ward internal external	 All All	 Nosiest 1-hour Nosiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Noise contours were generated over contiguous private lot areas for each of the four modelled stages with feasible and reasonable noise mitigation controls applied. From these, the maximum envelope of predicted noise emission was determined to evaluate the maximum extent of noise impact over the life of the Proposed Modification. The percentage of private land exceeding the acceptable amenity noise level plus 5 dB did not exceed 25% of any private landholding areas.

Sleep disturbance assessment

Potential sleep disturbance impact was assessed by predicting levels from plant items known to generate noise levels that at times stand out above the general mining continuum. Shovel and excavator bucket noise, first pass loads into empty truck trays, rear dump truck exhaust and dozer track noise are recognised as sources which can generate high, short term noise levels that may cause sleep disturbance. Sleep disturbance model predictions are less than the criterion of $L_{A1,1minute}$ 45 dB for all receptors. As such, there is no sleep disturbance impact predicted. This is consistent with the outcome of the BOP NIA.

Low frequency noise assessment

At the time the Bulga Revised and Amended Project NIA was prepared (August, 2013), the preferred method for evaluation of low frequency noise was the Broner method, which is based on comparison of total predicted C-weighted levels at receptor locations with an upper limit criterion (Broner, 2010). Since that time the Broner method has been replaced with the contemporary method outlined in the NPfI. It is worth noting that total C-weighted predictions for the Proposed Modification with feasible and reasonable noise controls applied remain at least 10 dB below the Broner desirable limit of $L_{Ceq,15minute}$ 60 dB.

The BCC has a fully attenuated mining fleet, and all major fixed plant infrastructure, including the CHPP, includes cladding in accordance with industry best practise. As a result of these mitigation measures, the BCC does not typically attract modifying factor adjustments, as evidenced by the analysis of real-time monitoring data. Continued use of the existing infrastructure area is proposed, and the same mining fleet will be retained until replacement is required. Replacement mining fleet will have noise mitigation included, which will be consistent with or better than the current fleet. On this basis, low frequency noise emissions from the Proposed Modification should not increase relative to the existing situation.

6.2.4 Cumulative Noise Assessment

The Bulga Revised and Amended Project NIA (2013) included an assessment of potential cumulative noise impacts due to concurrent operation with MTW mine. The Bulga Revised and Amended Project NIA (2013) assessment indicated that receptor 1A, which is located in the Mount Thorley area, had predicted exceedance of the night period acceptable amenity noise level. This receptor along with other receptors in this area, have acquisition rights from MTW, which was primarily responsible for the predicted cumulative noise level. No exceedances of acceptable amenity noise criteria were predicted for the Bulga Village area. Additionally, no exceedances of acceptable amenity noise levels were predicted for receptor 217s, demonstrating compliance at locations further from the MTW complex.

A NIA for the Warkworth Continuation Project has since been prepared (EMGA Mitchell McLennan, 2014) including a cumulative noise impact assessment which used the BOP NIA predictions to assess cumulative noise at receptor locations that may be impacted by both MTW and the BCC. The outcome was that relevant acceptable amenity noise levels would be satisfied at most locations. The exception was one receptor in Warkworth Village, which would not be affected by noise from the BCC.

This NIA demonstrates that the Proposed Modification will be able to continue to operate within approved operational noise criteria prescribed in SSD 4960. Therefore, future contributions to cumulative noise levels from the Proposed Modification should not exceed the model predictions presented in the Bulga Revised and Amended Project NIA. Outcomes of previously prepared cumulative noise impact assessments for the BOP and Warkworth Continuation Project NIAs remain unchanged, and compliance with acceptable amenity noise levels is expected to continue.

6.2.5 Management and Mitigation Measures

BCM operates a comprehensive noise management system on site, as outlined in the approved Noise Management Plan, that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of mining operations, and the implementation of both proactive and reactive noise mitigation measures. BCM will continue to operate under the approved Noise Management Plan which will be updated for the Proposed Modification as required.

The BOP EIS outlined commitments BCM made to assist in managing noise emission from the site, and to achieve the predicted noise levels presented in the Revised and Amended Project NIA. Relevant management measures and noise controls have been included in the noise models and stage plan development, including the noise and visual bund. Throughout the life of the mine, alternative noise controls and management strategies may be implemented to ensure ongoing compliance with approved noise criteria.

BCM will continue to implement the management measures outlined in the Revised and Amended Project NIA, except where they are no longer relevant or are now complete. BCM intends to operate the Proposed Modification in line with the following commitments:

- Overburden emplacement strategies will be implemented to meet relevant noise criteria. This may include measures such as provision of shielded tipping locations for night period dumping and different day and night period hauling/dumping scenarios.

- Haul road bunds will be constructed to a height of 3 m above road level, where safe and practicable, in strategic locations on the exposed side of long-term haul roads. A sensitivity analysis was completed that showed increasing the bund height above 3 m provides minimal additional noise reduction.
- An earth bund (approximately 20 m high) will be formed adjacent to the long term haul road that will be constructed along the inside face of the noise and visual bund to provide a higher degree of shielding to the haul road that will connect the southern mining area to the northern waste emplacement areas. Alternate or additional measures may be used over time to provide equivalent outcomes.
- Operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria.
- Retention of the hydraulic snubber on the face shovel so this noise source will not be a cause of sleep disturbance.
- Continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages.
- Continuous noise monitoring will be continued at strategic off-site locations to provide real time feedback to the mine for noise management.
- Continuation of existing attended noise monitoring for ongoing compliance purposes.
- Monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management.
- Reasonable and feasible noise mitigation measures will be offered to landowners listed in Table 2 (Condition 2 of Schedule 3) of SSD 4960.

In addition to the long-term measures above, a series of reactive noise management strategies have been developed that will be progressively implemented in active mining and overburden emplacement areas as required to maintain compliance with approved noise criteria. These include:

- Ancillary equipment such as rehabilitation dozers, drill preparation dozers and road/pit maintenance equipment operating in exposed areas will be relocated or shutdown.
- Exposed waste emplacement area dozers will be either replaced with rubber tyre dozers, restricted to first gear operation, relocated, or shutdown.
- Any other dozers operating in exposed areas will be either replaced with rubber tyre dozers, restricted to first gear operation, relocated, or shutdown.
- Haulage to exposed waste emplacement areas will be relocated to use more shielded haul roads and emplacement areas deeper in the pit.
- Exposed blast hole drills may be relocated or shut down.
- Excavators and associated equipment, including haul trucks, will be progressively shutdown or relocated to more shielded pit areas.

6.3 Blasting

A Blasting Impact Assessment (BIA) for the Proposed Modification was prepared by Enviro Strata Consulting Pty Limited (ESC). The BIA presents an assessment of blast impacts associated with the Proposed Modification on the surrounding environment, including residential receivers, heritage items/historical sites, infrastructure, and adjacent mines.

BCM currently utilises a number of blast control measures and technologies detailed in the approved Blast Management Plan (2016) for the operations. BCM currently effectively manages blasting activities to comply with the approved criteria for residential receivers, heritage items, historical sites, infrastructure and adjacent mines. Blasting for the Proposed Modification is to be conducted in accordance with the existing Blast Management Plan (2016). The BIA for the Proposed Modification predicts that any associated blast impacts can be effectively managed through the application of the Blast Management Plan (2016). Future updates of the Blast Management Plan may be made to consider improvements in blast techniques and blasting technology to assist in managing blast impacts.

The BIA report is provided in **Appendix 5** and the results of the assessment are summarised below.

6.3.1 Blast Emission Criteria

Blasting is currently undertaken for the approved operations in accordance with the conditions specified in SSD 4960, reproduced in **Table 6.4** below.

Table 6.4 Summary of Blast Emission Criteria (from SSD 4960)

Location	Airblast overpressure (dBLin Peak)	Ground Vibration mm/s)	Allowable Exceedance
Residence on privately-owned land	120	10	0%
	115	5	5% of the total number of blasts over 12 months
330kV Suspension Towers, PID pipeline and public roads	-	100	0%
Other public infrastructure	-	50 (unless otherwise agreed with the Secretary)	0%

Note: These criteria do not apply if BCM has a written agreement with the relevant owner and has advised the Department in writing of the terms of this agreement.

In addition, blasting must only be carried out on site between 9.00 am and 5.00 pm Monday to Saturday inclusive. No blasting is allowed on Sundays, public holidays, or at any other time without the written approval of the Secretary. BCM may carry out a maximum of:

- Three blasts a day
- Five blasts a week, averaged over a calendar year, on the site.

This condition does not apply to blasts that generate ground vibration of 0.5 mm/s or less at any residence on privately-owned land, blast misfires or blasts required to ensure the safety of the mine, its workers or the general public.

A number of operating conditions related to blast management, property inspections, road closures, communication, reporting and coordination of blasting with surrounding mines also apply under SSD_4960. These conditions are addressed in the approved BOC Blast Management Plan (BCM, 2016) for the existing operations.

6.3.2 Conceptual Blast Design

The drill and blasting activities for the Proposed Modification will be consistent with the current blasting activities undertaken by BOC. The primary focus of the drill and blasting activities will be to uncover coal material by blasting the overburden and interburden rock strata material for further handling.

A review of the geological model of the area allowed for an estimation of the blasting parameters. There is substantial variation in the local geology of the additional mining area (i.e. the presence of the Mount Thorley monocline) resulting in a flat coal seam section in the west and a steeply dipping coal seam section in the east. Because of this, there will be a need to extract different bench heights for each mining area to maximise coal recovery.

Based on the assessment of the geological model, blasting benches were identified as ranging between 3.6 and 46.4 m for the western section and 15 to 22 m for the eastern section (through seam blasting only due to the steeply dipping seam section). The projected charge masses were therefore identified to be in the order of 26 to 2,810 kg and 290 to 1,168 kg (depending on the choice of drill rig) for the western and eastern sections, respectively.

6.3.3 Modelling

Both the ground vibration predictive model and the airblast overpressure predictive model used in the analysis were based on models developed specifically for Bulga conditions. To optimise the accuracy of the predictions for the Proposed Modification a review of actual monitoring results from the southern section of Bulga operations was undertaken. This included a review of the vibration and airblast monitoring results from blasting in Bayswater Pit (representative of the eastern section of the operations i.e. steeply deeping strata) and Southern Extension Pit (representative of the western section of the operations i.e. the flat seam section). The collated data included vibration and airblast monitoring results from permanent monitoring stations collected within the 2016 – 2017 monitoring period.

The resultant models were used to assess the impacts of ground vibrations and airblast overpressure on the surrounding environment within a 5 km radius. The modelling accounts for the worst-case scenario, i.e. blasting from the edge of the proposed extraction area, which corresponds to the minimum distance between the blasting area and residential receivers.

Further details on the setup of ground vibration and airblast predictive models are contained in the Blast Impact Assessment in **Appendix 5**.

6.3.4 Impact Assessment

Impact on Residential Receivers

The ground vibration modelling for private residential receivers located within a 5 km radius confirmed that vibration impacts can be managed effectively within the specified blasting parameters. The model showed that by decreasing the charge mass the predicted vibration exposure will comply with the required limit of 5 or 20mm/s at Residence 149. This can be achieved by blasting smaller benches, using smaller hole diameters or by the application of deck charges and the use of precise initiation timing.

The airblast modelling for residential receivers within a 5 km radius indicates that airblast impacts can be managed effectively (to remain below the imposed airblast criteria of 115 dBL) by using lower charge masses, especially applicable to residential receivers located within a 2 to 3 km range. This can be achieved by blasting smaller benches, using smaller hole diameters or by the application of deck charges and the use of precise initiation timing.

The Proposed Modification will operate using a standard 0.5 km exclusion zone for flyrock management. Due to the substantial distances to private residential receivers the issue of flyrock impact on the residential receivers is considered to be fully managed and the potential risks are considered negligible.

Impact on Heritage Items and Infrastructure

All heritage sites are located in excess of 2.7 km from the Proposed Modification blasting boundary. Ground vibration and airblast modelling identified that the predicted vibrations for all heritage sites will be below the existing imposed limit criteria and/or damage levels.

The assessment identified that the closest infrastructure including Broke Road, adjacent pipelines, fibre optic cable and the 330 kV powerlines will be located within 0.5 km of the Project Area. The ground vibration modelling for these items shows that the ground vibration impact can be managed effectively below the applicable vibration limit criteria of 50 and 100 mm/s via the application of lower charge masses.

Ground vibration modelling for all other infrastructure facilities located in excess of 0.8 km from the Project Blasting Boundary identified that the predicted vibrations will be well below the imposed limit criteria and/or damage levels.

Bulga Open Cut will operate using a standard 0.5 km exclusion zone for flyrock management. The impact of flyrock on the closest infrastructure (i.e. less than 0.5 km), including public roads, and adjacent pipelines and fibre optic cable will be managed effectively using the Blast Clearance and Firing Procedure implemented and currently in use. Similarly, the impact of flyrock on the adjacent 330 kV powerlines (when located within 0.5 km radius) will be managed according to blast management measures similar to the current system already developed when blasting in the proximity of powerlines. The other public infrastructure will be in excess of 0.8 km from the Project Blasting Boundary and the closest heritage site will be in excess of 2.7 km from the Project Blasting Boundary. The issue of flyrock impact is therefore considered to be fully managed and the potential risks are considered negligible.

Impact on Mine-Owned Infrastructure and Bulga Underground Mine

The impacts on the mine-owned infrastructure and Bulga Underground Mine will be managed internally in order to maintain safe work practices. This will be done in consultation with the relevant infrastructure owners and management. The development of such a protocol has previously taken place in consultation with the relevant operators with a commitment to maintaining safe work practices between the operations and will continue to be implemented. Bulga Underground Mine ceased mining in May 2018 and as such a new protocol is recommended to be developed to account for all potential risks related to strata failure, gas inrush/gas exposure, etc. for inactive underground workings.

Interactions with nearby mines

The vibration exposures for MTW mine infrastructure (adjacent mine) are below the applicable ground vibration criteria of 25 and 100 mm/s (for occupied and unoccupied structures respectively) and the 133 dBL airblast criterion.

BOC has already implemented a successful system of liaising with the operators of nearby mines (i.e. MTW Operations) in relation to the coordination of blast times. This is to avoid concurrent blasting and therefore reduce the potential for cumulative airblast and vibration impacts on the local community. No changes to the system are required.

6.3.5 Existing Performance Analysis

An analysis of the existing performance of BCM's blasting practices was also undertaken to assess the adequacy of the coverage of the existing monitoring system and included a review of ground vibration and airblast overpressure monitoring results for the 2014 to mid-2017 period. The results were compared with the airblast overpressure and ground vibration limits imposed on the mine. The assessment concluded a good overall blast performance with a low impact on the local community. The current multi-station vibration monitoring system was determined to provide adequate coverage of the vibration monitoring impacts for residential receivers, historical sites and infrastructure.

6.3.6 Management and Mitigation Measures

The results of the assessment indicate that all impacts on residential receivers, heritage items, historical sites, infrastructure and adjacent mines can be managed effectively to comply with the current criteria. To facilitate compliance with ground vibration and airblast limits it is recommended to continue with the management measures identified in the approved Blast Management Plan.

BCM currently utilises a number of blast control measures and technologies (detailed in the approved Blast Management Plan (2016)). As blasting for the Proposed Modification is to be conducted in accordance with the existing Blast Management Plan (2016), any associated blast impacts can be effectively managed through the application of the Blast Management Plan (2016).

BCM will continue to undertake blasting for the Proposed Modification in accordance with a detailed blast design process that considers operational, geological and environmental constraints, with the design and size of each blast determined to meet these constraints and meet blasting criteria. Blast design and sizes will vary over the life of the operations and will depend on a number of factors including the nature of the overburden/interburden strata material, the design of open cut benches and environmental considerations. The detailed blast design process will seek to maximise blast efficiency, and minimise potential vibration, overpressure, dust and fume impacts. Blasts will be designed to achieve compliance with the site-specific blast conditions.

Based on the modelling results, blasts can be managed to meet the specified emission criteria by utilising the methods outlined in the BMP (2016).

6.4 Air Quality

A comprehensive Air Quality Impact Assessment (AQIA) of potential air quality impacts associated with the Proposed Modification has been prepared by Jacobs Group (Australia) Pty Limited (Jacobs 2019). A summary of the key findings is provided in this section and the full report is provided in **Appendix 6**.

A key consideration of the project design for the Proposed Modification was to continue to operate the BCC in accordance with approved air quality criteria. BCM implements a range of proactive and reactive emission management measures, currently implemented as part of the existing approved Air Quality Management Plan (AQMP), which will continue to be adopted as part of the Proposed Modification.

6.4.1 Potential Air Quality Issues

The potential for the Proposed Modification to result in increased air quality impacts was raised by surrounding residents as a key local community issue, and is a high priority established environmental management commitment for BCM.

Potential air quality issues have been identified from a review of the Proposed Modification and associated activities and in the context of BCM's experience in operating the Bulga Open Cut and managing air quality issues at the BCC. This identification process has considered the types of emissions to air and the proximity of these emission sources to sensitive receptors.

Emissions to air will occur from a variety of activities including material handling, material transport, processing, wind erosion, blasting and potentially from the spontaneous combustion of coal. These emissions would mainly comprise of particulate matter in the form of total suspended particulates (TSP), particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM10) and particulate matter with equivalent aerodynamic diameter of 2.5 microns or less (PM2.5). There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NOx) and particulate matter, and to a lesser extent sulphur dioxide (SO2), hydrogen sulphide (H2S) and potentially odour and other substances from the spontaneous combustion of coal. However, spontaneous combustion of coal or overburden emplacement areas has historically not been an issue at the Bulga Open Cut.

The potential air quality issues associated with the approved and proposed mining activities have been identified as:

- dust (that is, particulate matter in the form of TSP, deposited dust, PM10 or PM2.5) from the general mining activities and exposed disturbed areas
- fume (that is, NOx emissions) from blasting
- emissions of substances from machinery exhausts, that is, diesel exhaust emissions.

The issues above are similar to the issues identified for BOP and are the focus of the assessment.

6.4.2 Air Quality Criteria

The predicted air quality impacts from the Proposed Modification have been determined by assessment against the air quality criteria set by the EPA as part of their *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (EPA 2016). These criteria are outlined in **Table 6.5** and apply to existing and potential sensitive receptors such as such as residences, schools and hospitals. It should be noted that the assessment to support the existing approved operations (PAE Holmes 2013) was based on an earlier version of the Approved Methods (DEC 2005). The 2016 version introduced a revised, more stringent criterion for annual average PM_{10} as well as new criteria for 24-hour and annual average $PM_{2.5}$. The air quality emissions criteria for the existing approved development, as prescribed in SSD 4960, reflect the criteria in the 2005 version of the Approved Methods. The existing air quality emissions criteria from SSD 4960 are also included in **Table 6.5** for comparison.

Table 6.5 Air Quality Assessment Criteria

Substance	Average Time	EPA Criteria (2016)	SSD 4960 Criteria
Particulate matter (PM10)	24-hour	50 µg/m^3	50 µg/m^3
	Annual	25 µg/m^3	30 µg/m^3
Particulate matter (PM2.5)	24-hour	25 µg/m^3	Nil
	Annual	8 µg/m^3	Nil
Particulate matter (TSP)	Annual	90 µg/m^3	90 µg/m^3
Deposited dust	Annual (maximum increase)	2 g/m^2/month	2 g/m^2/month
	Annual (maximum total)	4 g/m^2/month	4 g/m^2/month
Nitrogen dioxide (NO_2)	1-hour	246 µg/m^3	Nil
	Annual	62 µg/m^3	Nil

The EPA air quality assessment criteria relate to the total concentration of air pollutant in the air (that is, cumulative) and not only the contribution from project-specific sources. Therefore, some consideration of background levels and other industrial sources needs to be made when using these criteria to assess the potential impacts.

In situations where background levels are elevated, the proponent must "demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical" (EPA 2016).

Accordingly, the Proposed Modification has been assessed against the current criteria detailed in the EPA Approved Methods (2016) with these criteria to be applied by the consent authority in accordance with the provisions of Clause 12AB of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) (2018 amendment).

The NSW VLAMP (2018) includes the NSW Government's policy for voluntary mitigation and land acquisition to address dust (particulate matter) impacts from state significant mining, petroleum and extractive industry developments. The current VLAMP (2018) brings the air quality criteria in line with the NEPM standards and EPA criteria. From this Policy, voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 6.6** at any residence or workplace.

Table 6.6 Mitigation criteria for particulate matter from the VLAMP

Substance	Averaging time	Mitigation criterion	Impact type
Particulate matter (PM2.5)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM10)	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

* Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).
** Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of criteria over the life of the development.

Voluntary acquisition rights may also apply where, even with best practice management, the development is predicted to cause more than five exceedances of the criteria in **Table 6.7** over the life of the project, at any residence or workplace on privately owned land, or on more than 25% of any privately-owned land (where there is an existing dwelling or where a dwelling could be built under existing planning controls).

Table 6.7 Acquisition criteria for particulate matter from the VLAMP

Substance	Averaging time	Mitigation criterion	Impact type
Particulate matter (PM2.5)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM10)	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health

Substance	Averaging time	Mitigation criterion	Impact type
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

* Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).
** Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

The particulate matter levels for comparison with the criteria in **Table 6.6** and **Table 6.7** must be calculated in accordance with the EPA's Approved Methods (EPA 2016).

6.4.3 Existing Environment

The AQIA included a review of the local meteorological and ambient air quality conditions in the vicinity of the Proposed Modification with the objective of identifying any existing air quality issues and meteorological conditions which would typically influence the local air quality conditions. The review considered data collected from existing meteorological and air quality monitoring networks in the area surrounding BCC as shown in **Figure 6.3**.

The following conclusions were made from the review of local meteorological and ambient air quality monitoring data:

- Wind patterns in the vicinity of BCC are similar to other parts of the Hunter Valley, with the prevailing winds being from either the northwest or southeast. Winds from the south are also common for this area.
- There are seasonal variations in particulate matter concentrations, with PM10 levels higher in spring and PM2.5 levels higher in winter.
- In terms of PM10, air quality conditions can be regarded as good, with annual average concentrations well below the revised assessment criterion of 25 µg/m^3. Most monitoring sites in the vicinity of BCC have experienced at least one day above the EPA's 50 µg/m^3 criterion in the past five years. This is not uncommon for most locations in NSW, including in both rural and urban areas with contributing influences including bush fires, drought etc.
- In terms of PM2.5, annual averages have been below the recently introduced assessment criterion (8 µg/m^3) at both BCM monitoring locations. Results from Singleton were above 8 µg/m^3 in one of the past five years. A study by the OEH (2013) found that wood smoke from domestic heating was one of the main factors that influenced PM2.5 concentrations in the Singleton area, especially in winter.
- TSP, dust deposition and NO2 levels are below their relevant EPA criteria.
- Conditions in the 2014 calendar year were considered to be representative of the longer-term air quality and meteorological conditions in the area and 2014 was therefore selected as the meteorological modelling year for the air quality impact assessment.

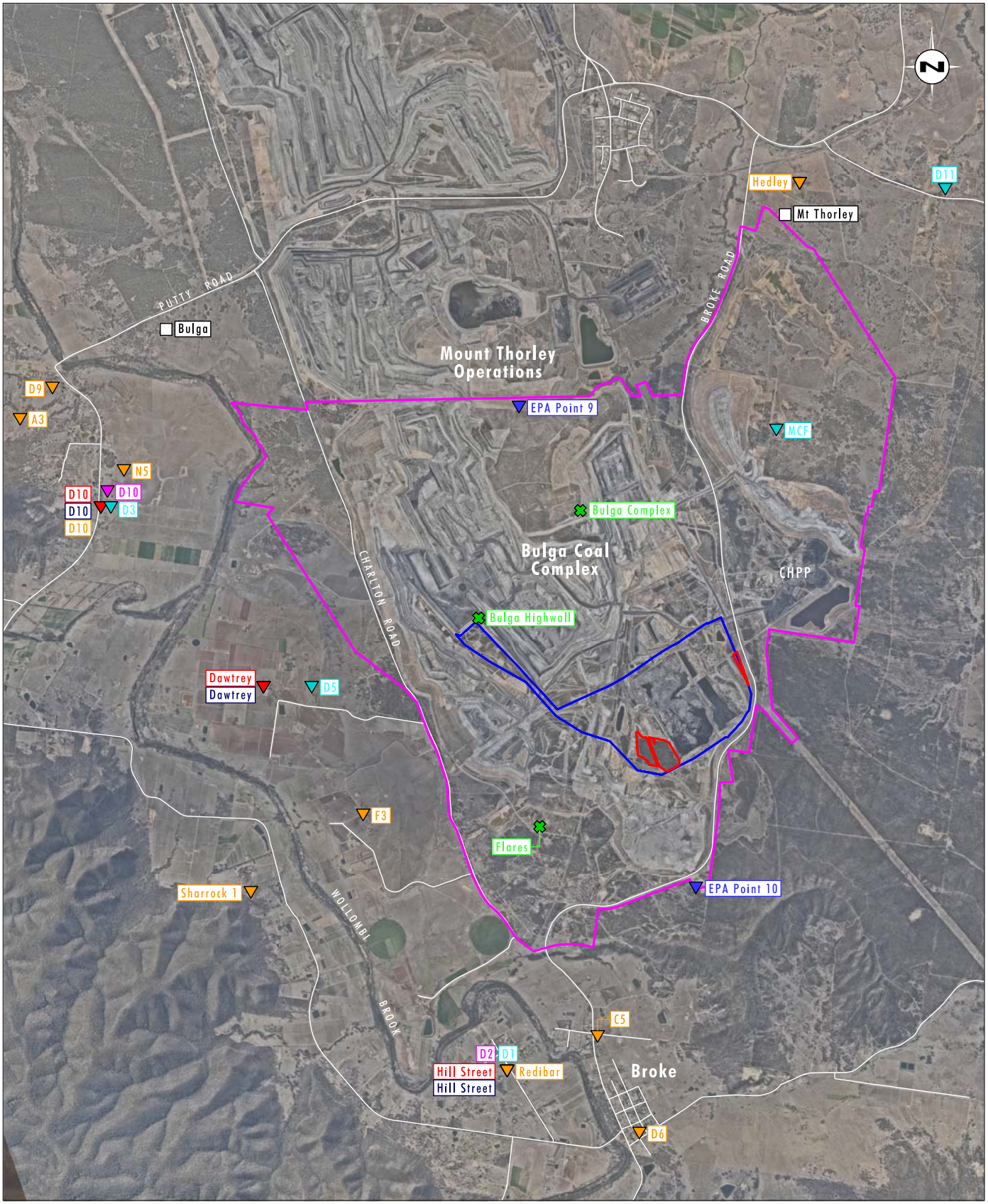


Image Source: Nearmap (Apr 2019)
Data Source: Bulga (2017)

0 1 2 4 km
1:75 000

Legend

- Project Area
- Additional Disturbance Area
- South Pit Extension Area
- TEOM (PM10)
- eSampler (PM19)
- High Volume Air Sampler (PM10)
- High Volume Air Sampler (TSP)
- BAM (PM2.5)
- Dust Deposition Gauge
- Meteorological Station
- OEH Monitoring Station

FIGURE 6.3

Location of Air Quality and Meteorological Monitoring Sites

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The use of 2014 as the representative years is considered appropriate and is in accordance with the EPA Approved Methods. When conducting air dispersion modelling to predict potential impacts, the EPA Approved Methods requires the use of site representative meteorological data that are "correlated against a longer-duration site-representative meteorological database of at least five years (preferably five consecutive years) to be deemed acceptable". The assessment carried for the Proposed Modification has addressed this requirement. A review against more recent years has not shown any potential for more frequent and more extreme particle concentrations.

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts, that is, mining contribution plus non-mining contribution. For this objective, the approach was to make use of data collected from all real-time air quality monitors in the vicinity of BCC and, at the same time, minimise the potential for adding model predictions to measurements which may already contain contributions from those sources being modelled (i.e. to avoid double counting). The estimated background levels that apply at sensitive receptors are provided in **Appendix 6**. These levels (or approach adopted) have been added to model predictions to determine the potential cumulative impacts.

6.4.4 Assessment Methodology

The AQIA was undertaken in accordance with the EPA's Approved Methods (EPA, 2016), which specifies how assessments based on the use of air dispersion models should be undertaken. The Approved Methods include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

The most significant emission to air from the Bulga Open Cut will be dust (particulate matter) due to material handling, material transport, processing, wind erosion, and blasting. Estimates of these emissions are included in the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and mine plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for the AQIA have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012)
- *Compilation of Air Pollutant Emission Factors AP-42* (US EPA, 1985 and updates).

Dust emission inventories have been developed for each of the modelled scenarios, namely:

- 2014, representing "existing" conditions (with the operations approved at that time) and for model performance evaluations
- Years 2022, 2026, 2031 and 2035, representing proposed future conditions, and assuming maximum production.

The CALPUFF air dispersion model has been used to predict ground-level concentrations and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality criteria, in accordance with the EPA's Approved Methods 2016. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions.

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model. The model comprises meteorological modelling as well as dispersion modelling.

Further details on the air quality assessment methodology including model calibration are provided in **Appendix 6**.

6.4.5 Assessment of Impacts

This section provides an assessment of the key potential air quality issues associated with the Proposed Modification, primarily based on model predictions and comparisons to air quality criteria. One objective of the AQIA was to predict the extent of air quality impacts due to the Proposed Modification, and to identify potential changes in air quality over existing approved levels, recognising that the BCC currently exists and the Proposed Modification represents the progression of mining. For the purpose of model validation, comparisons of actual air quality monitoring results and model predictions were undertaken for 2014.

The AQIA (Jacobs 2019) provides the following predicted air quality outcomes.

6.4.5.1 Particulate Matter (as PM_{10})

Modelling indicates that the project-specific contribution of the Proposed Modification will not exceed a 24-hour average concentration of 50 µg/m^3 at any private properties. The 24-hour average concentration 50 µg/m^3 PM10 is applied as an incremental criterion in the VLAMP, for the purposes of determining land acquisition.

The cumulative maximum 24-hour average PM10 concentrations may exceed 50 µg/m^3 at various private properties, due to contributions from the BCC (as modified), MTW mine and background (other) sources of particulate matter. The potential contributions of each source to cumulative concentrations at three locations (195, 217s and 311) have been examined. There are days predicted when the background levels plus the contribution from MTW mine would be below 50 µg/m^3 and the contribution of the Proposed Modification may contribute to an exceedance of 50 µg/m^3. Specifically:

- up to two days per year in the vicinity of property 195, with a maximum contribution from the BCC of 24 µg/m^3
- up to one day per year in the vicinity of property 217s, with a maximum contribution from the BCC of 6 µg/m^3
- up to two days per year in the vicinity of property 311, with a maximum contribution from the BCC of 9 µg/m^3.

The monitoring data has shown that, in the past five years, there have been between zero and seven days where cumulative 24-hour average PM10 concentrations have exceeded 50 µg/m^3, at locations to the west of the Project Area. With this information it can be anticipated that 24-hour average PM10 concentrations will continue to be variable from day-to-day, due to existing conditions and sources, and that operations will need to be managed in a way which minimises the contribution to off-site PM10 levels, as is done under the existing approved operation at BCC.

One property (1A) is predicted to experience exceedances of the annual average PM_{10} concentration criterion of 25 µg/m^3, with a prediction of 27 µg/m^3 in both 2022 and 2026. The contribution of the BCC to annual average PM_{10} concentrations at property 1A is predicted to be up to, and in the order of 7 µg/m^3 (in 2022). It is noted that the annual average PM_{10} contribution from BCC at property 1A is not predicted to significantly increase as a result of the Proposed Modification, however given the change in criteria from 30 µg/m^3 currently approved under SSD 4690 to 25 µg/m^3 applied to this Proposed Modification, the exceedance at property 1A is now predicted to occur due to the reduced criteria.

Compliance with the cumulative annual average PM10 criteria is predicted at all other private sensitive receptors.

6.4.5.2 Particulate Matter (as PM2.5)

The project-specific contribution of the Proposed Modification to maximum 24-hour average PM2.5 concentrations is predicted to be up to 5 µg/m^3 at the nearest private sensitive receptors.

The predicted cumulative maximum 24-hour average PM2.5 concentrations due to all modelled sources and with the derived background dataset indicate that concentrations at all private sensitive receptors will not exceed the 25 µg/m^3 criterion at any stage of the Proposed Modification.

There are no private sensitive receptors which are predicted to experience exceedances of the annual average PM2.5 criterion (8 µg/m^3) at any stage of the BCC. On the basis of the modelling there are no additional predicted impacts to private land and sensitive receivers associated with the Proposed Modification, relative to the existing approved operations.

6.4.5.3 Particulate Matter (as TSP)

There are no private sensitive locations which are predicted to experience exceedances of the annual average TSP criterion (90 µg/m^3) at any stage of the Proposed Modification.

6.4.5.4 Deposited Dust

There are no private sensitive locations which are predicted to experience exceedances of the annual average dust deposition criteria at any stage of the Proposed Modification.

6.4.5.5 Post-Blast Fume (NO_2)

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are included in the dispersion modelling results presented in previous results. Post-blast fumes comprise of oxides of nitrogen (NOx) including nitric oxide (NO) and nitrogen dioxide (NO2). In general, at the point of emission, NO will typically account for 90% of the volume of the NOX. The remaining 10% will comprise mostly NO2. It is the NO2 which has been linked to adverse health effects.

No changes are proposed to the number of blasts per day, permissible blasting hours, blasting practices or blast management procedures as part of the Proposed Modification. Therefore, the extent of potential blast fume impact will be within the extent of potential blast fume impact predicted under the approved operations and will continue to be managed in accordance with existing approved management plans and processes. Post blast fume emissions are not expected to result in any adverse air quality impacts, based on model predictions which show compliance with air quality criteria.

6.4.5.6 Diesel Emissions

The most significant emissions from diesel exhausts are products of combustion including carbon monoxide (CO), oxides of nitrogen (NOx) and particulate matter (PM10 and including PM2.5). It is the NOx, or more specifically NO2, and PM10 (including PM2.5) which have been reviewed in the AQIA and summarised below.

Diesel Exhaust Particulate Matter (as PM_{10} and $PM_{2.5}$)

The emission factors used in the AQIA represent the contribution from both wheel generated particulates and exhaust particulates. These emission factors, including with control factors, are based on measured emissions which include diesel particulates in the form of both PM10 and PM2.5. The potential impacts of diesel exhaust emissions (as PM10 and PM2.5) are therefore already represented in the preceding results. Further details are presented in **Appendix 6**.

Nitrogen Dioxide (NO_2)

Emissions of NOx from diesel exhausts have been estimated using fuel consumption data, reported by BCM as part of their AEMR greenhouse gas emission estimates, and an emission factor from the EPA's 2008 Air Emissions Inventory (EPA 2012). **Table 6.8** provides the calculations.

Table 6.8 Estimated NOx emissions from diesel exhausts

Item	Value
Total fuel used (litres) (based on maximum annual fuel usage between 2015 and 2017)	68,061,340
Diesel exhaust emission factor (NOx kg/kL)	40.77
Diesel exhaust emissions – all equipment (NOx kg/y)	2,774,861

The NOx emission estimate from **Table 6.8** has been modelled using the same source locations as 2031 to provide an indication of the off-site NO2 concentrations due to diesel exhaust emissions. The 2031 source locations were selected as the number and position of sources in this year were likely to result in the highest model predictions at sensitive receptors. At the nearest sensitive receptors, the predicted maximum 1-hour average NO2 concentrations are in the order of 50 to 100 µg/m^3. With the addition of maximum background levels (74 µg/m^3) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion.

At the nearest sensitive receptors the predicted average NO2 concentrations are in the order of 5 µg/m^3 or less. With the addition of conservative background levels (16 µg/m^3) the results show compliance with the EPA's 62 µg/m^3 criterion.

6.4.6 Monitoring and Management

Appendix 6 summarises the range of proactive and reactive emission management measures, currently implemented as part of the existing approved AQMP, which will continue to be adopted as part of the Proposed Modification. The current AQMP will be review and revised where necessary should the Proposed Modification be approved. It is also noted that the predicted impacts assume that MTW is at full capacity and the Bulga Surface Operations are still operating, therefore the predicted impacts are conservative in nature.

The dust management measures have been compared to the measures outlined in the NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining (Donnelly et al. 2011). This comparison identified that the majority of proposed measures are consistent with best practice dust mitigation measures.

BCM implements both proactive and reactive dust control strategies. Reactive air quality management includes the modification or suspension of activities in response to the following triggers:

- visual conditions, such as visible dust from trucks above wheel height as observed by operators and via the in-pit camera system

- meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors

- ambient air quality conditions (that is, elevated short-term PM10 concentrations) identified through real-time air quality monitoring.

Specific "triggers" are defined in the BCM AQMP. These triggers are linked to specific actions for managing dust at both private and mine owned residences.

Proactive air quality management involves the discussion and planning of activities in advance of potentially adverse conditions. Specifically, the pro-active air quality management approach includes:

- plant operator training and awareness of potentially adverse conditions

- implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation

- discussion of the dust forecast at daily pre-shift meetings

- modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts.

The meteorological and air quality monitoring network currently operated by BCM is designed to measure the key air quality parameters, compliance with air quality criteria, and to allow for the contribution of mining activities to be determined. This monitoring network will continue to be operated as part of the Proposed Modification.

The proposed mitigation measures to manage diesel combustion emissions aim to address the equipment maintenance and engine replacement strategies based on the *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions* (EPA 2014).

The emission control measures proposed by BCM include:

- servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance

- targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle

- defining failure modes, effects and criticality which help to minimise potential equipment failure

- constructing timelines for downtimes.

6.5 Greenhouse Gas and Energy

A comprehensive Greenhouse Gas and Energy Assessment (GHGEA) has been prepared for the Proposed Modification and is contained within **Appendix 7**. The assessment focused on changes to the open cut components as there are no significant changes to the underground mining components that would lead to a change in greenhouse gas emissions. The scope of the GHGEA included:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification

- estimating energy use directly associated with the Proposed Modification

- qualifying how the Proposed Modification's greenhouse gas emissions may impact the environment

- estimating the impact of the Proposed Modification's emissions on national and international greenhouse gas emission targets
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

6.5.1 Assessment Methodology

The GHGEA framework was based on the methodologies and emission factors contained in the *National Greenhouse Accounts (NGA) Factors 2018* (DEE 2018), while also incorporating the principles of *The Greenhouse Gas Protocol 2004* (WRI and WBCSD, 2004).

Scope 1 (direct emissions) and Scope 2 (emissions from the generation of purchased electricity) emissions were calculated based on the methodologies and emission factors contained in the NGA Factors 2018 (DEE 2018). Fugitive emissions from the open cut operation were calculated based on the modelled gas reservoir of the Proposed Modification, which was calculated by BCM, using the Method 2 approach described in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Clean Energy Regulator, 2018).

Scope 3 emissions (indirect emissions) associated with product transport were calculated based on emission factors contained in the *National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators* (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the *NGA Factors 2018* (DEE 2018).

Greenhouse gas and energy use estimates have only been calculated for the operational stage of the Proposed Modification. Construction activities are a relatively minor part of the Proposed Modification (civil works are included in operational energy use forecasts), and the decommissioning impacts have already been considered as part of the approved operations.

The following information and assumptions were used to estimate the greenhouse gas emissions from the operational stage of the Proposed Modification:

- recover an additional 63 Mt ROM over 21 years
- extend the life of the BOC coal mine to approximately 31 December 2039
- no change to the extraction rate, mining methods, processing, transport or major infrastructure
- electricity use averages 0.0184 GJ/ROM tonne
- electricity use required to relocate 31 GL of tailings will average approximately 91,000 GJ per annum over 6 years
- product coal will be approximately 22% coking quality and 78% thermal quality
- 100% of all product coal will be exported
- product coal will yield approximately 66% of ROM coal
- fugitive emissions will average 0.048 t CO2-e/ROM tonne
- rail transport will be approximately 92 km
- ship transport will be approximately 9,500 km.

6.5.2 Results

The Proposed Modification's life of mine (LOM) greenhouse gas emissions are summarised in **Table 6.9**.

Table 6.9 Greenhouse Gas Emission Summary for the Proposed Modification

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Proposed Modification	Scope 1 (Direct)	Diesel use	1,238,248	4,262,248
		Fugitive emissions	3,024,000	
	Scope 2 (Indirect)	Electricity	388,647	388,647
	Scope 3 (Indirect)	Product use	104,584,912	109,716,962
		Associated with energy extraction and distribution	111,577	
		Product transport	5,012,874	
		Materials transport	7,599	
Total GHG Emissions for LOM Operations				**114,367,857**

The Proposed Modification's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 96% of the Proposed Modification's greenhouse gas emissions will occur either upstream or downstream of the Proposed Modification and outside the direct operational control of BCM. Approximately 4% of the greenhouse gas emissions associated with the Proposed Modification are related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions).

The Proposed Modification is forecast to generate approximately 4,263,000 t CO2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. The Proposed Modification is forecast to produce approximately 207,000 t CO2-e Scope 1 emissions per annum (averaged over 21 years), which is comparable to other Hunter Valley open cut coal mining operations of similar size. It should be noted that annual average Scope 1 emission estimates should not be used to benchmark annual performance, as annual emissions will vary significantly due to normal variations in annual activity. The majority of Scope 1 emissions are generated by fugitive emissions and diesel combustion. BCM has a direct influence over Scope 1 emissions and these emissions will be subject to management and mitigation plans.

The Proposed Modification is forecast to be associated with approximately 389,000 t CO2-e of Scope 2 emissions from consuming electricity. The Proposed Modification is expected to increase annual Scope 2 emissions from the Approved Project, by an average of approximately 19,000 t CO2-e per annum. BCM can influence reductions in Scope 2 emissions by driving electricity reduction and efficiency initiatives.

The Proposed Modification is forecast to be associated with approximately 109,717,000 t CO2-e of Scope 3 emissions. The Proposed Modification is expected to increase annual Scope 3 emissions from the Approved Project, by an average of approximately 5,225,000 t CO2-e per annum. Scope 3 emissions associated with the Proposed Modification will be generated by third parties who transport and consume coal products. BCM has no operational control over Scope 3 emissions, as these emissions are generated by the activities of other organisations.

6.5.3 Impact Assessment Summary

The greenhouse gas emissions generated by the Proposed Modification have the potential to impact the physical environment and the greenhouse gas reduction objectives of both national and international governing bodies.

The accumulation of greenhouse gases or carbon in 'carbon sinks' is the primary environmental impact of greenhouse gas emissions. The Proposed Modification's greenhouse gas emissions will have a dispersive impact as they are highly mobile and are generated up and down the supply chain. To put the Proposed Modification's emissions into perspective, under current policy settings, global greenhouse gas emissions are forecast to reach 56,200,000,000 t CO2-e per annum by 2025 (UNEP 2016). During operation, the Proposed Modification will contribute approximately 0.0004% to global emissions per annum (based on its projected Scope 1 emissions). The relative environmental impact of the Proposed Modification is likely to be relative to its proportion of global greenhouse gas emissions.

The Scope 2 and 3 emissions associated with the Proposed Modification should not be considered, as global projections only represent Scope 1 emissions (i.e. the sum of all individual emission sources).

Likewise, the GHGEA found that the Proposed Modification is unlikely to impact national greenhouse gas policy objectives due to the relatively small contribution the Proposed Modification will make to national emissions on an annual basis. The Proposed Modification will contribute to global emissions, however, the extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions which includes all major emission sources and sinks.

6.5.3.1 Impact on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007).

Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation (IPCC 2007).

Climate change models forecast many different climate change impacts, which are influenced by future GHG emission scenarios. Climate change forecasts also vary significantly from region to region.

The Proposed Modification, in isolation, is unlikely to influence global emission trajectories. Future emission trajectories will largely be influenced by global scale issues such as; technology, population growth and greenhouse gas policy.

6.5.3.2 Impact on Policy Objectives

Under the Paris Agreement, the Australian Government has committed to reducing greenhouse gas emissions by 26 to 28%, on 2005 levels, by 2030 (Commonwealth of Australia, 2015).

Should Australia achieve its 28% mitigation commitment under the Paris Agreement, the DoEE estimates that the Australian economy must set a mitigation trajectory which will save approximately 762,000,000 t CO2-e between 2021 and 2030 (DoEE 2018).

The Proposed Modification's cumulative Scope 1 emissions (4,263,000 t CO2-e) will increase the required national mitigation effort. It is important to note, however, that mining associated with the Proposed Modification ceases in 2039 (subject to timing of granting development consent) and as such will not influence national mitigation efforts after this time.

The Proposed Modification's Scope 2 and 3 emissions will be generated in international jurisdictions, and by Australian facilities with environmental approval to generate greenhouse gas emissions.

6.5.4 Mitigation Measures

BCM has incorporated a range of measures into the Proposed Modification's design to minimise potential greenhouse gas emissions and improve energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The Proposed Modification's design inherently minimises greenhouse gas emissions from the mining operations, primarily through energy use reduction initiatives. Key measures included in the Proposed Modification design to minimise emissions include:

- limiting the length of material haulage routes (where feasible), thus minimising transport distances and associated fuel consumption
- selecting equipment and vehicles that have high energy efficiency
- scheduling activities so that equipment and vehicle operation is optimised.

Further details on specific energy efficiency measures incorporated into the Proposed Modification are available in the GHGEA in **Appendix 7**.

6.6 Biodiversity

A comprehensive Biodiversity Assessment Report (BAR) has been undertaken by Umwelt for the 20.2 ha of additional disturbance area associated with the Proposed Modification. The additional disturbance area is relatively minor, in the context of the currently approved BCC disturbance area of 3,786 ha. BCM currently manage a number of offsets in relation to the approved disturbance area associated with the BCC as well as operating in accordance with the approved Biodiversity Management Plan.

The BAR addresses the specific requirements of the *Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major* Projects (FBA) (OEH, 2014). The FBA process is a credit driven system where calculators provided by the NSW government are populated with ecological data about the site to generate 'impact credits'. The Proposed Modification is then required to offset these credits through a biodiversity offset strategy.

The Proposed Modification is being assessed under the FBA as it was substantially completed prior to the commencement date of the new *Biodiversity Conservation Act 2016*. As a result, DPE confirmed that the environmental assessment could continue under the FBA, as the Proposed Modification is considered a "*pending or interim planning application*" under clause 27(1)(d) of Part 7 of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*.

A full copy of the BAR is contained within **Appendix 8** with a summary included in this section.

6.6.1 Methodology

The threatened species and ecological communities known or likely to occur within the additional disturbance area were identified through a systematic approach that comprised relevant database searches, a review of recent literature and targeted field surveys. There has been a long history of biodiversity survey and investigation across the Project Area and surrounds associated with the approved operations and there was substantial local biodiversity data that was available to inform the BAR.

A review of previous documents and reports relevant to the Proposed Modification was undertaken. This included regional and sub-regional vegetation mapping reports, annual monitoring reports, ecological surveys undertaken in the vicinity of the additional disturbance area and also relevant ecological database searches. The information obtained was used to inform survey design and was also used to assist in the assessment of potentially occurring threatened and migratory species, endangered populations (EP) and Threatened Ecological Communities (TEC). Relevant documents included:

- Ecological Impact Assessment for the Bulga Optimisation Project (Umwelt 2013)
- Bulga Extension Project – Environmental and Social Impact Pre-feasibility Reporting (Umwelt 2017)
- 2016 Ecological Monitoring Report (DnA Environmental 2016)
- Bulga Coal Annual Review – 1 January to 31 December 2016 (SLR Consulting Australia Pty Ltd 2017)
- Upper Hunter Strategic Assessment – Bulga Biodiversity Certification Assessment Report (Umwelt 2015a)
- The Vegetation of the Central Hunter Valley, NSW (Peake 2006)
- Greater Hunter Native Vegetation Mapping (Sivertsen et al. 2011)
- VIS Classification Database (OEH 2018b), accessed January 2018
- OEH Online Search Tool (OEH 2018c) for known/predicted threatened communities in the Hunter IBRA subregion
- OEH BioNet Atlas of NSW Wildlife database and mapping tool (OEH 2019), accessed January 2018
- OEH Threatened Species Profile Database (OEH 2018a) for known/predicted threatened species in the Hunter IBRA subregion, accessed January 2018 through the archived dataset (http://www.environment.nsw.gov.au/projects/biometric-dataset.htm)
- PlantNET (Botanic Gardens Trust) database search for threatened plants within a 10 km radius search from Broke, accessed January 2018
- DoEE Protected Matters Search Tool for known/predicted EPBC Act-listed TECs, accessed January 2018.

A preliminary assessment using the Threatened Species Profile Database (TSPD) was undertaken which provided a list of species-credit species that might require survey and the suitable survey periods for each species. The results of these database searches, literature review and TSPD review were used to design the survey requirements for species-credit species so that adequate surveys were undertaken as part of the FBA.

The vegetation of the additional disturbance area was surveyed using best-practice techniques to delineate vegetation communities across the additional disturbance area. Flora surveys included floristic plots, rapid assessments and opportunistic surveys in order to accurately sample the vegetation communities and potentially occurring threatened flora species within the additional disturbance area.

Targeted surveys and transects for cryptic and seasonal threatened flora species were conducted over August to November 2017. Extensive previous ecological surveys including targeted surveys for threatened flora species have been undertaken in the BCC within and adjacent to the additional disturbance area.

Fauna surveys across the additional disturbance area were undertaken from August to October 2017. Fauna survey methods included a range of survey techniques including targeted searches, call playback, anabat echolocation recording, spotlighting, remote detection camera sampling and meandering transects.

Following completion of the field survey, the BioBanking Credit Calculator (BBCC was applied in accordance with FBA methodology (OEH 2014) to calculate the credit requirements for the Proposed Modification.

6.6.2 Key Diversity Values

The following sections provide a summary of the key biodiversity values for the additional disturbance area.

6.6.2.1 Native Vegetation within the additional disturbance area

Surveys of the Development Footprint identified two Plant Community Types (PCT) across three condition classes being:

- HU564/PCT922 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion
  - Moderate to Good Condition (Zone 1)
  - Low condition (Zone 2)
- HU817/1603 PCT Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter
  - Moderate to Good Condition (Zone 3).

The PCTs were then categorised into three vegetation zones, as shown in **Figure 6.4**. All other areas not mapped as part of a vegetation zone are cleared land which cannot be aligned with a PCT or vegetation zone and is excluded from further assessment. The vegetation zones and their site value scores are detailed in **Table 6.10** below.

Table 6.10 Vegetation Zone Site Value Scores

Vegetation Zone	PCT Name and Condition	Area within additional disturbance area (ha)	Current Site Value Score
1	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	2.1	65.10
2	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	0.7	29.69
3	HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	16.4	65.80
N/A	Cleared land	1.2	-
	Total	**20.2**	

One vegetation zone (Zone 3) recorded in the additional disturbance area conforms to two TEC (refer to **Figure 6.5**), being:

- *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act
- *Central Hunter Valley Eucalypt Forest and Woodland* listed under the EPBC Act.

The residual area of additional disturbance of 1.2 ha is primarily cleared and/or disturbed areas.

6.6.2.2 Threatened Species within the additional disturbance area

Three ecosystem-credit species were recorded in the additional disturbance area during the surveys undertaken for this assessment. These were:

- squirrel glider (*Petaurus norfolcensis*)
- speckled warbler (*Chthonicola sagittata*)
- grey-crowned babbler (*Pomatostomus temporalis temporalis*) – recorded as a disused nest.

Other ecosystem-credit species records that have been previously recorded within the BCC are outlined in **Appendix 8**.

No species-credit species are considered likely to be impacted by the Proposed Modification. Given this, no species credits have been generated for the Proposed Modification.

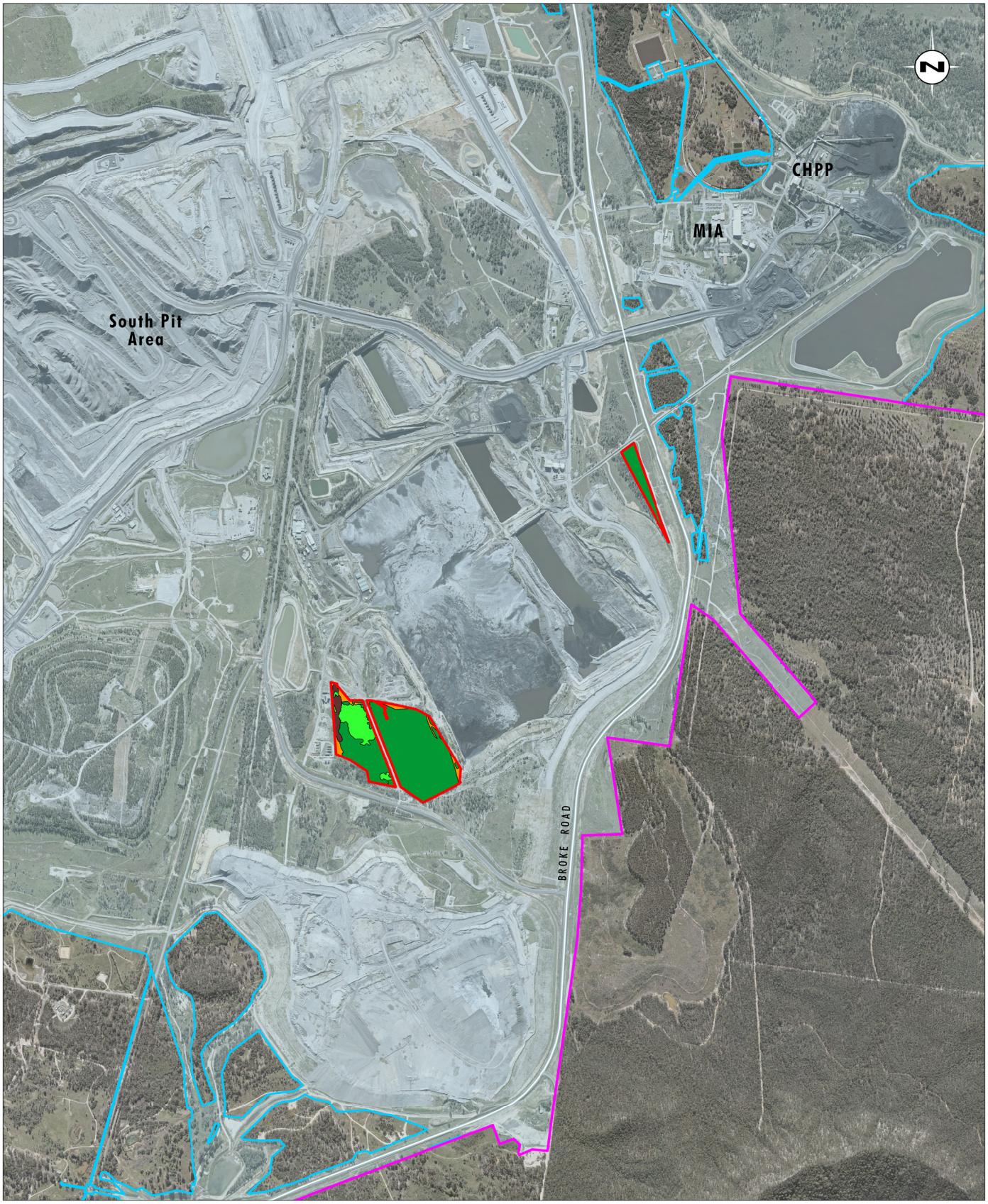

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area
- Zone 1 - HU564/922 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion - Moderate to Good Condition
- Zone 2 - HU564/922 - Low Condition
- Zone 3 - HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter - Moderate to Good Condition
- Disturbed Land

FIGURE 6.4

Vegetation Zones in the Additional Disturbance Area

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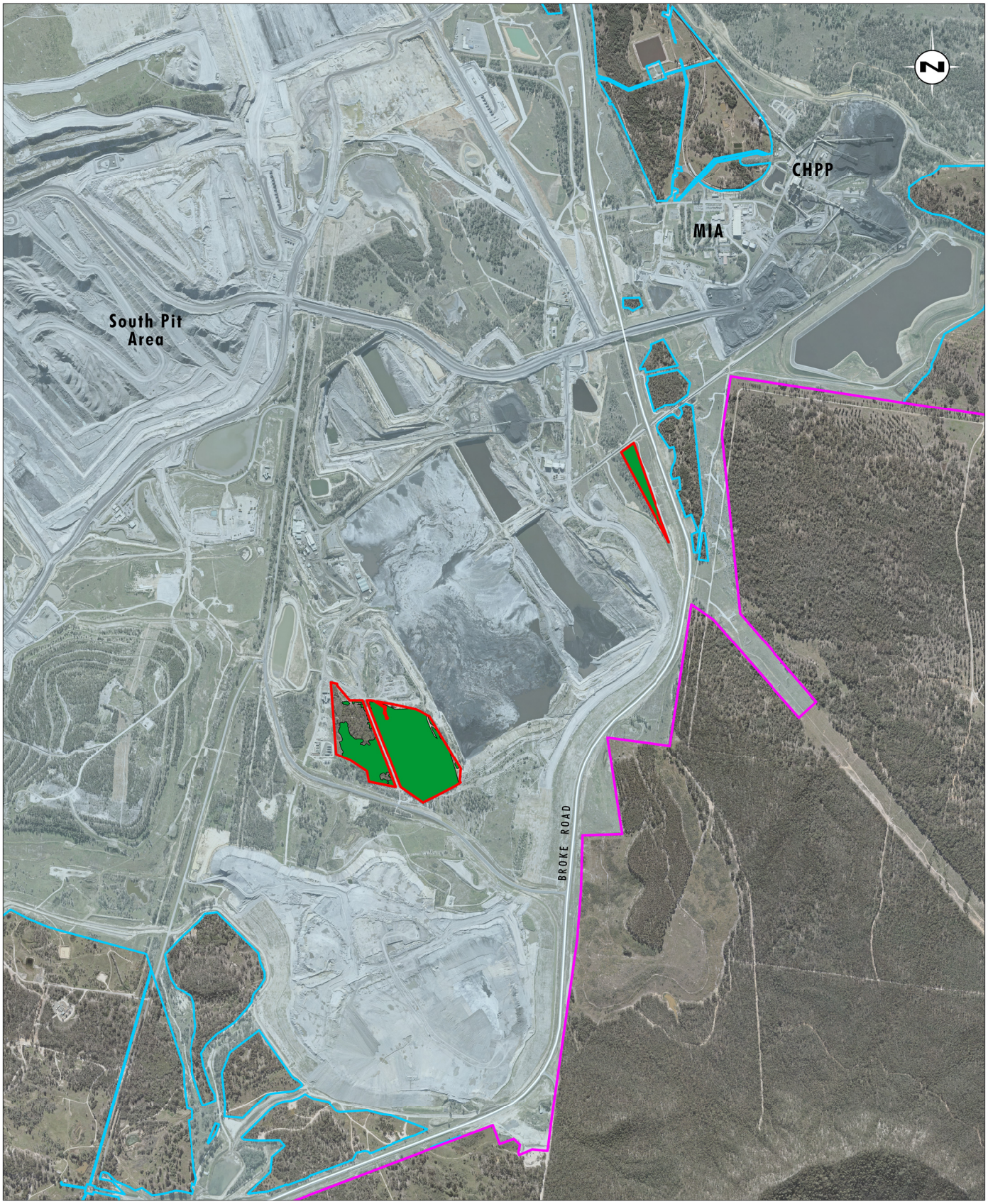

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area
- *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act and *Central Hunter Valley Eucalypt Forest and Woodland* CEEC listed under the EPBC Act

FIGURE 6.5

Threatened Ecological Communities in the Additional Disturbance Area

6.6.3 Avoidance and Mitigation Measures

6.6.3.1 Avoidance

Given the location of the additional disturbance area, being an isolated remnant area within the overall Project Area and the relatively small size, it is not possible to avoid impacts to all biodiversity values within the additional disturbance area without compromising the viability of the Proposed Modification.

A total of 19.2 ha of native vegetation, across three vegetation zones, will be directly impacted as a result of the Proposed Modification. Given this, detailed minimisation/mitigation measures are proposed where the development of the Proposed Modification will result in direct impacts on biodiversity values within the additional disturbance area. Direct impacts include the loss of native vegetation and fauna habitats as a result of clearance works.

6.6.3.2 Mitigation Measures

BCM is committed to minimising the unavoidable impacts of the Proposed Modification through implementation of a comprehensive biodiversity mitigation strategy (refer to **Section 6.6.5**).

The existing approved BCC Biodiversity Management Plan details specific control measures considered to be integral to the mitigation of impacts on the biodiversity features of the additional disturbance area. Where relevant, these control measures consider the Upper Hunter Strategic Assessment Guidelines for the Mitigation of Coal Mining Impacts on Biodiversity (OEH 2016). The specific control measures proposed to mitigate the impacts on biodiversity features of the additional disturbance area and surrounds include:

- landform and rehabilitation establishment as mining progresses
- salvage of biodiversity features
- pre-clearance and tree-felling procedures
- weed management
- feral animal control
- access control
- bushfire management
- erosion and sedimentation control
- provision of appropriate environmental management measures as part of the mining operations to minimise the potential for indirect impacts.

Further details are provided in **Appendix 8**.

The existing BCC Biodiversity Management Plan will be revised should the Project be approved to include the additional disturbance area and to address any additional development consent requirements.

6.6.4 Assessment

The construction and operation of the Proposed Modification will result in a range of direct impacts on biodiversity values within the additional disturbance area. Direct impact includes loss of native vegetation and fauna habitats as a result of clearing works and works associated with the construction and operation of the Proposed Modification. **Table 6.11** outlines the impacts of the Proposed Modification on vegetation communities and the biodiversity credit required to be offset to counterbalance this impact.

The Proposed Modification is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands greater than indirect impacts resulting from currently approved operations. Some minor indirect impacts associated with habitat connectivity, fugitive light emissions, dust, noise, surface water flow changes, groundwater changes, weeds and feral animals may occur during the current operations and the Proposed Modification of the approved operations.

Table 6.11 Direct Impacts of the Proposed Modification on Native Biodiversity Features

Name	Area of Impact (ha)	Credits Required
Ecosystem Credits		
Zone 1 HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	2.1	55
Zone 2 HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	0.7	8
Zone 3 HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	16.4	868
Total	**19.2**	**931**

6.6.4.1 Impacts on Matters of National Environmental Significance

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on MNES.

On 17 December 2018, the Commonwealth DoEE confirmed the Proposed Modification was a controlled action for potentially significant impacts on the following:

- Central Hunter Valley Eucalypt Forest and Woodland – Critically Endangered
- Regent Honeyeater (Anthochaera phrygia) – Critically Endangered
- Swift Parrot (Lathamus discolor) – Critically Endangered
- a water resource, in relation to coal seam gas development and large coal mining development.

Potential impacts on these matters are discussed in **Section 7.0**.

6.6.5 Biodiversity Offset Strategy

BCM is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Proposed Modification, in consideration of the FBA and the *NSW Biodiversity Offsets Policy for Major Projects* (Offsets Policy) (OEH, 2014).

The following offsetting options are available under the FBA:

- in-perpetuity conservation through the establishment of proponent-managed Stewardship site established in accordance with Part 5 of the *Biodiversity Conservation Act 2016*, achieved through the retirement of credits
- securing required credits through the open credit market and/or
- payments to the Biodiversity Conservation Fund (established under the *Biodiversity Conservation Act 2016*).

BCM has undertaken surveys of an area of Glencore owned land proximate to the Proposed Modification (hereafter referred to as the proposed Vere Offset Site) which contains the required biodiversity credits for the Proposed Modification. The location of the proposed Vere Offset Site is shown on **Figure 6.6**.

6.6.5.1 Adequacy of Biodiversity Offset Strategy

Table 6.12 outlines the BVTs/PCTs at the proposed Vere Offset Site and the biodiversity credits generated at this site as part of a BBCC assessment. **Table 6.13** details the amount of existing and proposed restoration of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC and also identifies areas and credits that could be established through the restoration of BVTs/PCTs that do not currently meet the key diagnostic thresholds of the CEEC.

Table 6.12 Biodiversity Credits Generated at the Proposed Vere Offset Site

Veg Zone	Plant Community Type/Species Credit Species *Condition Class*	Area (ha)	Credits Generated
Ecosystem Credits			
1	PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good*	91.6	1,041
2	PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Shrubland*	6.3	81
3	PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Derived Native Grassland*	28.2	282
4	PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good - Previous Ground Disturbance*	8.4	104
5	PCT1692/HU906 Bull Oak grassy woodland of the central Hunter Valley *Moderate to Good*	7.0	78
6	PCT1598/HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good*	0.8	8
7	PCT922/HU564 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	1.5	15
8	PCT1731/HU945 Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley *Moderate to Good*	1.3	16
9	PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter Low Condition Exotic Grassland	0.2	2
-	Cleared Land (including water bodies)	8.4	0
	Total	**153.7**	**1,627**

* Averted loss in site value assigned to the Vere Offset Site to maximise ecosystem credit yield as the land is zoned as RU1 – Primary Production.

Table 6.13 Biodiversity Credits Associated with Existing and Proposed Restoration of Central Hunter Valley Eucalypt Forest and Woodland CEEC

EPBC Act Status	Area (ha)	Credits Generated
Central Hunter Valley Eucalypt Forest and Woodland CEEC	81.1	917
Central Hunter Valley Eucalypt Forest and Woodland CEEC to be restored	33.8	371
Total	**114.9**	**1,288**

BCM propose to offset the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC for the Proposed Modification in a like-for-like manner in accordance with the Offsets Policy. The use of the proposed Vere Offset Site would result in a suitable like-for-like outcome for the offsetting and conservation of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC. This approach results in an outcome where like-for-like offsetting is prioritised at the highest levels of the biodiversity conservation hierarchy.

The proposed offsetting approach seeks to offset *Central Hunter Valley Eucalypt Forest and Woodland* CEEC for the same *Central Hunter Valley Eucalypt Forest and Woodland* CEEC, which when defined at the highest level of threat (listed as critically endangered), provides the best and most credible offset outcome for the Proposed Modification.

This approach is considered to be consistent with the Offsets Policy as it provides a like-for-like offsetting outcome for the CEEC and will be protecting and improving biodiversity that is under the same level of threat, in accordance with the EPBC Act listing for the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC. This approach also addresses the practical implementation issue that arises with the strict application of Subsection 10.5.3.1 (referring to Table 5) of the FBA offsetting rules which inadvertently results in limitations on the proposed like-for-like offset for this CEEC.

A total of 931 ecosystem credits are required to offset the biodiversity impacts associated with the Proposed Modification. The proposed Vere Offset Site generates a total of 1627 ecosystem credits, which exceeds the ecosystem credit requirements of the Proposed Modification using the FBA 'like for like' rules and the proposed 'CEEC for CEEC' approach.

In addition, the proposed Vere Offset area offers extensive scenic views of the local landscape, including the village of Broke, vineyards and distant mountain views across the Wollombi Brook valley. These values represent an opportunity for the co-use of the offset area for public walking trails as a future land use. BCM has committed to incorporating the provision for ongoing public access for compatible land uses including bushwalking and mountain biking into the Conservation Management Plan for the proposed Vere Offset area.

The promotion of this type of post-mining land use and economic diversity is consistent with local and regional planning strategies as discussed in **Section 6.12**.

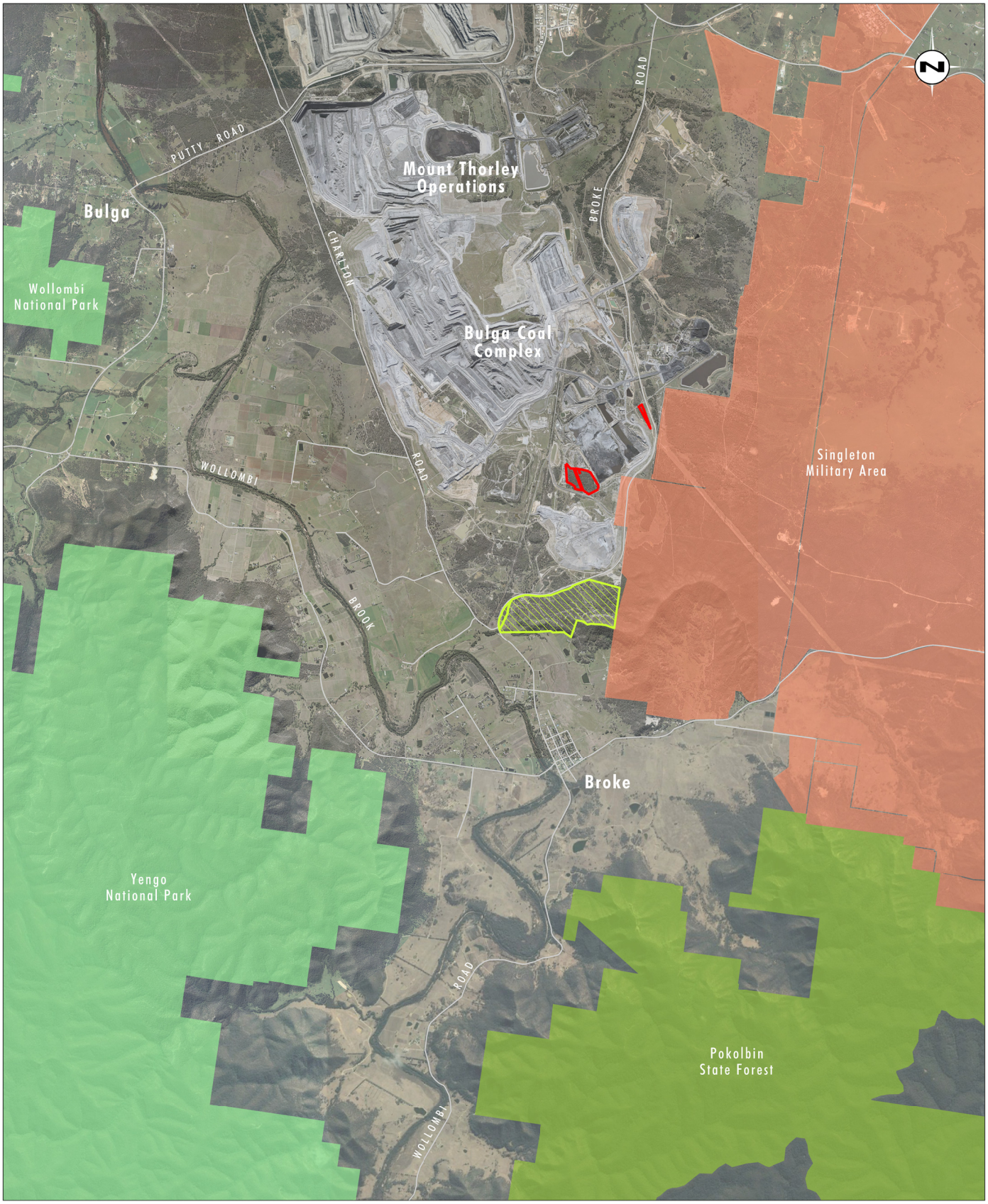

Image Source: Bulga (2017), Google Earth (2018)
Data Source: Bulga (2019)

0 1.0 2.5 5.0km
1:100 000

Legend

- Additional Disturbance Area
- Proposed Vere Offset Site
- State Forest
- National Park
- Singleton Military Area

FIGURE 6.6

Proposed Vere Offset Site

6.7 Water Resources

The Proposed Modification will interact with both surface waters and groundwater, and the effective management of this valuable natural resource was a key consideration in project planning. To assess the potential impact of the Proposed Modification on water resources, comprehensive assessments of the potential surface water impacts, site water balance and groundwater impacts were undertaken and are provided in **Appendix 9, Appendix 10**, and **Appendix 11**. These assessments were prepared in accordance with the Commonwealth Assessment Requirements issued for the Proposed Modification (refer to **Table 5.1**). An overview of the key findings of the surface water, water balance and groundwater assessments are provided in the following sections.

As outlined in **Sections 1.0** and **1.3.1**, the BCC has been operating for over 30 years and as such is within an area that has existing approved impacts to water resources resulting from the current Bulga Surface Operations, Bulga Underground Operations and the adjacent MTW.

As outlined in **Section 3.1.5**, as part of the BOP, significant upgrades to the BCC integrated WMS were completed to accommodate the future mining within the Project Area. The existing integrated WMS has been designed to accommodate the approved mine plan. The Proposed Modification will result in relatively minor changes including the removal of some of the existing water storage facilities, a minor increase to the mining area catchment, minor incremental increase in groundwater inflows and construction of new or modified water management facilities.

6.7.1 Surface Water

A detailed surface water impact assessment (SWIA) has been completed for the Proposed Modification. A detailed assessment of the potential surface water impacts of the Proposed Modification is provided in the SWIA included as **Appendix 9**, with a summary of the key assessment findings included below.

Notwithstanding the measures to minimise impacts, the following aspects of the Proposed Modification have the potential to impact on surface water resources:

- landform changes as a result of the open cut mining operations, including:
  - open cut mining
  - overburden emplacement areas
- changes to water balance for the BCC, including the import and export of water to and from the site.

The additional disturbance area associated with the Proposed Modification is fully contained within the existing Bulga Surface Operations disturbed mine area catchment. There is no additional proposed disturbance within the Loders Creek or Wollombi Brook catchment areas. As such, the potential impacts on surface water catchments within the Wollombi Brook system are limited to impacts on baseflows (associated with groundwater depressurisation impacts) and changes to the location and shape of the final void and associated final landform.

6.7.1.1 Regulatory Context

The Project Area exists within a well-regulated water resource management system that has been designed to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take with consideration of environmental flow requirements of watercourses and the needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with EPL requirements.

There are two key acts that provide the regulatory framework for water management in NSW. These acts are the *Water Management Act 2000* (WM Act) and the *Water Act 1912*. The *Protection of the Environment Operations Act 1997* (POEO Act) is the key piece of environment protection legislation that regulates pollution control (including water pollution) in NSW and is administered by the EPA.

In addition, the Proposed Modification was referred to the Commonwealth DoEE under the EPBC Act. The Proposed Modification was determined to be a controlled action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on biodiversity and a water resource in relation to coal seam gas development and large coal mine development. In particular, consideration must be given to potential impacts on Wollombi Brook, Loders Creek and the Hunter River. Further details of the specific assessment requirements provided by DoEE are outlined in **Section 5.1.1** and include potential impacts on private groundwater users, groundwater and surface water quality, groundwater dependent ecosystems, surface water catchments, surface water flows and flooding and water licencing arrangements. In particular, consideration must be given to potential impacts on Wollombi Brook, Loders Creek and the Hunter River.

6.7.1.2 Existing Surface Water Environment

The BCC is located in the catchment areas of Wollombi Brook and Loders Creek (refer to **Figure 6.7**). Previous mining operations have modified local catchments through the capture of runoff from mining areas within the integrated WMS and diversion of upslope runoff around the mining operations. No new catchment areas will be intersected by the Proposed Modification.

BCM undertake surface water monitoring in accordance with the surface water monitoring program within the BCM Water Management Plan (approved June 2016). Data presented in the 2015 to 2017 annual reviews indicate that mining activities had negligible impact on the water quality in downstream watercourses with monitoring results remaining within historical ranges. Historical monitoring results from January 2004 to September 2018 for pH, EC and TSS are presented graphically in **Appendix 9**.

Water is extracted from the Hunter River to supplement on site supply. The supplementary water is transferred through the Mount Thorley Water Supply Scheme of which BCM is a member, and BCM holds appropriate Hunter River water extraction allocation rights for this purpose.

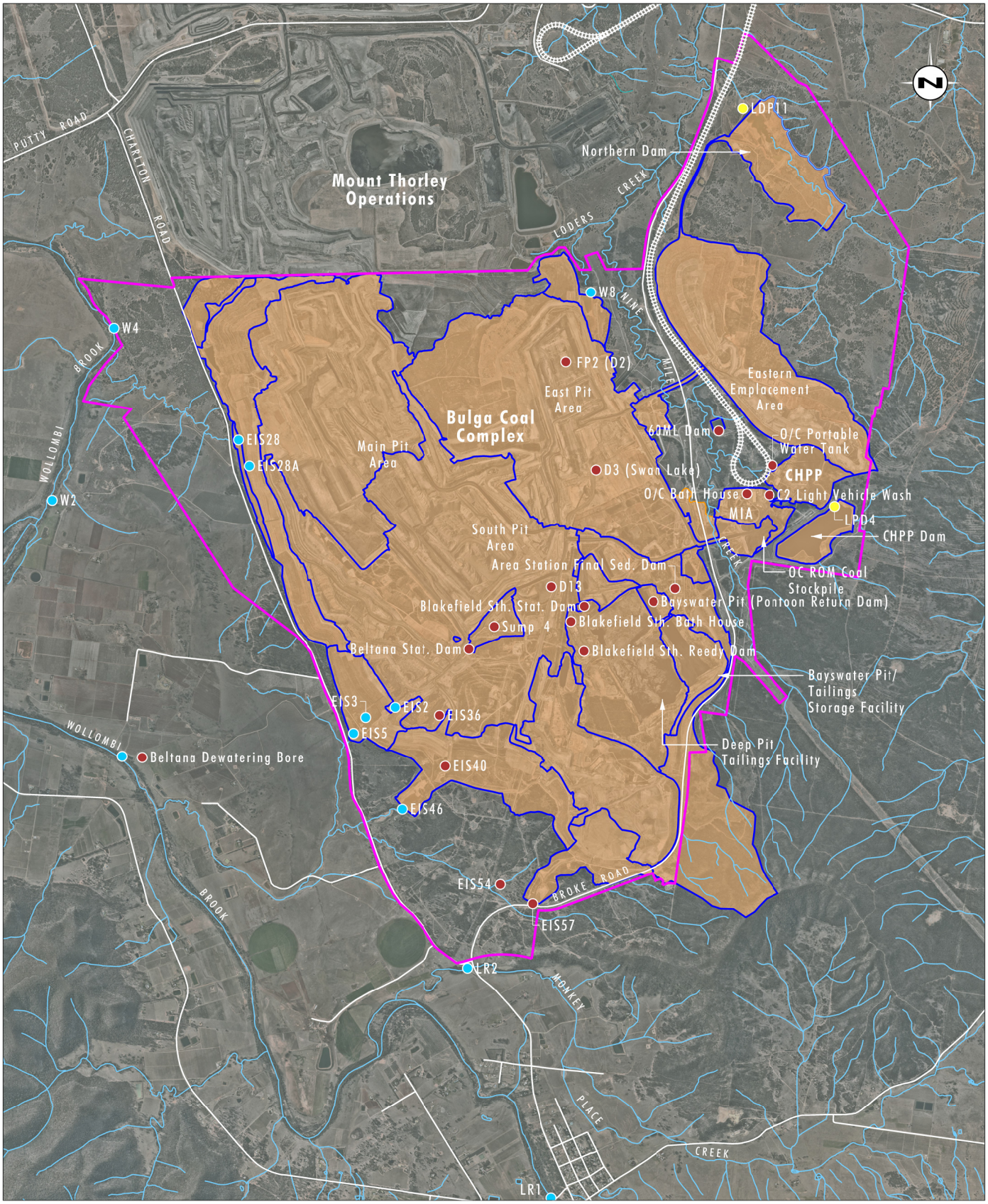

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

0 1 2 3km
1:60 000

Legend

- Project Area
- Water Management System Boundary
- Catchment Boundary
- Existing HRSTS Discharge Point
- Mine Water Monitoring Location
- Surface Water Monitoring Location

FIGURE 6.7

Surface Water Context

File Name (A4): R03/4100_206.dgn
20190905 10.33

6.7.1.3 Water Management System

The approved BCC Water Management Plan (2016) (WMP) includes all aspects of the BCC integrated WMS, and has the following key objectives and functions:

- minimise the contamination of clean water runoff from catchment areas upslope of the operations
- minimise potential effects of erosion and its associated impacts as a result of mining operations
- securely contain mine water (groundwater and surface water which reports to open cut and underground mining areas), and other site water that comes into contact with areas disturbed by mining activities – including overburden emplacement areas, coal stockpiles and the CHPP area
- maximise the re-use of mine water for onsite water use such as coal washing and dust suppression. Reusing mine water is preferred over using water from the Hunter River
- manage the discharge of excess water back to the Hunter River in accordance with the Hunter River Salinity Scheme.

Water management at the BCC considers three categories of water, each with different potential to cause environmental harm. The target design criteria for each of the three categories of water are summarised in **Table 6.14**.

Table 6.14 Water Management System Design Criteria

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or rehabilitated areas.	Release, where practicable, to downstream environment.
Dirty	Runoff from disturbed areas (does not include water captured in mining pit areas or runoff from mine infrastructure areas).	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E). Designed to manage runoff from the five day, 95th percentile rainfall event.
Mine	Runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas.	Contained for events up to and including the 1% annual exceedance probability (AEP) 24 hour storm event.

One of the key objectives of the integrated WMS is to convey clean water around the mining operations or, when runoff water from rehabilitated areas becomes clean, enable the runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the integrated WMS.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to storages within the WMS.

Mine water (i.e. runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas) is managed as part of the mine WMS.

Changes with the Proposed Modification

It is proposed to continue to utilise the existing integrated WMS with appropriate revisions for the Proposed Modification. As previously noted, the additional disturbance area is relatively minor 20.2 ha compared to the approved disturbance area of 3,786 ha and is fully contained within the existing mining disturbance area. However, the Proposed Modification will result in changes to overburden emplacement areas and associated sub catchments within the BCC. The existing approved WMP will be updated to reflect the progressive changes to the integrated WMS should the Proposed Modification be approved. Excess water that cannot be reused will continue to be discharged in accordance with the NSW Hunter River Salinity Trading Scheme (HRSTS), the site EPL and associated regulatory arrangements.

The integrated WMS components (major dams and drains only) required for the Proposed Modification for 2022, 2026, 2031 and 2035 are presented in **Appendix 9**. The integrated WMS will be modified, and new water management components will be constructed, as and when required, to support the infrastructure changes and mine development components of the Proposed Modification. The conceptual plans provided in **Appendix 9** indicate only the likely components of the integrated WMS which are required for a particular stage of mining and do not preclude the construction of some components earlier.

The conceptual storage capacities recommended for the various water management dams are based on existing dam sizes, and new storages have been sized for the purposes of meeting environmental compliance and mine operational water demand requirements. The actual dam configuration and geometry for both the dirty water dams and other structures will be determined during future detailed engineering design stages.

The existing integrated WMS will be revised as required to manage runoff with all mine water and dirty water runoff management structures to be constructed to meet the design criteria outlined in **Table 6.14**. There are no new clean water diversions proposed or required as part of the Proposed Modification.

6.7.1.4 Site Water Balance

A detailed site water balance has been completed with the aim of assessing future site water and salinity balance behaviour and water supply reliability for the Proposed Modification (refer to **Appendix 10**). The model builds upon the previous BCC water balance model, with the addition of modified water management storages required for the Proposed Modification. Given the Bulga Underground Operations are currently suspended, the assessment has modelled three possible mining scenarios in the site water balance for completeness, being:

- the Proposed Modification with the Bulga Underground Operations as approved
- The Proposed Modification with the Bulga Underground Operations suspended until 2029
- The Proposed Modification with the Bulga Underground Operations not operating.

This approach as allowed a range of outcomes to be assessed and considered.

A final void water and salt balance model has also been developed.

The existing water management system at the BCC involves a series of interlinked pits, voids, dams ponds, the Main Pit TSF, their catchments, the former and suspended underground mining areas, the CHPP and water pumping systems. The majority of water is supplied through captured runoff from disturbed mine landforms and from water reclaimed from the TSF. Site (make-up) water supply is pumped from the Hunter River (licensed extraction) to the 60 ML Dam (a small 'turkey's nest' dam with no external catchment). BCM has access to high security water access licence (WAL) totalling 867 ML/year. Water accumulating in pit sumps is usually pumped via Dam S7 to the Surge Dam (the Bulga South open cut can also pump to the Beltana goaf storage).

Licensed discharge (in accordance with the HRSTS) can occur from the Surge Dam and Northern Dam at release rates of up to 127 ML/d and 500 ML/d respectively. BCM currently hold 121 HRSTS credits – this may change into the future in line with credit auctions which occur every two years.

No new significant water storages are planned as part of the Proposed Modification and the existing system of water storages should be adequate for Project requirements with some modifications. Some storages are located within the path of planned open cut operations and would therefore only remain in place for a period of time.

The dredging operations necessary for removal and relocation of the current TSFs will be supplied with water from the Bayswater Pit which in turn would be supplied by other storages. The Proposed Modification would continue to source site make-up water from Hunter River WAL and to discharge via the HRSTS as required.

The model predictions for average inflows and outflows over the simulation period have shown that site rainfall runoff provides the greatest inflow, totalling just under half of total inflows. In regard to outflows, dredging (tailings relocation) amounts to approximately 30% of all outflows over the simulation period. This is followed by supply to the CHPP, totalling approximately 20% of outflows.

Modelling predicts that the risk of accumulation of water in the open cut is low. However, lower total site demands coupled with higher forecast groundwater inflow rates result in a forecast increase in open cut stored water volume within the open cut in the latter period of operations. Water reliability is predicted to be high, with on average greater than 98.0% of all water demands able to be supplied. This high reliability is contingent on adequate extraction from the Hunter River via WALs, of which BCM currently hold 867 ML/year of High Security WALs. Where necessary BCM will source additional WALs to meet the Hunter River abstraction requirements or manage operations to suit, if not available at the time.

Modelling has indicated that a median annual licensed supply of up to 1,670 ML/year (for the case of approved underground operations, 1,950 ML (for the case of underground operations restart delayed) or 1,570 ML/year (for no further underground operations) is likely to be required to supply the Proposed Modification during the dredging period but this will fall to less than approximately 420 ML/year following completion of dredging.

Licensed discharge via the HRSTS may be required to mitigate spill risk and control water inventories during high rainfall periods. It is expected that discharge will not be necessary until dredging is completed, with up to 2,000 ML/year median discharge predicted during the last eight years of the Proposed Modification.

Model results indicate that the final void water body would reach an equilibrium level approximately 120 m below spill level. The equilibrium level would be reached very slowly over a period of several hundred years. Groundwater outflow would occur in the longer term at a rate of up to 0.3 ML/d. Final void salinity levels would increase slowly as a result of evapo-concentration, however are expected to be approximately 6,000 uS/cm after 200 years of recovery.

6.7.1.5 Surface Water Impacts

Catchment Areas

The Proposed Modification is predicted to impact on the Wollombi Brook (final landform only) and Loders Creek catchment areas (refer to **Table 6.15**).

Table 6.15 Predicted Impact on Catchment Areas

Catchment	Pre-Mining (ha)	Approved Final Landform (ha)	Proposed Modification Final Landform (ha)
Wollombi Brook	200,000	199,931	200,285

Catchment	Pre-Mining (ha)	Approved Final Landform (ha)	Proposed Modification Final Landform (ha)
Loders Creek (at confluence with Hunter River)[1]	5,985	5,071	4,674

[1] The Loders Creek catchment excludes the contribution from Doctors Creek. Doctors Creek joins Loders Creek immediately upstream of the confluence with the Hunter River. The catchment area of Doctors Creek has also been impacted on by mining at Mount Thorley Operations.

The impacts on catchment areas are driven by the increase in the catchment area associated with changes to the final landform including changes to the final void. That is an approved final void catchment area of approximately 756 ha compared to a final void catchment area of 799 ha with the Proposed Modification.

The assessment indicates that, compared to the currently approved operations:

- Loders Creek final landform will be reduced by approximately 397 ha (i.e. 8%) when compared to the approved final landform catchment area.
- Wollombi Brook final landform catchment area will be increased by approximately 354 ha (i.e. less than 0.2%) when compared to the approved final landform catchment area.

Flow Regimes

Mining operations have the potential to impact on flow regimes in watercourses by impacts on baseflow contributions.

The Groundwater Impact Assessment (KCB, 2019) indicates that the inferred leakage from the alluvial aquifers to the underlying Permian strata is similar to the predictions of the approved mine. The predicted additional impact on baseflow (where these may occur), are not predicted to have any measurable impact on surface water flows. Potential impacts on flow regimes in Wollombi Brook have been assessed using a combination of historical flow gauging data and modelled baseflow impacts (refer to the Groundwater Impact Assessment, KCB 2019).The groundwater model predicts a reduced leakage from the Permian strata to the alluvial aquifer for the Proposed Modification compared to the approved case simulations. Reduced discharge of saline Permian strata groundwater will help reduce the contribution of salts to the alluvial aquifer.

Flooding and Water Stability

The Proposed Modification has the potential to influence flooding and watercourse stability in Loders Creek as a result of catchment changes associated with the mining operations and overburden emplacement areas.

As outlined in **Appendix 9**, the modelling indicates decreases in peak flows and depths in Loders Creek compared to the pre-mining scenario. Modelling indicates minor increases in peak velocities between 1% and 3% for the Proposed Modification final landform scenario when compared to the pre-mining scenario. The modelled increases in velocities, which are less than 3% compared to the pre-mining scenario is associated with peak velocities in the order of 1.15 m/s. As such it is considered unlikely this will increase erosive potential in Loders Creek. The modelled impacts are due to the changes in catchment areas and topography between the pre-mining and Proposed Modification final landform scenarios. The reduction in peak flows also results in a small increase to peak velocity.

Glencore's required flood immunity for open cut mining pits is the 0.1% AEP event. Flood modelling indicates that flood levels adjacent to the open cut pit range from 62.8 mAHD to 84.9 mAHD. In the same locations the lowest elevation on the eastern side of the open cut pit (over the progressive mine stage plans) ranges from 70 mAHD to 90 mAHD (respectively). Freeboard estimates during the 0.1% AEP event adjacent the open cut pit range from 2.5 to 17.5 m. Modelling indicates that the 0.1% AEP event flood levels are lower than the crest of the open cut pit.

The SWIA indicates that the Proposed Modification will have negligible impact on flood flows or extents during the Probably Maximum Flood (PMF) and as such will not impact on the extent of flood prone land in the Loders Creek catchment area.

Water Quality

The approved BCC WMP is designed to enable BCM to manage and operate the integrated WMS to meet licence conditions within the requirements of the POEO Act, taking account of both historical and current water qualities in the surrounding watercourses, and current and future downstream water users. Design criteria for integrated WMS Dirty Water structures are based on the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E). These structures are designed to manage runoff from the five day, 95th percentile rainfall event. Mine water structures are designed to contain runoff from events up to and including the 1% annual exceedance probability (AEP) 24 hour storm event (refer to **Table 6.14**). The risk of overflows during events that exceed the approved design criteria and potential impacts associated with overflows is currently managed by the Water Management Plan. If the Proposed Modification is approved, BCC will update the existing Water Management Plan to reflect the changes to the water management system associated with the Proposed Modification.

Consistent with the approved operations, discharges will only occur from the BCC via the licensed discharge points located at the Northern Dam or the CHPP Surge Dam under the HRSTS scheme in accordance with the EPL. As such it is considered the Proposed Modification will have minimal impact on water quality in downstream watercourses.

Geomorphological and Hydrological Values

The Proposed Modification is not expected to have a significant impact on the geomorphological and hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Proposed Modification have been assessed and indicate that there is minimal risk of increased erosion or scour.

The Proposed Modification will result in lower peak flows with reduced flood levels in Loders Creek compared to the pre-mining scenario. It is considered that scour potential along Loders Creek will not be increased from the pre-mining scenario due to the Proposed Modification.

Riparian and Ecological Values

The predicted changes to flow regimes both during and following the mining operations associated with the Proposed Modification are predicted to be negligible on Wollombi Brook.

The changes to flow regimes are also considered to be negligible on a regional scale, i.e. Wollombi Brook and Loders Creek flows into the Hunter River regulated river system.

Water Users

There are no known licensed water users on Loders Creek downstream of the BCC.

The Proposed Modification will have minor impacts on the annual flow volumes in Loders Creek compared to the currently approved operations landform conditions and will result in a minor reduction with the final landform. As such only minimal impacts are expected on basic landholder rights on Loders Creek. The majority of the land adjacent to Loders Creek downstream of the BCC is owned by either Glencore (or subsidiaries of Glencore) or MTW (Yancoal).

The proposed changes to surface water baseflows in Wollombi Brook are considered to have negligible impact on downstream water users.

Cumulative Impacts

Mount Thorley mine has surface operations in the Loders Creek catchment downstream of the BCC. Similarly, further downstream, in the Wollombi Brook catchment, Wambo Coal Mine and United Coal Mine operate.

The Proposed Modification is considered likely to have limited impact on waterway stability and scour potential. The Proposed Modification is not expected to have any negative impact on cumulative flows in Wollombi Brook.

Through management of dirty water and mine water within the integrated WMS, in accordance with the approved WMP over the life of the operations, it is not anticipated that water quality in downstream waterways will be adversely impacted as a result of the Proposed Modification. As such the cumulative potential impacts on water quality in downstream watercourses are considered to be negligible.

Water quantity is not anticipated to be adversely impacted by the Proposed Modification on a sub-regional or regional scale. As the Proposed Modification and adjacent mining operations operate in a highly regulated water system any water take associated with the Proposed Modification or existing approved operations will need to meet the requirements of the *Water Management Act* in regards to licensing of water take. As such the Proposed Modification is considered to have negligible cumulative impacts on downstream water users.

6.7.1.6 Management and Monitoring

BCM will continue to manage its operations in accordance with the approved BCC WMP, EPL and HRSTS. Surface water monitoring will continue in accordance with the existing BCC WMP and associated sub plans which will be updated should the Proposed Modification be approved.

The management plans include specific monitoring for:

- erosion and sediment control measures
- surface water quality monitoring
- stream health and channel stability monitoring.

6.7.2 Groundwater

A detailed groundwater impact assessment (GIA) was completed for the Proposed Modification. A detailed assessment of the potential groundwater impacts of the Proposed Modification is provided in the GIA included as **Appendix 11**, with a summary of the key assessment findings included below.

Previous groundwater impact assessments have been completed to address the various Commonwealth and NSW State legislation applying to mine developments since the approval of the Bulga Underground Operations in 2004. This includes the mine's current EPBC approvals 2002/773 and 2012/6637. The Proposed Modification was referred under the EPBC Act and determined by the Commonwealth Minister for the Environment to be a controlled action regarding a water source in December 2018. The aspects considered in the assessment include *Significant Impact Guidelines 1.3 for Coal seam gas and large coal mining developments*.

The GIA has been undertaken with consideration of the AIP. A project is assessed to determine the potential level of impact relative to the considerations in Table 1 of the AIP and identify where further mitigation, prevention or avoidance measures would be necessary to meet the Level 1 minimal impact considerations or, under the Level 2 minimal impact considerations, what further studies are necessary to assess whether the project will not prevent the long-term viability of a relevant dependent ecosystem or significant site. The assessment includes determining the rigour of impact predictions and the suitability of proposed mitigation, prevention or avoidance strategies.

The groundwater assessment updated the site's conceptual hydrogeological model, to reflect the Proposed Modification and used this update to inform and update the numerical groundwater models that have been used to obtain previous approvals (Mackie 2013 and AGE 2016). The three-dimension groundwater model was updated, and a process of model re-calibration and uncertainty and sensitivity analysis was completed. Output from the uncertainty and sensitivity assessment was used to inform the final model modification for the Proposed Modification application. Due to the more contemporary modelling approach, the model represents a conservative approach.

6.7.2.1 Groundwater Resources

There are three general hydrogeological systems across the Project Area:

- alluvial aquifers associated with the Monkey Place Creek and Wollombi Brook which overlie Permian strata and wrap around the south and west of the main mining area
- Warkworth Sands Woodlands, adjacent to the west of the existing Bulga open cut operations and the Mount Thorley mine. This system is interpreted as having a perched water table, positioned over lower permeable Permian and not in hydraulic connectivity with the underlying groundwater system
- the Permian coal measures of the Singleton Super Group which host the mined coal resource and represent outcrop in all areas where regionally mapped alluvium is absent (low yielding, confined aquifers).

Loders Creek and its tributary (Nine Mile Creek), northeast and north of the open cut operations drain to the Hunter River approximately 5.5 km north of the BCM operations. The system is ephemeral and known for increased salinity as flow recedes (Mackie, 2013), and does not include regionally mapped alluvium.

The Jurassic basalt has in some instance provided localised low yielding good quality water supplies but like the Triassic sandstones of the Narrabeen Group and the Hawkesbury Sandstone are not aquifers of relevance to local mining conditions.

Longwall mining operations are mature and approved, and lie west of the central topographic high, while open cut mining, overburden management and tailings storage straddles and lies to the east of the high.

BCM has a substantial groundwater monitoring network which has developed and evolved throughout the operations' life. Observations from this monitoring network are detailed in **Appendix 11**.

6.7.2.2 Methodology

A detailed Groundwater Impact assessment of the Proposed Modification was undertaken by Klohn Crippen Berger (2019) and is provided in **Appendix 11**. Potential groundwater impacts associated with the Proposed Modification were assessed through a numerical simulation code model known as MODFLOW-SURFACT over an area of approximately 358 km^2. The groundwater model used in this study is an update to previous work completed initially by Mackie (2013), and then by AGE (2016a and 2016b). The model was developed to assess the potential impact of the Proposed Modification. A detailed discussion of the groundwater modelling methodology is provided in **Appendix 11**. Key aspects of the modelling approach include the following:

- include the changes associated with the Proposed Modification
- assess changes to local and regional groundwater flow patterns due to the Proposed Modification (i.e. as a result of the expansion of the open cut and tailings relocation
- assess incremental and cumulative changes to potential impacts on groundwater resources of the Proposed Modification, to other users and the environment
- estimate mine inflows to inform the ongoing mine water balance and future mine water demand
- predict the incremental impacts on the water resources of the immediate mine area from the Proposed Modification
- assess the condition of groundwater systems at, or following cessation of mining, in year 2039.

The groundwater model, including the calibration and sensitivity analysis was peer-reviewed by Dr Noel Merrick (Hydroalgorithmics). Dr Merrick's peer review indicates that the modelling has been conducted competently and the model is *fit for purpose.* **Appendix 11** contains the peer review comments and the responses provided by Klohn Crippen Berger.

The three-dimensional groundwater model includes both the Proposed Modification scenario and the previously Approved scenario. The previously Approved scenario includes both approved open cut and underground mines. Comparison of the results of modelling the predicted water inflows and drawdown between the previously Approved scenario and Proposed Modification scenario allows the potential incremental impacts of the Proposed Modification to be identified. Whilst this modelling has not been undertaken to re-assess potential impacts of ongoing approved mining operations, it does provide a prediction of potential cumulative impacts from BCM approved open cut and underground operations, the Proposed Modification and the adjoining Mount Thorley open cut mine.

Both the Project Area and the surrounding areas have been subject to open cut and underground mining operations for over 30 years. This existing mining has already significantly altered the groundwater environment within the vicinity of the Project Area, with the coal seams proposed for mining currently being significantly depressurised.

6.7.2.3 Groundwater Impact Assessment

Predicted groundwater heads in the Wollombi Brook or Monkey Place Creek alluvial indicate negligible difference between the Proposed Modification and the currently Approved scenario. The Proposed Modification case does not appreciably change groundwater conditions in any of the mapped alluvial areas. In the Permian strata, a strong drainage effect toward the final void, as would be expected, is noted in the Proposed Modification model predictions. This is also evident in the approved scenario.

While the Warkworth Sands are assessed as disconnected to the modelled Permian layers, model results for the Proposed Modification suggest that no additional drawdown will occur in the Permian units immediately underlying these sands and no impacts are predicted on the associated Warkworth Sands Woodland vegetation communities resulting from the Proposed Modification.

Incremental impacts of the Proposed Modification on the Alluvial Water Source of Wollombi Brook, including nearby registered private bores, are not predicted to cause exceedances of the Minimal Impact Considerations of the NSW Aquifer Interference Policy.

Heads in the in-pit spoil stockpile increase to reach around 80 mAHD in the northern part of the mine but remain below the current ground level outside of the extent of the mining. This increase for the Proposed Modification results in a predicted hydraulic gradient developing towards the north in the direction of the Mt Thorley mine. Model predictions suggest that despite the development of this gradient, groundwater flow rates in the northern area will remain low (in the order of 1 L/s).

Predicted incremental changes in mine inflows from the transient groundwater model resulting from the Proposed Modification are shown in **Table 6.16**.

Table 6.16 Summary of Mine Inflows

Mine	Seam	Model Layer	Start Year	End Year	Proposed Modification Incremental Impact (ML/year)
Bulga OC	Bayswater	19	1982	2039	346
South Bulga UG	Lower Whybrow	8	1994	2002	-3
Beltana UG	Lower Whybrow	8	2003	2011	-7
Blakefield South	Blakefield	11	2010	2017	-1
Blakefield North	Blakefield	11	2018	2020	-4
Glen Munro	Glen Munro	13	2021	2026	-2
North Woodlands	Woodland Hill	15	2027	2033	138
South Woodlands	Woodland Hill	15	2033	2039	7

As shown in **Table 6.16**, the effect of the Proposed Modification is negligible in terms of the predicted changes to mine inflows resulting directly from the Proposed Modification.

The open cut, in the approved operations plus Proposed Modification scenario, is expected to observe a largely static inflow until about 2023 due to inflows being diminished as underground operations dominate water make. After 2023, as the open cut deepens, inflows progressively increase to a peak of approximately 2,000 ML/year, which then settles to approximately 1,700 ML/year to the end of mining.

Based on a total approved hard rock aquifer allocation held by BCM of approximately 2,400 ML/annum, the predicted cumulative inflow volumes from approved open cut and underground mining operations along with the small incremental increase attributed to the Proposed Modification are predicted to exceed current hard-rock aquifer license allocations held by BCM in 2016 to 2018 (Blakefield South operation), 2020 (Blakefield North operation), 2024 to 2026 (Glen Munro operation) and in 2028 to 2033 (North Woodland operations). On average, cumulative water inflow production across the remainder of the mining life (Approved mines plus Proposed Modification impacts) is predicted to average approximately the amount of current approved hard rock allocation.

Glencore holds significant quantities of transferable hard rock aquifer allocations at other mining operations in the upper Hunter Valley which will be available to transfer to BCM if increased water extraction is required beyond current allocation volumes.

6.7.2.4 Other Groundwater Users

Privately owned registered bores were identified from the NSW Department of Primary Industries Water (DPIW), 2016) database. The closest privately-owned registered bore (GW200120) is located approximately 3.42km south of the Proposed Modification mining area. All identified privately owned registered bores are shown in **Appendix 11**.

Based on the results of the groundwater modelling, there are no registered privately-owned bores located in the area where greater than 2 m drawdown would occur due to the Proposed Modification.

The predicted impacts from the Proposed Modification scenario are summarised as:

- The alluvium impacts are consistently small to moderate due to the strong hydrogeological isolation of this system from the Permian. This is consistent with current monitoring records and supported by model predictions inclusive of sensitivity and uncertainty analysis results;
- The areas of greater than 2 m predicted drawdown are in weathered Permian and alluvium (Beltana Reach), however not near other sensitive users or receptors and there are no externally registered privately owned bores included within the greater than 2 m drawdown;
- Mining induced drawdown impacts in the Permian strata are prominent between the lateral edge of the alluvium and the eastern extent of longwall mining operations, consistent with previous monitoring data; and
- Outside of the mining voids the drawdown impacts are limited and generally considerably less than 2m.

6.7.2.5 Potential Impacts on GDE

There are no proximal springs mapped in the vicinity of the mining area. The nearest mapped spring or GDE is the Parnell spring, which is located about 15 km to the west of the mine in Triassic Sandstone. The nearest mapped wetlands are some 40 km to the east near Maitland. The project-only impact of the Proposed Modification is considered to be negligible to nil to each of these features.

The Warkworth Sands Woodlands Ecological Community (WSWEC) was declared a critically endangered ecological community (CEEC), under section 184 of the EPBC Act, as well as being listed as threatened in New South Wales (Threatened Species Conservation Act 1995). An area of WSWEC is located to the north west of the currently approved Bulga Surface Operations open cut mining area, as shown in **Appendix 11**.

The Warkworth Sands soils which support the WSWEC are perched, thin deposits of aeolian sands lying predominantly over low permeability Permian and weathered Permian rock. The Warkworth Sands are a perched groundwater system overlying low permeable weathered Permian and recharged by rainfall. The model results indicate that the change to Permian groundwater levels as a result of the Proposed Modification in this area is negligible. In addition, the Warkworth Sands are expected to be hydraulically disconnected from the regional saturated groundwater systems.

While the Warkworth Sands are assessed as disconnected from the modelled Permian layers, model results for the Proposed Modification suggest that no additional drawdown will occur in the Permian units immediately underlying these sands, as a result of the Proposed Modification. The model results as well as the probable long-term presence of perched conditions, suggest that it is unlikely that ongoing mining under the Proposed Modification scenario will negatively impact on groundwater conditions in the Warkworth Sands.

6.7.2.6 Summary of Assessment against Aquifer Interference Policy

Predicted groundwater impacts associated with mining have been assessed in relation to the AIP which states that any mining activity must consider 'Minimal Impact Considerations' with respect to groundwater sources. Key criteria to demonstrate minimal harm include:

- less than 10% cumulative variation in the water table in the alluvial lands within 40 m from any high priority GDE or high priority culturally significant site
- a maximum 2 m decline at any water supply work

- no mining activity to be within 200 m laterally from the high bank of a connected stream or 100 m vertically.

Appendix 11 provides consideration against the AIPs Table 1 – Minimal Impact Considerations for Aquifer Interference Activities.

There are two levels of minimal impact considerations specified in the AIP. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable. Where the predicted impacts are greater than the Level 1 minimal impact considerations then the AIP requires additional studies to fully assess these predicted impacts. If this assessment shows that the predicted impacts do not prevent the long-term viability of the relevant water-dependent asset, then the impacts will be considered to be acceptable. If more than 2 m decline is experienced at any water supply works, then make good provisions will be required.

Based on the groundwater modelling, predicted impacts are considered less than the Level 1 minimal impact considerations.

6.7.2.7 Groundwater Management and Mitigation Commitments

BCM have an existing Water Management Plan which addresses all activities associated with the management of water at the BCC. The monitoring network at BCC is comprehensive and reporting obligations are met through regular monitoring.

The groundwater monitoring program currently comprises:

- bi-monthly water level monitoring in all standpipe piezometers including the measurement of electrical conductivity
- continuing monitoring of pressure heads in 15 VWPs
- continuing monitoring of water levels in 22 standpipe piezometers which are equipped with data loggers
- comprehensive geochemical sampling and analysis undertaken on a half-yearly basis in all 49 standpipe piezometers (including major ions and metals).

The existing Water Management Plan will be updated as necessary to accommodate the Proposed Modification. This may include modifying the monitoring network to suit the future needs of the operation, including:

- increased monitoring near the edge of the alluvial in the reach of the northern flow
- more detailed mapping of Loders and Nine Mile creek alluvium, to provide improved conceptual understanding of the easterly and northerly flowing drainages for future groundwater model upgrades
- hydrogeological ground-truthing at the Warkworth Sands Woodlands located to the west, to verify current understanding of perched aquifers of aeolian sand sheet deposits, and assess the suitability of a site for monitoring if warranted
- consideration of establishment of monitoring of perched groundwater aquifer in the event these systems are confirmed to require closer monitoring.

Mining activity to the north of the BCC in the short and long term remains uncertain. The timing of mine development and the nature of post-mining landforms outside of the BCC will affect predictions of impact from the Proposed Modification, and consequent model updates may be required.

6.8 Visual

As discussed in **Section 4.0**, a comprehensive Stakeholder Engagement Program was undertaken as part of the BOP which included consultation with neighbouring landholders and residents, local community groups, businesses, government agencies and other stakeholders. Visual impacts were a key perceived issue identified during the BOP consultation program. For the purposes of the Proposed Modification, further consultation supporting the SIA also identified stakeholder interest in visual impacts of the proposed changes.

As discussed in **Section 2.1.1**, BCM committed to the noise and visual bund which creates a landform between the open cut operations and the Bulga, Milbrodale and Broke areas to mitigate visual impacts associated with the operations. The design of the final landform and noise and visual bund aims to provide a stable landform in keeping with the natural landscape, reducing the visual differentiation between the natural landform and mine-formed landform.

The noise and visual bund will continue to mitigate potential visual impacts associated with mining activities undertaken for the Proposed Modifications.

As outlined in **Section 3.2.3**, it is proposed to relocate some items of infrastructure required for the Bulga Underground Operations to a location south of the Noise and Visual Bund, shown on **Figure 3.8**. This location is the site of some existing underground mine infrastructure including gas flares and associated services (pipes, powerlines, access track etc). The infrastructure items to be relocated include the existing gas fired power generation plant, electrical substation, and an area for storage of underground mine equipment. The chosen site requires minimal disturbance and is bordered by existing vegetation including casuarina and eucalyptus trees which provide broken views of the site from public locations or private residences. The infrastructure to be relocated is of relatively low height, for example the gas fired power generator is housed in three shipping container style of enclosures with a maximum height of approximately 6m above ground level and are coloured a deep olive green. The flares located adjacent to the power station are approximately 8 m high. The closest potential public views of the proposed power station location will be from the top of Cobcroft Road west of the operation and from this location it is estimated that there will be only filtered views through trees of the tops of the flares and power station. BCM will implement additional tree screening at the infrastructure relocation site as required to manage any residual visual impacts.

6.8.1 Visual Impact of Approved Operations

In the vicinity of the BCC the visual environment is generally comprised of mined surfaces, coal related infrastructure (conveyors, mining surface facilities, rail facilities and lines) and other built infrastructure such as high voltage power lines, with a backdrop of wooded areas to the west comprising the Singleton Military Base and the “Vere” elevated ridgeline. Outside of mining land, the local area land uses include agricultural land uses, predominately grazing, viticulture, tourism and hospitality and rural-residential buildings. The Broke/Bulga area has significant contrast in the existing visual catchment with the vegetated elevated slopes and ridges of the Broken Back Range, and Wollemi and Yengo Escarpments framing the Wollombi Brook Valley.

BCM remains cognisant of the potential amenity impacts of its ongoing surface operations on the surrounding area. The Noise and Visual Bund around the western and southern perimeters of the open cut pit was a key design feature of the BOP, designed to act as a visual screen and reduce noise impacts for residents in the villages of Broke, Milbrodale and Bulga to the south and west of the mine. The final bund landform was designed to integrate with the shape and character of the surrounding natural landscape in keeping with the natural terrain features of the area.

The Noise and Visual Bund is approximately 9.5 km long and its elevation varies between 30 and 70 m above the natural ground surface. The Noise and Visual Bund was expected to be completed by 1 December 2018. An extension of timing for completion of the Noise and Visual Bund was approved on 30 August 2018 (SSD 4960 Mod 2), allowing the outer face of the noise and visual bund to be emplaced and rehabilitated by the end of August 2019.

With the exception of the eastern emplacement area, the majority of the mining infrastructure and operations are screened from views from the north and east of the site by the existing topography and vegetation. The existing operations currently result in a night time glow, which affects the night time visual amenity.

The visual impacts of the BCC are currently managed within the context of the approved *Visual Impact Management Plan* (BCM, 2018) as required under SSD 4960.

6.8.2 Potential Visual Impact of the Proposed Modification

The key aspects of the Proposed Modification that may have the potential to result in visual impacts include:

- emplacement of overburden associated with minor landform changes including raising the main central overburden emplacement 10 m above its current approved height, which may be associated with views of mobile plant and equipment, exposed surfaces, dust and night lighting
- rehabilitation, which may be associated with views of mobile plant and equipment and regenerating vegetation
- prioritising rehabilitation of the outer faces of emplacement areas which are visible to the surrounding areas.

A combination of these activities will occur throughout the life of the Proposed Modification as each of the active mining areas progress and the overburden emplacement areas progressively achieve their final landform and are rehabilitated. It should also be noted that views of the approved and proposed mining operations are largely obscured by the approved noise and visual bund.

6.8.3 Visual Assessment Methodology

To assess the potential visual impacts of the Proposed Modification a series of radial analyses and visual montages were prepared from the same viewing locations used in previous visual assessment studies for BOP (where possible) and a comparison to the visual montages prepared for the BOP is provided in **Appendix 12**. Radial analyses were developed using 3D topographic information and electronic data files relating to the Proposed Modification to identify the theoretical extent of potential views based on topography in comparison to the approved operations. The radial analyses illustrate what parts of the landscape are visible from a height of 1.7 m at that location (i.e. from average eye height).

Some locations used an elevated eye height to simulate viewing from the verandah of a residence in circumstances where a verandah is elevated above a typical single storey house height, such as for a double storey house or steeply sloping land. It should be noted that the radial analyses are topography-based only and do not include vegetation which may in fact screen a portion of a viewshed. Radial analyses were completed using consolidated mine plans for the years 2022, 2026, 2031, 2035 as well as the final landform to gauge the potential visual impact from targeted viewpoints relative to the approved operations.

At locations where increased visibility of the mining operations (as modified) were identified from radial analyses and photographs, visual montages were subsequently developed using a panoramic photograph (made using a series of individual photos), 3D topographic information, and electronic data files pertaining to the Proposed Modification. Constructing visual montages of 'before and after' scenarios illustrates the existing landscape and provides a comparison landscape including the Proposed Modification in comparison to the Approved Operations at comparative stages of the mining operations and any additional visual amenity management measures that may be required.

Of the eleven visual locations included in the BOP assessment, the assessment indicated that five have the potential for increased visibility associated with the Proposed Modification and there would be no increase in visibility of the modified mining operations, in comparison to that approved mining operations from six locations at any stage of the Proposed Modification. The BOP and Proposed Modification visual assessment locations are illustrated on **Figure 6.8**.

The radial analysis indicates that due to the construction of the approved noise and visual bund and/or the approved overburden emplacement areas, there will be no increased visibility of the proposed operations relative to the approved operations, therefore no further assessment has been undertaken from the following visual assessment locations:

1. Butlers Road – representative of the residences north of Broke Village located in a rural setting.
2. Intersection of Broke Road and Charlton Road – a representative location for assessment for road users travelling from Broke in a northerly direction and either continuing along Broke Road or turning at the intersection onto Charlton Road.
4. Fordwich Road –This location point was selected for the BOP as it was a prominent vantage point for the existing Bulga Surface Operations with a high potential visual impact associated with the approved operations. The radial analysis indicates that due to the construction of the approved noise and visual bund there will be no increased visibility of the proposed operations relative to the approved operations, therefore no further assessment has been undertaken.
6. Cobcroft Road – provides a representative view from a high vantage point which captures the view from the road for motorists travelling along Cobcroft Road.
10. Gromor facility (Mitchell Line of Road) – representative of views from the Gromor facility and road users travelling in either direction on Mitchell Line of Road.
11. Mitchell Line of Road – provides an additional representative viewshed from Mitchell Line of Road for residences along this road and road users travelling in either direction.

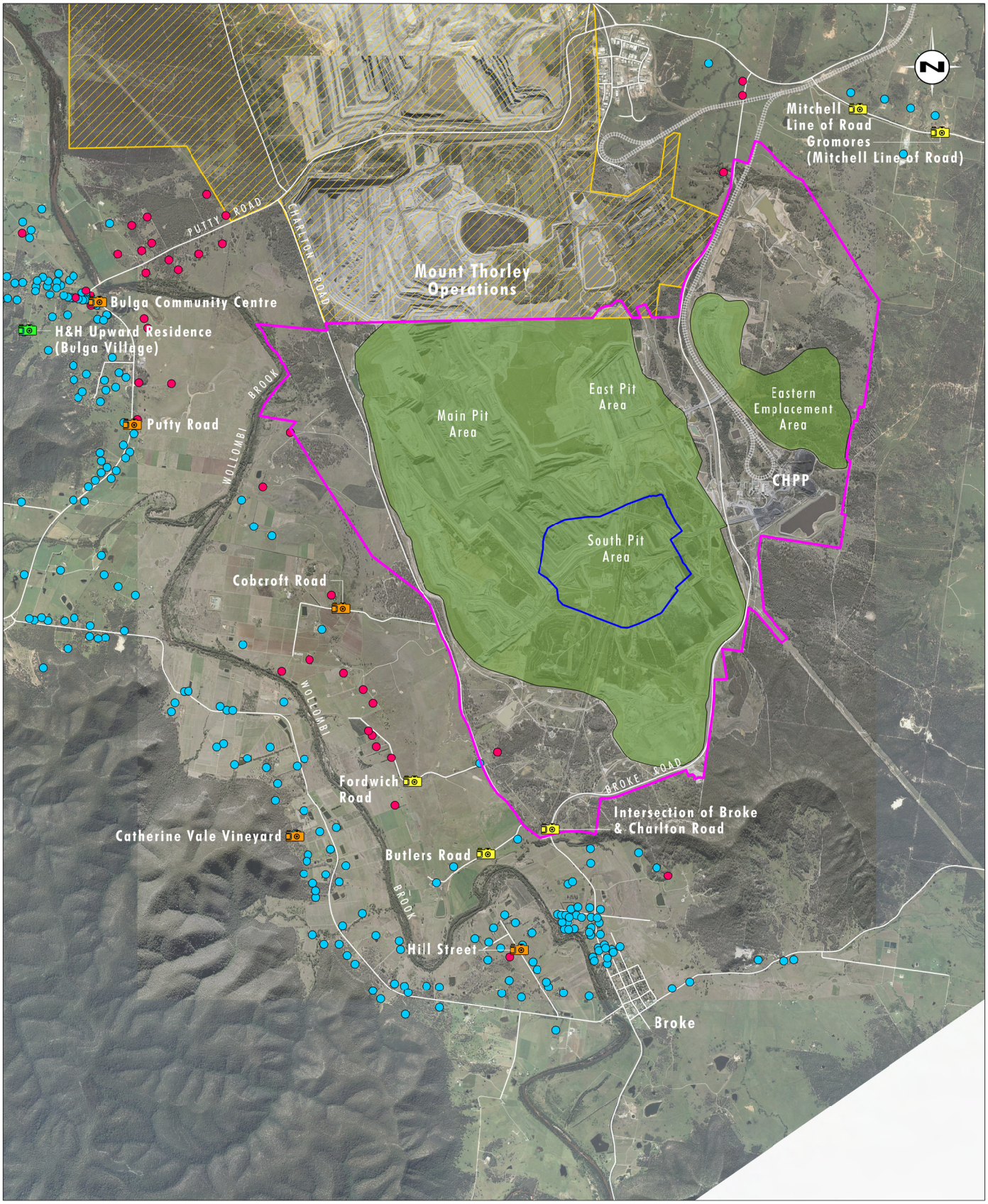

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1 2 4 km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Mt Thorley Operations
- Visual Location Points Approved Operation
- Visual Location Points Approved Operations and Proposed Modification
- Visual Location Point Proposed Modification
- Private Residence Location
- Mine Owned Residence Location

FIGURE 6.8

Visual Location Points

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20190903 15.56

The radial analysis indicates there will be minor increased visibility associated with the change in overburden emplacement associated with the Proposed Modification at the following location points:

3. Hill Street, Broke – provides a representative location for residents on the eastern end of Milbrodale Road and a worst-case scenario for residents in this location.
5. Catherine Vale Vineyard – provides a representative vantage point for those properties located on the uphill side of Milbrodale Road.
7. Putty Road, Bulga – representative of views for road users travelling in either direction and for residences along this road.
8. Residence in Upper Bulga Village – representative of the views from a high vantage point within Bulga Village.
9. Bulga Community Centre –representative of a local meeting place and residences in its vicinity.

6.8.4 Visual Assessment Results

Visual amenity assessment results for the five representative viewing locations are described below.

6.8.4.1 Visual Location Point 3 - Hill Street, Broke

Figure 6.9 illustrates the radial analysis from a location on Hill Street in Broke, which is located south of the existing Bulga surface operations. The radial analysis from the locality on Hill Street indicates that the majority of the approved operations are not visible from this location due to the approved Noise and Visual bund. The Proposed Modification will result in distant glimpses of the overburden emplacement area becoming visible due to the minor changes associated with the proposed landform. These views are long distance and are considered to be only a minor change to the approved landform.

Visual montages from the Hill Street location (refer to Figures 1 and 2 in **Appendix 12**) show the following:

Existing view – The existing view from Hill Street includes the approved Noise and Visual Bund which is visible for the central part of the viewshed, with the remainder of this view shielded by existing established vegetation.

Approved Year 3 view – corresponding to the existing view, includes the approved noise and visual bund (as currently viewed).

Year 2026 – A small area of active overburden emplacement is visible in the central and left part of the viewshed from Year 2026, not previously visible as a result of the approved operations. However, as illustrated by the visual montage, the increased visibility of the overburden emplacement area is very minor and results in only a minor increase relative to the approved operations. Additionally, the existing treed vegetation is expected to assist in reducing the potential visual amenity impacts.

Year 2035 – Final Landform - there is no active overburden emplacement visible from this location due to the area being rehabilitated and the proposed changes to the landform do not significantly alter the appearance of the proposed final landform relative to the approved final landform.

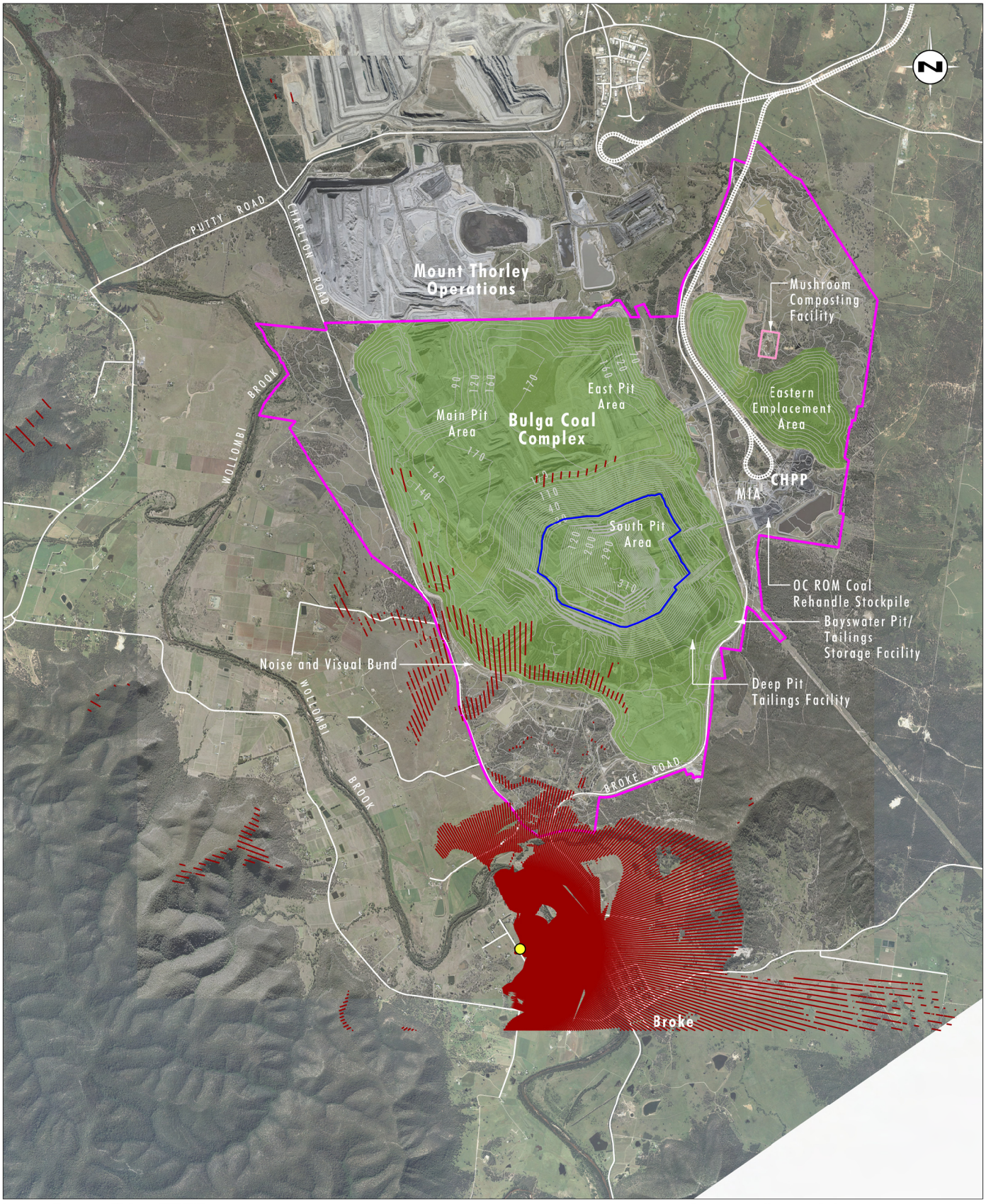

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Visual Location
- Terrain Visible from Visual Location

FIGURE 6.9

Visual Location
Point 3 - Hill Street

6.8.4.2 Visual Location Point 5 - Catherine Vale Vineyard, Milbrodale Road

Figure 6.10 illustrates the radial analysis from the cellar door verandah of the Catherine Vale Vineyard on the uphill side of Milbrodale Road, south west of the existing Bulga surface operations. The radial analysis suggests minor areas of overburden emplacement will be visible, relative to the approved operations, to the west and behind the noise and visual bund.

Visual montages from the Catherine Vale Vineyard (refer to Figures 3 and 4 in **Appendix 12**) illustrate the following:

Existing view –The existing view from the Catherine Vale Vineyard is dominated by rural properties and vegetation with the approved Noise and Visual Bund which obscures views of the approved operations.

Year 2031 – From 2031, there will be a minor increase in the visibility of the overburden emplacement areas to the west and central to the viewshed from this location point relative to the approved operations. However, the existing vegetation and rehabilitation of the approved Noise and Visual Bund will make it difficult to differentiate between the natural landform and mine-formed landform resulting in an overall low level of visual amenity impact.

Final Landform – Figure 3 in **Appendix 12** provides a comparison between the approved and proposed final landform, although there are minor changes to overburden emplacement associated with the Proposed Modification, these minor changes have no effect on the design and appearance of the final landform.

6.8.4.3 Visual Location Point 7 - Putty Road, Bulga

Figure 6.11 illustrates the radial analysis from location point 7 on Putty Road, to the west of the existing Bulga surface operations. The approved noise and visual bund blocks the view of the majority of the approved operations from this location point, as a result of the Proposed Modification there will be a minor increase in the visibility of overburden emplacement areas beyond the noise and visual bund.

Visual montages from Putty Road (refer to Figures 5 and 6 in **Appendix 12**) illustrate the following:

Existing view – The existing view from the location on Putty Road includes the Noise and Visual Bund and active overburden emplacement areas associated with the adjoining Mount Thorley operations.

From Year 2022 to Year 2035 – As a result of the Proposed Modification there will be a minor increase in the visibility of overburden emplacement areas beyond the noise and visual bund.

Final Landform –Although minor changes to the landform will result from the changes to the overburden emplacement areas as part of the Proposed Modification, there will be only minor changes to the appearance of the final landform from this location point, relative to the approved final landform, refer to Figure 6 in **Appendix 12**. Consistent with the approved operations, it is anticipated that the progressive rehabilitation to achieve the final landform will lower the level of visual amenity impact at the Putty Road location.

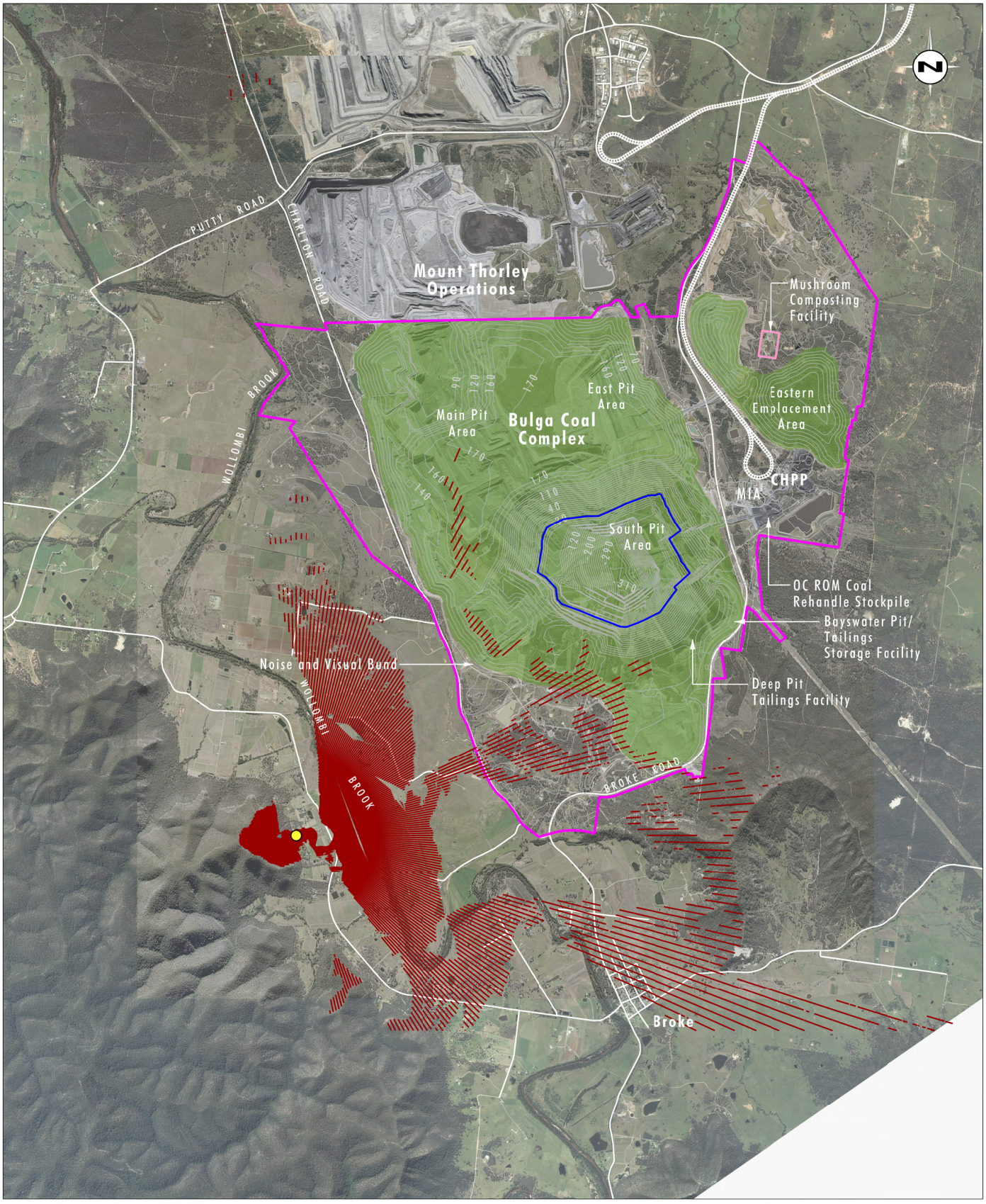

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Visual Location
- Terrain Visible from Visual Location

FIGURE 6.10

Visual Location
Point 4 - Catherine Vale Vineyard Verandah

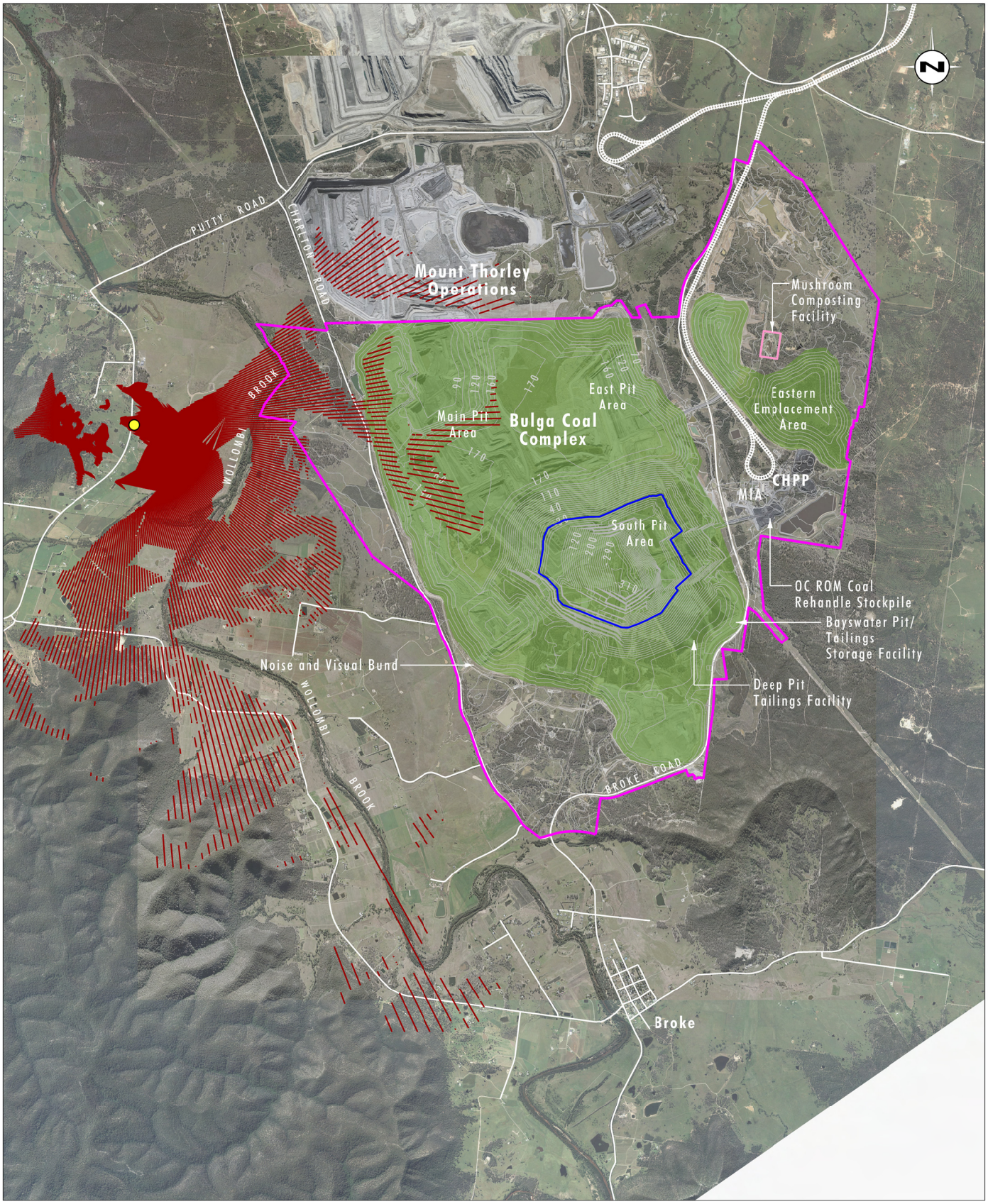

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Visual Location
- Terrain Visible from Visual Location

FIGURE 6.11

Visual Location
Point 6 - Putty Road

6.8.4.4 Visual Location Point 8 - Bulga Village

Figure 6.12 illustrates the radial analysis from a residential location within the upper area of the Bulga Village, west of the existing mining operations. The approved mining operations are largely obscured from view at this location due to the approved noise and visual bund and existing established vegetation. Large areas of the adjacent Mount Thorley Operations are also visible from this location.

Visual montages from Bulga Village (refer to Figures 7 and 8 in **Appendix 12**) illustrate the following:

Existing view – the existing view from the residential location within Bulga Village includes the approved Noise and Visual Bund on the southern side of the viewshed. Mining activity visible on the northern side of the viewshed is the Mount Thorley Operations. Existing established vegetation provides shielding across the foreground for the majority of the viewshed.

Year 2022 to Year 2035 – there will be minor changes to the landform over the proposed modification which will result in the active overburden areas being slightly more visible (beyond the noise and visual bund) relative to the approved operations (refer to Figure 10 in **Appendix 12**) It should be noted that the established vegetation on the noise and visual bund and the fact that the majority of the viewshed is shielded by existing established vegetation will lower the level of visual amenity impact associated with the Proposed Modification at this location.

Final Landform – Figure 8 in **Appendix 12**provides a comparison of the approved and proposed final landform. Although minor changes to the overburden emplacement areas will result in these areas being slightly more visible over the life of the modified operations, there will be minimal change to the appearance of the proposed final landform relative to the approved final landform. The final landform and noise and visual bund design ensures that the proposed landform is consistent with the surrounding landscape, making it difficult to differentiate a between the natural and man-made landform.

BCM has consulted with a number of the residents situated in elevated locations and provided radial analysis as requested to help better explain the potential exposure. An additional photomontage (refer to Figure 9 in **Appendix 12**) was provided for residents of a Bulga Village property (refer to **Figure 6.8**) to better represent the visual impacts from their main view point being the verandah of their house.

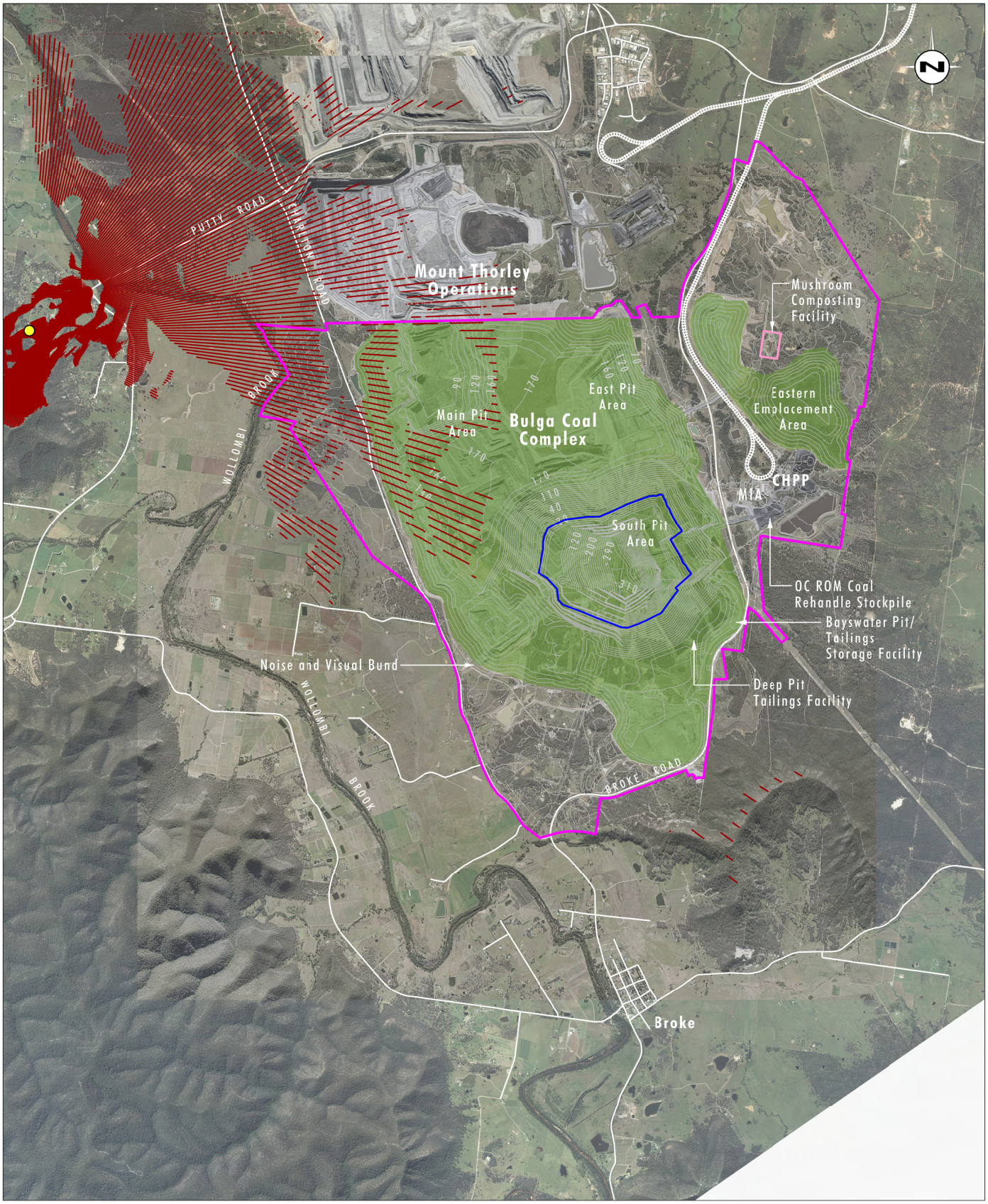

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Visual Location
- Terrain Visible from Visual Location

FIGURE 6.12

Visual Location
Point 8 - Bulga Village

6.8.4.5 Visual Location Point 9 - Bulga Community Centre

Figure 6.13 illustrates the radial analysis from the Bulga Community Centre in Bulga Village, north-west of the existing Bulga Surface Operations. The analysis illustrates that the Majority of the mining operations are obscured by the Noise and Visual Bund with restricted views of the overburden emplacement area visible from this location. The visual montage sequence constructed from this visual location (refer to Figures 9 and 10 in **Appendix 12**) illustrates the following:

Existing view – the existing view from the Bulga Community Centre includes a portion of the existing Noise and Visual Bund with areas of inactive overburden emplacement and areas of rehabilitation, however the existing established roadside vegetation provides a shield for the majority of the viewshed.

Year 2022 to Year 2035 – Minor changes to the overburden emplacement areas as a result of the Proposed Modification will result in minor increase to the visibility of the overburden emplacement areas in this location, however the established vegetative cover will continue to assist in keeping visual impacts low. Additionally, the final landform has been designed to fit within the existing landscape profiles, making it difficult to distinguish the natural landscape from the mine-formed landscape.

Final Landform - Figure 12 in **Appendix 12** provides a comparison of the appearance of the approved and proposed final landform from this location point. Although minor changes to the overburden emplacement areas will result in these areas being slightly more visible over the life of the modified operations, there will be minimal change to the appearance of the proposed final landform relative to the approved final landform. The designs of the final landform and noise and visual bund, have been developed such that the noise and visual bund and the proposed landform is consistent with the surrounding landscape, making it difficult to differentiate between the natural and the final man-made landform.

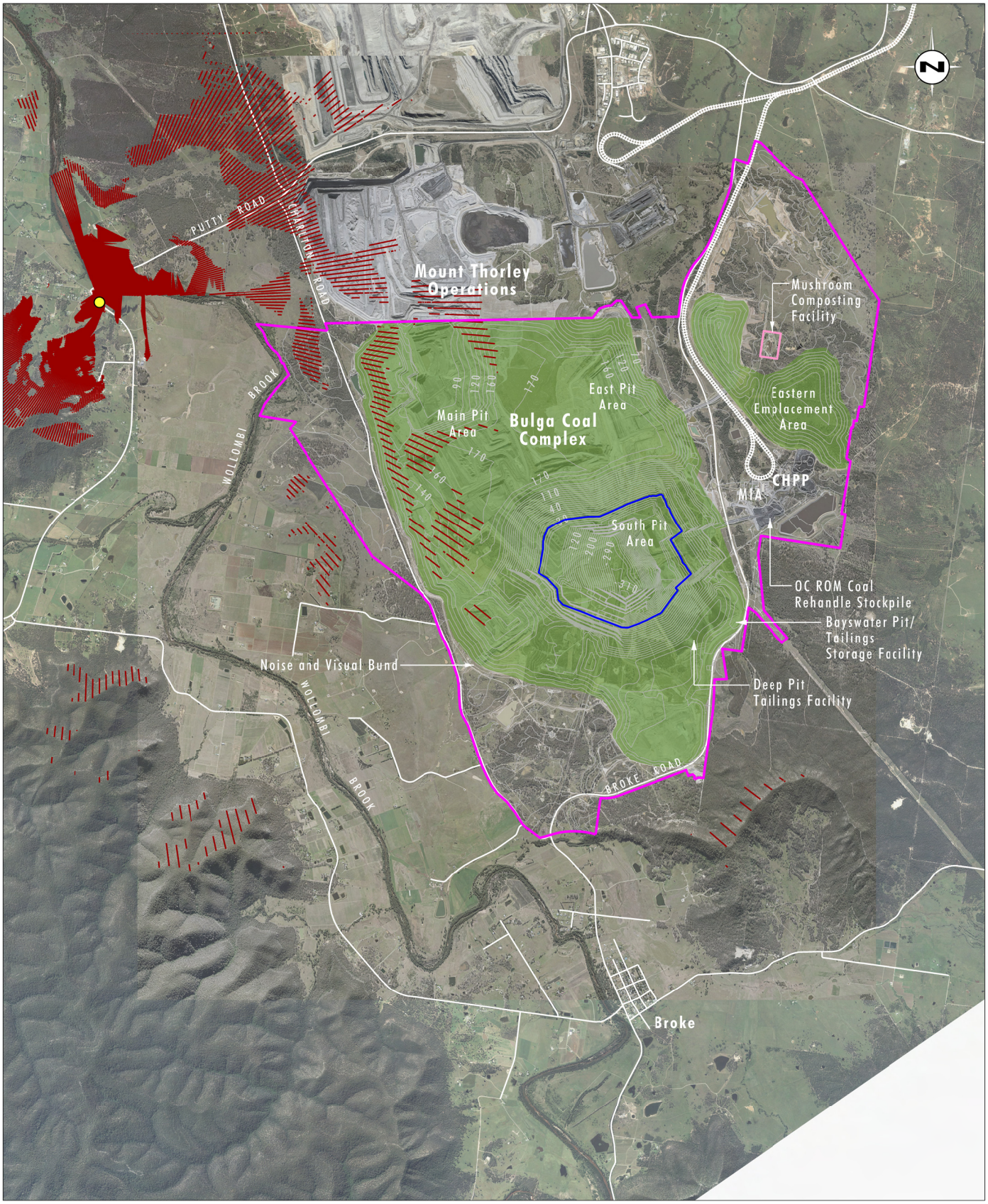

Image Source: Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Maximum Modelled Pit Lake Level
- Rehabilitation
- Visual Location
- Terrain Visible from Visual Location

FIGURE 6.13

Visual Location
Point 9 - Bulga Community Centre

6.8.5 Night-time Scenic Quality

The approved 24-hour mining operations at the BCC currently result in a night time glow which, along with that produced by adjacent mining operations, affects the local night time visual amenity. To manage these impacts, BCM has implemented a range of measures to reduce the impact on the scenic quality of the area including significant planting, the use of shields, louvres and directional lighting.

Permanent lighting will continue to be required for the existing infrastructure which includes the CHPP facility and other fixed infrastructure areas including coal handling conveyors and stockpiles during night time operations. Mobile lighting will also continue to be required in active mining areas during night time operations. This is provided by mobile lighting plants and equipment headlights. Generally, mobile lighting plants are located in-pit and screened from nearby viewpoints. The approved Noise and Visual Bund also serves to screen night lighting from the residences to the west, south west and south of the mine.

As is the case with the Approved Operations, ongoing management will continue to be required at active emplacement areas that are visible from public roads to ensure that mobile lighting does not impact on road users. This is typically managed by pointing lights away from public roads and through the use of shields/louvres and through directing the lights down at operational areas.

Consistent with the approved operations lighting will be kept to the minimum required for operational needs and safety. All permanent lights will continue to have shields and all lighting will be directed down onto working areas to ensure that fugitive light emissions are limited. All lighting will continue to be installed and maintained in accordance with the relevant Australian Standard (Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting) over the life of the Proposed Modification.

6.8.6 Impact Summary and Visual Mitigation Controls

The visual assessment has indicated that views of the site from many of the public viewing locations are currently obscured by the approved Noise and Visual Bund and there will be either no increase or only minor changes to the visibility of the active and inactive overburden areas. Over the various stages of the Proposed Modification, minor changes to overburden emplacement will occur which will result in the overburden areas being visible from some locations, although this change is minor relative to the approved operations. The design of the final landform and Noise and Visual Bund aims to provide a stable landform in keeping with the natural landscape, reducing the visual differentiation between the natural landform and mine-formed landform. This results in a lowering of the overall level of visual amenity impact.

Visual mitigation controls will continue to be implemented including:

- progressive rehabilitation to reduce the duration of visible soil exposure, including the use of temporary rehabilitation as appropriate
- planting of appropriate vegetation or other screening to reduce views of mining infrastructure
- ongoing management of mobile lighting to reduce the impacts of lighting at night, including the use of shields as required and the ongoing implementation of procedures about the appropriate placement of mobile lighting plant
- night lighting will be kept to a minimum needed for operational management and safety to limit the extent of night lighting glow
- all lighting will be installed and maintained in accordance with Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting.

6.9 Aboriginal Cultural Heritage

Bulga Coal Management Pty Ltd (BCM) and Umwelt would like to acknowledge the Traditional Owners of the Project Area – the Wonnarua people – and pay respect to their cultural heritage, beliefs and continuing relationship with the land.

We also acknowledge and pay respect to the post-contact experiences of Aboriginal people with attachment to the Project Area and surrounds.

We pay respect to the Elders, past and present, for they hold the memories, traditions, culture and hopes of Aboriginal people in the area.

We thank the Registered Aboriginal Parties, their families and elders for their engagement in this Project.

The BCC is located within the traditional homelands of the Wonnarua, whose history extends from the present day back many thousands of years. The Project Area, including the additional disturbance areas, is also within the modern day Wanaruah Local Aboriginal Land Council boundary. Through the involvement of RAP who identify a range of connections to both Country and community, and through a number of past heritage investigations, the BCC is understood to contain a range of sites and areas of cultural, historic and aesthetic value, and to contain archaeological sites and features that are of cultural and scientific value.

An ACHA was prepared by Connect for Effect in collaboration with some of the RAP to assess the Aboriginal cultural heritage values of these RAP as part of BOP. It is noted that the Project Area for BOP which was considered in the BOP ACHA included the additional disturbance area associated with the Proposed Modification. Two knowledge holder groups, The Plains Clans of the Wonnarua People (PCWP) and the Wonnarua People (WP), also undertook their own Aboriginal cultural heritage values assessment reports which incorporate the cultural, historic and aesthetic values of the members (including RAP individually registered separately, plus other members) of these groups which were not captured by the ACHA. At the request of these two groups, all parts of the assessment reports completed for BOP, other than the sections related to management recommendations, are to be kept confidential for cultural reasons.

An Aboriginal Archaeological Values Assessment was also prepared by OzArk Environmental and Heritage Management (OzArk) to assess the scientific (archaeological) value of sites and artefacts identified within the Project Area for BOP, which also included the additional disturbance are for the Proposed Modification.

An ACHA was prepared by OzArk in collaboration with the RAP and Knowledge Holder groups to assess the Aboriginal cultural heritage values for the Proposed Modification (refer to **Appendix 13**).

The Aboriginal community consultation for the BOP included identified Knowledge Holder groups presenting their cultural values. As well, the cultural values of the wider Aboriginal community were also sought. This comprehensive assessment, encompassing the study area for the Proposed Modification, identified a number of culturally significant places. While none of these are located within the additional disturbance area for the Proposed Modification, this previous work enables the Proposed Modification to draw on this body of knowledge to ensure that significant cultural places will not be harmed during the proposed work.

Throughout all stages of the assessment process, the RAP were invited to identify how they would like to participate in the Aboriginal cultural heritage assessment process for the Proposed Modification, including what cultural information they wanted to share to inform the assessment process, and what information (if any) should remain non-disclosed in the assessment and reporting process.

6.9.1 Study Methodology

The ACHA was designed to satisfy the requirements of:

- *National Parks and Wildlife Act 1974* (NPW Act)
- *National Parks and Wildlife Regulation 2009* (NPW Regulation)
- the principles of the Burra Charter (Australia ICOMOS 2013)
- *Code of Practice for the Investigation of Aboriginal Objects in New South Wales* (DECCW 2010a)
- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011)
- *Code of Practice Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010b).

The ACHA concentrated on those landforms within the Proposed Modification that have been minimally impacted by approved mining activities and are not approved for disturbance as part of the BOP under SSD 4960. This generally comprises the additional disturbance area which includes two non-contiguous areas to the south west and to the east the Deep Pit TSF. In addition this report covers the 'infrastructure study area' that includes the route of a power line and the footprint of the proposed relocation of an existing power station under the Bulga Underground consent that are proposed to be relocated. The additional disturbance area is approximately 20.2 ha in size and the infrastructure study area is approximately 7.5 ha in size. This equates to a total assessment area of approximately 27.7 ha. It should be noted that the 7.5 ha associated with the infrastructure is already approved to be disturbed.

It is noted that portions of the infrastructure study area were assessed for BOP, however, the whole area has been reassessed as part of the assessment for the Proposed Modification for completeness.

The purpose of the study was to identify and assess heritage constraints relevant to the proposed works within the additional disturbance area and infrastructure study area.

Aboriginal community consultation followed the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010b). In the evaluation of the cultural values of the study area, the assessment also relied on the extensive consultation for the BOP that included landforms surrounding the study area. A full consultation log is included as an appendix to the ACHA.

6.9.2 Aboriginal Community Consultation Process

As outlined above, the current ACHA for the Proposed Modification draws on the body of knowledge previously assessed as part of BOP. Consultation with the Aboriginal community was undertaken with reference to the relevant DEC 2005 and DECCW 2010 guidelines and in accordance with the principles of The Burra Charter (Australia ICOMOS 2013).

In accordance with OEH guidelines, consultation has involved:

- **Stage 1:** Aboriginal parties with an interest in the Project were identified and registered.
- **Stage 2:** BCM and OzArk provided information about the Project to all RAP.
- **Stage 3:** BCM and OzArk developed a methodology for the assessment of Aboriginal cultural heritage in the study area. BCM and OzArk provided the methodology to the RAP for review and comment. OzArk carried out archaeological surveys of the study area along with two RAP.

- **Stage 4:** BCM and OzArk sought review and comment by RAP of the draft ACHA report, including values recorded from the BOP assessment process.

A full list of all RAP and consultation is contained in **Appendix 13**.

6.9.3 Previous Aboriginal Heritage Studies

An extensive history of Aboriginal cultural heritage and archaeological assessments has been conducted within the Project Area and immediate surrounds. In recent decades, the Upper Hunter Valley, has become one of the most intensively studied regions in NSW with numerous archaeological surveys and excavations conducted in advance of proposed mining activity. This body of research has identified numerous archaeological sites, and provides a broad understanding of archaeological site patterning at local and regional levels.

The Aboriginal Archaeological Values Assessment for BOP provides an overview of the extensive history of past archaeological research undertaken within the Project Area, a summary of key information on investigation type and area, and number of recorded archaeological sites.

The assessment area for the BOP covered approximately 3615 ha and portions of the assessment area were located directly adjacent to portions of the additional disturbance area.

Connect for Effect were engaged by BCM to undertake Aboriginal community consultation for the BOP assessment and to author the ACHAR (Connect for Effect 2013) to which OzArk 2013 contributed. Also contributing to the ACHAR were confidential cultural values assessments authored by two Wonnarua Knowledge Holder groups, the PCWP and the WNAC. Connect for Effect 2013 contains the cultural, aesthetic and historic values of the area, while OzArk 2013 contains an examination of the scientific values of the area.

6.9.4 Landscape Context

An understanding of the environmental context of a study area is requisite in any Aboriginal archaeological investigation (DECCW, 2010a). It is a particularly important consideration in the development and implementation of survey strategies for the detection of archaeological sites. In addition, natural geomorphic processes of erosion and/or deposition, as well as humanly activated landscape processes, influence the degree to which these material culture remains are retained in the landscape as archaeological sites; and the degree to which they are preserved, revealed and/or conserved in present environmental settings.

A review of the environment of the study area and surrounding landforms presents a landscape that has been extensively disturbed and modified; both as a result of agricultural practices and approved mining associated activities. As such, the study area presents a landscape unlikely to retain any form of structural integrity. As the study area is located away from permanent water sources in undifferentiated landforms, the likelihood of the study area containing large, complex sites is dramatically lowered. In the region, landform units away from water, such as ridgelines, can contain sites, however, these are absent from the study area.

While smaller, more transient sites may have once existed in the study area, it is likely, due to the widespread disturbances from both agriculture and mining, that these sites have either been previously destroyed or dispersed.

6.9.5 Aboriginal Archaeology Background

The study area is located in the Wonnarua tribal area of the upper Hunter Valley.

Using ethno-historic sources, Brayshaw (1986) has shown that the Wonnarua people lived in an environment rich in food resources. A diverse diet was obtained by eating freshwater fish, shellfish, retiles, mammals, birds and plant food. Brayshaw (1986) suggests that inland groups visited the coast during the summer when marine resources were plentiful, and coastal groups travelled inland to participate in the winter kangaroo hunts. Trade and/or exchange also occurred between the coastal and inland groups. Reed spears and shells were traded inland for possum skin rugs and fur cord (Brayshaw 1986). Social gatherings were a feature of Aboriginal life in this area.

In a regional context, within the Upper Hunter Valley, Aboriginal site types such as isolated finds and artefact scatters are the most common. They are generally identified through erosional processes, which also act to remove the stratified and datable context of archaeological sites.

On a local scale, the large number of archaeological studies undertaken within the vicinity of the study area provides information to obtain a sound understanding of the nature and distribution of archaeological sites within the area. Although there is some conjecture about the relationship between stream order, site numbers and densities, the general pattern is that the majority of sites are present within 30 m of watercourses (Dean-Jones 1992; AMBS 1997). Although sites are present in locations at a greater distance from water, these sites are limited in terms of both number and size, constituting a lower density scatter than is found along the creek lines (Dean-Jones 1992; ERM 1999). The majority of sites are small, with larger sites typically found in association with permanent watercourses. Reduced visibility has been proffered as an explanation for the higher number of sites and artefacts present along the more heavily eroded and less vegetated minor watercourses as compared to major creeks (Umwelt 2004; ERM 1999).

6.9.6 Scientific (Archaeology) Assessment

The survey of the study area recorded two new Aboriginal sites and located four previously recorded AHIMS sites. The newly recorded sites are isolated finds and were recorded within the eastern portion of the additional disturbance area. Details of all sites are provided in **Table 6.17** below.

Table 6.17 Aboriginal Archaeology Survey Results

AHIMS Site ID	Bulga Site ID	Site Type	Location
AHIMS #37-6-3763	Bulga IF-2	Isolated mudstone flake	Additional disturbance area
AHIMS #37-6-2844	BOP OS-10	Artefact scatter	Infrastructure study area
AHIMS #37-6-1659	BP L5	Artefact scatter	Infrastructure study area
AHIMS #37-6-1660	BP L6	Isolated chert core	Infrastructure study area
Awaiting AHIMS ID	Bulga IF3	Isolate mudstone core	Additional disturbance area
Awaiting AHIMS ID	Bulga IF4	Isolated silcrete flake	Additional disturbance area

The predictive model formulated by OzArk suggested that the study area's distance from a permanent water source would indicate that stone artefact sites would be sparse and of low density. Additionally, the area's long agricultural history and the recent impact of mining have resulted in disturbances including: vegetation clearance, grazing, cultivation, service corridor and infrastructure installation, erosion, and mining related activities such as bunds and dams. These have combined to create landform modifications that have affected the integrity and density of Aboriginal sites. Likewise, the absence of scarred trees is due to a lack of endemic trees of sufficient age for Aboriginal cultural scarring throughout the study area due to land clearance.

The survey results support the predictive model that suggested that the study area's distance from a permanent water source would indicate that stone artefact sites would be sparse and of low density. Given that only a low number of new Aboriginal sites with a low artefact density were recorded, and that a high degree of land use and landform modification was noted, there is a low likelihood that intact subsurface archaeological deposits are present within the study area.

6.9.6.1 Assessment of 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 any proposed developments. Cultural, scientific, aesthetic and historic significance are identified as baseline elements of significance 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 new Aboriginal sites identified during the field survey were assessed for significance, as detailed in **Table 6.18** below. The significance assessment undertaken for the previously recorded Aboriginal sites is based on revisiting the sites during the recent field survey, and details on their site cards.

Table 6.18 Significance Assessment

Site ID	Site name	Social or Cultural Value	Archaeological/ Scientific Value	Aesthetic Value	Historic Value
#37-6-3763	Bulga IF-2	High	Low	Low	Low
#37-6-2844	BOP OS-10	High	Low	Low	Low
#37-6-1659	BP L5	High	Low	Low	Low
#37-6-1660	BP L6	High	Low	Low	Low
Awaiting AHIMS ID	Bulga IF3	High	Low	Low	Low
Awaiting AHIMS ID	Bulga IF4	High	Low	Low	Low

A series of guidelines have been developed by DP&E to quantify and standardise impact assessments (DPE 2016). The rubric outlined in DPE 2016 leads to all impacts being graded within a matrix to arrive at a standardised 'value of impact'. Using this method, the proposed impact on the newly recorded sites, Bulga IF3 and Bulga IF4, has been evaluated as having a low overall heritage value.

It needs to be borne in mind that the conclusion stating that the Proposed Modification has a 'low value' of heritage impact is not a reflection that artefacts or sites are considered to have a 'low value', rather that the loss of heritage value has a 'low value' when considered at a regional setting. It is accepted that the Aboriginal cultural heritage sites discussed within the report are part of the Aboriginal cultural landscape of the area, and that they are linked and collectively tell an important story about the Aboriginal use of the area. As a result, they are significant and valued by Aboriginal people and should ideally be protected. However, if they must be impacted, then the sites under discussion here have a 'low value' in that they can add little to our knowledge or understanding of this Aboriginal cultural landscape.

6.9.7 Aboriginal Cultural Heritage Impact Assessment

Consultation for the BOP was extensive and included identified Knowledge Holder groups preparing their own cultural values assessments. As the BOP Project Area encompasses the Proposed Modification's study area, the BOP Aboriginal community consultation, and the information gained, is applicable to the current study.

The BOP EIS included the following statement regarding the cultural connections to the BOP Project Area, of which the additional disturbance area is a part:

The RAPS consulted for the (BOP) Aboriginal Cultural Heritage Assessment (ACHA) identified a range of cultural values and attachments to the (BOP) Project Area and the broader region, ranging from traditional connection to the area, historical attachments, connection to the traditional homelands (Country), connection to the community, and reconnecting attachments.

In identifying their cultural values of place, some RAPs focused on the significance of the (BOP) Project Area as a whole, rather than the individual places and objects, stating that the (BOP) Project Area and all components within it and external to it can only be understood as part of a larger cultural landscape defined by its cultural, spiritual and social connectivity.

...RAPs identified the (BOP) Project Area to be of high social, cultural and spiritual significance to Traditional Owners and Knowledge Holders and other RAPs, because it has spiritual and ceremonial associations to extremely high value sacred Creation and ceremonial places within the region".

Key cultural values identified in the cultural values assessment included the Loders Creek grinding grooves and the significance of items in the cultural landscape located outside of the Project Area such as Baiame Cave and Lizard Rock. None of these locations are within the study area for the Proposed Modification.

6.9.8 Management and Mitigation

BCM currently operates under an ACHMP prepared in consultation with RAP. The management measures align to the Principles of the Burra Charter and to the Aboriginal Community Wellbeing toolkit and criterion.

The complete impact avoidance of newly recorded Aboriginal sites and the previously recorded AHIMS sites by the Proposed Modification is not considered feasible. The BCC ACHMP will be updated to include all additional components of the study area (additional disturbance area and infrastructure study area), and will include conditions for the management of the surface artefacts prior to the commencement of the Proposed Modification. Management and mitigation of the Aboriginal sites associated with the Proposed Modification will be undertaken in consultation with the Aboriginal community as per Section 3 of the ACHMP.

6.10 Historic Heritage

A comprehensive assessment of the potential impacts of the Bulga Surface Operations on historic heritage values was prepared as part of the BOP EIS (Umwelt, 2013). The Historic Heritage Assessment (Umwelt, 2012) was undertaken to provide an understanding of the historic heritage values of the local area, and to allow identification of heritage sites and/or items that may potentially be impacted by the BOP. The Historic Heritage Assessment was undertaken across the entire BOP Project Area (approximately 4,879 ha), which included the additional disturbance area (20.2 ha) of the Proposed Modification.

The 2012 Historic Heritage Assessment identified a number of potential historical heritage items within the BOP Project Area, through a combination of relevant heritage register searches, historical research and site survey.

Only one of the items identified is located in the vicinity of the additional disturbance area of the Proposed Modification, as shown on **Figure 6.14**. Identified as item PS7 – Post and Rail Fence it comprises an approximately 130 m length of semi-derelict post-and-two-rail-and-wire fence (refer to **Plate 1**). At the time of the survey only a few posts remained standing and the majority of the rails had collapsed. Barbed wire appeared to have been used in places to replace rails and three holes beneath the lower mortice indicated the likely addition of wire to the existing post-and-two-rail fence line (Umwelt, 2012).The Heritage Impact Statement (Umwelt, 2012) for Item PS7 stated:

"The site has been assessed as having no significance and no research potential.

The site should be retained in the landscape as it is not proposed to be impacted, however it could be removed without further assessment if required in the future."

Item PS7 will be impacted by the Proposed Modification and will consequently require removal, however it is considered to be of no significance to local heritage values.

In undertaking further site surveys for the ACHA for the Proposed Modification in 2018 (refer to **Section 6.9**), further searches for potential historic heritage items were also conducted. No further historic heritage items/sites were identified by these additional surveys. No further assessment of historical heritage has been undertaken for the Proposed Modification.



Plate 1 Item PS7 – Post and Rail Fence

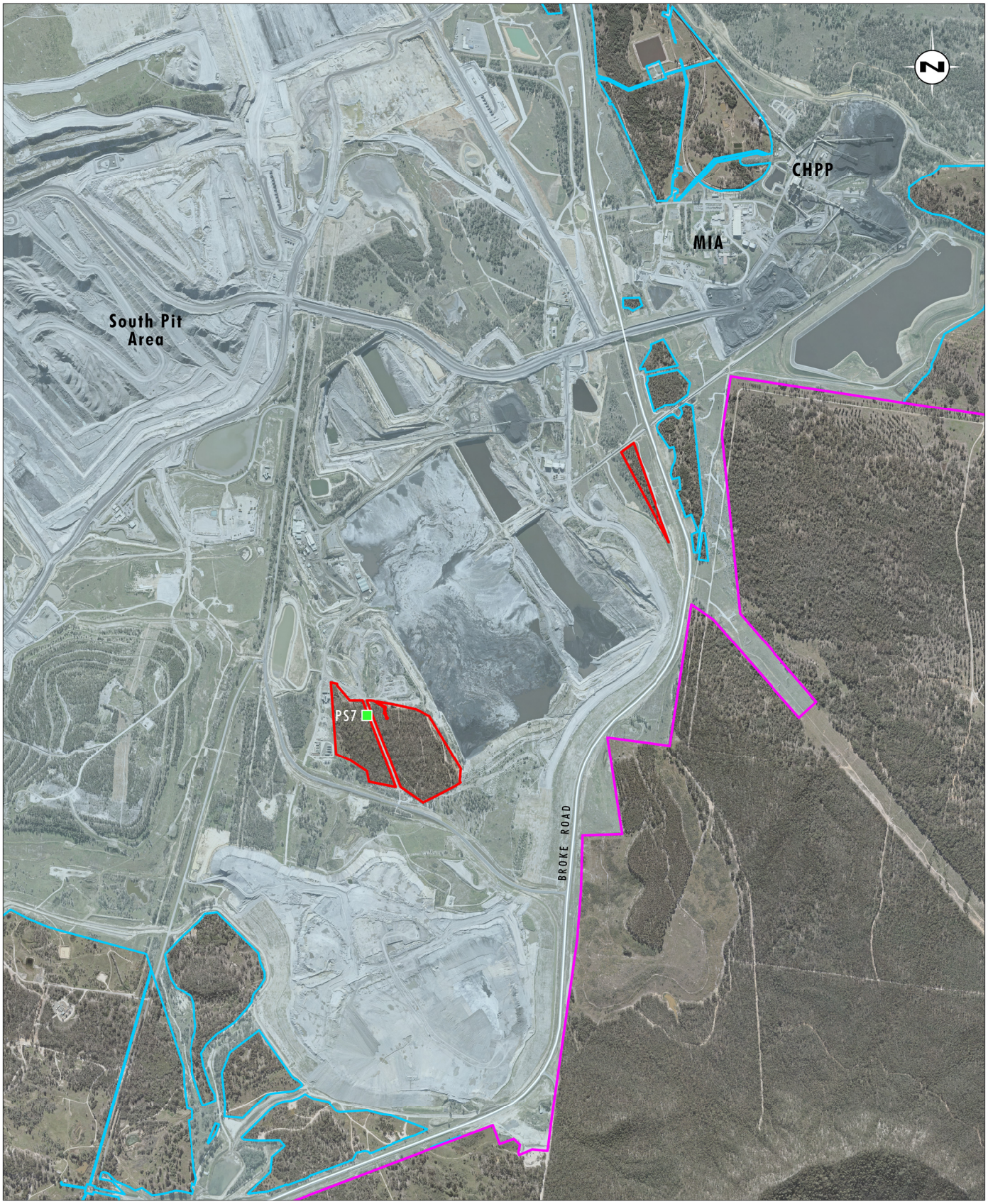

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Current Disturbance Footprint
- Additional Disturbance Area
- Potential and Known Heritage Sites/Items

FIGURE 6.14

Historical Heritage Items in the Additional Disturbance Area

6.11 Traffic and Transport

A detailed assessment of the potential impacts on the capacity, efficiency and safety of road and rail movements was undertaken for BOP. The Proposed Modification does not propose to increase operational employee numbers therefore it is not expected to change operating traffic volumes associated with BOC.

The Proposed Modification will require some construction activities associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure, and water management structures. Construction activities will generally be for a limited period and not require a significant construction workforce. It is noted that the Bulga Underground Operations is not currently operating which provides capacity in the local road network. It is anticipated that any construction activities will be completed while the Bulga Underground Operations is in a period of suspended operations.

As part of the Proposed Modification it is intended to continue use of the temporary MIA area known as East Pit Muster Area which was constructed as a temporary mining infrastructure area (refer to **Figure 1.2**). A road traffic assessment has been prepared by GHD to determine potential impacts on the capacity, efficiency and safety of road movements as a result of the ongoing use of the intersection providing access to the East Pit Muster area. The analysis focused on the intersection of Broke Road and the access road to the East Pit Muster area.

The East Pit Muster intersection was designed by GHD and constructed in 2016 to provide access for staff and large heavy vehicles associated with the construction and operation of the mine. Broke Road functions as a rural local road and is constructed to a rural highway standard. At its intersection with the open cut mine access road, Broke Road provides an auxiliary right turn (AUR) and an auxiliary left turn (AUL) deceleration lane. The open cut mine access road provides a single travel lane in either direction. It intersects Broke Road at a priority (stop) controlled intersection.

According to the *Roads and Maritime Guide to Traffic Generating Developments* the existing traffic volumes on Broke Road indicate that it is operating well within the acceptable limits of its mid-block capacities. Crash data from the Centre for Road Safety website indicates that there have been no crashes recorded at the intersection of interest since its construction.

SIDRA traffic modelling analysis undertaken indicates that the intersection has significant capacity. The current intersection configuration is expected to accommodate future traffic growth along Broke Road until 2028 and beyond, including a 100% increase in traffic staff movements at the BOC during peak hours.

Given the Proposed Modification is not proposing an increase in operational staff levels there is not predicted to be any traffic impacts associated with the Proposed Modification.

6.12 Rehabilitation and Closure

The Proposed Modification does not significantly alter the broad mine closure and rehabilitation commitments and practices currently undertaken at the BOC pursuant to the current approval. Importantly, the Proposed Modification does not alter the general rehabilitation or land use objectives for the site. The final void retains its suitability for a range of potential end land-uses including pumped-hydro electricity generation.

The following section outlines the key changes to the Approved Operations that will affect rehabilitation processes at the site associated with the Proposed Modification. The currently approved Mining Operations Plan for the BCC will be updated to reflect changes to the mine plan and impacts on rehabilitation commitments associated with the Proposed Modification.

6.12.1 Comparison to Approved Operations

The overall rehabilitation strategy for the Proposed Modification is consistent with the currently Approved Operations. The Proposed Modification will result in an extension of the South Pit Area to the south of the current approved area (refer to **Figure 1.3**). This proposed extension to mining largely impacts on areas previously impacted by past mining operations, including mining through the existing TSFs. As a result the Proposed Modification only results in small areas of additional disturbance totalling 20.2 ha. The key changes to the Approved Operations that result in changes to the final landform and rehabilitation of parts of the site are:

- expansion of the in-pit tailings facility
- removal of tailings from Deep Pit and Bayswater Pit TSF prior to being mined through
- extension of mining in South Pit Area, and
- changes to the sequence of mining and in-pit overburden emplacement.

These changes are discussed further below.

6.12.1.1 Changes to tailings facilities

The extension of the South Pit Area to mine through the Deep Pit and the Bayswater Pit TSF requires the relocation of tailings currently stored in these facilities to the approved in-pit tailings facility currently being constructed in the northern end of the Main Pit. The Main Pit TSF is proposed to be increased in size to accommodate the tailings from Deep Pit and Bayswater Pits as well as the additional fine tailings from the Bulga CHPP associated with the processing of additional coal from the Proposed Modification. This change reduces the overall number of TSF to be rehabilitated from four to two (noting that one of these, the 'Old Tailings Dam' in the south of the site, has already been decommissioned and capping has significantly progressed).

The currently approved Main Pit TSF is contained within the Main Pit mining area and has been designed to appropriate standards. The proposed changes to the Main Pit TSF will continue to be located within the Main Pit mining area to achieve the same safe design outcome.

The Main Pit TSF will be managed to optimise water recovery and improve consolidation which will assist in the timely rehabilitation of the facility. Tailings emplacement in the Main Pit TSF will incorporate the reasonable and feasible practices to improve long term rehabilitation outcomes including:

- multiple discharge points to enhance the beaching of material to promote dewatering and consolidation of the tailings
- secondary thickener and/or secondary flocking or similar to promote the liberation and recovery of water, as required
- effective removal and reuse of the tailings decant water.

Throughout the life of the Project, other techniques may be investigated to improve water recovery and increase consolidation processes in the Main Pit TSF; where practical and feasible, these will be implemented should further improvements be required and incorporated in the MOP.

As per the existing approved operations, the Main Pit TSF will be capped and shaped into a free draining landform with overland flow generally directed to the north west. Where possible, capping and final landform shaping material for the in-pit tailings facility will be obtained through the rehandle of emplaced overburden adjacent to the facility.

Due to the timing of consolidation of the Main Pit TSF, progressive shaping may be required to achieve a free draining landform. As with other large, deep tailings facilities, the consolidation process may take in excess of ten years post the cessation of coal processing at the CHPP. It is noted that similar long term consolidation timeframes are likely to have resulted in regard to the capping of the existing Deep Pit TSF under the existing approved Bulga Surface Operations.

The design of Main Pit TSF capping and the selection of appropriate capping material including the importation of selected ameliorants, will have regard to the hydrological, physical and geochemical characterisation of the fine rejects and the proposed cover materials to achieve an effective cover system design.

The Final Mine Closure Plan developed for the operations will include detailed consideration of the Main Pit TSF. The decommission process for the TSF will have regard to the anticipated consolidation timing.

6.12.1.2 Final Landform Changes

The Proposed Modification will result in the extension of the Bulga Surface Operations mine life and a modified final landform to that currently approved. The Proposed Modification will maintain the design of the outer face of the approved noise and visual bund. The Proposed Modification will require an increase in emplacement heights within the in-pit emplacement areas from 150 to 160mAHD with selected areas emplaced to approximately 175m AHD to improved landform variability and assist in catchment design for the final landform. The proposed increase in the in-pit emplacement area height removes the need to seek additional out-of-pit emplacement area which would result in additional impacts associated with increased disturbance area. Visual impacts associated with the increased dumping will be largely screened by the Noise and Visual Bund at most vantage points to the south and west of the operation.

The conceptual final landform for the Proposed Modification will be largely consistent with existing current approved operations. This design will include variable terrain which is profiled to effectively manage runoff to enhance long term landform stability and to be sympathetic to the profile of the adjacent landscape (refer to **Figure 6.15**). The proposed final landform also incorporates the design controls developed for the Approved Operations including designing the final landform and drainage of water to natural catchments particularly in relation to Loders Creek and Wollombi Brook.

Consistent with the Approved Operations, a single final void will remain, however the Proposed Modification will result in it being located approximately 1 km to the south east of the location contemplated for the Approved Operations. The landform within the final void will include highwalls, benches, the floor of the working area, low walls and ramps. The highwall will consist of the unmined rock face which represents the western edge of the South Pit Area and extends down to the pit floor. It is made up of a series of semi vertical unmined rock faces with relatively level benches, designed to achieve acceptable long term geotechnical stability. The pit floor consists of unmined material beneath the mined area in the deeper parts of the pit. In areas of steeper mining such as the East Pit, the pit floor will be inclined. The low wall is the internal facing surface of emplaced overburden within the pit. The final batter angle of the low walls within the proposed final void ranges from 10° to18° which is steeper than the internal batter slope in the approved South Pit Area final void. This design has been adopted to maximise internal emplacement volumes, which also reduces the need to expand the emplacement area footprint, which would otherwise result in additional areas of disturbance being required for the Proposed Modification. Refer to **Figure 6.15** for the proposed locations of the above features.

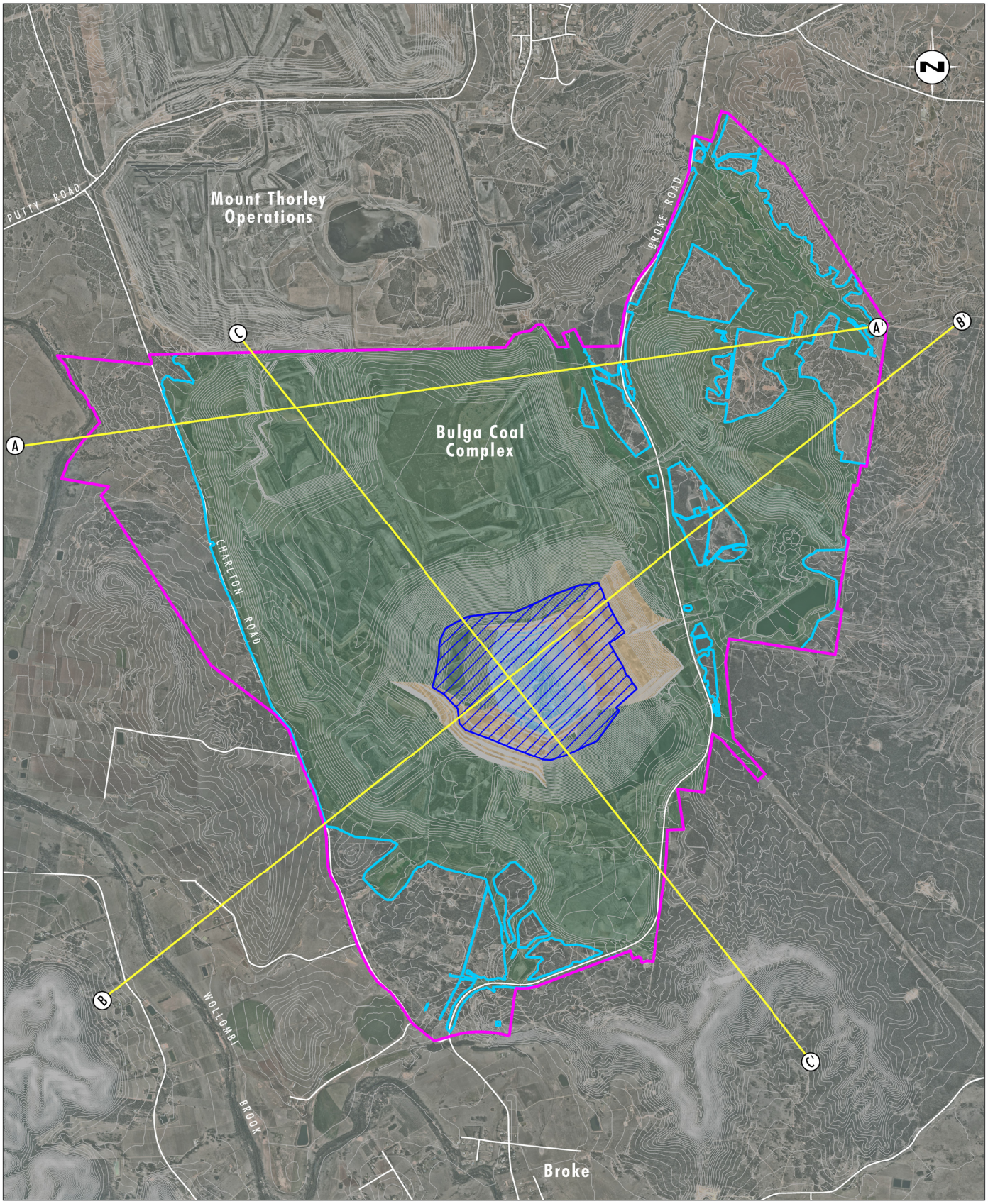

Image Source: Bulga (Jul 2017)
Data Source: Bulga (2018)

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Legend

- Project Area
- Disturbance Footprint
- Transect Line
- Rehabilitation Woodland/Grassland
- Highwall/Footwall with Vegetated Benches
- Road
- Pit Lake
- Maximum Modelled Pit Lake Level

FIGURE 6.15

Conceptual Final Landform

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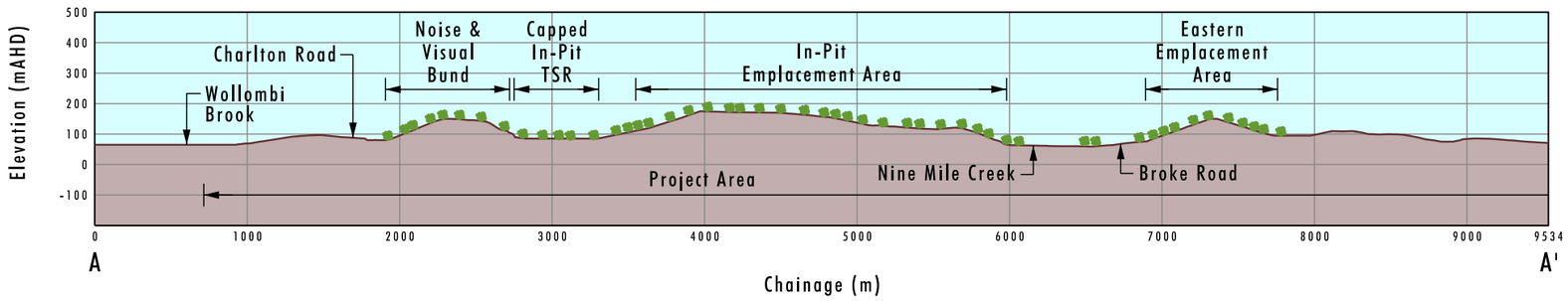
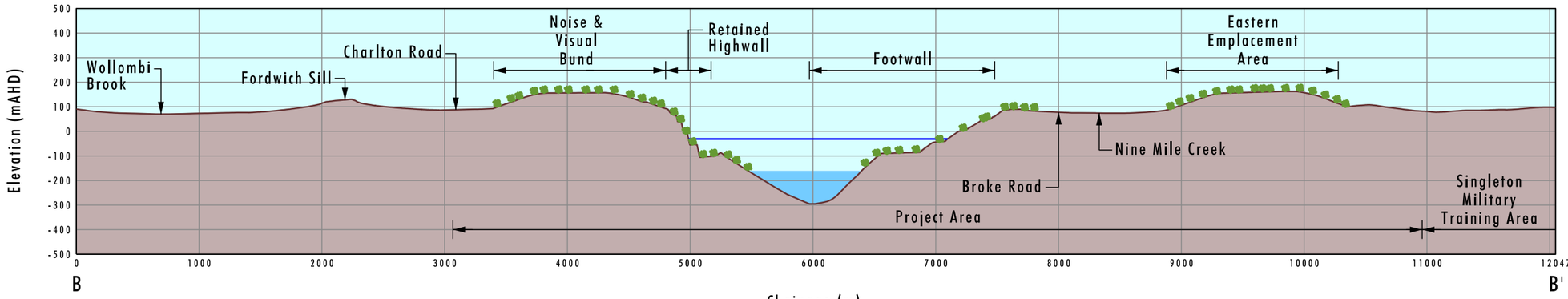
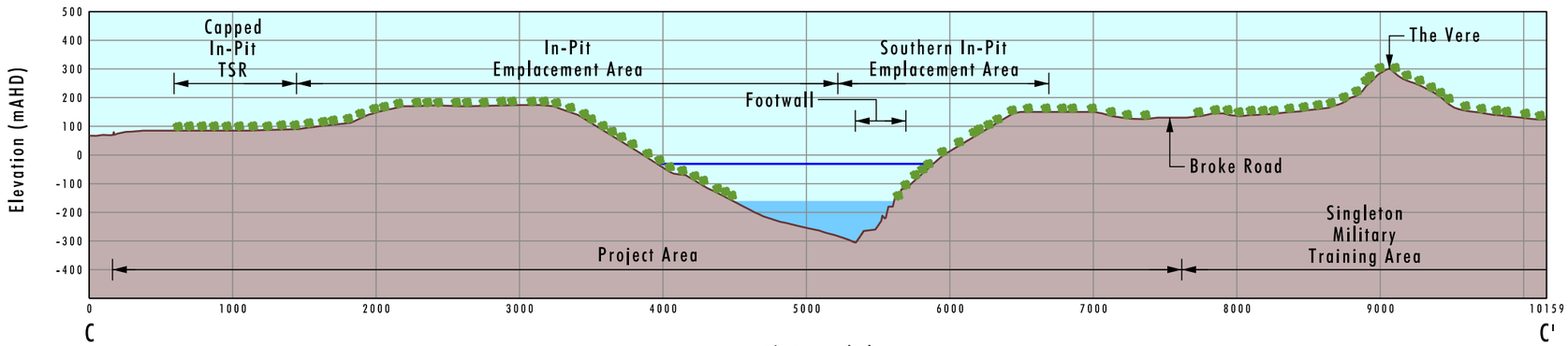


Cross Section A-A'



Cross Section B-B'



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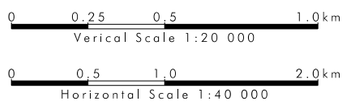

Legend

- Modelled Maximum Pit Lake Level
- Pit Lake

FIGURE 6.16

Conceptual Final Landform - Cross Sections

Relative to the Approved Operations, the conceptual final landform for the Proposed Modification includes the following key changes:

- changes to the depth and design of the final void following extraction of additional resources
- repositioning of the final void approximately 1km to the south east of the currently approved conceptual final landform
- an increase to the conceptual final void catchment area (756 v 938 ha) predominantly due to deeper mining in the open cut and removal of the southern highwall from the final void layout
- additional emplacement of overburden within in-pit emplacement areas generally to 160 m AHD with areas up to maximum elevation of approximately 175 m AHD for terrain variability and catchment management purposes
- low wall batter slopes in parts of the final void landform to up to 18°
- extend closure and final rehabilitation of the site by approximately four years due to the extension of mine life.

Figure 6.16 contains comparative cross sections between the conceptual final landforms contemplated for the Approved Operations and the Proposed Modification.

Table 6.19 details the key changes in terms of rehabilitation and final landform for the Proposed Modification relative to the Approved Operations. Rehabilitation practices for the Proposed Modification are set out in the approved BOC Rehabilitation Management Plan.

Table 6.19 Comparison of Project Area rehabilitation/final landform changes: Current Operations vs. Proposed Modification

Feature	Approved Operations	Proposed Modification	Comments
Final landform shaping	Rehabilitated slopes are generally 10° except in the north-west corner of the Noise and Visual Bund to limit impacts on Warkworth Sands Woodland EEC and Charlton Road. However, to allow for the creation of local relief in topography on the top of overburden dumps as well as the creation of alternative stable slope designs (i.e. if concave profiles are utilised), slope angles may exceed this criteria subject to approval by DRE. Emplacement in Noise and Visual Bund to 150 mAHD with selected areas to 160 mAHD. Emplacement in in-pit emplacement area and Eastern Emplacement Area to approximately 150 mAHD with selected areas emplaced to 160m AHD.	Outer slopes of in-pit emplacement areas battered to a (toe to crest) slope of up to 14°. Emplacement in in-pit emplacement area to approximately 160m AHD with selected areas emplaced to 175 m AHD to accommodate the incorporation of micro-relief landform features.	No change to Noise and Visual Bund emplacement heights or slopes. Eastern Emplacement Areas to a (toe to crest) slope of up to 14°. Increases to typical overburden emplacement heights from 150 to 160 mAHD with selected areas emplaced to approximately 175 mAHD to accommodate the incorporation of micro-relief landform features. External batters of in-pit emplacement areas to a (toe to crest) slope of up to 14°. No change to objectives for slope stability.
Highwalls	Western and southern highwalls retained in final landform.	Western highwall retained in final landform. Lower sections of northern highwall to be retained in final landform below pit lake equilibrium level.	As with existing approved operations, western highwall not proposed to be battered due to proximity to approved noise and visual bund. Southern Highwall no longer retained in final landform as revised mining sequence results in in-pit emplacement against highwall as mining progresses deeper and back towards the north. Final landform highwall treatments generally consistent with approved operations.
Low wall	Low wall slopes battered to an average slope of 10°. Steeper slopes permitted subject to approval by Resources Regulator.	Northern and southern internal slopes of final void to be battered to (toe to crest) slopes ranging between 10° and 18°.	No change to overall objective of maintaining stable slopes. Final void catchment area reduced through increased batter slope. Run-off from internal slopes able to be directed towards highwalls to reduce risk of erosion. Detailed drainage strategy to be developed over the life of the operation and included in the mine closure plan developed for the Project.

Feature	Approved Operations	Proposed Modification	Comments
Revegetation commitments	Establish native woodland vegetation across majority of the operation including highwall benches and battered low wall slopes (except where benches used for drainage flows).	Establish native woodland vegetation across majority of the operation including highwall benches* and battered low wall slopes (except where benches used for drainage flows or safety constraints restrict access to benches).	No change to currently approved, focus on re-establishment of woodland vegetation. Restrictions on revegetation of high wall benches due to drainage and safety constraints.
Number of voids	One – Approved South Pit Area.	One – South Pit Area	No change to that currently approved. Final void for Proposed Modification located approximately 1km to the south east of that contemplated for current approved operations.
Final void depth	Final pit floor approximately -260 m RL.	Final pit floor approximately -320 m RL	Increase depth due to ability to mine deeper seams through increased pit area during operations.
Modelled maximum pit lake level	Approximately 60 mAHD. Final Void to operate as a long term hydraulic sink however seepage though spoil at low point of pit crest anticipated to occur prior to equilibrium – seepage predicted to occur into Loders Creek Catchment. Seepage water quality predicted to be similar to long term baseflow water quality in Loders Creek.	Approximately -30 mAHD. Final void modelled to act as long term hydraulic sink with no seepage through spoil predicted.	Revised groundwater model inflows and refined final landform run-off predicts that the proposed final void will operate as a long term hydraulic sink, reaching a lower pit lake water level at equilibrium. Final Void design limits the risk of spill to environment with no long term seepage through spoil predicted.
Time to equilibrium water level	Approximately 500 years.	Approximately 500 years.	
Pit Lake Water Quality	TDS levels increasing to 6,000 uS/cm. Pit lake pH expected to be neutral due to excess buffering capacity present in overburden material.	TDS levels increasing to approximately 9,000 mg/L at equilibrium. Pit lake pH expected to be neutral due to excess buffering capacity present in overburden material.	Predicted final void salinity will be moderately saline based on the Food and Agricultural Organisation of the United Nations (FAO 2013) categorisation of water salinity. The predicted final void salinity is considered suitable for some uses for a period of time, including stock watering (mature cows and sheep), recreation, industrial water use and the maintenance of aquatic ecosystems.

Feature	Approved Operations	Proposed Modification	Comments
Pit Lake Spill risk	Equilibrium level of 65 mAHD. Approximately 19 m freeboard to spill level at 84 mAHD.	Pit lake to reach equilibrium at mAHD, approximately 100 m below spill level.	Risk of potential spill to the environment is negligible. Reduced risk of spill relative to Approved Operations. Proposed Modification also modelled to avoid risk of seepage through spoil.
Number of tailings storage facilities	Four (including the now-capped Old Tailings Dam).	Two (including the now-capped Old Tailings Dam).	Bayswater Pit and Deep Pit Tailings storage facilities to be decommissioned with tailings transferred into expanded in-pit Main Pit Tailings Storage Facility.
Tailings Facility Capping Strategies	TSFs to be capped and shaped to be free draining. Capping to commence following tailings consolidation.	TSFs to be capped shaped to be free draining. Capping to commence following tailings consolidation.	Main Pit TSF consolidation is expected to take at least 10 years from completion of mining. Capping will commence when TSF is adequately stabilised. Final landform shaping of Main Pit TSF may require rehandle and reshaping of adjacent in-pit overburden emplacement areas to ensure free draining landform. Similar consolidation issues anticipated for Deep Pit tailings storage facility under Approved Operations.
Final land use	Mixed woodland to the east of Charlton Road. Opportunities for agriculture and other higher value land uses to be investigated as part of Mine closure planning process.	Mixed woodland to the east of Charlton Road. Opportunities for agriculture and other higher value land uses to be investigated as part of Mine closure planning process.	No change. Potential future opportunities for alternative final land uses are explored in **Section 6.12.3.**

*Native vegetation on highwall benches (where possible) will have regard to potential constraints to rooting depth presented by shallow depth of growing medium. Species selection will be similar to that used in woodland communities but ultimately established vegetation communities on benches may not meet formal woodland structural definitions.

Final landform design changes have been developed having regard to long term experience at Bulga as well as ongoing consultation with the Resources Regulator and Singleton Shire Council in relation to other Glencore projects in the Hunter Valley.

6.12.2 Management of Rehabilitation Risks

As noted in **Section 6.12.1**, the Proposed Modification is largely consistent with the current operations at BOC. The changes associated with the Proposed Modification do not have a material impact on the approved closure commitments outlined in the BOP EIS. The key rehabilitation risks, , associated with the proposed conceptual final landform design are discussed below:

In summary, key conclusions relevant to management of rehabilitation risk were:

- steeper rehabilitation slope angles proposed within the conceptual final void may require a combination of water management structures currently used by BCM including contour drains and drop structures, along with additional slope stabilisation techniques to manage erosion and slope stability risks

- the increased tailings emplacement volume within the Main Pit TSF will maintain a final landform profile that is consistent with commitments in the existing approval.

In the development of the proposed mine plans, including preparing the final landform design, consideration was given to achieving reduced gradients on battered slopes within the final void. If implemented, lower internal void slopes would have, resulted in a combination of the following:

- increase the need for additional out-of-pit emplacement areas to accommodate the overburden that cannot be placed in-pit, resulting in the need to clear more undisturbed land, and

- increase the area of the final void catchment that cannot be diverted away from the void, reducing the surface flows that can be returned to surrounding surface water catchments, and

- increased pit lake area resulting in greater surface evaporation which would contribute to higher final pit lake salinity levels, and

- significant rehandling of overburden beyond practicable,`

The additional works associated with battering the highwalls and/or reducing slopes would also extend the duration of earthworks associated with final void shaping site well beyond the planned cessation of mining and, under some scenarios, significantly delay the rehabilitation of the final landform. Complete backfill of the void is not considered to be feasible given the existing mine pit configuration and depth of the void. Backfilling would significantly extend the life of operations at the site and would significantly delay the establishment of woodland communities and habitat corridors across the site due to the need to re-disturb areas progressively rehabilitated during the life of the project.

The management of drainage from the battered slopes within the proposed void remains the highest rehabilitation risk due to the length and gradient of slopes. BOC completed an assessment of control measures across varying slope gradients from the approved 10° limit to 14° and 18° during the rehabilitation concept design phase of the Proposed Modification. This assessment identified a number of potential methodologies that can be used to manage erosion across the variable slope gradients of the proposed final void, as described below:

- Internal low-wall slopes within the final void will be battered to an average of between 10° and 18°

- Drainage structures will be established along the top of the battered section of the internal low wall slopes to minimise the surface catchment area reporting to the final void, and maximising the surface catchment reporting to surrounding natural drainage systems.

- Low wall slopes will be established in stages. Battering and the establishment of areas of the low wall forming the final landform will occur as the stages are progressively established. Drainage across battered slopes will also be established progressively.

- The detailed design of the drainage on the low wall slopes within the final void in the final landform will be defined in the MOP/RMP to be developed and progressively reviewed and revised throughout the life of the Project. The development of the detailed drainage design for the final landform will have regard to erosion modelling and geotechnical assessments to confirm long term stability of the low wall.

- Access roads may be retained on the slopes for maintenance purposes

- Battered slopes will be revegetated to suitable woodland species mix generally consistent with the remainder of the rehabilitated landform having regard to soil characteristics.

- Internal void slopes will be progressively topsoiled and vegetated as the final landform slopes are established (i.e. rehabilitation will commence as the final landform slopes are established). Seeding will be undertaken using safe methods appropriate for the slope conditions for both initial and infill seeding.

Additional management measures to be implemented to improve the long-term stability of the final void high-walls include:

- Geotechnical assessments of the highwalls and highwall benches will be undertaken and armouring/ highwall shaping undertaken where necessary to improve long term stability.

- A trench and /or safety berm will be established along the top of the retained section of the highwalls or the top of the battered section of overburden emplacement slopes above the highwalls. The bunds will be designed to divert surface water runoff away from the highwall and restrict inadvertent access to the highwall.

- The detailed design of the drainage on the highwalls in the final landform will be defined in the MOP/RMP developed for the mine closure process. The development of the detailed drainage design for the final landform will have regard to erosion modelling and geotechnical assessments to confirm long term stability of the high walls.

- Access along the highwalls may be retained for maintenance purposes

Those slope gradients which remain consistent with the Approved Operations conceptual final landform will be manageable through application of existing drainage management practices applied by BCM. Where feasible, opportunities to direct water flows to hard rock and vegetated areas will be used to limit erosion risks and reduce long term management associated with constructed drop structures on spoil.

As with currently approved operations, it is likely that a range of different methodologies will be used to suit the different conditions, and new techniques may be investigated as improvements in technology are developed throughout the life of the mine. The approach to final landform development and slope stabilisation methodologies will be documented in the BOC MOP/RMP.

6.12.3 Clearing of Rehabilitation Areas

The Proposed Modification involves the progressive re-disturbance of approximately 200 ha of mine rehabilitation located on the in-pit emplacement area, behind the noise and visual bund. This re-disturbance will occur in stages as shown on the mining stage plans **Figures 3.1** to **3.4**. The area of rehabilitation to be disturbed is predominantly located on the upper levels of the existing in-pit mine overburden emplacement. This action is required in order to raise the height of the in-pit emplacement area (located behind the noise and visual bund) from approximately 150 mAHD to approximately 160 mAHD with selected areas emplaced to approximately 175 mAHD to accommodate the incorporation of natural relief landform features. Raising the height of the in-pit emplacement is proposed to create additional in-pit overburden emplacement capacity as an alternative to expanding the footprint of out-of-pit overburden emplacement areas, which would require disturbance of areas not previously disturbed by mining activities. Raising the in-pit overburden area avoids the biodiversity impacts that would result from expanding the out-of-pit overburden emplacements onto undisturbed land. Conceptual progressive rehabilitation disturbance and re-establishment is shown in **Figures 3.1** to **3.4**.

Following the raising of the in-pit emplacement area to the revised final height, the newly formed area will be shaped in accordance with the final landform design and rehabilitated. This process is expected to be undertaken in phases, taking in the order of two to four years after re-disturbance and overburden emplacement to replace the topsoil and re-seed the corresponding elevated area.

6.12.3.1 Condition of Rehabilitation to be Disturbed

Each year, in accordance with the approved Bulga Coal Complex Rehabilitation Management Plan, BCM engages independent ecological specialists to undertake annual monitoring of rehabilitation at various locations across the mine, in addition to approved reference sites. Rehabilitation monitoring is undertaken using the NSW OEH recommended Biodiversity Assessment Methodology, and monitoring reports are available on the Bulga Coal website for the years 2013 to 2018.

The 2018 Rehabilitation Monitoring Report was prepared by Emergent Ecology who undertook monitoring within the area of rehabilitation proposed to be disturbed by the Proposed Modification, at three monitoring locations SB8, NB6 and SB7. Emergent Ecology determined Biodiversity Integrity scores to each site, where a score of 100 indicates the site has achieved the benchmark conditions determined for the Plant Community Type (PCT) that is to be established, with a score of 50 indicating that the site provides 50 percent of the PCT benchmark attributes. Emergent Ecology attributed Biodiversity Integrity Scores of 29.6, 28.8 and 4.8 to sites SB8, NB6 and SB7 respectively, against a target benchmark of 50. The target PCT for these areas is identified as PCT1603: Narrow Leafed Ironbark – Bull Oak – Grey Box shrub – grass open forest of the central and lower Hunter.

It is noted that 2018 represents a period of ongoing drought conditions at the Bulga Coal Complex, which has had negative effects on the progress of rehabilitation vegetation development. Additionally, these rehabilitation areas were established with target final land use of open woodland, prior to the granting of the BOP Project Approval in 2014 (with the exception of NB6).

Excerpts of summary results of the monitoring by Emergent Ecology are provided below:

SB8

- Site SB8 was established in 2013 and achieved an integrity score of 29.6.
- The site provides good diversity of canopy species however at this early stage of rehabilitation the canopy trees are not providing adequate cover. As the trees mature it will increase the integrity score of the site.

- Litter cover for SB8 was within 30% of the benchmark PCT indicating resources are available for the soil profile to develop.
- Fallen timber was not recorded at SB8.
- The low understory diversity and lack of fallen timber contributed to the lower integrity score for the site.
- SB8 is trending towards PCT target, however if no action is taken, weeds are likely to dominate the ground cover, resulting in reduced biodiversity, and the site will not achieve the benchmark values for relinquishment.

NB6

- Site NB6 was established in 2015 and achieved an integrity score of 28.8.
- Litter cover was low at for NB6, which is not uncommon for early stage rehabilitation.
- The diversity of shrub, grass, forb and fern species was low, however the diversity of shrubs at NB6 exceeded the PCT value.
- The low understory diversity and lack of fallen timber contributed to the lower integrity score for the site.
- NB6 is trending towards PCT target, however if no action is taken, weeds are likely to dominate the ground cover, resulting in reduced biodiversity, and the site will not achieve the benchmark values for relinquishment.

SB7

- Site SB7 was established in 2013, provided the lowest integrity score of 4.8.
- This site has the lowest cover diversity in all vegetation stratum, high density of weeds in the groundcover, and low abundance of fallen logs, large trees or trees with hollows.
- SB7 had a moderate leaf litter component, and moderate function attribute score, indicating it is developing a soil profile.
- SB7 is currently not trending towards the target PCT.

SE1

- Site SE1 was established in 2007 and achieved the integrity score of 37.5.
- The canopy cover (to 5m) at SE1 is high, resulting in a poor diversity and cover of understorey species, with moderate leaf litter.
- Management measures including canopy tree thinning and mulching in areas without ground cover are encouraged to provide organic material and allow absent shrubs, grass and forb diversity to establish.

Soil stability value across the sites has ranged from 45 to 80 since 2014, compared to the reference site values (non-mined sites) of 74 to 81.

The results of photographic monitoring at the rehabilitation monitoring sites over time are provided in **Plates 2 to 5** below.

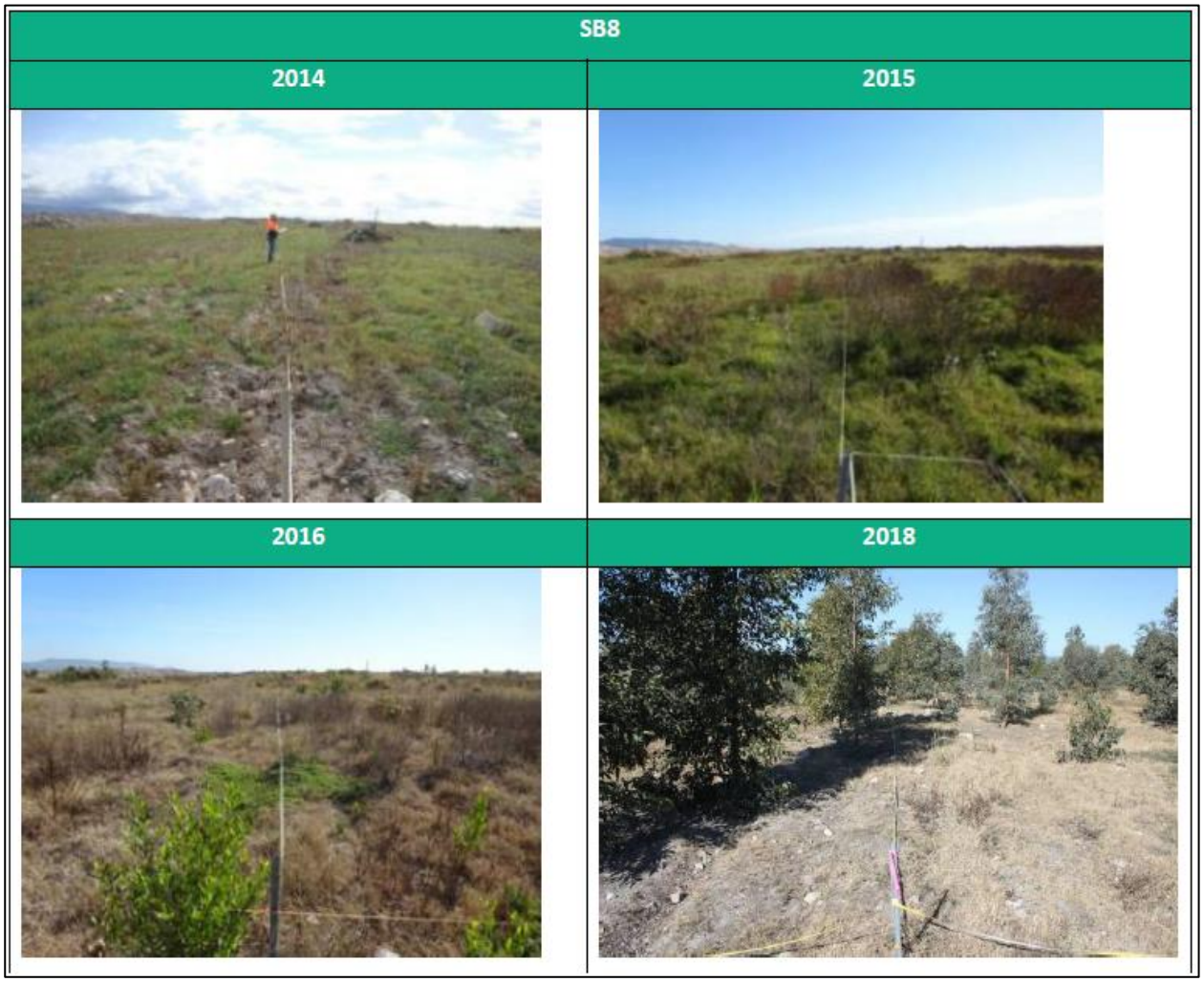

Plate 2 Provides results of photographic monitoring of vegetation at rehabilitation monitoring site SB8
(Source: Emergent Ecology, 2018)

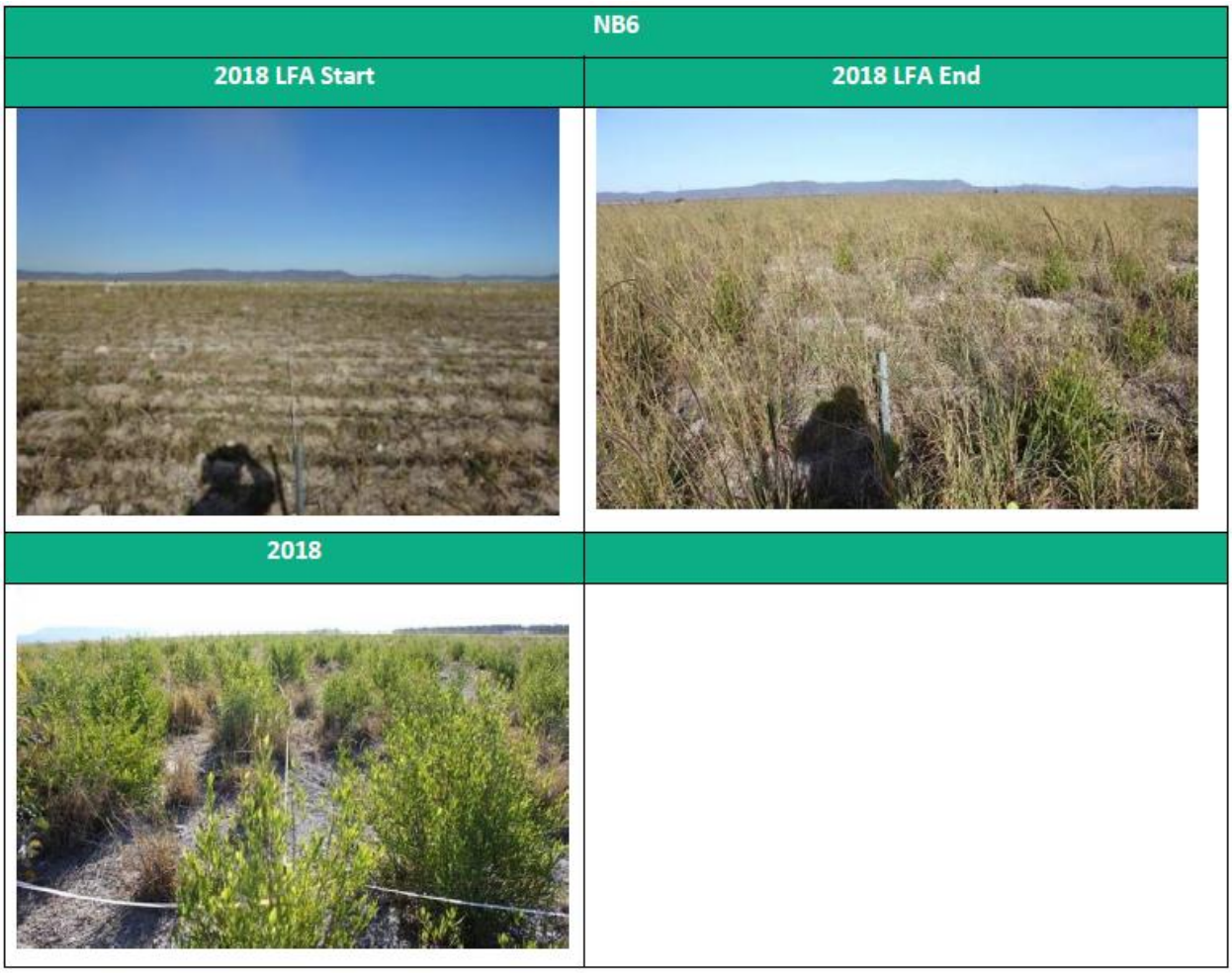

Plate 3 Provides results of photographic monitoring of vegetation at rehabilitation monitoring site NB6
(Source: Emergent Ecology, 2018)

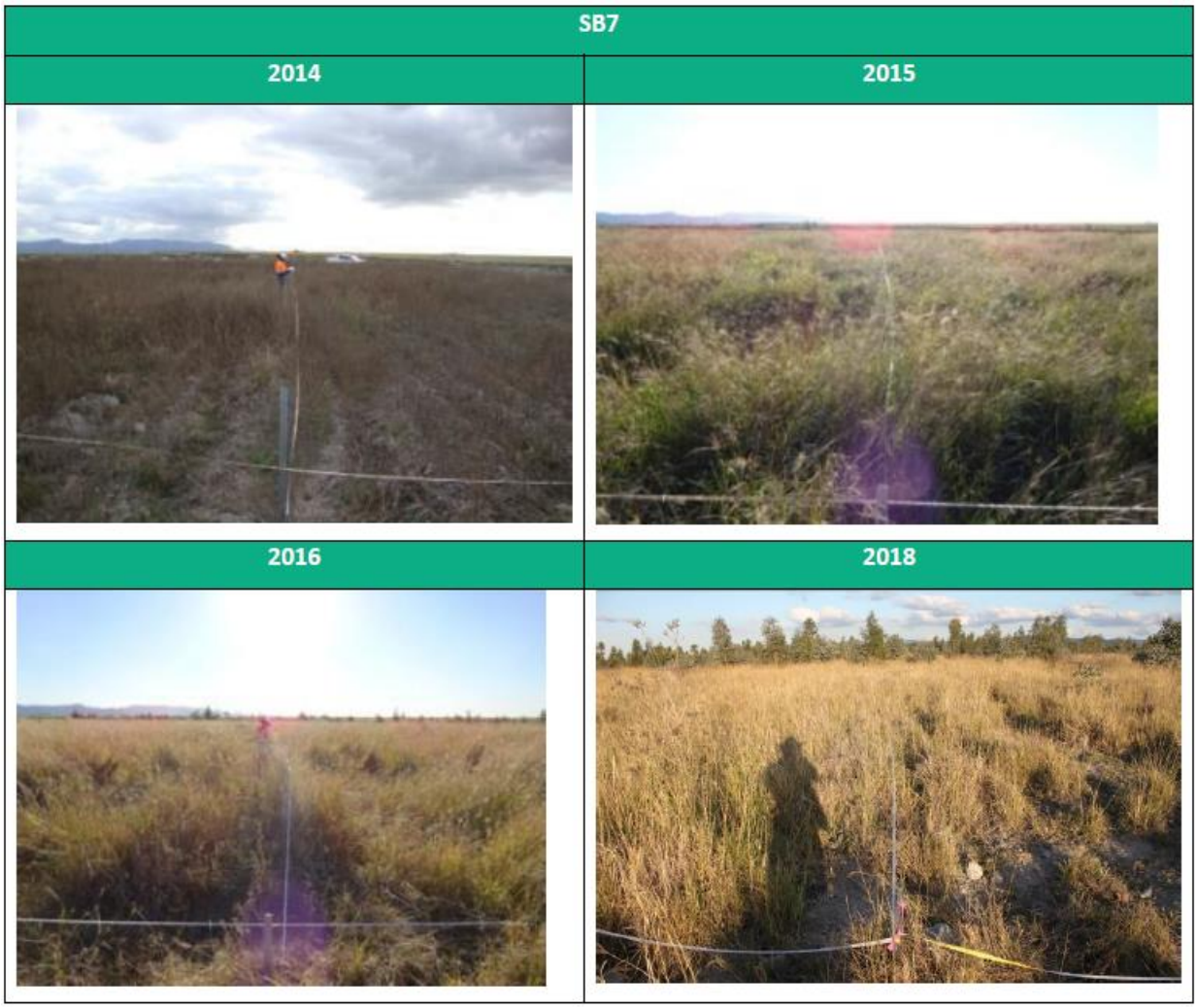

Plate 4 Provides results of photographic monitoring of vegetation at rehabilitation monitoring site SB7
(Source: Emergent Ecology, 2018)

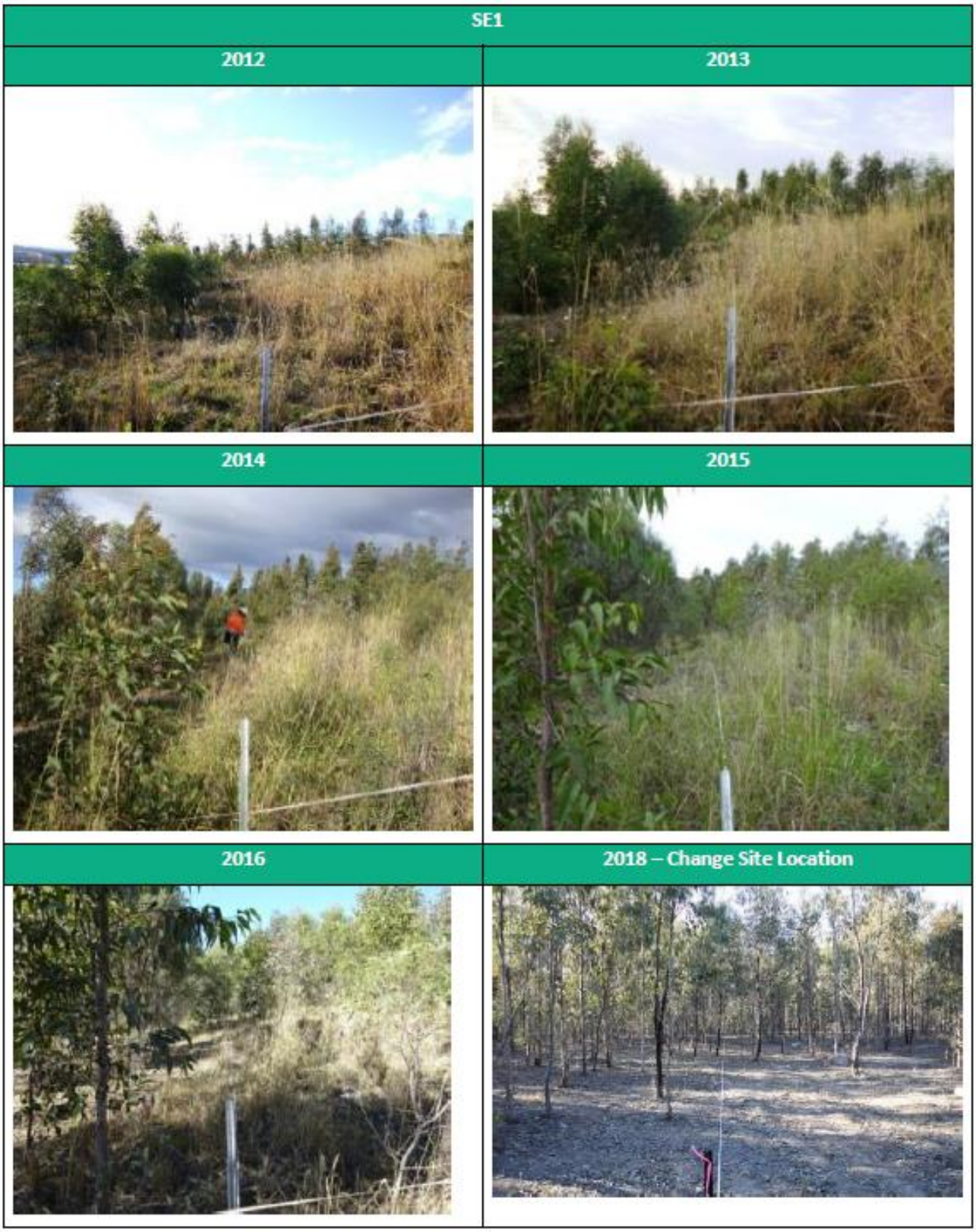

Plate 5 provides results of photographic monitoring of vegetation at rehabilitation monitoring site SE1 (Source: Emergent Ecology, 2018)). Note: monitoring location changed in 2018 due to disturbance from a powerline relocation.)

6.12.3.2 Re-establishing Biodiversity Values

Emergent Ecology report that soil characteristics such as fertility and stability are acceptable, and that the Landscape Function Analysis for these sites is trending towards the reference site. It is predicted that the soil on these sites should be able to be recovered and placed on the proposed new rehabilitation areas with similar results.

However ecological aspects such as vegetation diversity and ecosystem structure (over-storey, mid-storey and groundcover) are not adequately developed on the rehabilitation areas proposed to be disturbed, and the monitoring sites are currently not trending towards the establishing the target PCT, and its associated habitat functions. It is therefore concluded that the rehabilitation areas to be disturbed currently offer low biodiversity values.

Should the Proposed Modification be approved, the re-established rehabilitation areas should be able to achieve comparable biodiversity values to the current rehabilitation areas in a reasonably short timeframe, and with ongoing management measures should be able to achieve improved outcomes over time, compared to the existing rehabilitation areas proposed to be disturbed.

6.12.4 Implications for Mine Closure and Final Land Use

The Approved Operations conceptual final land use is a combination of woodland and agricultural land for grazing. **Figure 6.17** shows the conceptual final land use and potential vegetation corridors post closure under the Proposed Modification.

Table 6.20 Comparison of vegetation in Approved Operations vs. Proposed Modification final landforms

Project Component	Approved Operations	Proposed Modification	Difference
Woodland/Open Forest (ha)	Minimum of 2,500	Minimum of 2,500	No Change
Pasture (ha)	260	260	No Change

The final landform and proposed revegetation strategy for the Proposed Modification has been developed to minimise unnecessary constraints on potential alternatives whilst enabling the progressive rehabilitation of the site to occur in a timely manner. The Proposed Modification is unlikely to have any material impact on the final land use options for the site relative to the currently approved operations other than potentially enhancing the viability of the final void for use as a pumped hydroelectricity generation facility. Notwithstanding, as there has been an increased focus on final land use options for mine sites since the approval of the BOP with additional focus on the usability of final voids potential final land use options for the BCC post mining are discussed in more detail in **Section 6.12.4.2**. It is noted however that the Proposed Modification is not seeking to change the current final land use approved for the site being a combination of woodland and agricultural land with a pit lake forming in the final void and further approvals may be required for any alternative land uses, subject to planning controls that may apply at the time.

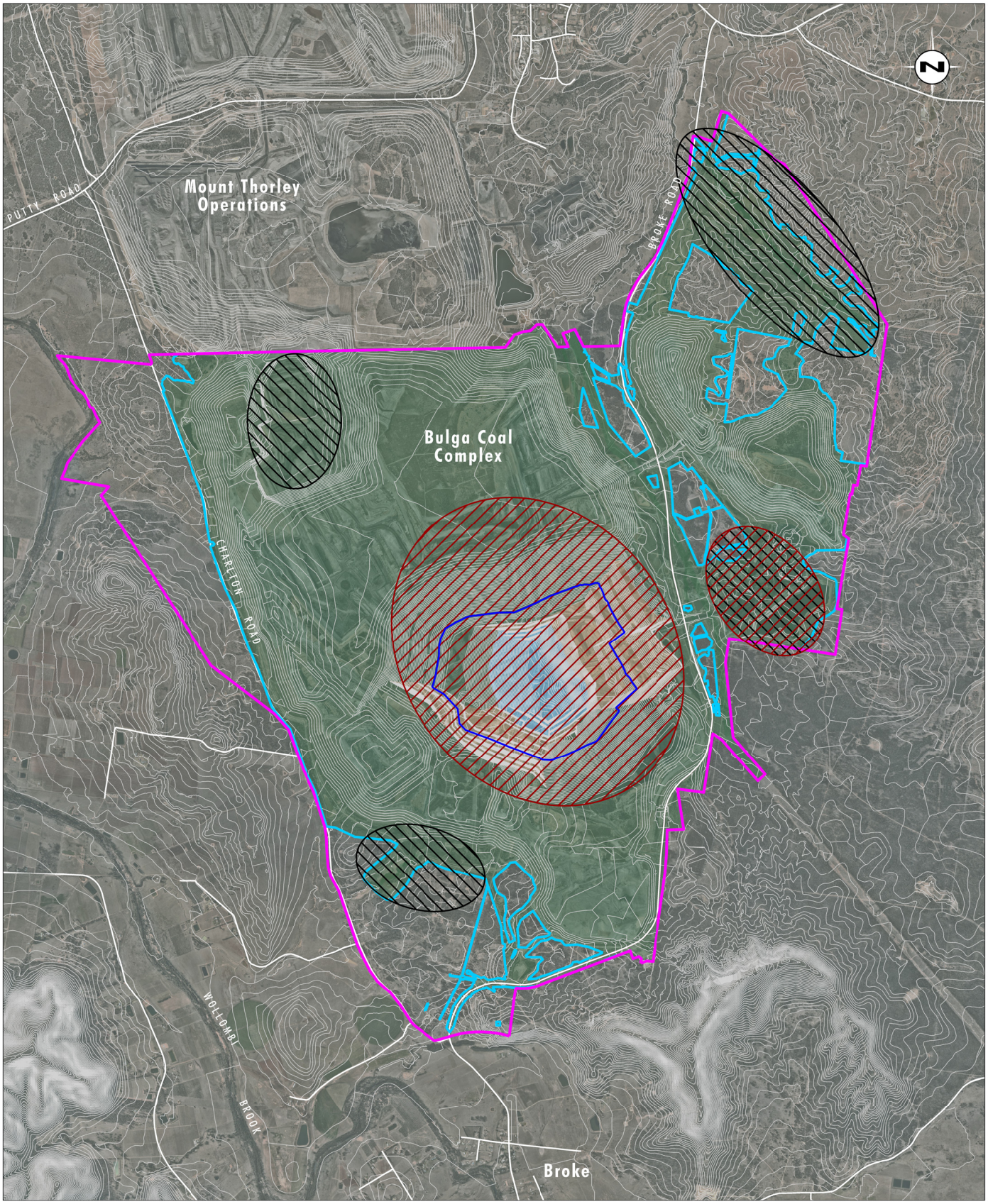

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2018)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Disturbance Footprint
- Rehabilitation Woodland/Grassland
- Highwall/Footwall with Vegetated Benches
- Road
- Pit Lake
- Modelled Maximum Pit Lake Level
- Areas with potential for agricultural landuse
- Area with greatest potential for alternative landuses

FIGURE 6.17

Conceptual Final Landform and Land Uses

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6.12.4.1 Strategic Context

Noting that there is relatively little difference between the Approved Operations and the Proposed Modification, the following is a high level analysis of the potential final land use options applicable to the BCC site and includes consideration of the current applicable land use strategies (Hunter Strategic Plan (2016), the Upper Hunter SRLUP (2012) and the Singleton Shire Land Use Strategy (2008)) in relation to land use planning applicable to mine sites.

Hunter Strategic Plan 2036 (2016) and Upper Hunter SRLUP (2012)

The Hunter Strategic Plan (issued by DP&E in 2016) provides an overarching strategic planning framework for the whole of the Hunter region, to be supported by more detailed district scale land use plans and infrastructure investment decisions. These detailed district scale land use plans are yet to be completed.

The Hunter Strategic Plan refers to a regional productivity transformation over the coming two decades. Drawing on the Smart Specialisation Strategy (RDA 2016) and the Upper Hunter SRLUP, the Hunter Strategic Plan identifies industry growth sectors for the region. Currently in the Singleton LGA, mining employment accounts for 23.4% of jobs and manufacturing for 7.5% of jobs.

Potential emerging or strengthened employment opportunities include:

- power generation, technology and mining – land needs to be identified for future technology, manufacturing, resources and diversified power generation sites (including renewable energy)
- growth opportunities in agriculture and agribusiness – 'high technology primary industry'; this requires the protection of natural resources
- global and regional connectivity, through transport infrastructure for regional products to capital city and international markets
- landscape tourism, linked to the scenic value and food trail possibilities of the viticulture and equine Critical Industry Clusters (DPE, 2012)
- knowledge intensive industries, such as research, training and support systems for new technology industries.

The Upper Hunter SRLUP also refers to the potential for high value carbon forestry and ecological restoration, as part of the regional mitigation of climate change.

The planning scale of the Hunter Strategic Plan is not compatible with detailed identification of site specific land use futures, however it does provide strategic guidance on landscape values and strategic actions that will contribute to a successful transition from the current mining, coal fired energy generation and agriculture based economy.

BOC will have available existing infrastructure such as low and high voltage electricity connections including direct access to the NSW power grid, water source from the Hunter River and extensive water storages, buildings and hard-stand areas, connectivity to road and rail transport, and a large buffer of land, providing potential for a variety of final land uses. By considering these values and actions in the context of the land assets and characteristics associated with rehabilitated mining sites (including final landforms, land capability, biodiversity, infrastructure connectivity and land use compatibility), it is possible to identify strategic opportunities for post mining land uses at BOC.

Singleton Shire Land Use Strategy 2008

The Project Area is located within the Singleton LGA. The Singleton Shire Land Use Strategy (2008), which has an implementation period extending to 2032, identifies future residential and rural residential growth areas; the value of rural/agricultural tourism linked to the scenic value and biodiversity of the landscape; and the continuation of mining and post mining rehabilitation. The Strategy notes the potential for new post mining uses, but also the need for a strategic review of rehabilitation, infrastructure, and land use options to reduce the risk of incompatible future land uses.

In relation to industrial land, the strategy notes the potential for adaptive reuse of sites having suitable infrastructure for industrial uses, highlighting former coal mines which have existing water and wastewater infrastructure, roads, rail access, electricity services and are separated from urban areas. The Strategy also notes that some of these sites are currently zoned rural (including the Project Area), rather than industrial, which limits the adaptive transition.

The Singleton Shire Land Use Strategy proposes that all new heavy industrial sites should be serviced by rail access. The Strategy prefers that sites do not have frontage/access to the New England or Goulburn Highways, but must have good sealed road access. The intent is that industrial land uses would be consistent with a spatial hierarchy, with industrial service land and light industry closer to the town, and large lot or heavy industry separated from town, to manage amenity impacts.

The values attributed to the BOC provide the opportunity for a range of final use options identified by the Hunter Strategic Plan and the Singleton Land Use Strategy, including industrial uses, power generation, agriculture/agribusiness, landscape tourism and research. Key values relevant to multiple potential final use options include:

- brownfield site (limited potential to further impact to EEC, threatened species, or cultural heritage values)
- established buffer land to minimise impact to neighbouring land uses
- existing industrial (coal processing) infrastructure
- existing ancillary infrastructure (workshops, offices, etc.) which can be readily repurposed
- diverse, disturbed terrain that can be re-shaped if required
- established water supply/storage and water quality management infrastructure
- voids for tailings storage and existing tailings management system
- void with high local relief (height difference of up to 300 m) and upper and lower water storage
- accessible rail loading infrastructure and rail loop with efficient access to Main Northern Rail Line and ready access to the Port of Newcastle
- recently upgraded road access to the New England Highway/Freeway system
- connection to communication and electricity infrastructure
- accessible to workforce
- proximity to urban areas (Singleton and Cessnock)
- connection to surrounding remnant vegetation areas to the south and east, including the Singleton Army base.

The proposed final land use for the site is consistent with the objectives of each of the strategic plans in that it increases the area land identified for ecological restoration and will significantly enhance regional biodiversity linkages. Importantly, the site also provides a number of opportunities for alternative land uses with increased employment opportunities which can occur concurrently with the biodiversity outcomes proposed. Some of these potential alternatives are considered in **Section 6.12.4.2.**

6.12.4.2 Suitability of the site for alternative land uses

As discussed in the assessment documentation for the BOP, the infrastructure areas associated with the Approved Operations also have potential for being suitable for industrial or intensive agricultural use. The availability of access to rail through the rail loop and water management storages, including the final void, as well as the large separation distances from adjoining landholders, may also lend parts of the site to being suitable for industrial or intensive agricultural (e.g. poultry, piggeries, mushroom composting and farming) uses in the future, subject to future planning controls that apply at the time. The proposed conceptual final landform terrain and revegetation strategy, coupled with the site's proximity to the SMTA also provides opportunities for the site being used for military training purposes.

The additional depth of the Proposed Modification final void may increase the viability of some potential end uses for the void such as use as a water storage and pumped-hydroelectricity. Further consideration of potential final land use options is discussed below.

Table 6.19 provides a high level analysis of potential post mining land uses for the Proposed Modification. **Table 6.19** identifies the land characteristics which would be consistent with sustainable operations of these land uses and the extent to which these beneficial land characteristics or values are present or could be present at the BOC as mine closure and rehabilitation proceed. **Table 6.19** also provides a brief commentary on the potential land uses which are best aligned with the characteristics and values of BOC.

In addition, the proposed ecological offset area to be located adjacent to the mine (known as the Vere Offset), may also provide opportunities for alternate land uses such as bush walking and mountain biking, which could be further enhanced with other adventure sport activities on the rehabilitated post mining landform, as explored in **Table 6.21**.

Table 6.21 Potential Final Land Use Analysis

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
Future Mining Operations	Accessible and economically viable coal resources.	Potential for additional coal resources to be available (subject to further exploration, feasibility investigations, environment impact analysis and approval).	There are further coal resources located within existing Glencore mining tenements. Subject to further exploration, feasibility investigations, and market considerations, it may become an option in the future to further optimise coal recovery from this area. Further advances in mining technology, exploration and geological investigations may lead to further mining within these existing tenements becoming viable Access and site facilities are in place and have sufficient life expectancy to continue to add value to potential future mining uses.
	Mining Infrastructure (MIA, CHPP etc.).	Existing BOC MIA and CHPP includes buildings such as offices, workshops, storage sheds, bath houses, potable water supply, sewage system, hard stand areas, car parks, power supply, access roads and intersections.	
	Water supply and storage. Tailings storage.	Existing water supply from the Hunter River and the existing Northern Dam and Surge Dam providing approximately 5 GL water storage. The Main Pit void providing tailings storage	
	Rail and road infrastructure providing access to the Port of Newcastle.	BOC rail loader and loop connecting to Main Northern Rail Line.	
	Access to communication and electricity infrastructure.	Established communication and electricity connections including high and low voltage connections and reticulation and close access to the NSW high voltage transmission grid.	
	Site with acceptable direct environmental impacts and with sufficient buffer land to minimise potential mining impacts and land use conflicts with sensitive land uses and Critical Industry Clusters (agriculture).	Established mining precinct, with extensive mine owned buffer land. Sensitive land uses in the context of the Bulga Open Cut have been identified and management strategies are in place.	
	Accessible to skilled mining workforce.	Significant skilled mining workforce in the region.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
Ancillary Mining Activities	Brownfield development sites with few environment and community constraints, preferably with existing coal processing infrastructure.	BOC MIA and CHPP.	
	Established water supply/storage and management. Tailings storage.	Approved Northern Dam providing water storage and the Main Pit void providing tailings storage.	
	Access to road and rail transport and electricity/communication infrastructure.	BOC rail loader and loop connecting to Main Northern Rail Line. Established communication and electricity connections.	
	Accessible to skilled mining/heavy engineering workforce.	Site is accessible to local workforce located with the Upper and Lower Hunter.	
Power generation (Solar, Gas, and Pumped Hydro energy storage)	Built assets (offices, workshops, car parks etc.).	BOC MIA can be readily repurposed to provide office/workshop facilities reducing establishment costs.	Requires more detailed feasibility studies and further development of regional scale strategic planning for employment transition. Site shows promise for potential power generation activities. Economic viability will depend on electricity demand and generation profile at time of mine closure.
	Significant height difference from upper to lower water storages for pumped hydro	BOC includes voids with high local relief (height difference of in excess of 300 m).	
	Water resources/storage of sufficient volume of water at different levels and sufficient water quality.	Multiple sites for upper water storages are potentially available in in-pit emplacement areas. Constructed dams would require lining but can be constructed economically as part of final landform development operations.	
	Connectivity to electricity grid Site with acceptable direct environmental impacts and with sufficient buffer land to minimise potential impacts (noise, air quality etc.).	Site is located immediately adjacent to 66 and 300 kV transmission network infrastructure. Established site with extensive mine owned buffer land. Reshaping activities consistent with impacts from final landform establishment activities.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
	Access to water.	Availability of water in pit lake from run-off, mine water storages on cessation of mining and from groundwater inflows to underground workings and final void.	Pumped hydro-infrastructure is not constrained by quality of water immediately available for use.
	Land that can be shaped and developed for turbines, battery storage, transmission etc. Road/rail access.	Opportunity to cost effectively shape land suitable for generation and storage with minimal environmental impacts.	
	Accessible to skilled engineering workforce.	Road and rail access in place. Rail access to the Port of Newcastle, road access to New England Highway (NEH)/Freeway system Site is accessible to skilled and experienced engineering and power generation workers from local region.	
Industrial/Manufacturing Uses	Built assets (offices, workshops, car parks etc.).	BOC MIA can be readily repurposed to provide office/workshop facilities reducing establishment costs. Established buildings and services includes buildings such as offices, workshops, storage sheds, bath houses, potable water supply, sewage system, hard stand areas, car parks, power supply, access roads and intersections.	The BOC provides potential opportunities for manufacturing or industrial land uses, subject to detailed feasibility studies and further development of a regional employment transition strategy that provides more direction on preferred sites than is currently available in the Hunter Strategic Plan 2036.
	Land resources – potential to create landforms suitable for large industrial sites.	Existing suitable flat land for heavy or medium industry in the final landform design, generally in parts of the site with good access to road and rail infrastructure and power supply.	
	Water infrastructure, storage available to prevent the need for licensed polluted discharge to waters.	Existing water supply from the Hunter River and the existing Northern Dam and Surge Dam providing approximately 4 GL water storage. Pit lake water quality will be suitable for a wide range of industrial purposes. Site has good track record of managing water on site.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
	Proximity to urban areas in terms of worker commute.	Located in close proximity to major centres in the Upper and Lower Hunter Valley.	
	Remote or shielded from sensitive residential areas or other sensitive users, where heavy industry is being considered which may have potential air (particulates, odour), visual or noise impacts.	The site and established buffer zone, are already managed to minimise noise, odour, lighting and other visual impacts on neighbouring residential land uses.	
	Access to road, rail and communications infrastructure –for materials and product; access to port or airport infrastructure.	Road and rail access in place. Rail access to the Port of Newcastle, road access to New England Highway (NEH)/Freeway system. Established communication and electricity connections.	
	Access to skilled engineering/ manufacturing workforce.	Road access to NEH/Freeway system.	
	Proximity to secure energy supply and potential for co-location of renewable energy.	Secure energy supply available and power could also be generated on site (solar, wind or storage based hydroelectricity).	
	Simple land tenure arrangements for zoning and/or subdivision.	Large portion of land in consolidated ownership.	
Industrial Agriculture (agribusiness, including intensive production and processing)	Built assets (offices, workshops, car parks etc.).	Bulga Open Cut MIA can be readily repurposed to provide office/workshop facilities reducing establishment costs.	Parts of the site – generally those closer to road and rail access, and to other site infrastructure, may be suitable, subject to detailed feasibility studies and comparison with other post mining sites Consistent with regional plan strategy to protect and enhance agricultural productivity. Use of site for intensive or industrial agricultural activities will not impact on agricultural land with a Land and Soil capability class 3 or better.
	Land resources – potential to create landforms suitable for large production sites; e.g. glasshouses, composting facilities etc.	Majority of the site is well suited. There is potential to retain and create additional areas suitable for large scale intensive agriculture/horticulture as part of post mining landform, particularly around existing MIA and rail loop areas.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
	Access to road, rail and communications infrastructure –for materials and product; access to port or airport infrastructure.	Road and rail access in place. Rail access to the Port of Newcastle. Road access to New England. Highway/Freeway system, and located in close proximity to Singleton and Cessnock.	
	Proximity to urban areas in terms of worker commute.	Local road access only to Newcastle airport (which applies to all sites in the region .	
	Proximity to secure energy supply and potential for co-location of renewable energy.	Proximity to secure energy supply. Power could also be generated on site (solar, wind or storage based hydroelectricity).	
	Water for irrigation is available and water can be managed on site (stored, reused, recycled) to prevent the need for licensed discharge to waters.	Water availability depends on water quality required – mix of fresh water and saline water available – and extent of treatment may be required to be suitable for some horticultural purposes. Access to water supply via the Mt Thorley Supply Joint Venture (subject to licencing requirements). Potential to utilise the Northern Storage Dam and Final Void Pit Lake for irrigation.	
	Remote or shielded from sensitive residential areas or other sensitive users, where intensive agricultural uses are being considered which may have potential air (particulates, odour), visual or noise impacts.	Site is generally remote from sensitive residential areas and screened by landform and vegetation.	
	Simple land tenure arrangements for zoning and/or subdivision.	Large portion of land in consolidated ownership.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
Military/other armed forces or specialist training facility, such as	Terrain suitable for diverse training experiences.	Site will have diverse terrain.	
extreme terrain exercises, firing ranges etc.	Remote or shielded from sensitive residential areas or other sensitive users, where military activity may have potential visual, noise, ecological or other impacts.	The site and established buffer zone, are already managed to minimise potential impacts on surrounding land uses particularly noise. SMTA is located to the east of BOC adjacent the approved MIA and Deep Pit/Bayswater TSF.	
Passive and active recreation/extreme sports (e.g. motocross, bicycle, mountain biking, rock climbing and high ropes)	Terrain suitable for (or scope to reasonably shape for) diverse physical challenges.	Final conceptual landform will have diverse terrain, potentially including very steep and long slopes and benches suitable for adventure sports. Brownfield site offers flexibility in terms of terrain design and design of adventure or extreme sports facilities.	A number of mine sites in the Upper Hunter may offer terrain suitable for adventure sports developments. BCC is conveniently located in proximity to other tourism areas (e.g. Broke/Fordwich viticulture district) which may make it a more suitable location. More detailed feasibility studies would be required, linked to more detailed regional employment transition planning. South Pit rehabilitated emplacement area and the Proposed South Pit void area may be best opportunity for this potential land use. Hunter Regional Plan 2036 suggests that niche commercial, tourist and recreation activities, set within an agricultural landscape, but not using the best quality agricultural land may be an employment opportunity. This would be relevant to final void sites and adjacent rehabilitated land.
	Access to road or rail transport routes.	Road and rail access in place. Rail access to the Port of Newcastle Road access to New England Highway/Freeway system.	
	In location that can be marketed with other related tourism experiences – such as Wine Country tourism and Sydney market.	Location in Hunter Valley and buildings suitable for offices/management of adventure recreation and could be marketed as part of a package of related tourism experiences – (note: no framework for this currently exists).	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
	Impacts on ground surface and vegetation can be controlled, with low chance of offsite impacts.	Well managed activities could be controlled to minimise direct impacts on existing and rehabilitated native vegetation, and to utilise more disturbed terrain for higher impact activities. Extensive buffer zone with minimal potential for off-site impacts.	
	Facilities for offices, cafes, accommodation or other associated infrastructure.	BOC MIA can be readily repurposed to provide café, office/workshop facilities reducing establishment costs.	
Waste, recycling, reuse and product development	Terrain suitable for all aspects of waste processing, including sorting, reprocessing (product development), repurposing, waste to energy, waste disposal.	BOC offers diverse terrain, including relatively flat land and infrastructure suitable for processing, and deep voids.	A number of other former mine sites in the Upper Hunter are likely to have similar beneficial characteristics. To identify optimal locations for this land use, more detailed feasibility studies are required, linked to more detailed regional employment transition planning. Waste management is not currently proposed for the BCC. Other mine sites may have more suitable characteristics.
	Access to road, rail and communications infrastructure suitable for transporting significant volumes of material.	The BOC has access to the Main North Rail line, with potential to receive waste from the greater regional area. Road and rail access in place. Rail access to the Port of Newcastle. Road access to New England. Highway/Freeway system.	
	Remote or shielded from sensitive residential areas or other sensitive users, where waste management activities may have potential visual, noise, odour, or other impacts Connections to waste research organisations and to appropriately skilled workforce.	The site and established buffer zone, are already managed to minimise noise, odour, lighting and other visual impacts on neighbouring residential land uses.	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
Aquaculture	Terrain suitable (or which can be shaped to be suitable) for aquaculture ponds and related processing activities, including large areas of flat land, land suitable for ponds or varying sizes.	Some potential to create landforms suitable for aquaculture ponds.	
	Buildings and infrastructure to support land-based aquaculture using large tanks. Suitable buildings to house tanks, water supply.	Existing water storages (Surge Dam and Norther Dam) have potential to be repurposed for aquaculture use.	
	Water quality, water treatment and storage management suitable for intensive aquaculture use, potentially high nutrient/organic load.	Access to water supply via the Mt Thorley Supply Joint Venture (subject to licencing requirements). Void water quality likely to be suitable for many aquaculture species.	
	Access to good road, rail, power and telecommunications infrastructure. Access to port and airport for rapid distribution to international customers.	The BOC has access to the Main North Rail line, with potential to receive waste from the greater regional area. Road and rail access in place. Rail access to the Port of Newcastle. Road access to New England Highway/ Freeway system. Secure energy and telecommunications supply available.	
	Remote or shielded from sensitive residential areas or other sensitive users, where waste management activities may have potential visual, noise, odour, or other impacts	The site and established buffer zone, are already managed to minimise noise, odour, lighting and other visual impacts on neighbouring residential land uses	

Potential Land Use	Beneficial Land Characteristics/Values Required	BOC Land Characteristics/Values	Comments
High value carbon forestry, ecological restoration, nature based education, low impact recreation, training and research	Site connected to natural vegetation area	BOC and offset areas are immediately adjacent to the SMTA and in close proximity to Wollemi and Yengo National Parks.	Hunter Regional Plan 2036 refers to growing 'landscape' tourism, building on existing scenic, fresh produce (including wine) and equine land uses. The opportunity at the BOC is more about managing/recreating natural areas (some of which may also be suitable for recreation in the medium term), rather than the gastronomic tourism referred to in the Regional Plan.
	Rehabilitated sites with a focus on biodiversity and ecological connectivity. Diversity of site conditions relevant to multiple aspects of research.	Work on enhancing ecological connectivity is already underway.	
	Proximity to education institutions including schools and university students; similarly proximity to markets for nature based tourism (major urban centres, but also international visitors).	The population of the Hunter region is expected to grow, with increasing numbers of school and university students. Well located in terms of regional urban centres, proximity to Newcastle and Sydney metropolitan areas, and reasonable airport access.	
	Connections with university research.	Glencore has a long established, strong link to Newcastle University researchers with regard to rehabilitation research.	

As demonstrated in **Table 6.19**, BOC could provide strategic opportunities for a variety of potential final land uses, given the extensive infrastructure and accessibility. These final land use options are considered as potential land uses however these will be considered closer to mine closure and will be dependent on market demand for products at the time, and technology available near to closure. It can be seen from the analysis outlined above, that there are a number of potential options for beneficial use of the final void.

Whether or not the void is used directly as an asset as part of the final land use (e.g. future mining, pumped hydro electricity generation, extreme recreation activities, aquaculture etc.), the existence of the void and predicted pit lake water quality should not constrain the range of potential land uses, provided appropriate access and safety considerations are in place, in accordance with standard mine closure requirements. Ultimately, the presence of the void and associated pit lake is considered to provide significant opportunities for high value (and high employment generating) land use options providing economic diversity into the future beyond mining. As discussed in **Table 6.19**, the predicted pit lake water quality will be suitable for a wide range of potential end land uses.

Consistent with the current operations, any final land uses other than woodland and extensive agriculture development will require further assessment and approval.

BOC operations are expected to extend to the end of 2039 and the detailed mine closure process will commence five years prior to planned cessation of mining with a detailed closure plan finalised no less than two years prior to planned cessation of mining. When the detailed mine closure planning process commences in more than 10 years from now, there will be a need for further consideration of the final land use based on State and Local Government strategic planning and Glencore strategic requirements, the economy and the demand/need for the uses being considered at the time. Consistent with the existing mine closure planning commitments for the Bulga Complex, consultation with stakeholders, including the local community and proximate landholders will commence prior to planned closure with a detailed mine closure plan being developed at least five years prior to planned closure.

6.13 Social

As discussed in **Section 4.0**, a comprehensive Social Impact and Opportunities Assessment (SIOA) was undertaken for the BOP (Coakes, 2013). The SIA prepared for the Proposed Modification builds upon the previous work, with DPE confirming this to be an acceptable approach. The SIA also has regard to DPE's *Social Impact Assessment Guideline for State Significant mining, petroleum production and extractive industry development* (DPE, 2017).

Potential environmental and social impacts (both positive and negative) of the Proposed Modification were identified through consultation processes and are discussed in detail below. .

During the development of the BOP, the project design team considered community feedback in refining the project design, with some key elements of the BOP being amended to address issues, including potential noise and visual impacts. The same key considerations and iterative design processes were undertaken to refine the design of the Proposed Modification in order to limit the potential for any additional adverse impacts.

Community engagement has been a key component in the Proposed Modification and the various specialist assessment studies. Through the SIA, stakeholders have been engaged through a wide variety of mechanisms including the use of community information sessions, newsletters, government briefings, website updates, surveys and community group meetings (refer to **Section 4.0**).

The detailed SIA has been prepared by Umwelt and is included as **Appendix 14** with the key assessment findings outlined below.

6.13.1 Methodology

A best practice approach to SIA has been adopted for the Proposed Modification, that integrates international and NSW social impact assessment guideline requirements. In line with best practice, the SIA has involved key phases of work that include:

- **Preparatory Planning -** undertaking appropriate planning for the Proposed Modification and the development of a Stakeholder Engagement Strategy, including a review of the previous SIOA undertaken for the operation in 2013
- **Profiling -** updating the baseline social context in which Proposed Modification is based
- **Scoping -** identifying key social impacts/issues relevant to the Proposed Modification
- **Assessment and Prediction of impacts -** evaluating and predicting positive and negative social impacts associated with The Proposed Modification
- **Strategy Development -** identifying any relevant strategies to minimise significant negative impacts and enhance positive impacts associated with Proposed Modification
- **Monitoring and Evaluation –** development of a framework outlining how social impacts should be monitored and evaluated should the Proposed Modification proceed.

Engagement with the community has been a key component of the SIA program at key phases of the assessment, to afford a participatory approach to assessment. Since late 2017, the BCM Project team and Umwelt have been engaging with both the local and wider community to identify their issues, concerns and aspirations through a variety of mechanisms including personal meetings, telephone liaison, community BBQs and project briefings.

The BCM team has strong existing relationships within their respective proximal communities – Broke, Milbrodale and Bulga - as clearly evidenced in the previous SIA for the BOP. Since gaining approval for the BOP in 2014, BCM has continued to build on, and further develop, these relationships with proximal landholders and community members through their continuing engagement efforts. Outcomes of this engagement have been used to inform the SIA.

Commissioning of the SIA early in the Proposed Modification, and regular meetings with the BCM Project team throughout the assessment program, has also provided opportunities to effectively align assessment outcomes with the wider SEE process, undertaken by Umwelt, and inform project planning and mine plan design.

Table 6.22 provides a summary of the assessment and engagement mechanisms that have been utilised during each phase of the SIA program.

Table 6.22 Summary of Social Assessment and Community Methods

Method	Description
Phase 1	**Community Profiling**
Township Resource Cluster (TRC) Analysis[1]	Documentation of the social and economic linkages/associations between BCM and communities within the region through analysis of employee, supplier/vendor and community investment data.
Community Capitals Analysis	Assessment and analysis of changes in ABS Census data and other relevant social and community indicators and data sets to update a social baseline profile of the communities of interest – Bulga, Broke, Milbrodale and the Singleton LGA. Areas of existing community resilience and vulnerability have been identified through application of a community assets/capitals approach.
Post Impact Studies Analysis	Review and analysis of secondary data (including local histories, local government strategic plans and assessment studies, local media, previous SEE/EIS/SIA studies, operational complaints) and primary data collected through stakeholder interviews, to understand historical, existing and emerging issues and opportunities within the community.
Indigenous profile and issues analysis	Review of socio-economic statistics relevant to the aboriginal population. Personal and telephone interviews with indigenous groups and service providers in the Singleton LGA to identify community values, needs and to document potential impacts (positive and negative) of mining in the region.
Phase 2	**Scoping of Issues and Opportunities**
Key Stakeholder Issues Analysis	Survey of near neighbours and community residents residing in proximity to the BCC, to identify perceived issues and opportunities relating to the Proposed Modification. Ranking of perceived issues and opportunities by relative frequency. Review of key stakeholder and community survey data undertaken in the communities relevant to the Proposed Modification obtained through the Glencore Community Survey (2018).
Review and analysis of BCMs existing consultation and complaints data	Review and analysis of engagement data including meetings, phone calls, newsletter feedback and community complaints.
Phase 3	**Assessment and Impact Prediction**
Social Risking	Assessment of unmitigated and mitigated social risks/impacts associated with the Proposed Modification through review of relevant social and environmental consequence and likelihood ratings. Prediction of social impacts associated with the Proposed Modification in line with identified impact characteristics (extent, duration, sensitivity/vulnerability, severity).

[1] Fenton, Coakes and Marshall, 2003

Method	Description
Key Stakeholder issues analysis - impacts and opportunities	Engagement with 86 near neighbours in relation to the Proposed Modification specifically, to further identify perceived issues and opportunities relating to the Proposed Modification. Mechanisms have included: • Personal meetings • Community BBQ program in Broke and Bulga (2 x 2 BBQs per community – total of 4 BBQs) • Targeted briefings with key stakeholders • Community Information Session (CIS) facilitated to allow input from near neighbours and residents of the Broke, Bulga and Milbrodale communities in regard to the impacts and opportunities relating to the Proposed Modification.
Phase 4	**Mitigation and Management**
Social Risk Matrix	Categorisation of impacts by social impact category and theme.
Social Impact Management and Residual Risk Ranking	Identification and development of appropriate strategies (mitigation and enhancement) to address significant predicted impacts from the Proposed Modification.
Engagement Methods	
Proximal neighbour/ Landholder meetings	Personal meetings with near neighbours to collect information and identify perceived social impacts early in the project and to discuss outcomes of the environmental and social impact assessment studies.
Telephone interviews with Indigenous services providers	Telephone interviews with 15 indigenous stakeholders and service providers to identify issues in relation to the Proposed Modification and mining more generally within the community; and potential opportunities for impact management and enhancement.
Community BBQ Program	The bi-annual Community BBQ Program developed to provide opportunity for the community to meet staff from the BCM operations in an informal setting. It provides a forum for BCM to update the community on their mining operations and activities, as well as answer any questions. The community barbeques also provide a social opportunity for community members to come together and network, with the mechanisms becoming a significant event in the local communities of Bulga and Broke.
Community Information Session	Drop-in session to share information about the Proposed Modification, and the SEE/SIA process, and to receive community feedback.
Glencore Community Perceptions Survey	Review and analysis of outcomes of a community perception survey undertaken by Umwelt on behalf of Glencore in July and August 2018, with the purpose of providing Glencore with a greater understanding of stakeholder issues and needs relating to company activities, past and present; and to assist in driving business improvement in the areas of environmental performance, stakeholder engagement and community development across neighbouring and regional communities associated with Glencore's operations in both NSW and QLD. For the current SIA, data from the perception survey involving landholders, key stakeholders and residents residing in the Singleton LGA has been reviewed and incorporated as appropriate.
Government briefings and consultation	Briefings and personal meetings with relevant government representatives (local and state) to present various stages of the assessment and obtain feedback on Proposed Modification aspects.

Method	Description
Community Consultative Committee Meetings	A total of two briefings to the local CCC to share information about the Proposed Modification and obtain committee member feedback.
Community Information Sheets	Development and distribution of two project dedicated information sheets to near neighbours and key stakeholders at key stages: • Project and Process Overview – to describe Proposed Modification and the SEE/SIA process • SEE Project Summary – summary of the key outcomes of the environmental and social impact specialist studies undertaken as part of the assessment program and proposed management approaches. Each information sheet also provided project and consultant contact details for further information and/or to request a personal project interview or briefing.
Email and phone correspondence	Phone calls and emails relating to the SIA process to landholders, as required, to organise meetings, provide information and/or respond to questions relating to the SEE and SIA process.
Website	Provision of information on the BCC website relating to the Proposed Modification including information sheets, newsletters, posters used at the CIS.

6.13.2 Operational Context – Existing Social and Economic Linkages

As part of the BOP SIOA in 2013, Coakes Consulting conducted a detailed Township Resource Cluster Analysis (TRC Analysis) (Fenton, Coakes and Marshall, 2003) of the links between the BCC operations and its surrounding communities. This study involved surveys of employees, contractors, and businesses that had a supplier relationship with the BCC operations, in order to determine residential location, expenditure estimates, use of local services and participation in community life.

The TRC has been updated by reviewing secondary data relating to employee residential location and household expenditure, where available. Current supplier data has also been sourced from BCM that focuses on business location and expenditure.

Major resource projects can make significant social and economic contributions to communities that extend far beyond the location in which an operation is based. For instance, the presence of an operation provides economic contributions to communities through indirect impacts such as employees' household expenditure. Furthermore, employees (and their families) that are supported by their employment on a project may contribute to communities through their participation in community groups and activities, or through their use of local and regional services. Likewise, indirect benefits may be experienced in communities where suppliers' head offices are located or where suppliers' business expenditure is undertaken.

Consistent with the analysis in the BOP SIOA (2013), the current TRC identified several key towns that appeared to be significantly associated with BCM's operations – these include Maitland, Singleton and Cessnock. Large numbers of employees reported living in these locations, and consequently it was assumed that most employee household expenditure and use of local services would take place in these communities. As the earlier study had specifically asked where employees/contractors spend their money, the similarity in locations of expenditure supports the findings of the current report. Where differences were evident, this was usually in communities that lack access to services.

Similarly, supplier locations and expenditure were found to be spread across equivalent communities, with Singleton, Newcastle, Sydney, Cessnock and Queensland (Brisbane) receiving the highest flow on expenditure in both instances. Estimates of supplier business reliance on BCC, collected in the earlier study, indicated that most businesses still have significant reliance on the operations.

Overall, BCM spent an estimated total of approximately $156 M on employee salaries and supply contracts within the communities of Singleton, Muswellbrook, Maitland/Branxton and Cessnock Shire Councils, and $251 M in the Hunter Region.

Approximately $63 M was spent on employee salaries and supplies over the course of a year, with $49 M going to employees and suppliers in the local government areas mentioned above, and a total of $60 M in the Hunter Region more broadly. Additionally, BCM pledged a total of $985,000 of investment for the communities of Broke and Bulga, and an equivalent amount for Singleton, over the life of the BOP – the majority of these funds has been used or is currently allocated to specific projects.

Given that the Proposed Modification will extend the life of the mine for a further four years, it can be inferred that the local area and the region more broadly, will continue to benefit from the presence of the operation and sustained employment for the workforce.

6.13.3 Social Profiling

As outlined, an extensive social profile was undertaken to support the SIOA for the BOP (Coakes, 2013). As such, the current SIA study provides an updated social baseline, building on the research undertaken as part of the previous assessment, including:

- **Geographic and historical context –** description of the context and identification of the communities of interest relevant to the current assessment, including a review of the history of the local area and communities, and the culture and values of local residents.
- **Community capitals/assets –** assessment of the areas of vulnerability and resilience across the communities of interest in line with the community capitals/assets approach.
- **Key community values, issues and aspirations –** documentation of current community issues in the Singleton LGA and Upper Hunter Region as a whole, as identified in key planning documents, regional studies, the previous SIOA, and media review.

The geographical local communities of interest for the Proposed Modification and SIA include the ABS state suburb communities of Broke and Bulga.

The social profile has utilised a community assets (or capitals) approach in defining the strengths and vulnerabilities of the community across five key areas – natural, social, human, physical and economic.

There have been a number of changes across community capital areas in the communities of interest between 2011 and 2016, notably:

- Employment in the mining industry in Bulga has increased (2011 and 2016) – up 3.2% to 25.7%; with a small decrease in employment in mining in the wider Singleton LGA.
- A rise in part-time employment and a corresponding fall in full time employment across all localities within the LGA between 2011 and 2016 – this may indicate a rising level of under-employment in the region.

- Unemployment rates increased across all study areas, and in NSW, with rates in Singleton LGA doubling between 2011 and 2016 (3% to 6%).
- Broke has experienced a population drop from 636 in 2011 to 579 in 2016, while Bulga and Singleton populations have remained relatively stable.
- The populations of Broke and Bulga are ageing, with a median age of 40 to 41 years, whilst Singleton (36 years) has a slightly younger population than NSW (38 years).
- Both Broke and Bulga have seen a small rise (2%) in the proportion of the population aged over 65 years since 2011.
- Volunteer rates remained steady in Singleton LGA between 2011 and 2016 and jumped 11 percentage points in Bulga (from 18% to 29%) in the same time period.
- Mobility across Broke, Bulga and Singleton has decreased, with lower proportions of the population living at a different address one year ago for all localities in 2016 compared to 2011. In 2016, Broke and Bulga had lower than state average proportions of the population who lived at a different address five years ago (29% and 28% respectively, compared with 39% for NSW), while Singleton LGA (37%) has mobility rates comparable to the State average. These rates have also remained stable since 2011 across all localities.
- Mobility across the LGA may relate to the mining downturn during 2012 to 13, and the migration of workers out of the area, or to other parts of the LGA and the region. This worker migration can be seen in decreases in people aged 25 to 64 years in Broke, 35 to 54 years in Bulga, and 15 to 44 years in Singleton LGA.
- Health indicators suggest that residents of the Singleton area are particularly vulnerable across a range of health factors, with heightened rates of obesity, smoking, drinking, and cancer. Hospitalisations for respiratory diseases (including pneumonia, asthma and chronic obstructive pulmonary disease) have increased (214 cases from 2002 to 2017).
- Singleton LGA experienced a rise in rental stress concurrently with a drop-in mortgage stress between 2011 and 2016. This general trend is echoed in NSW figures for the same period.
- Increases in rental prices in both Broke and Bulga are evident from 2011 to 2016, and only minor decreases in median mortgage repayments in Singleton compared to a state-wide trend towards decreasing mortgage repayments.
- Higher rental and mortgage costs may indicate housing stress, and this may be evident in the decrease in homes both fully owned and being purchased, and the rise in homes being rented between 2011 and 2016.
- The Hunter Expressway opened to traffic in 2014 which has improved travel time for motorists between Newcastle and the Upper Hunter.

6.13.4 Perceived Issues and Opportunities

A key component of the SIA is the process of understanding, from a community perspective, community values and uses in the assessment area, and specifically the social impacts and opportunities associated with the Proposed Modification.

Engagement activities undertaken to support the SIA program had three main objectives:

- to identify perceived issues/impacts associated with the Proposed Modification

- to identify perceived social issues/impacts associated with cumulative mining development in the region
- to identify strategies for management and opportunities of enhancement of perceived social impacts of the Proposed Modification.

These objectives were achieved through consultation with:

- **Proximal landholders** – landholders and the community in the villages of Broke, Milbrodale and Bulga.
- **Community stakeholders and residents** - stakeholders and residents of the wider Singleton LGA.
- **Indigenous stakeholders -** local indigenous groups and services providers in the Upper Hunter across the Shires of Singleton and Muswellbrook.

As part of the wider SEE Community Engagement Process representatives from the BCM have also met with local government representatives, State and Commonwealth Government agencies and local business and industry, community, cultural and heritage groups (associated with the area).

Proximal Landholders

An extensive stakeholder engagement program was undertaken as part of the BOP from 2012 to 2013, with over 180 stakeholders engaged as part of the associated assessment process during this time. The most common perceived social impact themes identified by proximal landholders, residents and community group representatives at that time, related to the impacts of air quality (15.4%) and noise (13.3%) on social amenity, visual impacts (11.6%) and community sustainability (11.3%) (refer to **Figure 6.18**).

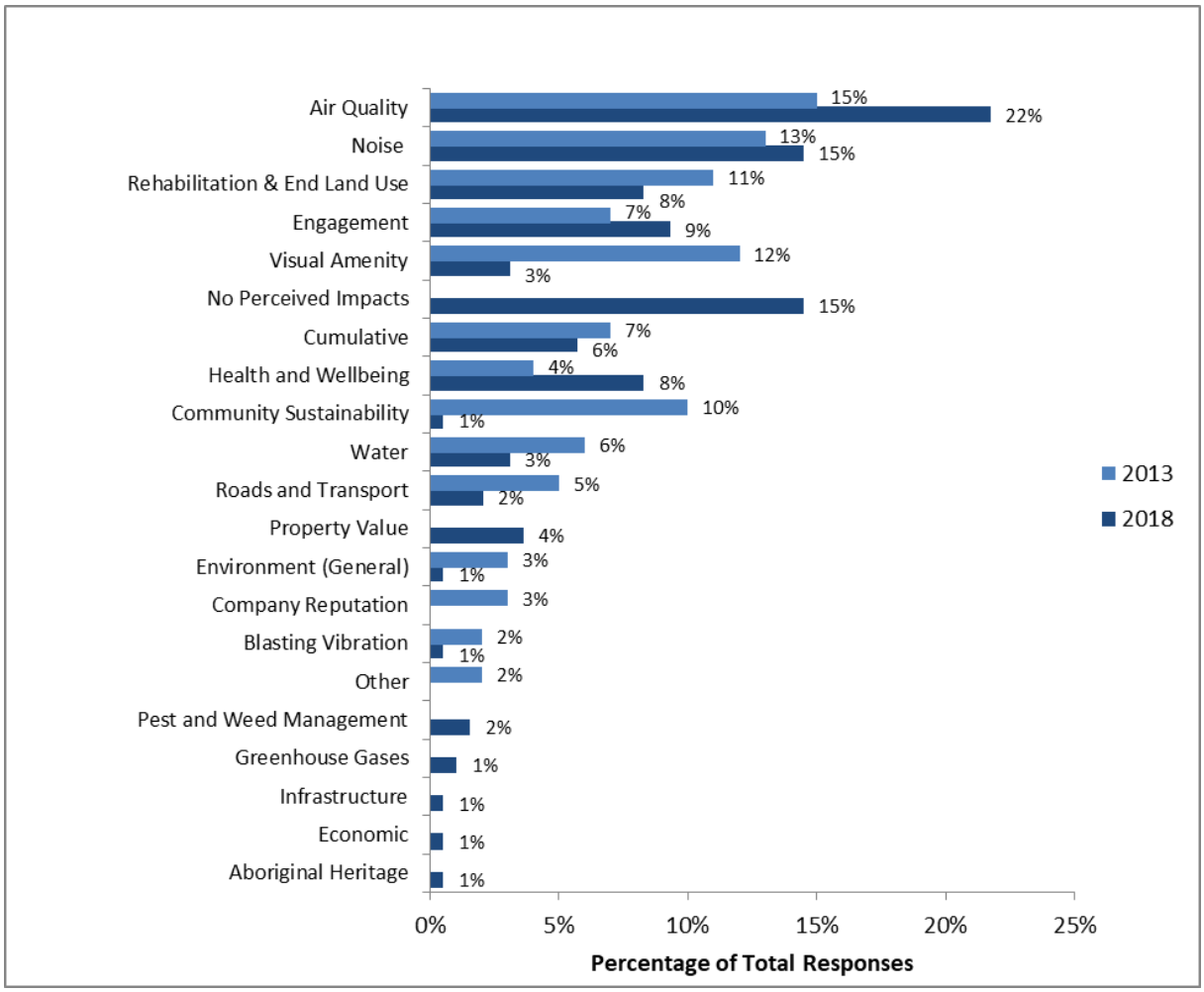

Figure 6.18 Comparison of BOP 2013 Predicted Impacts and Existing Operational Impacts

Source: Umwelt (2018)

Note: 2013 n =149; 2018 n=86, multiple responses allowed

More recently, a survey of near neighbours/proximal landholders to the BCC was carried out to inform the current SIA, with respondents asked to provide feedback on both existing operational issues and perceived positive or negative impacts associated with the Proposed Modification.

A total of 86 respondents (Bulga n=45 and Broke n=41) participated in the survey and an additional 11 stakeholders attended a Community Information Session held in April 2019. The seven closest neighbours/landholders (those most directly affected by the Proposed Modification) were offered SIA interviews, with six choosing to participate.

Regarding perceptions relating to the **existing operation** at BCC:

- 28 respondents (32.6%) stated they did not have any concerns in relation to BCCs existing operations
- for those that did have concerns, the greatest concerns noted were associated with the impact of air quality on social amenity (n = 42 or 22% of respondents)

- noise was the second highest negative concern, again in relation to the impact on social amenity (n=28 respondents or 15% of respondents) and was particularly noted by Bulga respondents
- trust and engagement, rehabilitation and end land use, impacts on health and wellbeing and cumulative impacts were also raised
- both positive and negative responses were recorded regarding engagement with the company (13 positive and 5 negative).

In relation to the perceived positive or negative impacts associated with the **Proposed Modification** (refer to **Figure 6.19**):

- 37 respondents (15%) stated they did not have any concerns
- the highest social impact area noted was the positive economic impacts of the Proposed Modification (N=23)
- concerns around mine life and end land use, including rehabilitation, was the highest perceived negative impact (11), followed by impacts on social amenity due to air quality (7), noise (4) and trust and engagement (4).

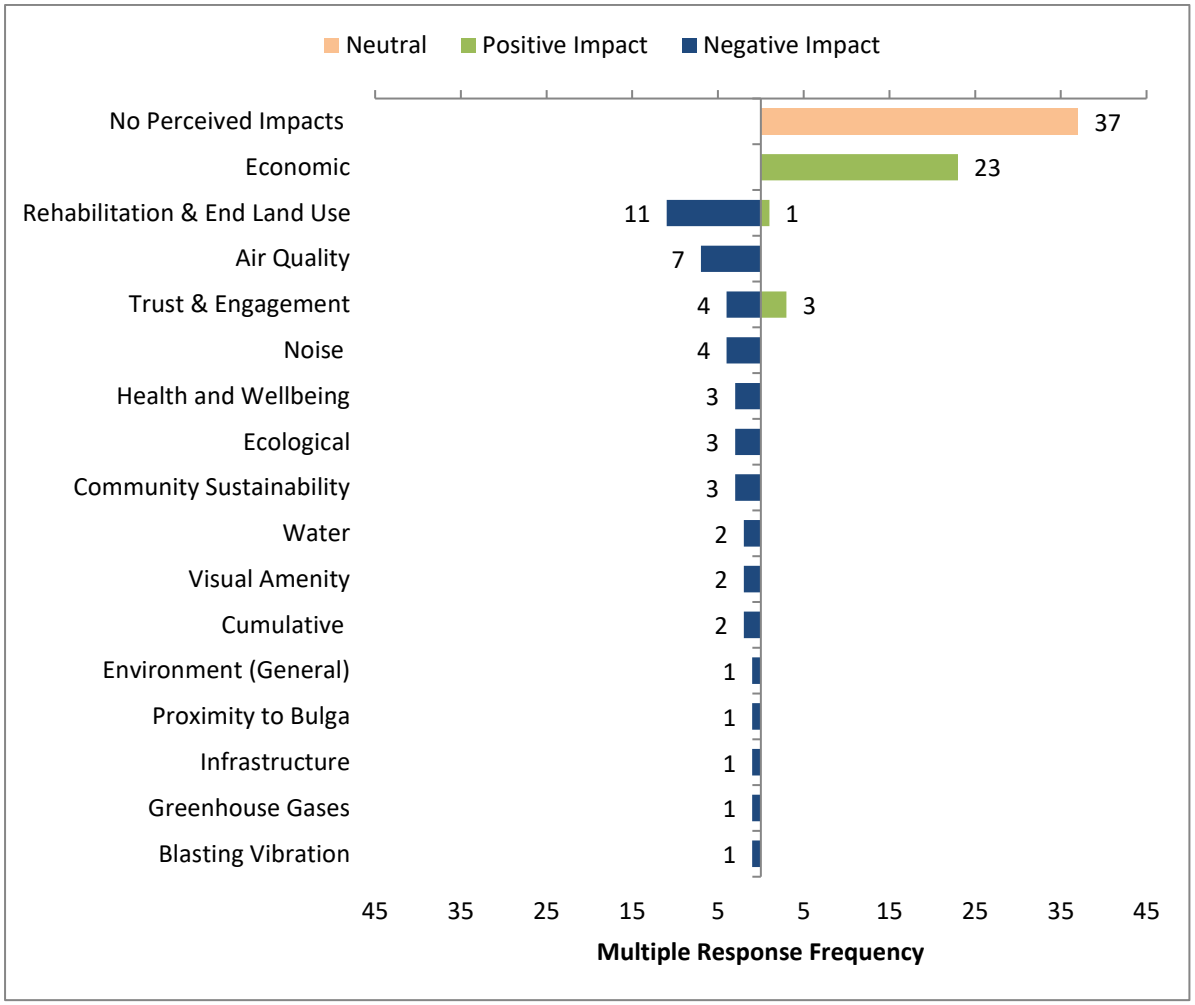

Figure 6.19 Perceived Positive and Negative Social Impacts of the Proposed Modification

Source: Umwelt (2018)

Note: n=86, multiple responses allowed

As shown in **Figure 6.20**, when comparing responses relating to the Proposed Modification by location, the Bulga locality had a higher number of neighbours/landholders with concerns across all impact categories, compared to Broke. These issues are also in line with the 2013 SIA engagement data.

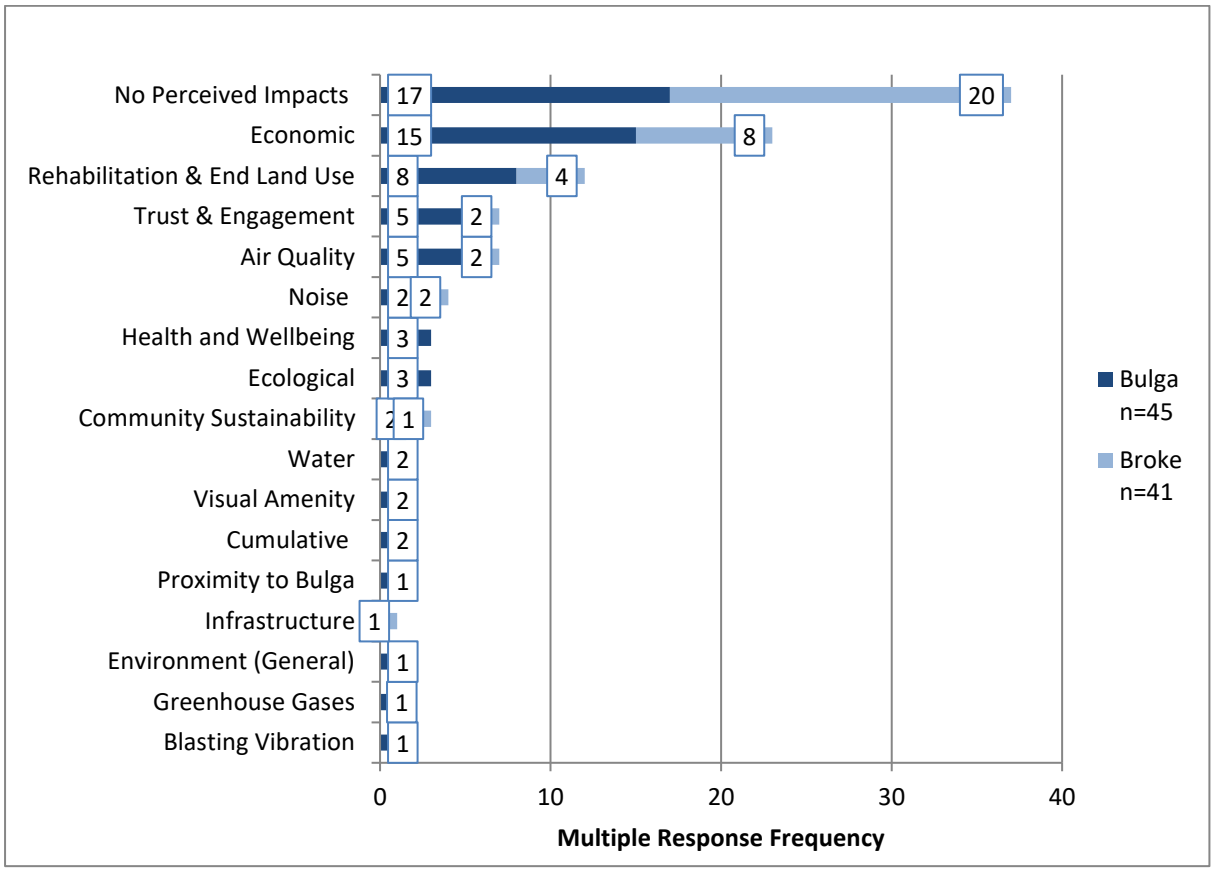

Figure 6.20 Perceived Social Impacts by Locality for the Proposed Modification

Source: Umwelt (2018)

Note: n=86, multiple responses allowed

Key Stakeholders and residents with the Singleton LGA

Consultation was also undertaken with a range of stakeholders at the Singleton LGA level as part of Glencore's Community Perception Survey (2018) and residents of the wider Singleton LGA through a random survey of households.

Although not conducted specifically as a part of the engagement program for the Proposed Modification, the survey has identified community perceptions of Glencore's operations in the wider Singleton LGA, affording input from a wider range of stakeholders than only those proximal to the existing operation and the Proposed Modification.

The survey identified a number of issues in relation to the presence of mining in the area, but particularly impacts on social amenity as a result of air quality and dust from blasting due to the presence of numerous mines within the LGA.

Indigenous Groups including local service providers and community groups

To further inform the SIA, interviews were also undertaken with local indigenous groups and services providers in the Upper Hunter across the Shires of Singleton and Muswellbrook. A total of 15 indigenous stakeholders participated in the interview process that held representative roles in Aboriginal service provision in Government, NGOs and the private sector. This included representatives from Hunter New England Health, Hunter Valley Aboriginal Corporation and the NSW Indigenous Chamber of Commerce as well as other more locally based group representatives and service providers.

It should be noted that the comments made by the organisations were generally related to mining in the Hunter Valley in general, with some specific comments related to BCC.

The issue themes identified through this consultation largely related to the cumulative impacts of mining and centred on the sustainability of the mining sector, employment and local procurement opportunities for indigenous community members, community investment and environmental impacts. In general, respondents expressed an overarching concern for the future sustainability of their communities, but also optimism for the potential of mining contributions and input to effect positive social change. Future opportunities for cooperation and engagement were also welcomed.

6.13.5 Assessment of Social Impacts

The aim of the SIA is to assess the proposed changes to the current baseline social environment (of which BCC is a part), as a result of the Proposed Modification proceeding. Social impacts associated with the Proposed Modification have been assessed via a detailed ranking of social impacts according to a number of key criteria, as defined in the SIA Guideline (DPE, 2017).

In order to prioritise the identified social impacts, a risk-based framework has been adopted. Stakeholder perception of risk/impact is considered an independent and no less valid component of risk. The integration of the outcomes of technical ranking (severity) with stakeholder perceived ranking of impacts, thus affords a true integration of expert and local knowledge in SIA and enables both types of risk to be addressed in the development of impact mitigation, amelioration and enhancement strategies.

The social risk matrix considers both the consequences of the potential social impact (minimal, minor, moderate, major and catastrophic) and the likelihood of the impact occurring (rare, unlikely, possible, likely and almost certain) and is then used to determine an overall risk assessment of the social impact as ‘low’, ‘moderate’, ‘high’ or ‘extreme’.

Each of the identified impacts has been assessed in detail in the SIA. **Table 6.23** provides a summary of the predicted unmitigated social risks in relation to the Proposed Modification. The predicted impacts after the application of mitigation measures are discussed in **Section 6.13.7** following the discussion of the social impact mitigation and enhancement measures that are proposed to be implemented as part of the Proposed Modification.

Table 6.23 Summary of Predicted Social Impacts

Project Aspect	SIA Impact Theme		Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Community engagement	Decision making systems and engagement	Decision making systems Way of life Fears and aspirations	Increased trust Increased knowledge of the project Opportunities for engagement and feedback	Proximal localities – Broke, Bulga, Milbrodale	Near neighbours/ proximal landholders Key stakeholders Singleton LGA community	Project life – additional four years	*High (positive benefit)*	*High (positive benefit)*
Construction and operational workforce change	Population change	Community Access to and use of infrastructure, and services and facilities	No additional influx of construction or operational workforce No impact on community infrastructure and services	Singleton LGA	Near neighbours/ proximal Landholders LGA residents Service Providers	>3months	Low	Low
Exceedance of noise and air quality criteria	Population change (due to property acquisition)	Personal and property rights Way of life Community	Acquisition of one property as a result of cumulative air quality criteria only	Property at Mount Thorley	Near neighbours/ proximal landholder	Project life – additional four years	Low	Low
Mining in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Singleton LGA	Proximal landholders Singleton LGA residents	Project Life – additional four years	High	Moderate
Presence of operation	Dust	Surroundings Health and wellbeing Way of life	Social amenity - dust	Bulga Broke Singleton LGA	Near neighbours/ proximal landholders LGA residents	Project life - additional four years	High	Moderate

Project Aspect	SIA Impact Theme		Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Presence of operation	Noise	Surroundings Health and wellbeing Way of life	Social amenity - noise	Bulga Broke Singleton LGA	Near neighbours/ proximal landholders LGA residents Local business/tourism operators	Project life – four additional years	Moderate	Moderate
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Bulga Broke	Near neighbours/ proximal landholders	Project life – additional four years Ongoing	Low	Moderate
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Singleton LGA	Singleton LGA residents	Project Life – additional four years Possibly ongoing	Moderate	Moderate
Presence of operation	Access to water – surface and ground	Surroundings Way of life	Access to water Livelihood Health	Bulga Broke	Proximal landholders Private bore owners	Project life Possibly ongoing	Low	Moderate
Presence of operation	Visual amenity	Surroundings Way of life	Impact on rural amenity as a result of visibility of: ○ Operational bunds ○ Overpass ○ Lighting spill from operations ○ Rehabilitation	Bulga Broke	Proximal landholders Singleton LGA residents Visitors to the area	Permanent – declining with rehabilitation progress	Moderate	Low

Project Aspect	SIA Impact Theme		Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Presence of operation and proposed modification	Economic – livelihoods	Way of life Community Personal and property rights	Sustained employment and local procurement / positive contribution to resident and employee livelihoods for an additional four years	Singleton LGA and surrounding region Local residents Local businesses	Existing employee workforce Local business Service providers Indigenous and non-Indigenous population	Project life - additional four years	*High (positive benefit)*	*Moderate (positive benefit)*
Presence of operation **Final Void**	Rehabilitation and end land use	Surroundings Way of life	Future access to and use of land and water resources (e.g. for agriculture, tourism etc.).	Bulga Broke Singleton LGA Visitors to the area	Proximal landholders to operation Singleton LGA residents Tourists/visitors to the Hunter Valley	Permanent	High	Moderate
Presence of operation **Offsets**	Ecological resilience and sustainability	Surroundings Health and wellbeing Way of life	Natural environment and rural amenity	Bulga Broke	Proximal landholders to operation and offset areas	Permanent	Low	Moderate
Presence of other mining operations in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Singleton LGA	Proximal landholders Singleton LGA residents	Project life – additional four years	Moderate	Moderate

6.13.6 Management and Enhancement Strategies

BCM has in place a range of existing mitigation approaches to address environmental and social impacts associated with their mining operations, including a Voluntary Planning Agreement (VPA) with Singleton Shire Council.

In relation to environmental impacts of the operations, predicted impacts are defined by performance-based criteria, as fixed by government; and applied through the VLAMP process for acquisition and mitigation in so far as noise and dust impacts are concerned. As noted in **Section 6.4**, one property will be afforded voluntary acquisition rights as a result of the change in the cumulative air quality criteria, but not as a direct result of the Proposed Modification.

To date, as part of BCM's existing operations, a range of management strategies have been applied to residences in the current operation's active management zone to mitigate noise, dust and sense of community and further reduce impacts of the operations.

BCM has a Stakeholder Engagement Strategy that outlines how and when they communicate with stakeholders, including their directly impacted near neighbours. It is suggested that this document continue to be reviewed annually and adjusted with changes in community sentiment. However, it should be noted that feedback from community stakeholders through the various engagement mechanisms outlined in **Section 6.13.4,** identified a high level of satisfaction with the engagement approach adopted by BCM.

As outlined in **Section 6.13**, the project design has been cognisant of the community perceptions of potential impacts and has been refined to limit the extent of the identified social and environmental impacts. Throughout the engagement process, landholders and key stakeholders were asked to suggest potential mitigation strategies they would like to see considered by BCM in the development of the Proposed Modification. Stakeholders consistently reported the need to:

- consider post mining land use both individually and collectively, with other industry players, and ensure the early development of strategic management plans to address land use post mining, with particular attention given to the consideration of community transition and sustainability once operations cease
- consider and assess a range of uses for the final void – e.g. a water storage catchment in times of drought; and further research undertaken to assess the effects of mining on surface and groundwater aquifers
- reduce the heights of overburden and visual bunds by spreading the waste soil over larger areas
- continue to support local community events and facilitate capacity building and development across other industry sectors.

A summary of the potential mitigation and enhancement measures identified through the course of SIA engagement are provided in **Table 6.24.**

Table 6.24 Stakeholder Identified Potential Mitigation and Enhancement Strategies

Impact/ Opportunity area	Potential Mitigation and Enhancement Measures – Stakeholder Suggestions	Existing or Proposed Mitigation and Enhancement Measures
Rehabilitation and End Land Use	Development of an End Land Use Strategic Management Plan, in consultation with key community stakeholders, including landholders, businesses, community groups and government agencies. Continued progressive development of noise and visual bunds and overburden emplacement areas and community engagement in this regard. Monitoring of visual change over time.	Mine Closure Planning (it is noted that a mine plan is to be developed no less than two years prior to planned cessation of mining). Community Engagement Plan. Rehabilitation Management Plan. Stakeholder Engagement Program.
Visual Impacts	Minimise bund and overburden heights Spread material over larger topographical areas to reduce heights of permanent bunds. Monitoring of visual change over time.	Visual Impact Management Plan. Stakeholder Engagement Program.
Dust – Social amenity	Continued use of dust suppression measures, including water trucks during night and day operations.	Air Quality Management Plan. Stakeholder Engagement Program.
Water Impacts	Detailed report to landholders outlining the quality and quantity of water in local catchments.	BCM currently report on water quality as part of an annual review which is available on the website, provided to the CCC, summarised in quarterly environment reports (also available on the website). *The existing Community Engagement Plan will be amended to include a communication mechanism that allows for those interested stakeholders to be notified (either via sms or email) when the quarterly information is available on the website.
Noise	Maintenance of noise criteria and adjusting operations where relevant, particularly during night operations.	Noise Management Plan.
Engagement	Continued engagement with local community through bi-annual community meetings/BBQs, personalised contact with affected stakeholders on a need's basis, and distribution of newsletters.	Community Engagement Plan. Stakeholder Engagement Program.
Community Sustainability	Continued support of local events. VPA contributions. Volunteer initiatives.	VPA. Glencore Community Investment Program. Community Engagement Plan. Stakeholder Engagement Program.

*denotes proposed additional mitigation and enhancement measure

Nature and Cultural Trail

To address the issues raised by stakeholders around the perceived concerns regarding end land use and rehabilitation (post mining), health and wellbeing and community sustainability; and to enhance perceived positive economic impacts, BCM will develop a Nature and Culture Trail to provide access to BCM offset areas for the benefit of the local community and visitors.

The strategy would focus on the identification of a potential track/trail that can be used by walkers, cyclists and horse riders that allows users to appreciate the indigenous and European history of the area and the natural environmental values including wildlife, flora and existing vistas which connect the local villages. The track could link the villages to the proposed Vere Offset area and Wollombi Brook Conservation Area.

Voluntary Planning Agreement

As part of the BOP approval, BCM has a VPA in place with Singleton Shire Council which includes $985,000 towards local community projects in Broke and Bulga and $985,000 for projects in Singleton.

To inform consultation and allocation of funding in relation to the BOP VPA, BCM utilised outcomes of the BOP SIOA (Coakes Consulting , 2013) and key findings of a community visioning project, undertaken with stakeholders across the villages of Bulga, Milbrodale and Broke. The objectives of the visioning project were to:

- identify community views for the future of the villages and create momentum to realise a shared community vision
- support community development and future planning;
- ensure alignment with Singleton Shire Council's Community Strategic Plan and other regional planning efforts.

A total of $128,000 was allocated to community contributions by BCM in 2017 and 2018, of this amount, $50,000 was contributed as part of the VPA and included sponsorship of community events held by the Broke Fordwich Wine and Tourism Association, the funding of teaching aide and future focused furniture at the Broke School and sponsorship of the Broke Fair.

BCM proposes to continue its existing VPA commitments, for the duration of the Proposed Modification, to facilitate continued and ongoing support for a range of community and environmental projects within the communities of Broke, Bulga and Milbrodale and the wider Singleton LGA community.

6.13.7 Mitigated Impacts

The social impact risks of the Proposed Modification were re-evaluated in the context of the proposed mitigation measures to identify the mitigated social risk using the SIA Guideline (DPE, 2017) social risk matrix.

Table 6.25 provides an overall summary of all social impacts associated with the Proposed Modification and their corresponding strategies and rankings of unmitigated and mitigated social risk.

Table 6.25 Summary of mitigation and enhancement strategies for the Proposed Modification

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Community engagement	Decision making systems and engagement	Decision making systems Way of life Fears and aspirations	Increased trust Increased knowledge of the project Opportunities for engagement and feedback	Near neighbours/ proximal landholders Key stakeholders Singleton LGA community	High (positive benefit)	High (positive benefit)	Stakeholder Engagement Plan	High (positive benefit)
Mining in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Proximal landholders Singleton LGA residents	High	Moderate	Management plans Continued participation in the Upper Hunter mining dialogue	Low
Presence of operation	Dust	Surroundings Health and wellbeing Way of life	Social amenity - dust	Near neighbours/ proximal landholders LGA residents	High	Moderate	Air Quality Management Plan	Low
Presence of operation	Noise	Surroundings Health and wellbeing Way of life	Social amenity - noise	Near neighbours/ proximal landholders LGA residents Local business/tourism operators	Moderate	Moderate	Noise Management Plan	Low
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Near neighbours/ proximal landholders	Low	Moderate	Nature and Culture Trail Strategic framework for mine closure	Low

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Singleton LGA residents	Moderate	Moderate	Nature and Culture Trail Strategic framework for mine closure	Low
Presence of operation	Access to water – surface and ground	Surroundings Way of life	Access to water Livelihood Health	Proximal landholders Private bore owners	Low	Moderate	Licensing agreements Water Management Plan	Low
Presence of operation	Visual amenity	Surroundings Way of life	Impact on rural amenity as a result of visibility of: • Operational bunds • Overpass • Lighting spill from operations • Rehabilitation	Proximal landholders Singleton LGA residents Visitors to the area	Moderate	Low	Visual Impact Management Plan Mine Operations Plan (Rehabilitation Plan)	Low
Presence of operation and proposed modification	Economic – livelihoods	Way of life Community Personal and property rights	Sustained employment and local procurement/ positive contribution to resident and employee livelihoods for an additional four years	Existing employee workforce Local business Service providers Indigenous and non-Indigenous population	High (positive benefit)	Moderate (positive benefit)	Nature and Culture Trail Employment and procurement strategy	Moderate (positive benefit)

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Presence of operation **Final Void**	Rehabilitation and end land use	Surroundings Way of life	Future access to and use of land and water resources (e.g. for agriculture, tourism etc).	Proximal landholders to operation Singleton LGA residents Tourists/visitors to the Hunter Valley	High	Moderate	Nature and Culture Trail Mine closure process Mining Operations Plan	Low
Presence of operation **Offsets**	Ecological resilience and sustainability	Surroundings Health and wellbeing Way of life	Natural environment and rural amenity	Proximal landholders to operation and offset areas	Low	Moderate	Biodiversity Management Plan	Low
Presence of other mining operations in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Proximal landholders Singleton LGA residents	Moderate	Moderate	Management plans Continued participation in the Upper Hunter mining dialogue	Low

6.13.8 Monitoring of Social Impacts

The social impacts from the Proposed Modification are consistent with the Approved Operations, therefore, there will be minimal additional social impact to the local communities of Broke, Bulga and Milbrodale and the wider Singleton LGA community.

BCM will also collect social data to monitor commitments made in this SIA namely:

- key areas of predicted impact, including perceived and experienced social impacts, through engagement with near neighbours and other proximal landowners, to determine if experience of the social impacts of the Proposed Modification are in line with predicted impacts
- evaluation of community contributions to ensure benefits to local stakeholders, e.g. local community organisations, schools and tourism events.

6.13.9 Summary

The SIA has identified that social impacts from the Proposed Modification are primarily consistent with the Approved Operations, with impacts largely rated as low or moderate.

Given the limited life of additional mining (approximately four years) and BCM's pre-emptive mine plan design to avoid and minimise impacts, the social impacts of the Proposed Modification have been minimised where possible through project design and the proposed management and enhancement approaches.

It would be reasonable to consider, that with the continued implementation of the management and mitigation strategies already in place by BCM, and the ongoing commitment by the BCM team to build on the strong existing relationships it already has within the respective proximal communities – of Broke, Milbrodale and Bulga - there will be minimal additional social impacts to the local or the wider Singleton communities as a result of the Proposed Modification.

6.14 Economics

A comprehensive Economic Impact Assessment (EIA) has been undertaken by Cadence Economics for the Proposed Modification. The EIA is based on a cost benefit analysis (CBA) and local effects analysis (LEA) prepared under the framework established in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the NSW Government in December 2015.

In addition, the Guidelines require an estimate of the potential costs generated by the Modification. To estimate the environmental, social and transport-related costs, Cadence have incorporated the *Technical Notes supporting the guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* into the analysis.

The key findings of the EIA are discussed in the following sections and the full report is provided in **Appendix 15**.

6.14.1 Cost Benefit Analysis

The Guidelines set out the CBA framework to measure the net benefits of the Modification to the NSW community. **Table 6.26** provides a summary of how these net benefits are measured.

Table 6.26 Cost Benefit Analysis framework as defined in the Guidelines

Direct Benefits	Indirect Benefits	Indirect Costs
The net benefits that accrue to NSW from the direct operations of the proposed mine Includes: • Net producer surplus attributable to NSW • Royalties payable • Company tax attributable to NSW	The net benefits that are generated for parties that economically interact with the proposed mine Includes: • Net economic benefits to landowners • Net economic benefits to NSW employees • Net economic benefits to NSW suppliers	Social costs generated by the proposed mine, borne by the NSW community Includes: • Net environmental, social and transport-related costs • Net public infrastructure costs • Loss of surplus to other industries

In net terms, the Proposed Modification will generate 62.4 Mt of additional ROM coal, 41.2 Mt of additional saleable coal. During the period of the currently Approved operations, 2019 to 2033, the Modification will increase total coal sales by 2.8 Mt, with an additional 38.5 Mt being sold beyond 2034. In some years of the Proposed Modification, saleable coal is actually lower than the currently approved operations, this is driven by a number of factors, including mine plan prioritisation and pit yield, such as 2022.

The Proposed Modification is expected to generate additional real revenue of just over $4,152.6 M over the 20 years in undiscounted 2019 Australian dollars. This equates to $1,319.4 M real revenue in net present value (NPV) terms based on a 7% real discount rate.

Based on the Guidelines, the direct benefits to NSW of the Proposed Modification are derived from three sources:

- the net producer surplus generated by the Proposed Modification that is attributable to NSW (estimated using cash outlays and revenues)
- the share of company tax payments that are attributable to NSW
- other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

The Proposed Modification is estimated to generate $195.4 M in total direct Benefits to NSW in NPV terms, as outlined in **Table 6.27**. These benefits are comprised of $74.5 M in company tax attributable to NSW and $120.9 M in NPV terms paid to the State government and Singleton Shire Council, in the form of coal royalties, payroll tax, council rates and land taxes.

Table 6.27 Summary of the direct benefits of the Project (NPV)

Net financial benefit	NPV (2019) ($M)
Net producer surplus attributable to NSW	-
Company income tax attributable to NSW	74.5
Royalties, payroll tax, council rates and land taxes to NSW and Local Government	120.9
Total financial benefit attributable to NSW	**195.4**

Consistent with the Guidelines, the indirect benefits of the Proposed Modification are summarised in **Table 6.28**. The total indirect benefits are estimated to be $215.2 M in NPV terms. The main source of these benefits is the $50.3 M in benefits to suppliers and $164.9 M in benefits to employees in NPV terms. There are no anticipated benefits to land owners as a result of the Proposed Modification.

Table 6.28 Summary of indirect benefits (NPV)

Indirect benefits	NPV (2019) ($M)
Net economic benefit to workers	164.9
Net economic benefit to suppliers	50.3
Land owner premiums (land sales made above market rates)	-
Total indirect benefit	**215.2**

The indirect costs of the Proposed Modification are classified as:

- net public infrastructure costs
- estimated loss of surplus to other industries
- net environmental, social and transport-related costs
- net environmental costs.

The Proposed Modification is expected to generate minor environmental, social and transport-related costs, above those generated by the approved operations as outlined in **Table 6.29**.

Table 6.29 Summary of indirect costs ($ million)

Indirect costs	NPV (2019)
Environmental costs	39.2
Loss of surplus to other industries	-
Net public infrastructure costs	-
Residual value of land	-
Total indirect costs	**39.2**

The CBA is based on comparing the net direct and indirect benefits and subtracting the indirect costs of the Proposed Modification compared against the baseline scenario or the approved operations where the Proposed Modification does not occur. The results are summarised in **Table 6.30**.

The Proposed Modification is estimated to provide a net benefit to NSW. This net benefit is estimated to be $410.6 M in NPV terms. This is comprised of $195.4 M and $215.2 M in direct and indirect benefits respectively. The incremental indirect costs of the Proposed Modification are estimated to be $0.02 M.

Table 6.30 Estimated net benefit of the Proposed Modification ($ million)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
Net producer surplus attributed to NSW	-		
Royalties, payroll tax and Council rates	120.9		
Company income tax apportioned to NSW	74.5		
Total direct benefits	**195.4**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
Net economic benefit to landholders	-	Environmental impact	31.4
Net economic benefit to NSW workers	164.9	Loss of surplus to other industries	-
Net economic benefit to NSW suppliers	50.3	Net public infrastructure cost	-
		Residual value of land	-
		Other costs	7.8
Total indirect benefits	**215.2**	**Indirect Costs**	**39.2**
Total Project economic benefit	410.6	Incremental Indirect Cost	0.02
NPV of project - ($m)	**410.6**		-

The direct benefits of the Proposed Modification are a function of its profitability which, in turn, depends on the prevailing coal price. The analysis shows that the combination of relatively low additional capital requirement, extraction cost savings and processing costs underpins the economic viability of the Proposed Modification. As a result, the Proposed Modification is predicted to generate:

- total corporate taxes of $231.6 M in NPV terms for Australia, of which $74.5 M is attributed to NSW
- $120.9 M in other government revenue for NSW in NPV terms, the largest component of this being royalties of $104.5 M with council rates and land taxes of $1.2 M and payroll taxes contributing $15.2 M.

The indirect benefits of the Proposed Modification are related to the linkages that it will have to the NSW economy through both the labour market and suppliers. The analysis shows that of the $215.2 M in estimated indirect benefits:

- worker benefits are predicted to amount to $164.9 M in NPV terms for the directly employed workers over the period 2019 to 2039, in net additional terms, the Proposed Modification employment peaks at 700 FTE workers
- supplier benefits are predicted to amount to $50.3 M in NPV terms based on total supplier inputs over the life of the Proposed Modification of $287.2 M.

The Proposed Modification is expected to result in minor incremental indirect costs on the NSW community of $0.02 M in NPV terms, through greenhouse gas emissions.

Sensitivity Analysis

As outlined in **Appendix 15**, a sensitivity analysis was undertaken consistent with the Guidelines. The sensitivity analysis considers all key areas of the CBA, particularly coal prices, key costs (both capital expenditure and operating costs) as well as worker benefits.

The sensitivity analysis shows that the estimated net benefits are robust in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

In isolation, the estimated net benefit of the Proposed Modification is most sensitive to the coal price assumptions underpinning the analysis, but even assuming coal prices are 25% lower than under the central case assumptions the net benefits are estimated at $354.9 M in NPV terms.

The robustness of the results to the sensitivity analysis is a reflection of the relatively low operating costs, the relatively low capital costs required to extract the resource and the relatively low level of indirect costs (externalities) attributable to NSW.

As a result of the incremental benefits accruing after 2033, the net benefits are sensitive to the discount rate used for the analysis. The Proposed Modification is expected to generate $410.6 M of net benefit using a 7% discount rate. Using a 4% discount rate increases the net benefit to $662.8 M, conversely a 10% discount decreases the net benefit to $258.5 M.

6.14.2 Local Effects Analysis

The LEA uses a similar framework to the CBA but is focussed on the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. In the case of the Proposed Modification the location used for the LEA is the Lower Hunter SA3. SA 3 includes the localities of Singleton and Cessnock, and towns like Wollombi in the southern end of the region and Chichester in the north.

The LEA accounts for the economic benefits to the Lower Hunter region only. It does not include any economic benefits that may accrue to the major regional centres that are located adjacent, including Maitland and Newcastle or the broader Hunter region.

Underpinning the LEA are the assumptions that:

- no net producer surplus accrues to the region
- no company income tax accrue to the Lower Hunter SA3 region
- based on information supplied by BCM, 39% of the workforce requirement for the Proposed Modification and 27% of intermediate inputs will be supplied from the SA3 region
- the average wage in the Lower Hunter SA3 is $67,358 per annum.

It is expected the Proposed Modification will generate additional indirect benefits to local suppliers and employees of $15.4 M and $64.7 M respectively in NPV terms above the approved operations. The Modification is estimated to confer a net benefit on the Lower Hunter SA3 region of $81.3 M in NPV terms.

Sensitivity Analysis

As outlined in **Appendix 15**, a sensitivity analysis was undertaken consistent with the Guidelines. The sensitivity analysis shows that the estimated net benefits are robust in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

The lower bound, or worst-case, estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits, yields an estimated net benefit of $67.3 M in NPV terms. The upper bound, or best-case, estimate based on the most optimistic assumptions, is $86.3 M in NPV terms.

6.14.3 Flow on Effects

Computable General Equilibrium (CGE) modelling has been undertaken to analyse the economy-wide impacts of the Proposed Modification on the regional and NSW economy. The aim of an economic impact study based on applied CGE modelling is to estimate the net benefit of the Proposed Modification on economic activity and the living standards of those residing within the Lower Hunter SA3, the same region used for the LEA analysis, and in NSW.

CGE modelling is the preferred technique to assess the impacts of large projects as they are based on a more detailed representation of the economy, including the complex interactions between different sectors of the economy.

The Proposed Modification is projected to increase gross regional product by $746.1 M in NPV terms. Gross regional income (GRI) or regional welfare, is projected to increase by $737.6 M in NPV terms. The projected increase in GRI is significant to the relatively small Lower Hunter region. In total, the Proposed Modification is projected to increase welfare for each person in the Lower Hunter by $6,498 in NPV terms.

For NSW, the projected increase in gross state product (GSP) is $885.5 M in NPV terms. GSI is projected to increase by $1,414.7 M.

Total employment in the Lower Hunter region is projected to increase by almost 196.1 FTE workers on average, across NSW, employment is projected to increase by 221.1 FTE.

7.0 Matters of National Environmental Significance

As discussed in **Section 5.1.1**, on 17 December 2018 the Proposed Modification, as referred under the EPBC Act, was determined to be a controlled action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on the following MNES:

- Central Hunter Eucalypt Forest and Woodland – Critically Endangered
- Regent Honeyeater (*Anthochaera Phrygia*) – Critically Endangered
- Swift Parrot (*Lathamus discolour*) – Critically Endangered
- a water resource, in relation to coal seam gas development and large coal mining development.

Detailed assessments have been undertaken as part of this SEE to assess the Proposed Modification's potential impacts on these MNES. The following section provides a summary of the key MNES assessment findings in relation to DoEE's assessment requirements. The following summary should be read in conjunction with:

- the BAR (refer to **Appendix 8**) and **Section 6.6** of this SEE which discusses biodiversity impacts
- the Surface Water Assessment (refer to **Appendix 9**) and **Section 6.7.1** of this SEE which discusses surface water impacts
- the Groundwater Impact Assessment (refer to **Appendix 11**) and **Section 6.7.2** of this SEE which discusses groundwater impacts.

7.1 Department of Environment and Energy Assessment Requirements

A checklist of DoEE's assessment requirements as outlined in **Appendix 2** and where they have been addressed in the SEE is outlined in **Table 7.1**.

Table 7.1 DoEE Assessment Requirements

Requirement	Relevant SEE Section
On 17 December 2018, a delegate of the Federal Minister for the Environment and Energy determined that the above project is a controlled action under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act controlling provisions for the proposed action are: i. listed threatened species and communities (sections 18 and 18A); and ii. a water resource, in relation to coal seam gas development and large coal mining development (section 24D & section 24E). The delegate also confirmed that the proposed action will be assessed under the State's accredited assessment process under Part 4 of the *NSW Environmental Planning and Assessment Act 1979* in accordance with the bilateral agreement between the two governments. These guidelines provide specific information on MNES environmental assessment requirements.	

Requirement	Relevant SEE Section
The Applicant must undertake an assessment of all protected matters that may be impacted by the development under the controlling provisions identified in paragraph 1. The Commonwealth DoEE considers that there is likely to be a significant impact on the following: i. listed threatened species and communities (sections 18 and 18A); a) Central Hunter Valley Eucalypt Forest and Woodland – Critically Endangered; b) Regent Honeyeater (Anthochaera phrygia) – Critically Endangered; and c) Swift Parrot (Lathamus discolor) - Critically Endangered; and ii. a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).	
The Applicant must consider each of the protected matters under the triggered controlling provisions that may be impacted by the action. Note that this may not be a complete list and it is the responsibility of the Applicant to undertake an analysis of the relevant impacts and ensure all protected matters that are likely to be impacted are assessed for the Commonwealth Minister's consideration.	
General Requirements	
The Statement of Environmental Effects (SEE) must address the matters outlined in Schedule 4 of the EPBC Regulations and the matters outlined below in relation to the controlling provisions.	Refer to SEE
The title of the action, background to the action of the action and current status.	Refer to **Sections 1.0**, **2.0** and **3.0**
The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Refer to **Section 3.0**
How the action relates to any other actions that have been, or are being taken in the region affected by the action.	Refer to **Sections 1.0**, **2.0** and **3.0**
How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	Refer to **Section 3.0**
The SEE must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including: i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts; ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; iii. analysis of the significance of the relevant impacts; and iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Refer to **Section 7.2.1** , **Section 7.2.2** and **Appendix 8**

Requirement	Relevant SEE Section
For each of the relevant matters protected that are likely to be significantly impacted by the action, the SEE must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: i. a description, and an assessment of the expected or predicted effectiveness of the mitigation measures, ii. any statutory policy basis for the mitigation measures; iii. the cost of the mitigation measures; iv. an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; v. the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Refer to **Section 7.2.2**, **6.6** and **6.7**
Where a significant residual adverse impact to a relevant protected matter is considered likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	Refer to **Section 7.2.4**
For each of the relevant matters likely to be impacted by the action the SEE must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: i. conservation advice or recovery plan for the species or community, ii. relevant threat abatement plan for a process that threatens the species or community iii. wildlife conservation plan for the species iv. any strategic assessment. [Note: the relevant guidelines and policy statements for each species and community are available from the Department of the Environment Species Profiles and Threats Database. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl]	Refer to **Section 7.2**
Biodiversity (threatened species and communities and migratory species)	
The removal of 16.4 ha of EPBC Act listed Central Hunter Valley Eucalypt Forest and Woodland will result in a reduction in the amount of this ecological community and a reduction in foraging habitat for the EPBC Act listed Regent Honeyeater and Swift Parrot.	Noted
For each of the EPBC Act listed species predicted to occur in the project site, and each of the EPBC Act listed ecological communities likely to be significantly impacted, the SEE must provide: a. survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements and/or the NSW Framework for Biodiversity Assessment (FBA); b. a description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices and recovery plans, threat abatement plans and wildlife conservation plans; and	Refer to Sections 2.0 and 3.0 of **Appendix 8** Refer to **Section 7.2.1** and Appendix E of **Appendix 8**

Requirement	Relevant SEE Section
c. maps displaying the above information (specific to each EPBC protected matter) overlaid with the proposed action. [Note - it is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the FBA as the basis for identifying EPBC Act-listed species and communities. The SEE must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act listed species or community, and provide individual maps for each species or community.]	Refer to **Figures 6.4** and **6.5**
The SEE must describe the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act listed species and communities. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act listed species or community.	Refer to **Section 7.2.2** and **Appendix 8**
For each of the EPBC Act listed species and communities likely to be impacted by the development, the SEE must provide information on proposed avoidance and mitigation measures to deal with the impacts of the action, and a description of the predicted effectiveness and outcomes that the avoidance and mitigation measures will achieve.	Refer to **Section 7.2.3** and **Appendix 8**
The SEE must identify each EPBC Act listed species and community likely to be significantly impacted by the proposed action. Where a significant impact is likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit, how offsets will be secured, and timing of protection. [Note - not all of the offset options under the NSW Biodiversity Conservation Act 2016 are endorsed under the EPBC Act for approval purposes. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same EEC or habitat being impacted, or funding to provide a direct benefit to the matter being impacted i.e. threat abatement, breeding and propagation programs or other relevant conservation measures.]	Refer to **Section 7.2.4** and **Appendix 8**
Water resource, in relation to coal seam gas development and large coal mining development	
The Applicant provided hydrological information that is insufficient for an adequate assessment of the impacts of the proposed action on a water resource. DoEE understands that the Applicant has commissioned detailed groundwater modelling specifically for the proposed modification to the Bulga Optimisation Project. This modelling will be available in late January 2019 and should allow a detailed assessment of the potential impacts on the proposed action on groundwater at, and in the vicinity of the site, to be undertaken.	Refer to **Section 6.7** , **Appendix 9Appendix 9** and **Appendix 11**
The SEE must provide a description of the location, extent and ecological characteristics and values of the identified water resource potentially affected by the project.	Refer to **Appendix 11**
The assessment of impacts should include information on: i. any substantial and measurable changes to the hydrological regime of the water resource, for example a substantial change to the volume, timing, duration or frequency of ground and surface water flows; ii. the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected; and	Refer to **Section 6.7**, **Appendix 8**, **Appendix 9** and **Appendix 11**

Requirement	Relevant SEE Section
iii. substantial and measurable change in the water quality and quantity of the water resource— for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland; or water temperature that may adversely impact on biodiversity, ecological integrity, social amenity or human health.	Refer to **Section 6.7**, **Appendix 8**, **Appendix 9** and **Appendix 11**
The SEE should specifically consider potential impacts on private groundwater users, groundwater and surface water quality, groundwater dependent ecosystems, surface water catchments, surface water flows and flooding and water licencing arrangements. In particular, consideration must be given to potential impacts on Wollombi Brook, Loders Creek and the Hunter River.	Refer to **Section 6.7**, **Appendix 9** and **Appendix 11**
The SEE must provide adequate information to allow the project to be reviewed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, as outlined in the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC, October 2015).	Refer to **Section 6.7**, **Appendix 9** and **Appendix 11**
Other approvals and conditions	
Information in relation to any other approvals or conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations 2000.	Refer to **Section 5.0**
Environmental Record of person proposing to take the action	
Information in relation to the environmental record of a person proposing to take the action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.	Refer to **Section 7.4**
Information Sources	
For information given in a SEE, the SEE must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	References are provided in **Section 10.0**

7.2 Key Issues – Biodiversity

As outlined in **Section 4.1**, on 17 December 2018, the DoEE confirmed the Proposed Modification was a controlled action. The Controlled Action decision was based on DoEE's assessment that the Proposed Modification is likely to have a significant impact on MNES, including the following ecological matters:

- Central Hunter Valley Eucalypt Forest and Woodland – Critically Endangered
- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered
- Swift Parrot (*Lathamus discolor*) – Critically Endangered.

Potential impacts on these matters are detailed further below.

7.2.1 Relevant Impacts of the Action on Biodiversity

The Proposed Modification would result in the removal of 20.2 ha of land to access coal resources directly beneath. Most of this land (except for 1 hectare of cleared areas) is vegetated, and 16.4 ha is comprised of HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter, which conforms to the EPBC listed *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

In addition to conforming to this CEEC, DoEE has identified this ecological community as potential foraging habitat for Critically Endangered species swift parrot (*Lathamus discolor*) and regent honeyeater (*Anthochaera phrygia*) on the basis of the presence of spotted gum (*Corymbia maculata*), a known feed tree for both these species. Spotted gum has been identified as occurring in low frequency in the CEEC within the additional disturbance area (five trees out of 25 in a 400 m^2 plot) and these individuals are reasonably young. All trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH according to the OEH BAM) were identified. Approximately 0.1 ha of this CEEC is anticipated to contain suitable foraging habitat for swift parrots and regent honeyeaters, as defined in the relevant recovery plans (CoA 2016; Saunders and Tzaros 2011).

The relevant impacts of the Proposed Modification are considered to be well known and predictable based on the extensive knowledge of the ecological values of the additional disturbance area and a sound understanding of the impacts of the Proposed Modification. The direct impacts of the Proposed Modification, as they relate to the clearing of threatened and migratory species habitat is predicted to be permanent, however these direct impacts will be offset in accordance with the FBA and the NSW Biodiversity Offsets Policy for Major Projects.

Central Hunter Valley Eucalypt Forest and Woodland CEEC

Central Hunter Eucalypt Forest and Woodland is listed as a CEEC under the EPBC Act. This community occurs in the Hunter Valley region on soils derived from Permian sedimentary bedrock (TSSC 2015a). Typically it is characterised as a eucalypt woodland and open forest, with a shrub layer of variable density and/or a grassy ground layer. Across its range, one or more of a complex of four eucalypt tree species, namely spotted gum (*Corymbia maculata*), narrow-leaved ironbark (*Eucalyptus crebra*), slaty gum (*Eucalyptus dawsonii*) or grey box (*Eucalyptus moluccana*) dominate the canopy (TSSC 2015a).

The results of the assessment for vegetation patches within the additional disturbance area against the key diagnostic characteristics listed above identified the presence of the necessary Permian derived soils in areas with floristic potential to be part of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and the CEEC was found to be present within the additional disturbance area.

Approximately 16.4 ha of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC was identified within the additional disturbance area and will be directly impacted as a result of the Proposed Modification. The following PCT in the additional disturbance area was identified as conforming to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (refer to **Figure 6.5**):

- PCT1603/HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter.

The conservation advice for the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC identifies any areas that meet the minimum moderate quality condition class as being areas critical to the survival of the community. Areas of moderate/high quality condition of the CEEC occur within the additional disturbance area, however given the current approximate extent of the community over its range (37,000 ha), the removal of the small area of CEEC resulting from the Proposed Modification is considered unlikely to affect the survival of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

Regent honeyeater

The regent honeyeater (*Anthochaera phrygia*) is listed as critically endangered under the EPBC Act and has a patchy distribution extending from south east Queensland, into NSW and the Australian Capital Territory, to central Victoria (CoA 2016). The species is highly mobile, capable of travelling large distances and occurs only irregularly at most sites in varying numbers. Adding further difficulty to the survey and study of this species is its ability to often go long periods without being observed anywhere (CoA 2016).

The regent honeyeater is endemic to mainland south eastern Australia and mostly inhabits inland slopes of the Great Dividing Range (TSSC 2015b). The regent honeyeater comprises a single population, with some exchange of individuals between regularly used areas (CoA 2016). As at 2010, the total population size is estimated at 350 to 400 mature individuals (CoA 2016).

As the species occurs as a single population in Australia, any record of the species would constitute part of a population as described above. The population of regent honeyeater has not been recorded within the additional disturbance area, however it has been recorded approximately 1.0 km north of the additional disturbance area in planted eucalypts in the BCC site office carpark in 2011 during the surveys for the BOP (Umwelt 2013).

The regent honeyeater's primary habitat is box-ironbark eucalypt woodland and dry sclerophyll forest, however it does utilise riparian vegetation and lowland coastal forest. Habitat critical to the survival of the regent honeyeater includes any breeding or foraging areas where the species is likely to occur and any newly discovered breeding or foraging locations (CoA 2016).

The additional disturbance area is not known as a historical or important foraging site for this species. The additional disturbance area contains one known foraging tree species (according to the approved National Recovery Plan (CoA 2016)). The Proposed Modification will result in the loss of approximately 16.4 ha of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young spotted gum (*Corymbia maculata*), which is a key tree species listed for the regent honeyeater (CoA 2016).

This area of habitat occurs within PCT1603/HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter. This PCT occurs across approximately 16.4 ha, however potential feed tree species were only observed in an area of 0.1 ha of this vegetation community. This area represents critical habitat as the Hunter Valley region has been mapped in the recovery plan as 'species likely to occur' despite a lack of recent records in the Project Area (OEH 2019).

The regent honeyeater mainly breeds in three key sites in NSW being the Bundarra-Barraba area, the Capertee Valley, and the Lower Hunter Valley (CoA 2016 & OEH 2019). Other breeding areas are known in the Pilliga woodlands and the Mudgee-Wollar areas of NSW. The regent honeyeater has not been recorded in the additional disturbance area and it is unlikely to contain breeding or nesting habitat for the species.

Although the area proposed to be disturbed has existing poor connectivity and the regent honeyeater has not been recorded utilising the potential habitat within the additional disturbance area or in the immediate surrounds for eight years, the additional disturbance area provides 16.4 ha of potential foraging habitat for this species.

Swift parrot

The swift parrot (*Lathamus discolor*) is listed as critically endangered under the EPBC Act. The species breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March) (Saunders and Tzaros 2011). Most of the population winters in Victoria and NSW where it disperses across broad landscapes foraging on nectar and lerps in eucalypts. Until recently it was believed that in NSW, swift parrots forage mostly in the coastal and western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region (Saunders and Tzaros 2011). However, evidence is gathering that the forests on the coastal plains from southern to northern NSW are also important. They return to Tasmania in spring (September to October). The movements of this species on the mainland are poorly understood, but it is considered to be nomadic and irruptive, moving in response to food supply.

The swift parrot occurs as a single population that migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders and Tzaros 2011). Approximately 200 mature birds (10% of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Roderick et al. 2013).

As the species occurs as a single population in Australia, any record of the species would constitute a part of a *population* as described above. There have been few records of the species within the Hunter Valley in the past few years, however recent sightings have been recorded in the winter 2017 season in the lower Hunter areas (Birdline NSW 2019). This species has the potential to make use of the forest and woodland habitat of the Development Footprint, particularly where there are prolific flowering eucalypts and this migratory species is likely to move throughout the area in response to mass flowering events. This species does not breed on mainland Australia, and as such the Development Footprint only represents potential foraging habitat for this species.

Priority sites for this species have been identified within the National Recovery Plan for the species (Saunders and Tzaros 2011). This species is likely to utilise coastal forest and river-flat vegetation associations within the coastal natural resource management region (which includes the Hunter-Central Rivers), in communities dominated by swamp mahogany (*Eucalyptus robusta*), blackbutt (*Eucalyptus pilularis*), forest red gum (*Eucalyptus tereticornis*) and spotted gum (*Corymbia maculata*) (Saunders and Tzaros 2011).

The additional disturbance area contains moderate quality potential foraging habitat for this species. In accordance with the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011) approximately 16.4 ha of potential woodland foraging habitat occurs within the additional disturbance area, based on the presence of spotted gum (*Corymbia maculata*) which has been identified as a key foraging resource for the swift parrot in the Hunter Valley . This area of habitat occurs within PCT1603/HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter. Analysis of vegetation survey data and habitat assessment results indicates that additional key foraging species that provide habitat for the species in the Hunter Valley, as per the Recovery Plan, were not recorded in the additional disturbance area.

We note that *Central Hunter Valley Eucalypt Forest and Woodland* CEEC is broadly known to provide habitat for this species in the Hunter Valley, where it contains spotted gum (*Corymbia maculata*). Analysis of the constituent canopy species in this CEEC was undertaken to determine the extent of potential foraging habitat for the swift parrot within this vegetation communities. It was found that characteristic species spotted gum (*Corymbia maculata*) was present in the additional disturbance area albeit at very low abundances and localised occurrence constituting a small number of reasonably young trees.

Habitat critical to the survival of the swift parrot includes those areas of priority habitat for which the species has a level of site fidelity or possess phenological characteristics likely to be of importance to the swift parrot (Saunders and Tzaros 2011). The swift parrot has not been recorded within the additional disturbance area or the immediate locality and has not shown site fidelity to the habitats of the additional disturbance area. The additional disturbance area does include 16.4 ha of vegetation that contains a very low abundance of reasonably young spotted gum, which is a key feed tree species for the swift parrot in the Hunter-Central Rivers (Saunders and Tzaros 2011). This vegetation community occurs across approximately 16.4 ha, however potential feed tree species were only observed in an area of 0.1 ha of this vegetation community.

Overall, the vegetation within the additional disturbance area is highly fragmented and dominated by non-key tree species that are not considered to comprise likely foraging habitat for the swift parrot. Furthermore, the swift parrot (*Lathamus discolor*) has not been recorded within the additional disturbance area despite targeted survey over multiple years.

7.2.2 Assessment of impacts to listed Threatened Species and Communities

The development of the Proposed Modification will result in direct, indirect and consequential impacts on biodiversity values within the additional disturbance area. Direct impacts include the loss of native vegetation and fauna habitats as a result of clearance works and subsequent mining activity. The Proposed Modification is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands. However, some minor indirect impacts associated with habitat connectivity, fugitive light emissions, dust, noise, groundwater changes, weeds and feral animals may occur during the life of the operations. The indirect impacts will generally be consistent with those approved for BOP.

It is recognised that the Proposed Modification will remove vegetation and further increase fragmentation and isolation of habitats, and thus contribute to cumulative habitat loss and vegetation clearance in the locality.

These impacts are summarised in **Table 7.2**.

Table 7.2 Predicted Impacts from the Proposed Modification on EPBC Act listed threatened species and communities

Impact Type	Description	Timing of Impact	Area (ha)
Direct	Loss of 16.4 ha of open forest that conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC	Medium – long term	16.4
Direct	Loss of potential foraging habitat for regent honeyeater (*Anthochaera phrygia*)	Medium – long term	16.4
Direct	Loss of potential foraging habitat for swift parrot (*Lathamus discolor*)	Medium – long term	16.4

Impact Type	Description	Timing of Impact	Area (ha)
Indirect	Removal of vegetation and further increase fragmentation and isolation of habitats, and thus contributing to cumulative habitat loss and vegetation clearance in the locality.	Medium – long term	19.2
Indirect	Fugitive light emissions resulting from the Proposed Modification may result in adverse impacts on adjacent habitats and cause behavioural changes in nocturnal birds and bats.	Medium term	Project Area
Indirect	Noise and blasting impacts may have a minor indirect impact on fauna species. Potential impacts include noise disturbing the roosting and foraging behaviour of fauna species and/or reducing the occupancy of areas of otherwise suitable habitat. Given that the proposed action is part of, and adjacent to an existing mine operation with existing impacts, any additional impacts resulting from noise emissions are not expected to be substantial for threatened species, populations and communities.	Medium term	Project Area
Indirect	Air quality impacts have the potential to adversely impact native species from dust generating activities during ground disturbing works. Potential impacts include dust covering vegetation thereby potentially reducing vegetation health and growth and increased air pollutants for native species (flora and fauna). Given that the proposed action is part of, and adjacent to an existing mine operation with existing impacts, any additional impacts resulting from air quality not expected to be substantial for threatened species, populations and communities.	Medium term	Project Area
Indirect	Weed species could be inadvertently brought into the Project Area with imported materials or could invade naturally through removal of native vegetation. The presence of weed species within the Project Area has the potential to decrease the value of extant vegetation to native species, particularly threatened species. Populations of feral fauna species such as foxes, rabbits, pigs, deer, dogs and cats can increase and quickly populate new areas as a result of disturbance. There will be no substantial change to impacts from weeds or feral animals, given that the proposed mine is part of, and adjacent to, an existing operation with existing impacts. Any additional impacts resulting from weeds or feral animals are not expected to be of any level of significance in relation to threatened species, populations and communities.	Medium term	Project Area
Cumulative	The history of land clearing, agriculture and mining development has resulted in an incremental loss of vegetation and fauna habitat surrounding the Project Area, and within the Hunter Valley more generally. The Proposed Modification will result in a loss of approximately 19.2 ha of native woodland and forest vegetation. The Proposed Modification will remove vegetation and further increase fragmentation and isolation of habitats, and thus contribute to cumulative habitat loss and vegetation clearance in the locality.	Medium – long term	Wider locality

The relevant impacts of the Proposed Modification are considered to be well known and predictable based on the extensive knowledge of the ecological values of the additional disturbance area and a sound understanding of the impacts of the Proposed Modification (e.g. clearing of vegetation, earthworks and water management). The direct impacts of the Proposed Modification, as they relate to the clearing of EPBC listed CEEC and threatened species habitat is predicted to be permanent; however, a detailed rehabilitation program will be proposed as part of the Proposed Modification in order to compensate for the residual impacts of habitat loss that cannot be adequately avoided or minimised. The proposed rehabilitation and reinstatement of habitat will mean that, over time, impacts will not be completely irreversible as most key ecological features will be recovered. Rehabilitation and regeneration of the mine site, in addition to an appropriate biodiversity offset strategy will ensure that there is no residual significant impact to the landscape in the medium-long term as a result of the Proposed Modification.

7.2.3 Biodiversity Impact Avoidance and Mitigation

Given the location of the additional disturbance area within the overall Project Area and the relatively small size, it was not possible to avoid all biodiversity values without compromising the viability of the Proposed Modification. Given this, detailed minimisation/mitigation measures are proposed.

BCM has committed to the implementation of a comprehensive biodiversity impact mitigation strategy to minimise the unavoidable impacts of the Proposed Modification. The impact mitigation measures proposed are based on best available practices and are widely used to mitigate the impact of coal mining developments in the Hunter Valley and elsewhere. Residual impacts of the Proposed Modification on EPBC listed threatened species and communities include:

- direct habitat loss for threatened species and ecological communities
- dust and air quality impacts
- fugitive light emission
- noise and blasting impacts
- weed encroachment
- impacts to corridors resulting in reduced connectivity for fauna movement
- introduction of feral animals.

Table 7.3 provides an outline of the avoidance and minimisation measures to be implemented by BCM for the impacts described above.

Table 7.3 Avoidance and mitigation methods for residual impacts on EPBC listed threatened species and communities

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
Central Hunter Eucalypt Forest and Woodland CEEC	Direct impact – removal of 16.4 ha of vegetation	The final biodiversity offset strategy to be delivered for the Proposed Modification will meet the offset requirements determined by the BioBanking Credit Calculator (BBCC) in accordance with the FBA and will include the in-perpetuity conservation of the proponent-managed Vere Offset Site which will be secured using a Stewardship agreement.
	Air quality impacts; dust covering vegetation impacting health and growth	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.
	Weed encroachment	Existing weed management controls as specified in the Bulga Coal Biodiversity Management Plan will be applied to the Proposed Modification. Weed control will be undertaken in accordance with current mine practices and, for noxious weed species identified as requiring control. Regular weed inspections will be undertaken across the Project Area and appropriate weed control methods will be implemented.
	Cumulative impacts of land clearing	Landform establishment and rehabilitation of native vegetation communities will occur as soon as practical following the completion of mining activities. Pre-clearance activities will identify and salvage biodiversity features to be used in the rehabilitation process. Resources that will be salvaged (where practical) from clearing activities include topsoil, vegetation and hollow-bearing trees/logs and native seed. These resources will be re-used in rehabilitation areas to improve revegetation outcomes and to augment habitat features.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
Regent honeyeater (*Anthochaera phrygia*) **Swift parrot (*Lathamus discolor*)**	Direct impact – loss of 16.4 ha of potential foraging habitat	The final biodiversity offset strategy to be delivered for the Proposed Modification will meet the offset requirements determined by the BBCC in accordance with the FBA and will include the in-perpetuity conservation of the proponent-managed Vere Offset Site which will be secured using a Stewardship agreement.
	Removal of vegetation and further increasing fragmentation and isolation of habitats, thus contributing to cumulative habitat loss and vegetation clearance in the locality.	BCM is committed to a mitigation and offsetting strategy including the provision of: • the delineation of clearance areas to avoid unnecessary impacts and clearance of surrounding vegetation • habitat enhancement measures such as the installation of nest boxes, salvaged hollows, fallen timber, hollow logs and rocks to supplement mine rehabilitation areas • rehabilitation of the Development Footprint post mining • the implementation of a biodiversity offset strategy (refer to Section 7.0 of the BAR).
	Fugitive light emissions may result in behavioural changes in fauna; disruption of seasonal day length, trigger changes in foraging behaviour	Appropriate lighting controls to minimise impacts will be implemented as part of the Proposed Modification as necessary (providing that these actions do not compromise site safety issues). There will be no substantial change to fugitive light emissions given that the Proposed Modification is already part of, and adjacent to an operation with existing impacts. Any additional impacts resulting from fugitive light emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Visual mitigation controls will continue to be implemented including: • ongoing management of mobile lighting to reduce the impacts of lighting at night, including the use of shields as required and the ongoing implementation of procedures about the appropriate placement of mobile lighting plant • night lighting will be kept to a minimum needed for operational management and safety to limit the extent of night lighting glow • all lighting will be installed and maintained in accordance with Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Noise and blasting impacts may disturb the roosting and foraging behaviour of fauna species and/or reduce the occupancy of areas of otherwise suitable habitat.	In regard to potential impacts on biodiversity, there will be no substantial change to noise impacts given that the Proposed Modification is part of, and adjacent to, an already existing operation with existing impacts. Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Noise minimisation strategies include: • continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages • monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management • operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria • blasts undertaken at the BCC will be managed so that relevant blast criteria is not exceeded at residences or other blast sensitive locations. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.
	Air quality impacts; increased air pollutants for native species	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.
	Introduction of feral animals	Feral animal control will be undertaken in accordance with current mine practices and as outlined in the BMP. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Noise and blasting impacts may disturb the roosting and foraging behaviour of fauna species and/or reduce the occupancy of areas of otherwise suitable habitat.	In regard to potential impacts on biodiversity, there will be no substantial change to noise impacts given that the proposed mine operation is part of, and adjacent to, an already existing operation with existing impacts. Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Noise minimisation strategies include: • continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages • monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management • operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria • blasts undertaken at the BCC will be managed so that relevant blast criteria is not exceeded at residences or other blast sensitive locations. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.
	Air quality impacts; increased air pollutants for native species	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.
	Introduction of feral animals	Feral animal control will be undertaken in accordance with current mine practices and as outlined in the BMP. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

The avoidance and mitigation measures proposed are expected to be effective in minimising the impact on the ecological features of the additional disturbance area during construction and operation of the Proposed Modification.

It was not possible to avoid all biodiversity values without compromising the viability of the Proposed Modification given the location of the additional disturbance area within the Project Area. However, given the small size of the habitat that will be impacted, the proposed mitigation measures will adequately compensate for the loss of biodiversity values.

7.2.4 Biodiversity Offset Strategy

A Biodiversity Offset Strategy is proposed to compensate for residual impacts on those species, vegetation communities and ecological features that are likely to be, or could potentially be, significantly impacted by the Proposed Modification at both the State and Commonwealth level. The Biodiversity Offset Strategy compensates for these residual impacts by using a direct land-based offset site.

BCM is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Proposed Modification.

It is currently proposed that the biodiversity offset strategy will consist of the in perpetuity conservation of one large Glencore owned land parcel proximate to the Proposed Modification which contains the required biodiversity credits for the Proposed Modification. The proposed Vere Offset Site is located proximate to the Proposed Modification, conserving vegetation and habitats close to the additional disturbance area and nearby Yengo National Park and Pokolbin State Forest.

A total of 931 ecosystem credits are required to offset the biodiversity impacts associated with the Proposed Modification. The proposed Vere Offset Site generates a total of 1627 ecosystem credits, which exceeds the ecosystem credit requirements of the Proposed Modification using the FBA 'like for like' rules and the proposed 'CEEC for CEEC' approach.

All offset methods proposed are considered 'like for like' in accordance with the Commonwealth Environmental Offsets Policy and the NSW Biodiversity Offset Policy for Major Projects. **Appendix 8** provides a description of the proposed Vere Offset Site.

7.3 Key Issues – Water Resources

The summary information below should be read in conjunction with **Section 6.7** and **Appendix 9** and **Appendix 11** of the SEE (that is, the Surface Water Assessment and the Groundwater Impact Assessment).

Water Context

The Proposed Modification exists within a well-regulated water resource management system that has been designed by the NSW government to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take from both surface water and groundwater with consideration of the environmental flow requirements of watercourses and the needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with pollution control requirements.

The BCC is located in the catchment areas of Wollombi Brook and Loders Creek. Previous mining operations have modified local catchments through the capture of runoff from mining areas within the integrated WMS and diversion of upslope runoff around the mining operations. No new catchment areas will be intersected by the Proposed Modification.

There are three general hydrogeological systems across the Project Area:

- alluvial aquifers associated with the Monkey Place Creek and Wollombi Brook which overlie Permian strata and wrap around the south and west of the main mining area
- Warkworth Sands Woodlands, adjacent to the west of the existing operations and the Mount Thorley open cut mines. This system is interpreted as perched, positioned over lower permeable Permian and not in hydraulic connectivity with the underlying groundwater system
- the Permian coal measures of the Singleton Super Group which host the mined resource and represent outcrop in all areas where regionally mapped alluvium is absent (low yielding, confined aquifers).

Loders Creek and its tributary (Nine Mile Creek), northeast and north of the open cut operations drain to the Hunter River approximately 5.5 km north of the BCM operations. The system is ephemeral and known for increased salinity as flow recedes (Mackie, 2013), and does not include regionally mapped alluvium.

Water Management System and Water Impacts

The approved BCC Water Management Plan (2016) includes all aspects of the BCC IWMS, and has the following key objectives and functions:

- minimise the contamination of clean water runoff from catchment areas upslope of the operations
- minimise potential effects of erosion and its associated impacts as a result of mining operations
- securely contain mine water (groundwater and surface water which reports to open cut and underground mining areas), and other site water that comes into contact with areas disturbed by mining activities – including overburden emplacement areas, coal stockpiles and the CHPP area
- maximise the re-use of mine water for onsite water use such as coal washing and dust suppression. Reusing mine water is preferred over using water from the Hunter River
- manage the discharge of excess water back to the Hunter River in accordance with the Hunter River Salinity Scheme.

One of the key objectives of the integrated WMS is to convey clean water around the mining operations or, when runoff water from rehabilitated areas becomes clean, enable the runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the integrated WMS.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to storages within the WMS.

Mine water (i.e. runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas) is managed as part of the mine WMS.

Pollution in NSW is regulated by the POEO Act with discharges from the mine WMS required to be licensed by an EPL if the discharge would otherwise constitute a pollution of waters (section 120 of the POEO Act). The quantity and quality of water discharges from mining operations in the Hunter Region are managed in accordance with relevant EPLs and consistent with the provisions of the HRSTS. As part of the development of the HRSTS, the NSW Government has determined the sustainable salt load for the Hunter River, considering the impacts on the environment. The HRSTS is managed such that discharges from industrial operations can only occur in suitable conditions. BCM has a licence and salt credits to discharge water in accordance with the HRSTS. Water within the mine water management system will continue to be either reused on site, including in the CHPP and for tailings relocation activities. Surplus water within the mine WMS will be managed under the EPL and HRSTS and discharged in accordance with these controls.

All water take predicted for the Proposed Modification, including take of surface waters and groundwater from the Permian aquifer will be licensed through existing allocations held by BCM or transferred from other Glencore owned operations. As noted above, the water policy framework in place in NSW is designed to ensure that licensed take of waters does not exceed the sustainable yield of the water systems.

Surface Water and Groundwater Monitoring and Water Quality

Surface water and groundwater monitoring programs are currently being implemented at the BCC with the content of these monitoring programs being approved by the NSW Government.

The surface water monitoring program requires monthly monitoring at each existing monitoring locations at various upstream and downstream locations on the streams and creeks impacted by BCC for the following parameters:

- pH
- electrical conductivity (EC)
- total suspended solids (TSS)
- flow condition (by way of visual observation as streams are ephemeral).

Water quality monitoring data for pH, EC and TSS and temperature are reported in the BCC Annual Reviews. Data presented in the 2015 to 2017 annual reviews indicate that mining activities had negligible impact on the water quality in downstream watercourses with monitoring results remaining within historical ranges.

Historical monitoring results from January 2004 to September 2018 for pH, EC and TSS are presented graphically in **Appendix 9**. The results are presented for individual monitoring locations within the clean water system including LR1, LR2, LR5, W2, W4 and W8. The monitoring results indicate the following for the routine parameters of pH, EC and TSS (note the typical ranges presented below correspond to 20th percentile and 80th percentile values):

- pH typically ranges between 7.3 to 8.0 in the clean water system and 8.5 to 9.2 in both the dirty water and mine water systems. As such, waters are typically neutral to alkaline in the various systems. No significant variation occurs throughout the various systems with the lowest reading of pH being recorded in the clean water system (pH of 6.3 at LR2).
- There are no visible temporal trends in the data available for pH for the clean or mine WMS.
- Historical EC typically ranges between 467 to 2363 µS/cm in the clean water system, 3120 to 6198 µS/cm in the dirty water system and 1788 to 6092 µS/cm in the mine water system. As such, waters are typically more saline in the dirty and mine WMS.

- TSS typically ranges between 5 to 17 mg/L in the clean water system, 16 to 120 mg/L in the dirty water system and 10 to 84 mg/L in the mine water system.

BCM has a substantial groundwater monitoring network which has developed and evolved throughout the operations' life. The alluvium of the Wollombi Brook and Monkey Place Creek are well instrumented, with 11 and 5 piezometers in each aquifer respectively. Monitoring of Permian coal measures is extensive, particularly across the underground operations. Instrumentation is established along the longwall panels and at their extents. This extensive network combined with data from the past and current mining operations provide a sound understanding of the local groundwater environment.

The GIA concluded that the Proposed Modification is not predicted to impact on groundwater quality in either the alluvium or Permian aquifer.

Water Users

Water extraction/abstraction both in and surrounding the Project Area is regulated by the NSW Government by water sharing plans (WSP). WALs are held by BCM under the *Water Sharing Plan for the Hunter Regulated River 2004* and the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009.*

Under NSW legislation, basic landholder rights allow take of surface water runoff and take of water from rivers, estuaries and lakes from land which has frontage to these sources under harvestable rights provisions and domestic and stock rights respectively. The majority of land adjacent to the Approved Operations is owned by Glencore subsidiaries or Yancoal. The Commonwealth of Australia owns the majority of land to the east of the Approved Operations and there are also some parcels of Crown Lands within and adjacent to the Approved Operations.

Bores listed with the NSW Department of Primary Industries Water (DPIW; 2016) database located within the model domain area are detailed in **Appendix 11**. Based on the GIA, predicted impacts on private groundwater bores are less than the Level 1 minimal impact considerations specified in the NSW Aquifer Interference Policy. Based on the results of the modelling, there are no registered bores included in the area where greater than 2 m drawdown occurs due to the Proposed Modification.

Project Design to Minimise Impacts on Water Resources

As outlined in **Section 1.0**, the design of the BOP was developed having regard to potential environmental and social impacts associated with mining operations, with the aim of minimising project specific and cumulative impacts. As outlined in **Section 3.1.5**, as part of the BOP, significant upgrades to the BCC integrated WMS were completed to accommodate the future mining within the Project Area. The existing integrated WMS has been designed to accommodate the approved mine plan. The Proposed Modification will result in relatively minor changes including the removal of some of the existing water storage facilities, a minor increase to the mining area catchment, minor incremental increase in groundwater inflows and construction of new or modified water management facilities.

Impacts on water resources in relation to the Proposed Modification are limited due to:

- The extent of existing and approved open cut and underground mining within and surrounding the Project Area, with mining already significantly altering the water environment.

- The coal seams proposed to be mined in the extension area have either been depressurised from existing mining or will be by approved mining.

- The management of impacts from the Proposed Modification within the regime established by NSW water and pollution control legislation, which provides for sustainable water take from water sources, management of water quality by imposition of discharge quality criteria and management of salt loads within sustainable targets by managing water discharges to the environment.

- By maintaining substantial buffer distances to Wollombi Brook and Loders Creek in accordance with the NSW Aquifer Interference Policy.

- Minimisation of works within the flood prone areas of Loders Creek to minimise the potential to impact on flood behaviour.

- Design of the water management system to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas) (as described in **Section 6.7**).

- Maximised water recycling within the BCC.

These factors reduce the potential for the Proposed Modification to result in a significant impact on existing water resources.

It is important to note that coal mining will always impact the groundwater regime, as dewatering of the mine workings is essential to the safe extraction of coal. The *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources* (DoE 2013) have been interpreted to mean that this unavoidable impact is only considered significant where there is a consequence from this impact; that is, that groundwater users or the environment are affected by changes in the quality or quantity of groundwater.

A summary of the potential water impacts against the *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE 2013) is included in **Table 7.4**.

Table 7.4 Assessment against Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

Aspect	Impact
Flow Regimes	The footprint of mining operations will increase with the Proposed Modification and water from this increased area will be captured, treated and reused within the integrated WMS. The assessment indicates that the Proposed Modification will have negligible impacts on flood flow velocities, and associated potential impacts on downstream landholders and watercourse stability in Loders Creeks when compared to the pre-mining scenario. The detailed assessment of potential impacts on flow regimes includes assessment of impacts on catchment areas and flow durations (refer to **Appendix 9**) including changes to catchment areas in Wollombi Brook and Loders Creek and flow duration impacts on Wollombi Brook. The assessment of potential impacts of flow regimes on riparian and ecological values is included in **Section 6.7.1** and **Appendix 9**.

Aspect	Impact
Recharge Rates; Aquifer pressure or pressure relationships between aquifers; Groundwater table levels	There is predicted to be a negligible change to recharge rates associated with the Proposed Modification. There is no predicted drawdown near water supply works for the Proposed Modification. There are no predicted impacts to aquifer pressure or pressure relationships between aquifers associated with the Proposed Modification. There will be negligible impacts to groundwater table levels resulting from the Proposed Modification. The detailed assessment of potential impacts on aquifer pressures, interactions between aquifers and groundwater table levels, including predicted drawdown zones, is included in **Appendix 11**.
Groundwater/surface water interactions	Predicted baseflow impacts show a minor (5 m^3/day or 0.05 L/s) increase in discharge and negligible changes associated recharge to and from natural drainage systems. The surface water assessment indicates that the baseflow impacts will not have a significant impact on flows in either Wollombi Brook or Loders Creek. In addition, the assessment of the final voids (refer to **Appendix 11**) indicates that the voids will be self-contained systems which will act as a sink in perpetuity, with no surface spills predicted to downstream watercourses. A more detailed summary of the impacts on groundwater/surface water interactions is included in **Appendix 9** and **Appendix 11**. The detailed assessment of the proposed final void is included in **Appendix 10**.
River/floodplain connectivity	The Proposed Modification is not expected to have an impact on river / floodplain connectivity as no mining is proposed in floodplain areas. Portions of the existing BCC operational areas are located within the flood prone land associated with Loders Creek. Loders Creek is a highly modified creek line with various historical diversion of its tributaries and changes in catchment areas due to mining in the catchment area for the last 30 years. It is considered that the Proposed Modification will not influence river/floodplain connectivity compared to the currently approved impacts. The detailed assessment of flood behaviour and potential impacts on flooding regimes, including impacts on river/floodplain connectivity is included in **Appendix 9**.
Inter-aquifer connectivity	There are no changes predicted to inter-aquifer connectivity as a result of the Proposed Modification.
Coastal Processes	No impacts on coastal process are predicted as a result of the Proposed Modification which is located well inland, being approximately 80 km from the coast.
Impact on water users	The assessment of impacts on water users indicates that there will be negligible impact on water users. All water take associated with the Proposed Modification will be licensed in accordance with the WM Act. The detailed assessment of impacts on surface water users is included in **Section 6.7.1**. A more detailed summary of the impacts on water users is included in **Sections 6.7.1** and **6.7.2** for surface water users and groundwater users respectively. The detailed assessment of impacts on surface water users is included in **Appendix 9**. The detailed assessment of impacts on groundwater users is included in **Appendix 11**.

Aspect	Impact
State Water Resource Plans	The surface water and alluvial water sources within and adjacent to the additional disturbance area are managed under the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan (WSP). In addition, water extraction from the Hunter River is managed under the Hunter Regulated River Water Source WSP. Both WSPs are State Water Resource Plans and are governed under the WM Act. The NSW Government WSPs provide a regional water balance for these water sources and consider cumulative water use. Water take for the BCC will continue to comply with the above listed WSPs and WM Act which are designed to provide for the sustainable use of NSW's water resources.
Water Quality	BCM has a comprehensive I integrated WMS in place at the BCC to manage the potential impacts of the existing mining operations on water resources. Changes to the integrated WMS required for the Proposed Modification will be designed in accordance with relevant government standards to limit potential impacts on downstream water qualities by managing water that has the potential to cause environmental harm. To manage water quality during operational and rehabilitation phases of the Proposed Modification, erosion and sediment control measures and other water quality control measures will be implemented in accordance with the relevant government standards, to minimise any potential impact on water quality. Monitoring results will be assessed against the relevant trigger values and reported. The risks to downstream environments associated with sediment laden water are mitigated by the design of the BCC integrated WMS in accordance with design criteria established by the NSW Government specifically for sediment control at mining and quarry operations. These controls will effectively manage this risk. Through management of sediment laden (dirty) water and mine water within the IWMS over the life of the operations, and based on flood assessment findings that indicate no changes to velocities and associated scour potential in Loders Creek, it is not anticipated that water quality in Wollombi Brook or Loders Creek will be adversely impacted by the Proposed Modification. All discharges of saline water will be undertaken in accordance with the HRSTS, ensuring that they remain within the sustainable salt level for the Hunter River determined by the NSW Government. The Proposed Modification is therefore considered to have a low potential to impact on water quality in downstream watercourses. A more detailed summary of the impacts on water quality is included in **Sections 6.7.1** and **6.7.2** for surface water and groundwater respectively. The detailed assessment of impacts on surface water quality is included in **Appendix 9**. The detailed assessment of impacts on groundwater quality is included in **Appendix 11**.

7.4 Environmental Record of Person Proposing to take the Action

BCM has a satisfactory record of responsible environmental management.

Mining has been carried out within what is now called the BCC since 1981. The BCC is managed by BCM on behalf of Bulga Coal Joint Venture. Over the years BCM has developed constructive relationships with the regulators and local communities largely as a result of demonstrating a high level of compliance, good environmental performance and proactive community engagement and support. Evidence of this can be seen in the BCC Annual Review and independent audits available from the Bulga Coal Web page (www.Bulgacoal.com.au).

BCC has an existing environmental management system (EMS) (also available on the Bulga Coal Web site) which outlines how it manages environment and community matters, impacts and performance. It provides a framework for the standards, plans and procedures implemented to ensure operations are managed in accordance with Glencore's business principles and Sustainable Development Policy and Standards and all relevant licences and approvals held by the BCC.

BCM has implemented a range of measures across the BCC to improve ecological outcomes including:

- progressive rehabilitation of overburden emplacement areas
- monitoring of rehabilitation
- management of site disturbance activities.

Two of the main environmental impacts of the BCC are noise and dust. BCC has installed an industry best practice real time noise monitoring network. When necessary the mining operations are modified to manage the noise levels within the approved noise criteria. BCC has also implemented industry best practice air quality management by installing real time dust monitors within the adjacent communities, dust surveillance cameras within the mine and proactively reducing the disturbed area. The BCC EMS had been developed generally in accordance with the ISO 14001.

There have been no proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action, or

(b) for an action for which a person has applied for a permit, the person making the application.

8.0 Environmental and Social Mitigation and Management Measures

As part of BOP (as modified), BCM has committed to a range of environmental and social mitigation and management measures.

BCM has prepared and implemented the environmental management and monitoring plans required by development consent SSD 4960 and the existing management plans and systems will be applied to the Proposed Modification. The relevant management plans will be updated in response to the Proposed Modification, if approved.

Additional mitigation and management measures committed to as part of the Proposed Modification are summarised below.

Noise

- Overburden emplacement strategies will be implemented to meet relevant noise criteria. This may include measures such as provision of shielded tipping locations for night period dumping and different day and night period hauling/dumping scenarios.
- Haul road bunds will be constructed to a height of 3 metres above road level, where safe and practicable, in strategic locations on the exposed side of long-term haul roads. A sensitivity analysis was completed that showed increasing the bund height above 3 metres provides minimal additional noise reduction, but construction becomes increasingly difficult and expensive.
- Operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria.
- Retention of the hydraulic snubber on the face shovel so this noise source will not be a cause of sleep disturbance.
- Continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages.
- Continuous noise monitoring will be continued at strategic off-site locations to provide real time feedback to the mine for noise management.
- Monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management.
- Reasonable and feasible noise mitigation measures will be offered to landowners listed in Table 2 (Condition 2 of Schedule 3) of SSD 4960.

Blasting

- BCM will continue to undertake blasting for the Proposed Modification t in accordance with a detailed blast design process that considers operational, geological and environmental constraints, with the design and size of each blast determined to meet these constraints and meet blasting criteria.
- Blasts will be designed to achieve compliance with the site-specific blast conditions.
- BCM will use an appropriate initiation sequence to minimise the possibility of a wavefront reinforcement effect to sensitive receivers.

- BCM will undertake a modified blast design around identified geological features (to reduce the risk of a face burst and excessive airblast emissions).
- BCM will use of a modified blast design to account for the presence of geologically affected rock strata to avoid a potential flyrock incident around the identified geological features.

Air Quality

The proposed mitigation measures to manage diesel combustion emissions aim to address the equipment maintenance and engine replacement strategies from the NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions (EPA 2014). The emission control measures proposed by BCM include:

- servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance
- targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle
- defining failure modes, effects and criticality which help to minimise potential equipment failure
- constructing timelines for downtimes.

Biodiversity

- BCM will retire biodiversity credits for the Proposed Modification in accordance with the FBA.
- The proposed land-based offsets will be managed as a conservation area and a Stewardship Agreement will be put in place for the offset within 12 months of development consent being granted, or as otherwise agreed with the Secretary. Stewardship Agreements will provide for the management and in-perpetuity conservation of the proposed offset site. The proposed offset site will be established and until such time as the Stewardship Agreements are in place, BCM will manage the offsets as conservation areas.

Visual

- Progressive rehabilitation will be undertaken on the outer faces of overburden emplacement areas to reduce the duration of visible soil exposure, including the use of temporary rehabilitation as appropriate.

Archaeology

- The BCC ACHMP will be updated to include all additional components of the study area (additional disturbance area and infrastructure study area), and will include conditions for the management of the surface artefacts prior to the commencement of the Proposed Modification. Management and mitigation of the Aboriginal sites associated with the Proposed Modification will be undertaken in consultation with the Aboriginal community as per Section 3 of the ACHMP.

Social

- BCM proposes to continue its existing VPA commitments, for the duration of the Proposed Modification, to facilitate continued and ongoing support for a range of community and environmental projects within the communities of Broke, Bulga and Milbrodale and the wider Singleton LGA community.
- BCM proposes to develop a nature and cultural trail to provide access to BCM offset areas, including the proposed Vere Offset, for the benefit of the local community and visitors. The proposed trail and access would be developed through an understanding of the local setting and potential opportunities for BCM to provide recreational opportunities.

9.0 Justification and Conclusion

This section provides a conclusion discussing the justification for the Proposed Modification, taking into consideration the environmental, social and economic impacts of the Proposed Modification and the suitability of the site, to assist the consent authority to determine whether or not the Proposed Modification is in the public interest.

9.1 Environmental Impacts

As detailed in **Section 6.0**, the environmental, social and economic impacts of the Proposed Modification have been identified and subject to a detailed environmental assessment based on:

- assessment of the site characteristics (existing environment)
- focused consultation with relevant government agencies
- engagement with local community and other stakeholders
- application of the principles of ecologically sustainable development, including the precautionary principle, inter-generational equity and conservation of biological diversity and ecological integrity
- expert technical assessment.

The key issues identified, including those specified in the Commonwealth Environmental Assessment Requirements, were subject to comprehensive specialist assessment to identify the potential impacts of the Proposed Modification on the existing environment. These assessments are detailed in **Section 6.0** and the appendices to this document.

As outlined in this SEE, the design of the earlier BOP mine was developed having regard to potential environmental and social impacts associated with mining operations, with the aim of minimising project specific and cumulative impacts. A comprehensive stakeholder engagement strategy was implemented during the BOP design and environmental assessment phases to assist in refining the project design and to identify appropriate management and mitigation measures. Similarly, the design of the Proposed Modification was informed by the identification of potential environmental and social impacts through stakeholder engagement mechanisms. The Proposed Modification design was prepared and refined with the objective of ensuring that the Proposed Modification could be undertaken in compliance with existing approved environmental impact criteria, to ensure that there is minimal incremental impact resulting from the Proposed Modification.

A key feature of the BOP design was the development of a noise and visual bund along the western and southern edges of the open cut pit to manage noise and visual impacts. The noise and visual bund creates a landform between the open cut operations, including the Proposed Modification operations and the Bulga, Milbrodale and Broke areas which assists in reducing noise impacts and visual impacts.

Table 9.1 provides an overview of the key outcomes of the environmental, social and economic impact assessment.

Table 9.1 Overview of Environment and Community Impacts

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Air Quality	• Comprehensive air quality management controls have been incorporated into the design of the project to minimise the contribution to impacts on local and regional air quality. • Cumulative dust levels and other air quality parameters are predicted to comply with the relevant criteria at all surrounding private residences, with the exception of a single private residence due to the change in criteria. This residence is located to the north of the BCC and has current noise acquisition rights for the adjacent MTW mine, and may be afforded acquisition rights from the Proposed Modification, in accordance with the VLAMP due to the revised criteria. • A proactive and reactive dust control strategy will be implemented to minimise dust emissions over the life of the operation.
Noise	• As part of the design of the Proposed Modification, BCM has incorporated a range of mine design changes and noise controls to minimise noise impacts. • Operational noise levels are predicted to meet the currently approved noise criteria for BCC at all surrounding private residences. • Noise impacts will be managed through the implementation of the ongoing real-time monitoring program combined with proactive and reactive noise management measures including adaptively manage mining operations as required.
Blasting	• Blasting activities will be managed so that relevant blast criteria are not exceeded at private residences or at blast sensitive infrastructure. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.
Land Use and Agriculture	• The primary existing land use of the Project Area is mining. • Much of the surrounding land is mine owned land significantly reducing the potential for impacts on private land uses. The existing mining operations have coexisted with the surrounding land uses since the 1980s without substantial land use conflict, and this is expected to continue. • The Proposed Modification will not result in any changes to surrounding land uses. • The Proposed Modification will have a minimal impact on surrounding land uses.
Water Resources	• A comprehensive WMS has been designed for the Proposed Modification to manage water in accordance with legislative requirements and relevant guidelines. • The WMS for the Proposed Modification will be integrated with the existing WMS to maximise water recycling, reducing external water import and releases. • The Proposed Modification is not predicted to have significant impacts on downstream water quality, flows, flooding or water users. • Incremental groundwater impacts associated with the Proposed Modification are negligible.

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Biodiversity	• The biodiversity impacts of the Proposed Modification are being assessed, managed and offset under the FBA. • The additional disturbance area of 20.2 ha is relatively minor, in the context of the currently approved BCC disturbance area of 3,786 ha. • Approximately 19.2 ha of native woodland/forest vegetation will be removed from the additional disturbance area associated with the Proposed Modification. • Approximately 16.2 ha of the Commonwealth listed Central Hunter Valley Eucalypt Forest and Woodland CEEC will be impacted by the Proposed Modification. • One State listed endangered ecological community will also be impacted by the Proposed Modification. • United has committed to a biodiversity offset strategy to offset the biodiversity impacts of the Proposed Modification.
Cultural Heritage	• A comprehensive ACHA was undertaken for BOP covering the Project Area. The assessment identified culturally significant features in the surrounding regional landscape context but not in the additional disturbance area. • A comprehensive ACHA process was completed for the Proposed Modification in consultation with the registered Aboriginal parties for the operations. • The Proposed Modification will impact on six sites (two artefact scatters and four isolated finds) which were assessed as low scientific significance. • The ACHA found that the additional disturbance area did not contain any key cultural values. • BCM will update the ACHMP to include the additional disturbance area and additional study area.
European Heritage	• A comprehensive assessment of the potential impacts of the Bulga Surface Operations on historic heritage values was prepared as part of the BOP EIS (Umwelt, 2013). • One item, PS7 – Post and Rail Fence, is located in the vicinity of the additional disturbance area. • Item PS7 will be impacted by the Proposed Modification and will consequently require removal, however it is considered to be of no significance to local heritage values.
Visual	• Views of the existing mining operations are currently available from residences surrounding the Project Area. It should be noted that views of the approved and proposed mining operations are largely obscured by the approved noise and visual bund. • There will be either no increase or only minor changes to the visibility of the active and inactive overburden areas as a result of the Proposed Modification. • The progressive rehabilitation of emplacement areas and shaping of the final landform using natural landscape principles is expected to reduce the visual impact of emplacement areas.

Environmental/ Social Issue	Overview of Key Outcomes (after proposed Management, Mitigation, Offsets)
Rehabilitation	• The overall rehabilitation strategy for the Proposed Modification is consistent with the Approved Operations. This design will include variable terrain which is profiled to effectively manage runoff to enhance long term landform stability and to be sympathetic to the profile of the adjacent landscape. • The Proposed Modification will result in a 4 year extension of the Bulga Open Cut mine life and modified final landform to that currently approved. • Consistent with the Approved Operations, a single final void will remain, however the Proposed Modification will result in it being located approximately 1 km to the south east of the location contemplated for the Approved Operations.
Greenhouse Gas	• A range of energy and greenhouse gas management initiatives will continue to be implemented as part of the operations to improve energy efficiency and reduce greenhouse gas emissions.
Transport	• The Proposed Modification will not increase operational employee numbers therefore it is not expected to a change in operating traffic volumes associated with the Bulga Open Cut. • The total approved maximum annual tonnage of coal transported by train will remain unchanged.
Social and Economic	• The Social Impact and Opportunities Assessment found that from a technical social perspective, it is unlikely that the Proposed Modification will result in significant change across any of the key community capitals (natural, economic, human, physical and social), thus affording a risk ranking of 'low' for impact on community sustainability. • A range of strategies will continue to be implemented to seek to minimise social impacts and maximise benefits. For example, to address the issues raised by stakeholders around the perceived concerns regarding end land use and rehabilitation (post mining), health and wellbeing and community sustainability and to enhance perceived positive economic impacts, BCM proposes to develop a Nature and Culture Trail - a Recreation and Tourism Strategy, for the landholders and residents residing in proximity to the BCC in the neighbouring villages of Bulga, Broke and Milbrodale. • The Project will provide significant ongoing benefits for local and wider communities through employment, local and regional expenditure and payment of royalties and taxes. • A cost benefit analysis indicates the Proposed Modification will provide a net benefit to NSW.

The impacts of the Proposed Modification have been kept to a minimum through:

- obtaining a detailed understanding of the issues and impacts by scientific evaluation and stakeholder engagement
- designing the mine around the mitigation of potential amenity impacts, particularly noise, air quality and visual impacts as these are recognised as key stakeholder concerns
- commitment to proactive and appropriate strategies to avoid, minimise, mitigate, offset or manage a range of potential environmental impacts (refer to **Sections 6.0** and **7.0**).

9.2 Suitability of the Site

The development of a coal mine and associated infrastructure is limited, by its nature, to the location of the coal resource. For the Proposed Modification, the additional resource proposed to be extracted is located adjacent to an existing operating coal mine, on land owned by Glencore that is currently primarily used for mining purposes.

The additional disturbance area of 20.2 ha is relatively minor, in the context of the currently approved BCC disturbance area of 3,786 ha. The additional disturbance area generally consists of land with lower land capability which is surrounded by land being used for mining or mining purposes. In terms of land use, it would be reasonable to determine that mining is the preferred land use for the site for the duration of the BCC operations. Post mining, the area will be rehabilitated and whilst the predominant post mining land use is proposed as native vegetation, that land (outside the final void) would be capable of being used for other purposes.

The additional disturbance area currently has a range of biodiversity values and these values will be impacted by the Proposed Modification, however, BCM has developed an offset strategy that fully offsets these impacts in accordance with government policy and which will contribute to and improve conservation outcomes in the local area and region.

The predominant existing land use for the broader Project Area is mining, with the proposed project consistent with this existing land use. The Proposed Modification is located in an area historically characterised by coal mining and includes a number of existing mining operations. The BCC operation is a well-established mining operation situated within the Hunter Coalfield, which is the largest coal-producing region in NSW. Some of the key objectives for the Proposed Modification are to maximise extraction of remaining coal resources from previously disturbed mine areas, maximise the use of previously disturbed areas, maximise use of existing mining infrastructure and further development of existing environmental and social mitigation and management strategies to mitigate and manage the predicted impacts associated with the Proposed Modification, thereby limiting potential for conflicts with other land uses.

From a mining perspective, the Proposed Modification is a logical continuation of the existing mine into adjacent resources within an area of 346.2 ha of additional mining area of which 326 ha has previously been or is approved for disturbance including two areas previously mined and used for tailings storage facilities. From a land use perspective, as a continuation of an existing approved land use, it is considered that while some impacts are predicted, with the application of the management and mitigation measures committed to by BCM, these impacts can be managed to a level that is consistent with currently approved impacts and can continue to coexist with surrounding land uses. BCM considers that this outcome has been demonstrated through its existing mining operations.

BCM has actively engaged with stakeholders including the local community, to seek to understand the key concerns and issues associated with the Proposed Modification and to assist with managing these issues through appropriate project design and application of management, mitigation and offset measures.

The BCC has provided substantial economic benefits at a local, State and Federal levels over its approximately 37 years of operations. The approved operations at the BCC will continue to provide substantial economic benefits until the existing open cut approved resource is extracted (approximately 2035 subject to the planned modification).

9.3 Ecologically Sustainable Development

An objective of the EP&A Act is to encourage Ecologically Sustainable Development (ESD) within NSW. As outlined in **Section 5.2**, the Proposed Modification requires approval from the Minister for Planning under the EP&A Act. This section provides an assessment of the Proposed Modification in relation to the principles of ESD.

To justify the Proposed Modification with regard to the principles of ESD, the benefits of the Proposed Modification in an environmental and socio-economic context should outweigh any negative impacts. The principles of ESD encompass the following:

- the precautionary principle
- inter-generational equity
- conservation of biological diversity
- valuation and pricing of resources.

Essentially, ESD requires that current and future generations should live in an environment that is of the same or improved quality than the one that is inherited.

9.3.1 The Precautionary Principle

The EP&A Regulation defines the precautionary principle as:

> *'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. In the application of the precautionary principle, public and private decisions should be guided by:*
>
> *(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and*
>
> *(ii) an assessment of the risk-weighted consequences of various options.'*

In order to achieve a level of scientific certainty in relation to potential impacts associated with the Proposed Modification detailed assessment of all key issues and necessary management procedures has been conducted and is comprehensively documented in this SEE.

The assessment process has involved a detailed study of the existing environment (refer to **Section 6.0**), and the use of engineering and scientific modelling to assess and determine potential impacts as a result of the Proposed Modification. To this end, there has been careful evaluation to avoid, where possible, irreversible damage to the environment.

The decision making process for the design, impact assessment and development of management processes has been transparent in the following respects:

- Government authorities, landholders potentially affected by the Proposed Modification, the local community, the Aboriginal community and other stakeholders were consulted during SEE preparation (refer to **Section 4.0**). This enabled comment and discussion regarding potential environmental impacts and proposed environmental management procedures.

- The community has been engaged throughout the development and assessment of the Proposed Modification through a range of mechanisms including one-on-one meetings, community information sessions and community newsletters amongst other mechanisms (refer to **Section 4.0**) which provided landholders and stakeholders with both information and the opportunity to influence outcomes.

- BCM has designed and implemented a comprehensive Environmental Management System (EMS), and related environmental management programs, that seek to implement best practice management. The Proposed Modification will incorporate the practices implemented and demonstrated to be effective at the BCC and the existing EMS will be revised to incorporate the additional controls outlined in this SEE.

- The SEE has been undertaken on the basis of the best available scientific information about the Project Area. Where uncertainty in the data used in the assessment has been identified, a conservative worst-case analysis has been undertaken and contingency measures have been identified to manage that uncertainty. A validation program has also been proposed to measure predicted against actual impacts of the Proposed Modification, so that contingency measures, if required, can be implemented in a timely and pro-active manner.

- An auditing and review process will be an integral component of the EMS, providing for verification of the Proposed Modification performance by independent auditors and relevant government agencies. The Proposed Modification will implement an auditing and verification process consistent with that currently undertaken at the current BCC operations.

9.3.2 Intergenerational Equity

The EP&A Regulation defines the principal of intergenerational equity as:

> *'...that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.'*

Intergenerational equity refers to equality between generations. It requires that the needs and requirements of today's generations do not compromise the needs and requirements of future generations in terms of health, biodiversity and productivity.

The objectives of the Proposed Modification are to:

- conduct mining in an environmentally responsible manner to minimise project-specific and cumulative environmental and social impacts, and make efficient use of the available coal resource

- maintaining or reducing impacts of the Bulga Surface Operations by incorporating mitigation measures into the project design

- continue to develop the Bulga Surface Operations with a long term focus on:
    - maximising efficiency and coal resource recovery from the BCC
    - optimising the use of existing infrastructure
    - minimising additional mining disturbance footprint by maximising use of existing disturbed areas

- maintaining and extending the employment opportunities for BCM employees

- developing comprehensive mitigation, management and offset strategies that expand on existing commitments to mitigate and offset predicted impacts associated with the Proposed Modification

- co-existing with the local community, including the villages of Broke, Milbrodale and Bulga
- establishing a final landform that is safe, stable and sustainable.

Further to the Proposed Modification objectives, a range of environmental management measures discussed in **Sections 6.0** and **7.0** have been developed and evaluated to minimise the impact on the environment to the greatest extent reasonably possible.

The design of the Proposed Modification and commitment to the management of environmental issues as outlined in this SEE will maintain the health, diversity and productivity of the environment for future generations. The Proposed Modification will also make a significant contribution to maintaining services in the community through the direct and flow on effects of employee and operational expenditure and through development contributions in accordance with the EP&A Act.

9.3.3 Conservation and Biological Diversity

The EP&A Regulation identifies that the principal of conservation of biological diversity and ecological integrity should be a fundamental consideration in the decision making process. The conservation of biological diversity refers to the maintenance of species richness, ecosystem diversity and health and the links and processes between them. All environmental components, ecosystems and habitat values potentially affected by the Proposed Modification are described in the SEE (refer in particular to **Section 6.6** and **Appendix 8**). Potential impacts are also outlined in the SEE (refer to **Section 6.6**) and measures to ameliorate any negative impact are outlined in **Section 7.0**.

NSW Government policy requires the biodiversity impacts of a project to be quantified and offset using a credit driven mechanism. The impacts of the Proposed Modification have been quantified and BCM has secured all of the required offsets to fully meet the biodiversity offset credit needs of the Proposed Modification. The retirement of biodiversity credits not only fully offsets the impacts of the Proposed Modification on biodiversity, it provides in-perpetuity conservation of areas of high biodiversity value and provides for ongoing improvement of the values through active management and conservation.

The proposed offset strategy for the Proposed Modification will result in conservation areas being established in the local area, contributing to long-term conservation and biological diversity outcomes. The proposed local conservation area will build on the existing conservation areas already established by BCM, adding to the existing conservation network.

9.3.4 Valuation of Pricing Resources

The goal of improved valuation of natural capital has been included in Agenda 21 of Australia's Intergovernmental Agreement on the Environment. The principle has been defined in the EP&A Regulation as follows:

> *that environmental factors should be included in the valuation of assets and services, such as:*
>
> *(i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement;*
>
> *(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste; and*

(iii) *environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems*

The polluter pays principle applies to the Proposed Modification through the discharge of salt in surface water discharges to the Hunter River catchment through the HRSTS (refer to **Section 6.7**). Pricing of resources is also captured in the regulatory regime applying to surface and groundwater extractions.

Project considerations have included the costs of management measures to minimise potential environmental and social impacts. There will also be additional costs associated with establishing and managing ecological offsets to reduce the magnitude of ecological impacts. In many cases, operational efficiencies are also associated with improved environmental outcomes. For example, efficient haul routes reduce total noise and dust emissions and diesel use (with associated greenhouse gas and particulate emission reductions). The Proposed Modification also optimises the valuation and pricing of the coal resources with minimal impact by optimising available use of the existing infrastructure and equipment.

9.4 Conclusion

As outlined in **Section 9.3**, the Proposed Modification has been assessed against the principles of ecologically sustainable development as required by the EP&A Act. This assessment has indicated that the Proposed Modification is consistent with the principles of ecologically sustainable development.

The SIA has identified that social impacts from the Proposed Modification are primarily consistent with the Approved Operations. Given BCM's proactive mine plan design to avoid and minimise impacts, the social impacts of the Proposed Modification have been minimised where possible through project design and the proposed management and enhancement approaches.

The Economic Assessment (refer to **Appendix 15**) describes a range of positive benefits from the Proposed Modification that will result at a local, regional and State level. These benefits include:

- continued employment of approximately 700 full time equivalent employees
- the Proposed Modification is estimated to provide a net benefit of $410.6 M to NSW, in net present value terms
- the Proposed Modification is estimated to generate $231.6 M (in net present value terms) in corporate taxes, of which $74.5 M is attributed to NSW
- the Proposed Modification is estimated to generate $104.5 M in royalties
- the Proposed Modification is estimated to provide a net benefit of $81.3 M to the region in net present value terms.

On this basis, it would be reasonable to consider that with the implementation of the management, mitigation and offset measures proposed by BCM, the Proposed Modification will result in a net benefit to the NSW community.

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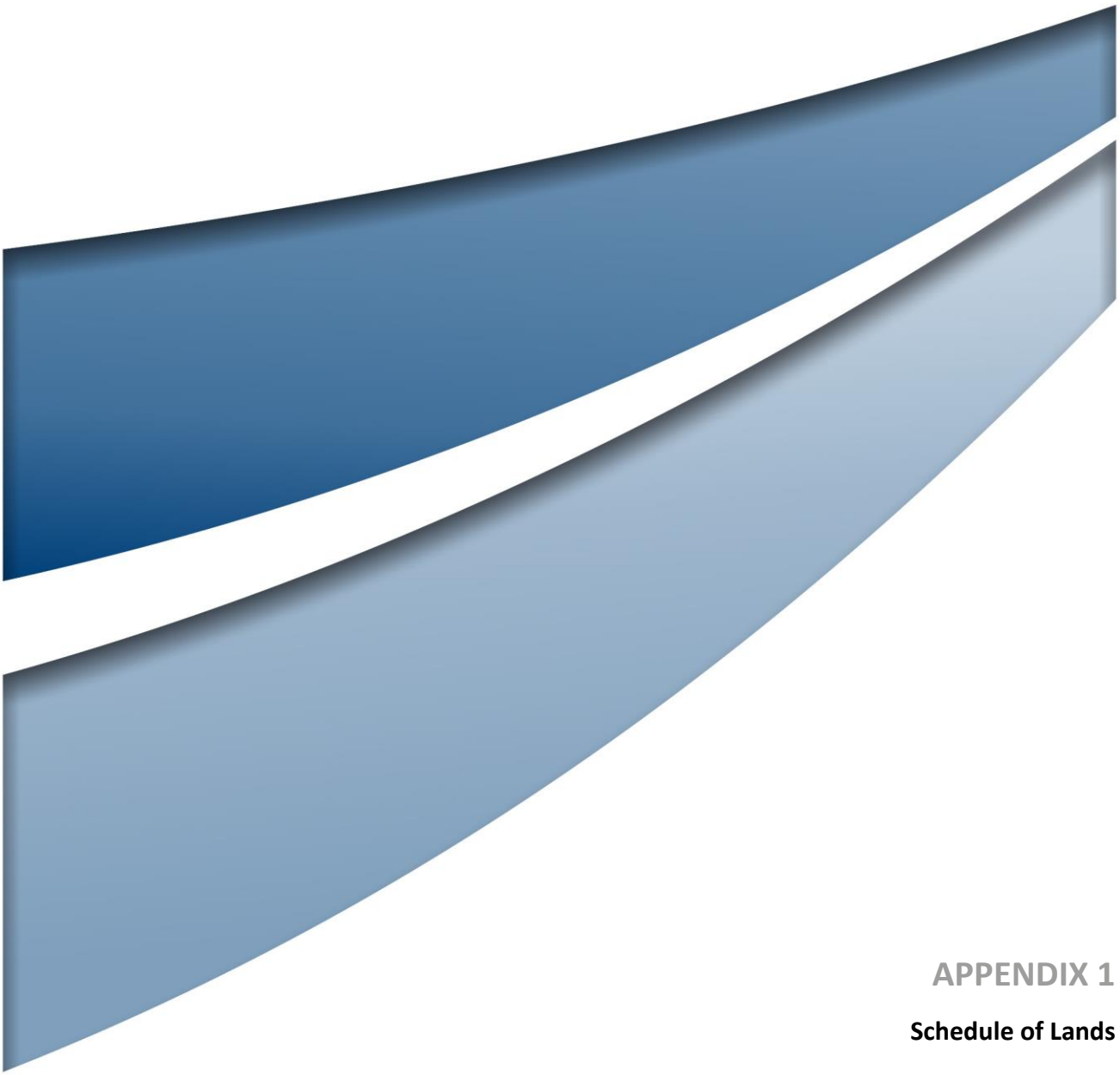


APPENDIX 1

Schedule of Lands

Appendix 1 – Schedule of Lands

Bulga Optimisation Project Modification 3 Schedule of Lands

Lot	DP	Owner
10	730762	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
11	730762	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
6	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
98	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
44	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
82	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
86	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
52	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
53	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
85	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
30	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	248448	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
80	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
56	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
54	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
84	856359	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
29	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
26	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
31	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	102103	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
81	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	784032	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
27	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
85	856359	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	102103	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
22	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
103	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
125	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
83	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
28	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
51	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
36	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
49	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
39	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	376892	Bulga Coal Management Pty Limited

Appendix 1 – Schedule of Lands

Lot	DP	Owner
11	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
44	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
40	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
8	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
76	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
9	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
19	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	563668	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
46	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
79	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
38	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
68	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
15	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
45	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
41	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
10	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
51	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
78	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
48	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
12	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
81	1006883	Mushroom Composters Pty Ltd
50	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
82	1006883	Mushroom Composters Pty Ltd
14	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
75	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
52	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
6	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	136366	Mushroom Composters Pty Ltd
16	247398	Saxonvale Coal Pty Limited 97.5% Nippon Steel Pty Limited 2.5%
17	247398	Bulga Coal Management Pty Limited
72	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
13	247398	Bulga Coal Management Pty Limited
37	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	133135	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
18	247398	Bulga Coal Management Pty Limited
77	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
73	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd

Appendix 1 – Schedule of Lands

Lot	DP	Owner
1	133135	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
A	174788	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
74	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
62	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
60	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	435160	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	205613	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	621145	Bulga Coal Management Pty Limited
2	621145	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
B	174788	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	704474	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	205613	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
1	821150	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	729923	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	1145329	Bulga Coal Management Pty Limited
2	1197528	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
126	729952	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	62544	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
852	612261	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
709	749857	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	62544	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
17	10022	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
1	657988	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	47305	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
125	755270	Bulga Coal Management Pty Limited
1	564480	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
69	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
192	545559	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
20	811613	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
191	545559	Bulga Coal Management Pty Limited
21	811613	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	171648	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
62	1179154	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	10022	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
2	1207737	Commonwealth of Australia
47	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
40	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
46	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
35	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
41	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
37	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
38	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
39	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
48	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd

Appendix 1 – Schedule of Lands

Lot	DP	Owner
26	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
27	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
28	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
34	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
29	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
36	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
49	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
30	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	745971	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
33	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
24	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
274	260663	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
127	856361	The State of NSW
1	723292	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
271	260663	Miller Pohang Coal Co. Pty. Limited
44	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
45	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
42	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
50	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd

Appendix 1 – Schedule of Lands

Bulga Underground Modification 7 Schedule of Lands

Lot	DP	Owner
10	730762	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
11	730762	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1/33	758164	Private
1/51	758164	Private
7/21	758164	Private
9/12	758164	Private
8/12	758164	Private
8/33	758164	Private
9/21	758164	Private
8/21	758164	Private
3/50	758164	Private
6/21	758164	Private
3/51	758164	Private
5/33	758164	Private
3/33	758164	Private
7/33	758164	Private
2/51	758164	Private
6/33	758164	Private
2/33	758164	Private
32	703892	Commonwealth of Australia
4/51	758164	Private
1	986831	Private
4/33	758164	Private
1	829741	Commonwealth of Australia
2	986831	Private
4	599574	Commonwealth of Australia
101	1033019	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
12	1069011	Private
13	1069011	Bulga Coal Management Pty Limited
11	1069011	Stevns & Company Pty Limited
6	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
98	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
44	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
82	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
86	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
52	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
53	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
85	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
30	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd

Appendix 1 – Schedule of Lands

Lot	DP	Owner
5	248448	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	248448	Private
80	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
56	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
54	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
84	856359	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
29	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	133168	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
26	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
31	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	102103	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
81	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	784032	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
27	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
85	856359	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	102103	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
22	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
103	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
125	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
83	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
28	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
51	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
36	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
49	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
39	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	376892	Bulga Coal Management Pty Limited
11	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
44	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
40	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
8	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
76	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
9	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
19	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	563668	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
46	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
79	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
38	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd

Appendix 1 – Schedule of Lands

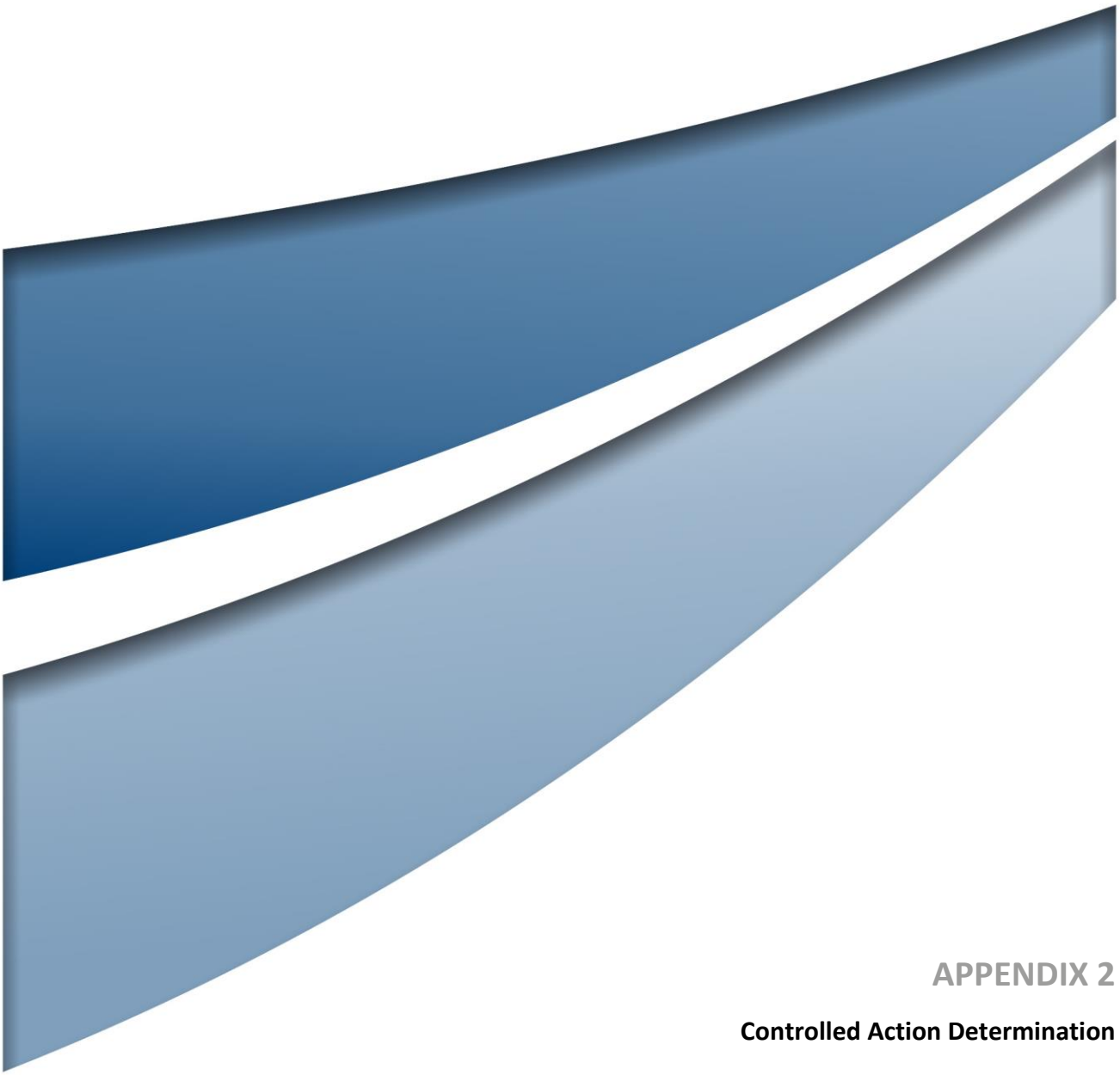
Lot	DP	Owner
68	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
15	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
45	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
41	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
10	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
51	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
78	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
48	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
12	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
50	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
82	1006883	Mushroom Composters Pty Ltd
14	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
75	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
52	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
6	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	136366	Mushroom Composters Pty Ltd
16	247398	Saxonvale Coal Pty Limited and Nippon Steel Pty Limited
17	247398	Bulga Coal Management Pty Limited
72	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	1007798	Private
13	247398	Bulga Coal Management Pty Limited
37	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	133135	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
18	247398	Bulga Coal Management Pty Limited
77	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
73	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	247398	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	133135	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
A	174788	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
74	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
62	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
60	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	435160	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
2	205613	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
1	621145	Bulga Coal Management Pty Limited
B	174788	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	704474	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	205613	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
1	821150	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	729923	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	1145329	Bulga Coal Management Pty Limited
2	1197528	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd

Appendix 1 – Schedule of Lands

Lot	DP	Owner
126	729952	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
851	612261	Miller Pohang Coal Co. Pty. Limited
1	62544	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	10022	Miller Pohang Coal Co. Pty. Limited
5	587986	Miller Pohang Coal Co. Pty. Limited
852	612261	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
57	755270	Miller Pohang Coal Co. Pty. Limited
709	749857	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	10022	Private
18	10022	Private
2	62544	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
17	10022	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
112	606531	Private
1	657988	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
8	10022	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	861535	Private
2	861535	Private
1	47305	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
5	861535	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
125	755270	Bulga Coal Management Pty Limited
1	564480	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
30	800688	Saxonvale Coal Pty Limited and Nippon Steel Australia Pty Ltd
1	966407	Bulga Coal Management Pty Limited
21	877447	Private
4	861535	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
31	800688	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
3	861535	Private
69	755270	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
11	705699	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
9	10022	Private
192	545559	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	822165	Bulga Coal Management Pty Limited
16	10022	Private
15	10022	Private
12	705699	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
26	852571	Bulga Coal Management Pty Limited
27	852571	Outram Estate Pty Limited
20	811613	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
13	705699	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
191	545559	Bulga Coal Management Pty Limited
21	811613	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	634708	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	171648	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
11	1118291	Private

Appendix 1 – Schedule of Lands

Lot	DP	Owner
62	1179154	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
7	10022	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
122	755270	Private
4	615819	Private
1241	1015814	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1243	1015814	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1242	1015814	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
24	816636	Bulga Coal Management Pty Limited
123	755270	Private
1244	1015814	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
122	914560	Singleton Council
120	755270	Private
121	755270	Private
2	1207737	Commonwealth of Australia
47	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
40	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
46	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
35	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
41	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
37	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
38	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
39	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
48	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
26	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
27	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
28	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
34	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
29	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
36	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
49	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
30	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	745971	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
4	561424	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
33	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
24	755264	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
274	260663	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
1	723292	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
44	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
43	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
45	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
42	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd
50	1224108	Saxonvale Coal Pty Limited and Nippon Steel & Sumitomo Metal Australia Pty Ltd



APPENDIX 2

Controlled Action Determination

EPBC Ref: 2018/8300

Ms Michelle Lawson
Director
Bulga Coal Management Pty Limited
PMB 15
SINGLETON NSW 2330

Dear Ms Lawson

Decision on referral
Bulga Coal Optimisation Project Modification, near Singleton, NSW

Thank you for submitting a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is to advise you of my decision about the referral of the proposed action, to extend the existing Bulga open-cut mine to access additional coal resources near Singleton, New South Wales.

As a delegate of the Minister for the Environment, I have decided under section 75 of the EPBC Act that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

The information that I have considered indicates that the proposed action is likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (sections 18 & 18A).
- A water resource, in relation to coal seam gas development and large coal mining development (section 24D & 24E).

Based on the information available in the referral, the proposed action is likely to have a significant impact on the following matters of national environmental significance:

- Central Hunter Valley Eucalypt Forest and Woodland – Critically Endangered.
- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered.
- Swift Parrot (*Lathamus discolor*) – Critically Endangered.
- A water resource, in relation to coal seam gas development and large coal mining development (section 24D & section 24E).

Please note that this may not be a complete list and additional impacts may be identified during preparation of the environmental impact statement. In this regard, the Department considers it the responsibility of the proponent to undertake an analysis of the significance of the relevant impacts and ensure that all protected matters that are likely to be significantly impacted are assessed for the Commonwealth Minister's consideration. Please note that this decision only relates to the potential for significant

impacts on matters protected by a provision of Part 3 of the EPBC Act. A copy of the document recording this decision is attached.

Assessment

The New South Wales Government has advised the Department that the proposed action will be assessed in accordance with the *Bilateral agreement made between New South Wales and the Commonwealth under section 45 of the EPBC Act*.

Each assessment approach requires different levels of information and involves different steps. All levels of assessment include a public consultation phase, in which any third parties can comment on the proposed action.

Indigenous communities may also need to be consulted during the assessment process. For more information on how and when indigenous engagement should occur during environmental assessments, please refer to the indigenous engagement guidelines at: environment.gov.au/epbc/publications/engage-early.

Cost recovery

Please note, under subsection 520(4A) of the EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000*, your assessment is subject to cost recovery. Please find attached a copy of the fee schedule for your proposal. Further details on cost recovery are available on the Department's website at: environment.gov.au/epbc/cost-recovery.

If you disagree with the fee schedule provided, you may apply under section 514Y of the EPBC Act for reconsideration of the method used to work out the fee. The application for reconsideration must be made within 30 business days of the date of this letter and can only be made once for a fee. Further details regarding the reconsideration process can be found on the Department's website at: environment.gov.au/protection/environment-assessments/assessment-and-approval-process/refer-proposed-action.

You may elect under section 132B of the EPBC Act to submit a management plan for approval at any time before the Minister makes an approval decision of the proposed action under section 133 of the EPBC Act. If an election is made under section 132B of the EPBC Act, cost recovery will apply to the approval of any action management plans you submit.

Cost recovery does not apply to the approval of action management plans where you do not elect to submit an action management plan for approval under section 132B of the EPBC Act, and, the approval of the action management plan does not arise from a variation to the approval conditions that you have requested. Where you vary an approval condition and it results in you being required to submit an action management plan for approval, cost recovery will apply to the approval of the action management plan. Please refer to Attachment A for more details.

Other information

Please also note that once a proposal to take an action has been referred under the EPBC Act, it is an offence under section 74AA to take the action while the decision making process is on-going (unless that action is specifically excluded from the referral or other exemptions apply). Persons convicted of an offence under this provision of the

EPBC Act may be liable for a penalty of up to 500 penalty units. The EPBC Act is available on line at: environment.gov.au/epbc/about/index.html.

The Department has recently published an *Environmental Impact Assessment Client Service Charter* (the Charter) which outlines the Department's commitments when undertaking environmental impact assessments under the EPBC Act. A copy of the Charter can be found at: environment.gov.au/epbc/publications/index.html.

If you have any questions about the referral process or this decision, please contact the project manager, Mark Jenkins, by email to mark.jenkins@environment.gov.au, or telephone 02 6274 1558 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely



Kim Farrant
Assistant Secretary
Assessments and Waste Branch
17 / 12 /2018

Enc

ELECTION TO HAVE AN ACTION MANAGEMENT PLAN APPROVED

Note: Pursuant to section 132B of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), this election must be given to the Minister before the Minister grants an approval of the proposed action under section 133 of the EPBC Act.

PERSON PROPOSING TO TAKE ACTION

1. Name and Title:
2. Organisation (if applicable):
3. EPBC Referral Number (if known):
4. ACN/ABN (if applicable):
5. Postal Address:
6. Telephone:
7. Email:
8. Name of designated proponent (if not the same person named at item 1 above and if applicable):
9. ACN/ABN of designated proponent (if not the same person named at item 1 above):

□ I elect to submit an action management plan(s) for approval in accordance with section 132B of the *Environment Protection and Biodiversity Conservation Act 1999*. I understand that a fee of $2,690 may apply under the cost recovery arrangements.

Declaration:

□ I declare that to the best of my knowledge the information I have given on this form is complete, current and correct.

□ I understand that giving false or misleading information is a serious offence.

Signature _____ **Date:** _____

Australian Government
Department of the Environment and Energy

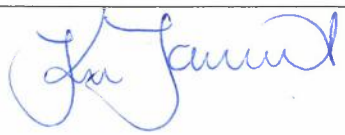
Notification of
REFERRAL DECISION AND DESIGNATED PROPONENT – controlled action

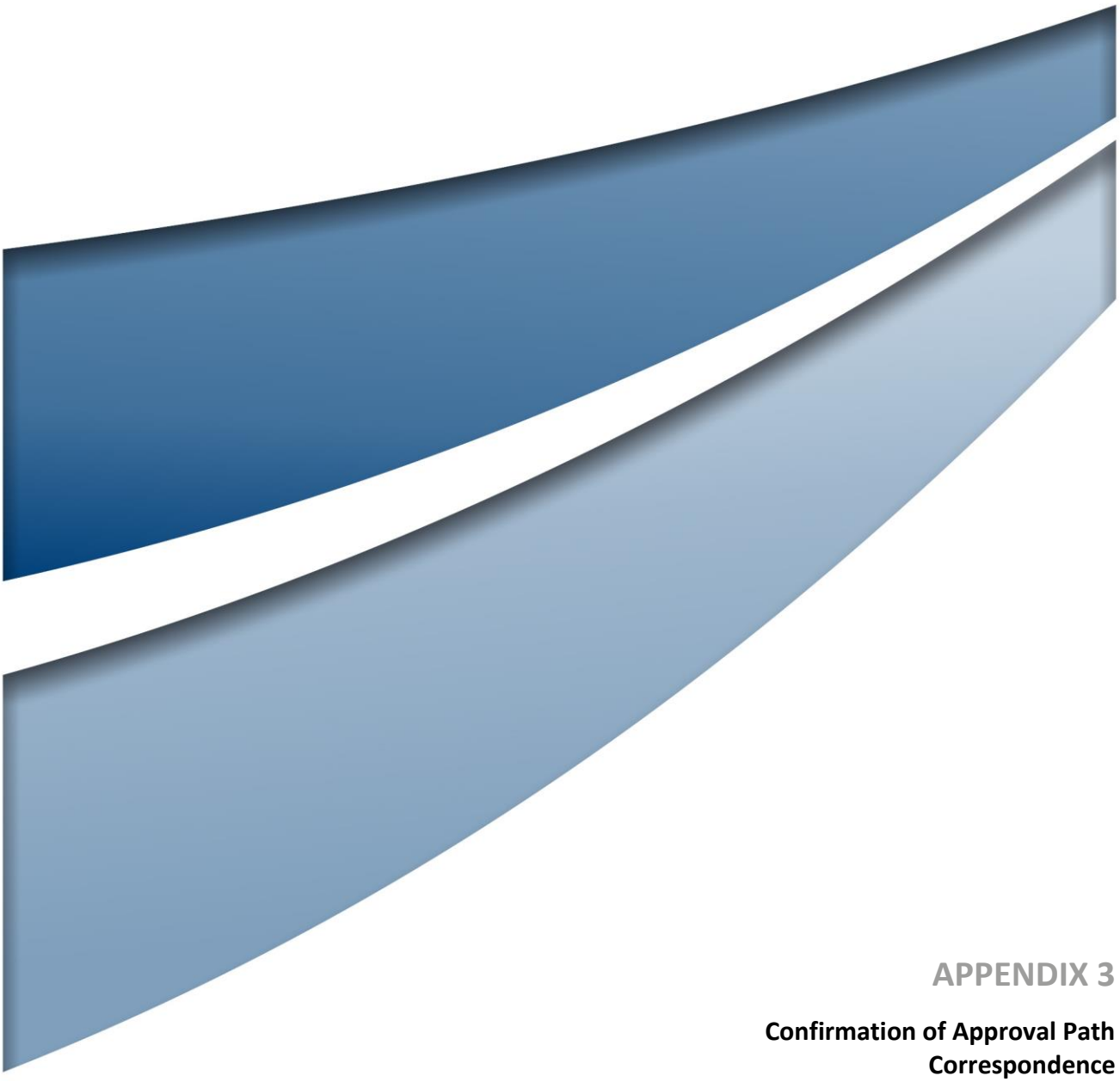
Bulga Coal Optimisation Project Modification, near Singleton, NSW

This decision is made under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

proposed action	To extend the existing Bulga open-cut mine to access additional coal resources near Singleton, New South Wales (See EPBC Act referral 2018/8300).
decision on proposed action	The proposed action is a controlled action. The project will require assessment and approval under the EPBC Act before it can proceed.
relevant controlling provisions	• Listed threatened species and communities (sections 18 & 18A) • A water resource, in relation to coal seam gas development and large coal mining development (section 24D & 24E)
designated proponent	Bulga Coal Management Pty Limited ACN: 055534391
assessment approach	The project will be assessed under the assessment bilateral agreement with New South Wales.

Decision-maker

Name and position	Kim Farrant Assistant Secretary Assessments and Waste Branch
Signature	
date of decision	17 / 12/2018



APPENDIX 3

Confirmation of Approval Path Correspondence

NSW GOVERNMENT | Planning & Environment

Geoff Kelly
Operations Manager
Bulga Coal Management Pty Ltd
Private Mail Bag 8
Singleton NSW 2330

Dear Mr Kelly

Bulga Optimisation Project (SSD 4960)
Modification 2 – Approval Pathway and Requirements

I refer to your letter of 13 October 2017 seeking confirmation of the approval pathway and the environmental assessment requirements for a proposed modification to the development consent for the Bulga Optimisation Project (SSD 4960 MOD 2). The Department understands that the proposed modification largely includes extending the approved mining area to the south into the Deep Pit area to recover an additional 64 million tonnes of coal. The proposal would also include relocating and reprocessing tailings from the Deep Pit tailings storage facility, disturbing an additional 21 hectares of land and extending the approved mine life by a further 4 years (to 2039).

Based on the information provided in your letter, I can confirm that the proposed modification falls within the scope of section 96(2) of the *Environmental Planning and Assessment Act 1979.* With respect to the supporting Statement of Environmental Effects (SEE), the Department is satisfied with your company's identification of key issues and supports the proposed assessment approach, which includes:

- detailed air quality, noise, blast, surface water and groundwater impact assessments;
- ecology and Aboriginal cultural heritage assessments for the additional surface disturbance area;
- an updated social impact assessment; and
- visual, economic and greenhouse gas and energy assessments.

With regards to the air quality impact assessment, please ensure it is undertaken in accordance with the EPA's 2016 *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.*

With regards to the ecology assessment, I note that you substantially commenced the assessment for this modification prior to 25 August 2017 and therefore anticipate that the modification can be assessed under OEH's 2014 *NSW Biodiversity Offsets Policy for Major Projects* and the *Framework for Biodiversity Assessment,* in accordance with the *Biodiversity Conservation (Savings and Transitional) Regulation 2017.*

With regards to the social impact assessment, I note your proposal is to build on the previous 2014 Social Impact and Opportunities Assessment rather than undertake a new comprehensive assessment. The Department considers this to be an acceptable approach. However, I request that you have regard to the Department's 2017 *Social impact assessment guideline for State significant mining, petroleum production, and extractive industry development.*

Notwithstanding the above, I remind you that all potential impacts of the modification must be assessed.

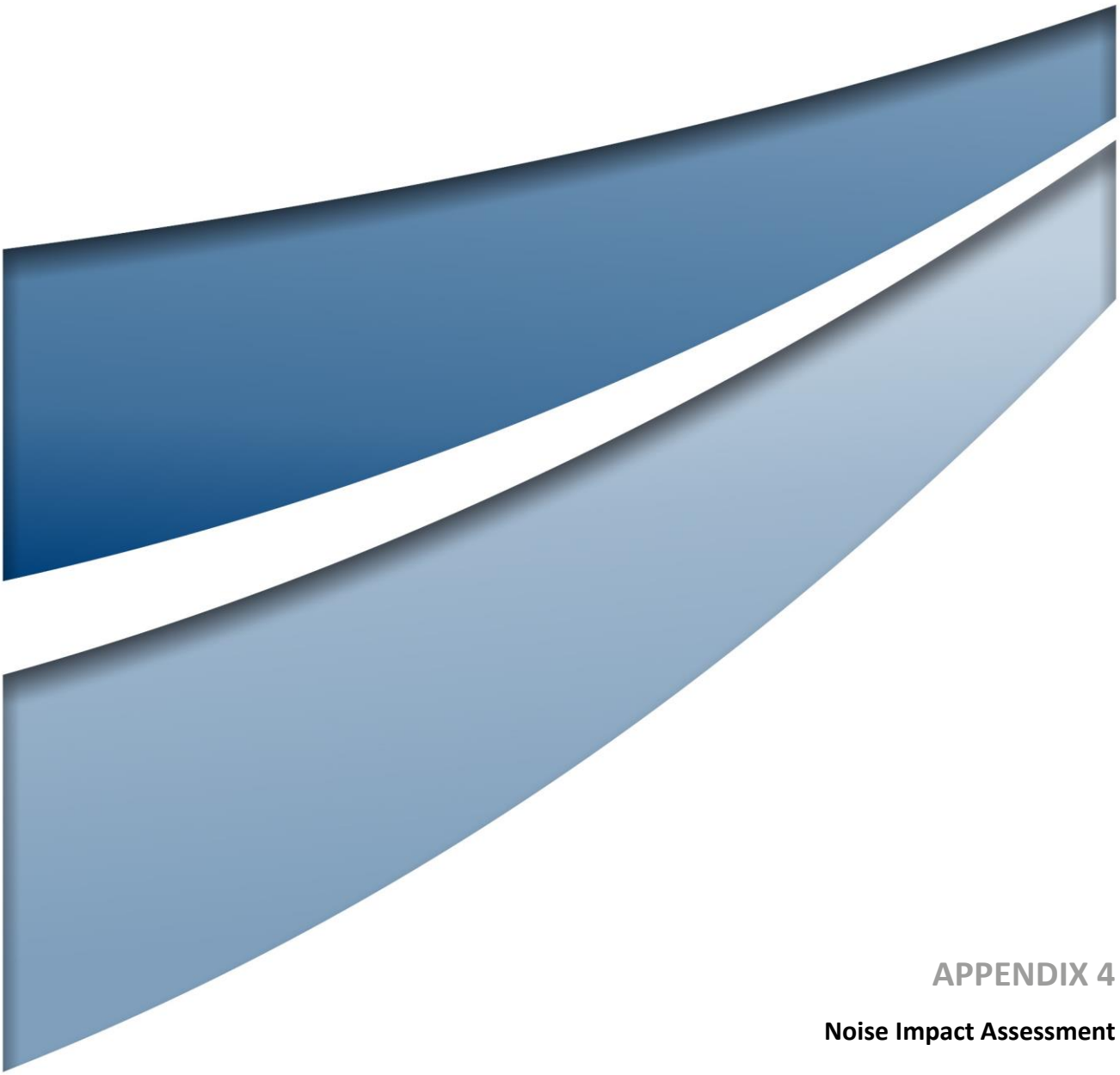
Please contact the Department at least two weeks before you plan to submit the modification application and supporting SEE. This will enable the Department to provide lodgement instructions, confirm the applicable fee, determine the required number of copies of the SEE and discuss exhibition periods.

Should you have any questions in relation to the above, please contact Megan Dawson, Team Leader – Resource Assessments, on 9274 6391.

Yours sincerely

Howard Reed

Howard Reed 17.10.17
Director Resource Assessments



APPENDIX 4

Noise Impact Assessment

Bulga Coal Complex

Bulga Extension Project
Noise Impact Assessment

Prepared for
Umwelt Australia

Global Acoustics
Noise and Vibration Analysis and Solutions

Global Acoustics Pty Ltd
PO Box 3115 | Thornton NSW 2322
Telephone +61 2 4966 4333
Email global@globalacoustics.com.au
ABN 94 094 985 734

Bulga Coal Complex

Bulga Extension Project
Noise Impact Assessment

Reference: 17344_R01.docx
Report date: 8 June 2019

Prepared for
Umwelt Australia
74 York Street
Teralba NSW 2284

Prepared by
Global Acoustics Pty Ltd
PO Box 3115
Thornton NSW 2322





Prepared:	Jeremy Welbourne Acoustics Consultant	QA Review:	Tony Welbourne Director

Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

EXECUTIVE SUMMARY

Bulga Coal Management (BCM) is proposing a modification to their open cut development consent which forms part of the Bulga Coal Complex (BCC) to maximise resource recovery within the approved Bulga Optimisation Project area by an extension of the open cut operations to the southeast into a former open cut mining area occupied by the current tailings storage facilities known as Deep Pit and Bayswater Pit (the Proposed Modification). The Proposed Modification will result in relatively minor changes to the mining footprint, including mining further south than currently approved.

The primary objective of this noise impact assessment was to evaluate any difference in noise emission from the Proposed Modification relative to the Approved Development, and to determine whether the Proposed Modification can continue to operate in accordance with approved noise criteria.

To allow comparison of 'like with like', as many assessment parameters as possible were retained from the Bulga Optimisation Project noise impact assessment. To ensure the proposed mine plan progression can be practically implemented whilst maintaining compliance with approved noise criteria, a series of noise controls and management strategies were identified and incorporated into the stage plan scenarios. Potential impacts on production associated with the implementation of these noise controls and management strategies were quantified, and BCM has incorporated these factors into mine planning, production schedules, and budgets to verify that the proposed management strategies are able to be implemented whilst achieving production targets.

Key assessment outcomes are:

- the Proposed Modification will be able to comply with approved noise criteria at all receptor locations throughout the mining progression with an appropriate level of noise mitigation applied during periods of adverse meteorological conditions;
- no additional receptors other than those listed in Tables 1 and 2 of Schedule 3 of SSD-4960 are entitled to mitigation or acquisition rights due to residual noise impact (in accordance with the Voluntary Land Acquisition and Mitigation Policy (the VLAMP)). BCM will continue to afford voluntary mitigation and acquisition rights to receptors currently afforded these rights in accordance with SSD-4960;
- relevant amenity noise levels were not exceeded over more than 25 percent area of any private landholdings;
- sleep disturbance model predictions are less than the criterion of $L_{A1,1minute}$ 45 dB for all receptors. As such, there is no sleep disturbance impact predicted;
- noise associated with minor construction activities will be managed to comply with consent criteria and will therefore be treated as an operational noise source for compliance purposes; and
- there are no changes to operational road traffic volumes or rail movements and so there should be no change relative to the existing situation.

This noise impact assessment demonstrates that the Proposed Modification will be able to continue to operate in accordance with approved noise criteria set out in Appendix 6 of SSD-4960 through

implementation of feasible and reasonable noise controls and management strategies. Examples of such controls and management strategies include (but are not limited to):

- construction of the noise and visual bund will be complete prior to commencement of the Proposed Modification;
- detailed mine planning and equipment configurations maximise topographical shielding and provided for alternate hauling and dumping options during periods of adverse weather;
- a higher degree of noise attenuation will be provided for some equipment; and
- whilst an increase in equipment quantities is proposed, sufficient flexibility has been incorporated into the production schedule to allow equipment to be shut down during adverse weather conditions as required to maintain compliance with noise criteria.

The existing noise management system is generally consistent with many other mining operations in the Hunter Valley, and is adequate for noise management purposes. The BCC noise management plan will be updated to incorporate revised noise commitments and noise management procedures.

In conclusion, whilst the proposed life of mine is four years longer than previously approved, noise emissions from the Proposed Modification will be similar to those predicted for the Bulga Optimisation Project for equivalent stages, provided feasible and reasonable noise controls and management strategies are applied.

Global Acoustics Pty Ltd

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1 INTRODUCTION

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located in the Hunter Valley, NSW (refer to Figure 1). The BCC consists of two existing coal mining operations: the open cut operations (Bulga Open Cut) and the underground operations (Bulga Underground Operations) using shared coal washing and rail loading infrastructure. The BCC is located approximately 4 kilometres (km) to the south-east of Bulga village, approximately 4 km to the north of Broke village, and approximately 12 km south-west of the township of Singleton.

Mining operations have been occurring at the site for over 30 years with Bulga Coal Management Pty Ltd (BCM) currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (SSD-4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD-4960 was subsequently modified (SSD-4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy. Approval was granted by the Planning Assessment Commission (under delegation from the Minister for Planning) on 17 January 2017. A second modification was approved in August 2018 (SSD-4960 Mod 2) to extend the period for construction of the outer face of the noise and visual bund by an additional nine months.

The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). BCM also operates the BCC in accordance with Environment Protection and Biodiversity Conservation (EPBC) Approval 2012/6637 (as modified).

BCM is proposing a further modification to SSD-4960 to maximise resource recovery within the approved Bulga Optimisation Project Area by extending the open cut operations to the southeast into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit (the Proposed Modification). The Proposed Modification does not preclude the ability to access approved underground mining resources in the future; therefore, both Bulga Open Cut and Bulga Underground Operations surface infrastructure were included in the noise impact assessment.

This noise impact assessment (NIA) has been prepared by Global Acoustics Pty Ltd, and is to form part of a Statement of Environmental Effects (SEE) being prepared by Umwelt Australia Pty Limited (Umwelt) for the Proposed Modification.

1.1 Proposed Modification Overview

The Proposed Modification will maximise resource recovery within the approved Bulga Optimisation Project Area by an extension of the open cut operations to the southeast into a former open cut mining area occupied by the current TSFs known as Deep Pit and Bayswater Pit. The extension of the pit to the southeast also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Mtpa Run of Mine (ROM) while enabling the extraction of an additional approximately 63 Mt of coal.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Surface Operations will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- an additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east by accessing deeper resources within the approved pit and proposed extension area;
- revised mining sequence to integrate mining in the approved mine with access to the modified and deeper mining areas;
- utilisation of existing coal handling and coal processing infrastructure;
- removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSFs to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings;
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure;
- construction of new water management facilities to manage site surface water catchments; and
- the use of all existing or approved infrastructure and equipment for the Bulga Coal mine with some minor additions to the existing mobile equipment fleet over the life of the operation.

The key aspects of the Proposed Modification are shown on Figure 2 and a summary of the key modifications are provided in Table 1.1.

Table 1.1: COMPARISON OF APPROVED DEVELOPMENT AND PROPOSED MODIFICATION

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Extraction rate limit	Extraction limit of 12.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal	No change to currently approved extraction limit 12.2 Mtpa
Total Recoverable Resource (ROM)	162 Mt	An additional 63 Mt
Project life	Mining operations on site until 31 December 2035	Extension to the life of mine until 31 December 2039 (an additional 4 years)
Project boundary / Schedule of Lands	Per SSD_4960 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit Mining undertaken within existing ML1547	Extension of mining areas to the south and west. Revised mining stage plans to enable access to deeper resources within the approved pit and the proposed extension area Mining undertaken within existing ML1547
Disturbance Areas	Approved mining disturbance footprint (3,786 hectares)	Additional disturbance area of approximately 20.2 hectares not currently part of the approved mining disturbance footprint
Key Infrastructure	Realignment of Broke Road (Complete) Relocation of 330kV transmission lines (Complete) Construction of new water storage dam (Complete) Upgrade to CHPP to improve yield and plant efficiency (Ongoing) Relocation of sections of Broke-Fordwich Private Irrigation District pipeline and Telstra infrastructure (Complete)	Relocation of some mine owned open cut and underground infrastructure Demolishing of some open cut and underground infrastructure to accommodate proposed mining Replacement/relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop Installation of tailings relocation infrastructure (pumps and pipelines, power lines, access tracks, etc.)
Coal Handling and Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput	Potential upgrade of CHPP to reprocess additional tailings No changes to CHPP throughput, ROM or product stockpiles
Coal Transport	20 million tonnes of product coal transported in any calendar year	No change
Equipment Fleet	Mining fleet generally remained unchanged however replacement mining equipment is required during the project life	Minor increases to fleet numbers to provide flexibility for mining operations
Overburden, coarse reject	Where feasible, overburden to be placed in-pit. Overburden waste is likely to go into establishing haul roads, bunds for visual abatement, noise abatement and water management	No change to overburden and coarse reject management Expansion of existing approved TSF in northern end of pit to accommodate life of mine tailings
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF. Main Pit TSF approved in SSD-4960 Mod 1	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining. Increased capacity of Main Pit TSF to cater for relocated tailings and ongoing tailings production
Final void	One void at the end of mining operations	One void proposed to be of similar size to the approved void

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Rehabilitation and final landform	Conceptual final landform is shown in SSD-4960 (Appendix 13) and includes 1 final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing Increases to typical overburden emplacement heights from 150 mAHD to 160 mAHD Revised conceptual final landform includes 1 final void
Employee Numbers	Approximately 700 FTE employees	No change

The Proposed Modification does not preclude the ability to access approved underground mining resources to the south and west of the proposed pit in the future.



Figure 1: Regional Context

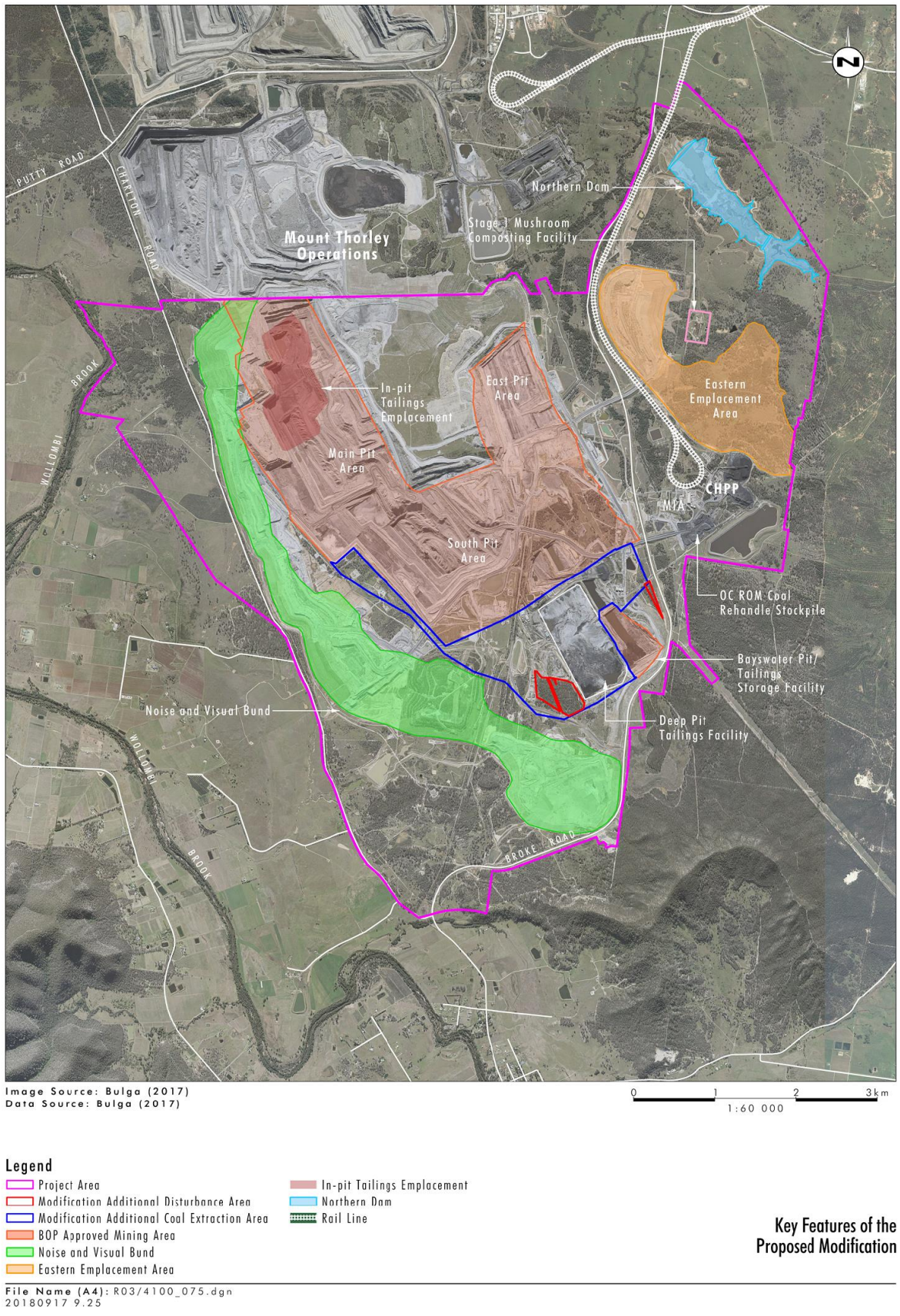

Figure 2 - Key Features of the Proposed Modification

1.2 Terminology & Abbreviations

Some definitions of acoustic terminology which may be used in this document are as follows:

- L_A, the A-weighted root mean squared (RMS) noise level at any instant;
- L_{A1}, the noise level which is exceeded for 1 per cent of the time;
- $L_{A1,1minute}$, corresponds to the highest noise level generated for 0.6 second during one minute. In practical terms, this represents the maximum measured level, and is often used to assess sleep disturbance;
- L_{A10}, the noise level which is exceeded for 10 per cent of the time, which is approximately the average of the maximum noise levels;
- L_{A90}, the level exceeded for 90 per cent of the time, which is approximately the average of the minimum noise levels. The L_{A90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes;
- L_{Aeq}, the average noise energy during a measurement period;
- dB(A), noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise;
- dB(C), noise level measurement units are decibels (dB). The "C" weighting scale is used as a measure of human response to high noise levels. It includes more of the low frequency range of sounds. It is often used to assess low frequency noise impact;
- sound power level (L_W denotes linear, L_{WA} denotes A-weighted), 10 times the logarithm of energy radiated from a source (as noise) divided by a reference power, the reference power being 1 picowatt;
- sound pressure level (Lp), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals;
- sound exposure level (SEL), the A-weighted noise energy during a measurement period normalised to one second.;
- Hertz (Hz), cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together;
- ABL, the 10th percentile background noise level for a single period (day, evening or night) of a 24 hour monitoring period;
- RBL, the background noise level for a period (day, evening or night) determined from ABL data.

Definitions of acronyms which may be used in this document are as follows:

- BCC, Bulga Coal Complex;
- BCM, Bulga Coal Management;
- CHPP, Coal Handling and Preparation Plant;
- CPP, Coal Processing Plant;
- DP&E, Department of Planning and Environment;
- EEA, Eastern Emplacement Area;
- EIS, Environmental Impact Statement;
- ENM, Environmental Noise Model;
- EPA, Environment Protection Authority;
- ICNG, Interim Construction Noise Guideline;
- INP, Industrial Noise Policy;
- MTW, Mount Thorley Warkworth Mine;
- NIA, Noise Impact Assessment;
- NMP, Noise Management Plan;
- NPfI, Noise Policy for Industry;
- NVB, Noise and Visual Bund;
- OCE, Open Cut Examiner;
- RING, Rail Infrastructure Noise Guideline;
- RNP, Road Noise Policy;
- ROM, Run of Mine;
- SEE, Statement of Environmental Effects;
- TSF, Tailings Storage Facilities; and
- VLAMP, Voluntary Land Acquisition and Mitigation Policy.

2 NOISE IMPACT ASSESSMENT OVERVIEW

2.1 Policy and Guidelines

Technical policy and guidelines relevant to assessment of industrial and transport noise in NSW include:

- Industrial Noise Policy (INP) (EPA, 2000);
- Noise Policy for Industry (NPfI) (EPA, 2017);
- Interim Construction Noise Guideline (ICNG) (DECCW[1], 2009);
- Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (VLAMP) (NSW Government, 2018);
- Road Noise Policy (RNP) (DECCW, 2011); and
- Rail Infrastructure Noise Guideline (RING) (EPA, 2013).

The initial development consent (SSD 4960) for the Approved Development was approved under Part 4 (Section 89E) of the EP&A Act following a comprehensive Environmental Impact Statement (EIS) prepared for the Bulga Optimisation Project. The Proposed Modification will result in minor changes to the mining footprint, including mining further south than currently approved. The Department of Planning and Environment (DP&E) has confirmed that the modified development can be considered 'substantially the same development' as that currently approved.

The Proposed Modification has been designed such that a hierarchy of noise controls can be progressively implemented when required to manage noise emission in order to maintain compliance with approved noise criteria set out in the consent (SSD-4960) for the Approved Development.

The primary objective of this NIA is to evaluate any difference in noise emission from the Proposed Modification relative to the Approved Development, and to determine whether the BCC can continue to operate in accordance with approved noise criteria.

To allow comparison of 'like with like', as many assessment parameters as possible were retained from the Bulga Optimisation Project NIA. In this way, any differences in predicted noise emission should be due to changes to the mine progression, and not due to changes to assessment parameters. It is also proposed that currently approved noise impact criteria in SSD-4960 are retained and applied to this Proposed Modification. This is seen as important in order to provide consistency to potentially affected residents given that BCM has made significant commitments to residents regarding noise mitigation and control measures.

This noise impact assessment has been prepared using generally the same assessment approach as the

[1] Now the Environment Protection Authority.

Bulga Optimisation Project, which was assessed in accordance with the INP. The INP and NPfI are considered relatively equivalent as they apply to this assessment. Primary differences between the INP and NPfI, as applicable to this assessment, pertain to setting of assessment noise levels and consideration of residual noise impacts. These differences have been resolved in this assessment through the following:

- existing criteria set out in SSD-4960 have been adopted in lieu of establishing new assessment noise levels. Should new assessment noise levels be established in accordance with the NPfI, higher allowable noise levels than currently approved could result for the day period, and, for maximum noise event levels at night; and

- residual noise impacts are evaluated in accordance with the VLAMP, which is more recent than the NPfI (evaluation of residual noise impact was not included in the INP).

The cumulative distribution of results methodology was employed in lieu of the prevailing meteorological conditions method outlined in the NPfI. The cumulative distribution method provides assessment of impact for a far more comprehensive set of meteorological conditions, and is the same method used for the Bulga Optimisation Project NIA. Further detail regarding this method is contained in Section 2.8 of this NIA.

Modifying factors have been assessed in accordance with Fact Sheet C of the NPfI. Section 3.2 provides further detail regarding modifying factors.

2.2 Approvals Pathway

The DP&E confirmed the proposed approvals pathway on 17 October 2017 as a modification pursuant to section 4.55(2) of the EP&A Act. There were no specific requirements for assessment of noise other than a general requirement to prepare a detailed noise impact assessment.

2.3 Operational Noise

Four staged operational scenarios were modelled representing the updated progression of mining operations over the proposed modified life of mine, with emphasis on targeting the highest noise impact and maximum extraction periods. Each stage modelled represents realistic worst case operating conditions for that period of operations. The stages nominally relate to years 2022, 2026, 2031 and 2035. The four stages represent:

- 2022: the early stages of the Proposed Modification. Relocation of the TSF is in progress. Mining in the southern pit area is elevated and relatively close to natural surface level. Waste haulage to the EEA is in progress. Waste haulage to the north of the pit void is in progress. Rehabilitation on the inside face of the Noise and Visual Bund (NVB) has commenced;

- 2026: relocation of the TSF continues. Mining has progressed further south and remains elevated and relatively close to natural surface level. Mining in other pit areas is now deeper. Waste haulage to the EEA is complete. Waste haulage to the north of the pit void continues. Rehabilitation on the inside face of the NVB is complete;

- 2031: relocation of the TSF is complete, and mining progresses under the original TSF area (Deep Pit and Bayswater Pit). Mining in the south is now in a relatively deep pit. Waste haulage to the north of the pit void continues; and

- 2035: mining in the south is complete and waste haulage to the south of the pit void is in progress. All mining areas are now in relatively deep pits. Waste haulage to the north of the pit void continues.

Operational intrusive noise, cumulative noise, modifying factor adjustments, and potential sleep disturbance impact associated with each of these stages is assessed. Section 4.2 provides further detail regarding operating scenarios.

An assessment area was defined that encompasses all known private residential receptors that may be noise impacted by the Proposed Modification.

Figure 3 to Figure 6 present conceptual mine plans for each of the four stages assessed.

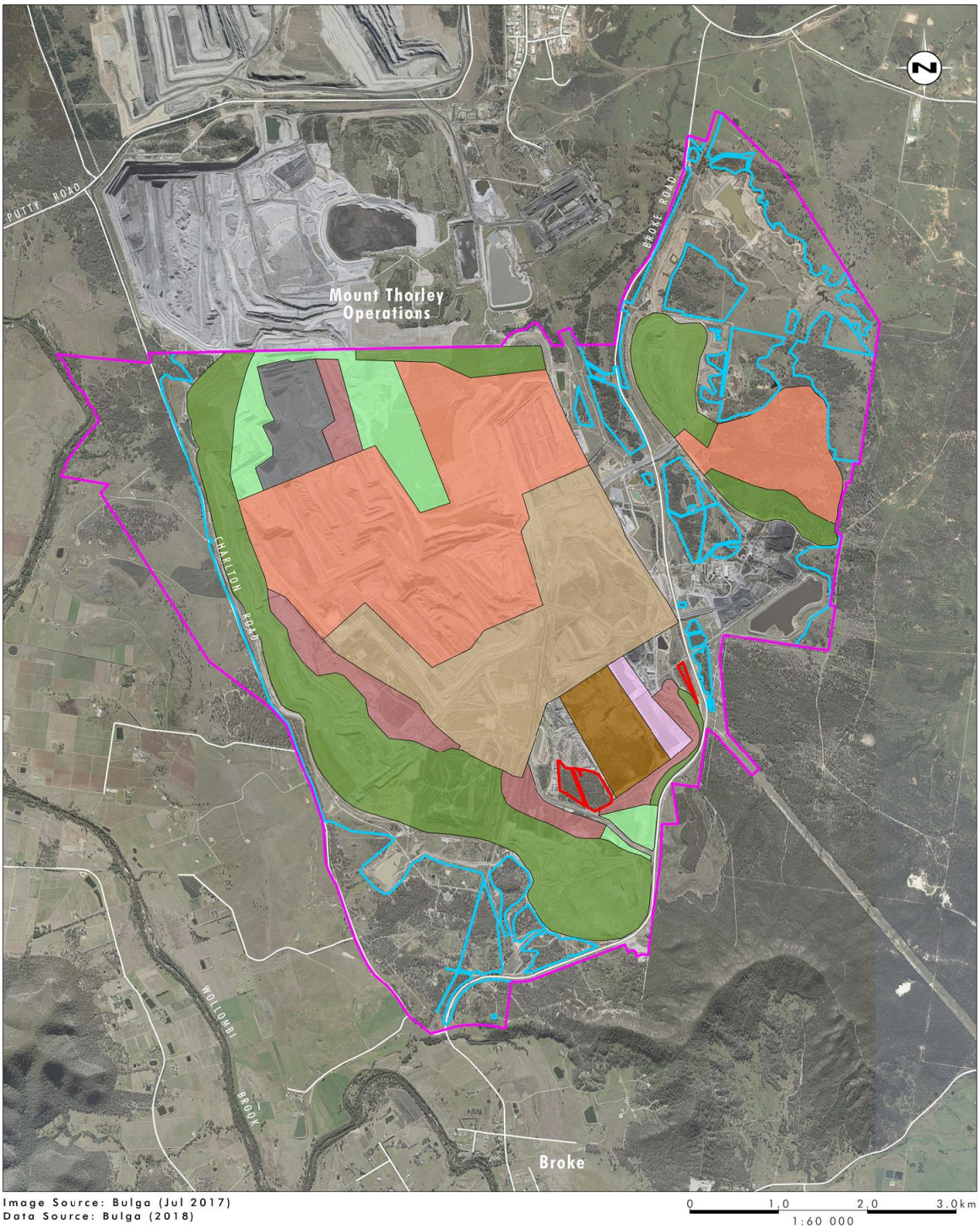

Figure 3 - 2022 Conceptual Stage Plan

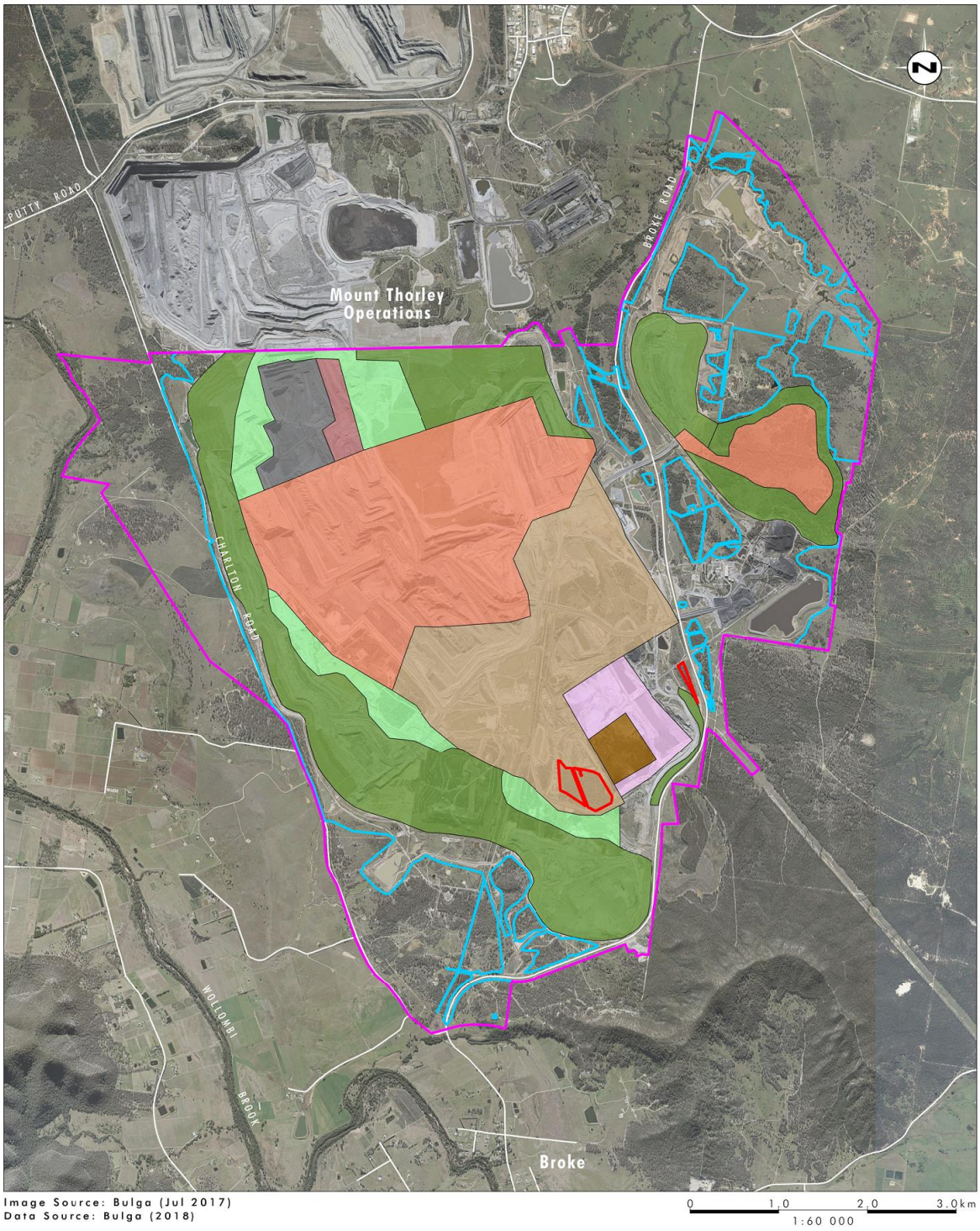

Figure 4 - 2026 Conceptual Stage Plan

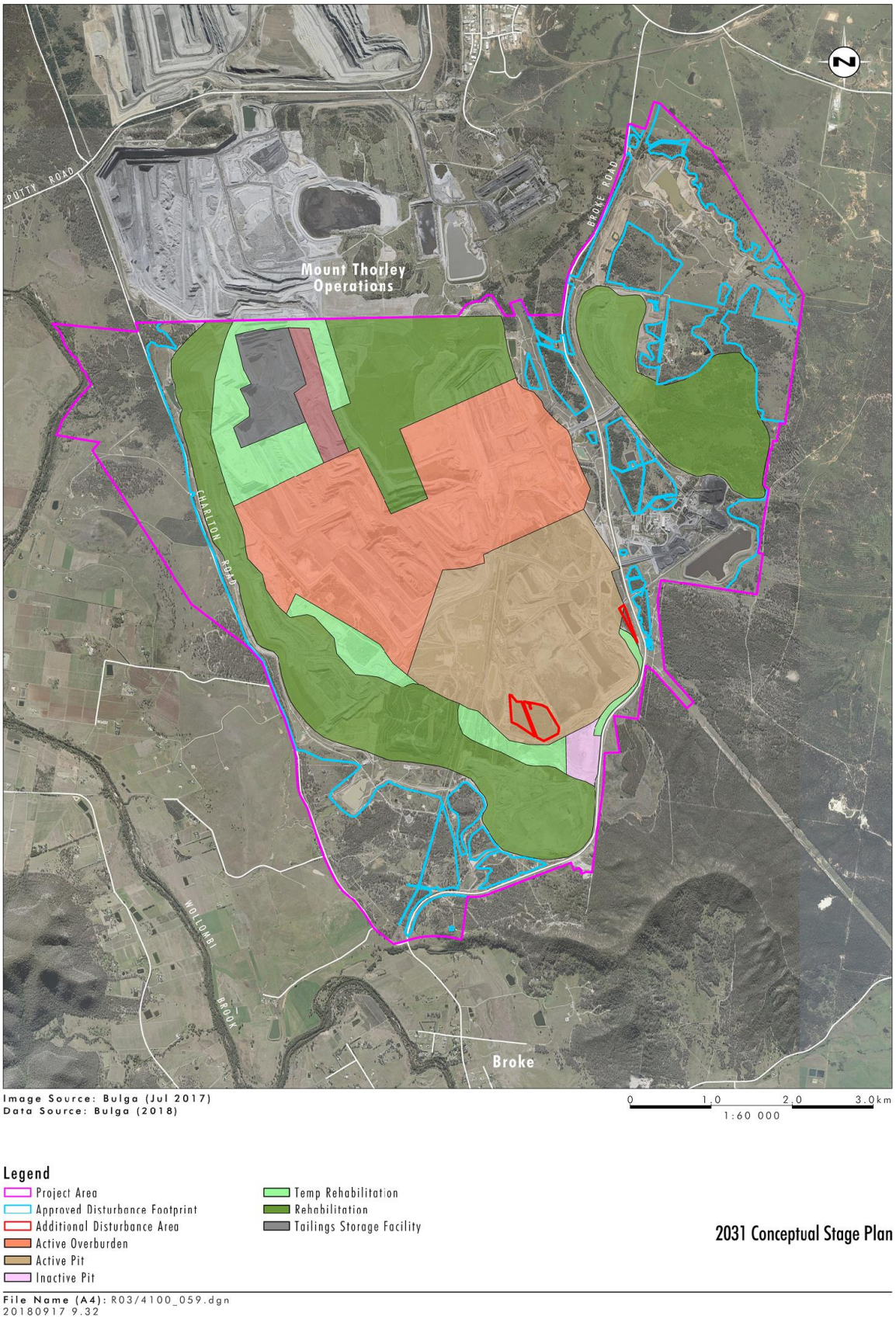

Figure 5 - 2031 Conceptual Stage Plan

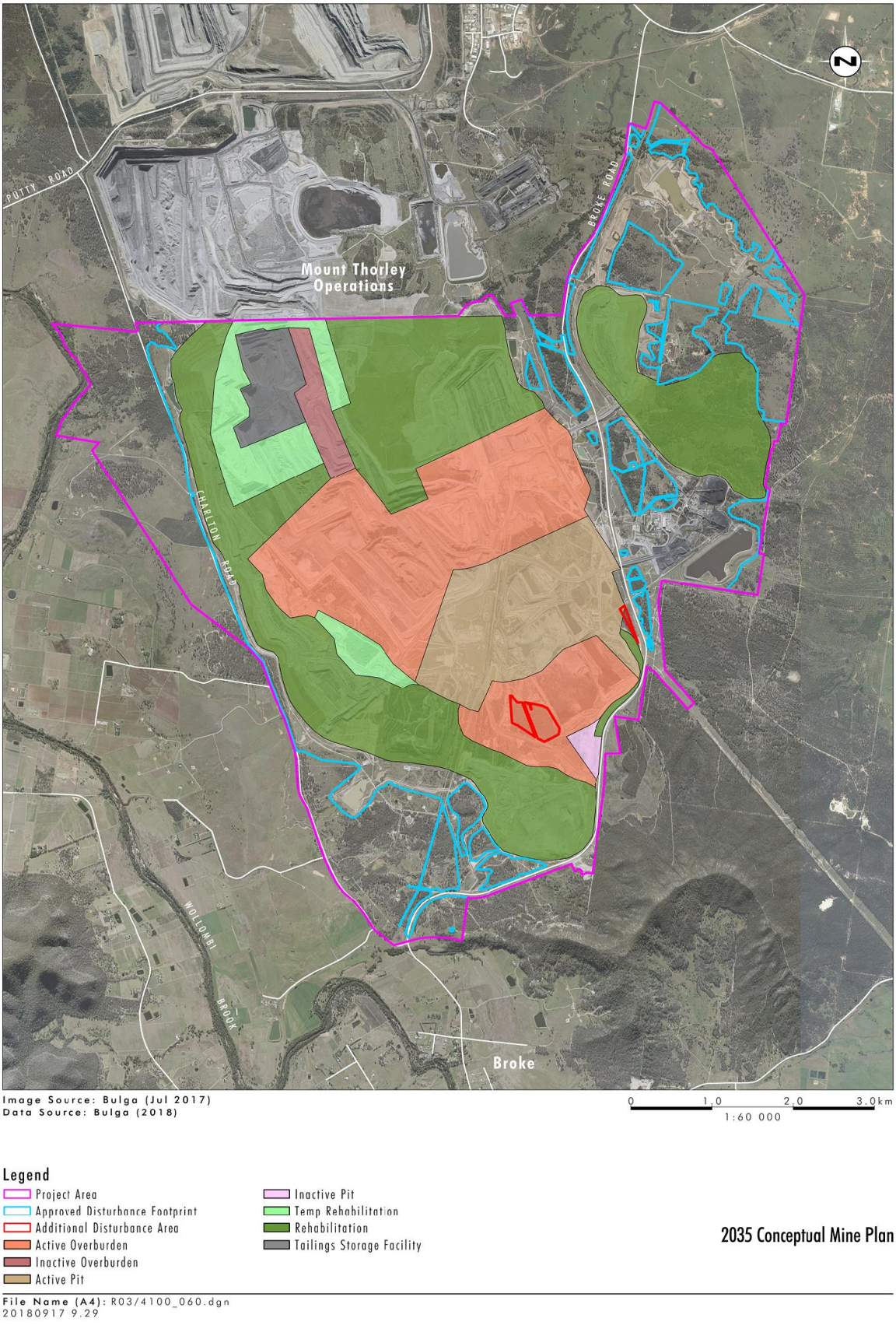

Figure 6 - 2035 Conceptual Stage Plan

2.4 Cumulative Noise

Existing L_{Aeq} from industrial sources in the areas around the BCC range widely due to variances in meteorological conditions. In the case of Bulga village, industrial noise levels are inaudible on some nights, can be relatively low during calm atmospheric conditions, and close to acceptable amenity criteria during periods with meteorological enhancement.

Section 5.7 includes an assessment of cumulative noise from other existing industrial sources, combined with predicted noise from the Proposed Modification, which includes both Bulga Open Cut and Bulga Underground Operations.

2.5 Construction Noise

Construction tasks required for the Proposed Modification include:

- relocation of some mine owned open cut and underground infrastructure;
- demolishing of some open cut and underground infrastructure to accommodate proposed mining;
- replacement/relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop;
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure (pumps and pipelines, power lines, access tracks, etc.); and
- construction of new water management facilities to manage site surface water catchments.

Noise emissions associated with tailings relocation are included in the operational noise assessment. No other significant construction tasks are proposed. As such, it is considered highly unlikely that construction noise from any minor onsite construction activities would be audible over and above the noise generated by the open cut mining operation; therefore construction noise has not been quantitatively assessed. Noise associated with minor construction activities will be managed to comply with consent criteria and will therefore be treated as an operational noise source for compliance purposes. Construction noise is not discussed further in this report.

2.6 Road Traffic Noise

There is no change to road traffic volumes associated with the Proposed Modification; therefore, no change in road traffic noise impact relative to the Approved Development should occur.

2.7 Rail Noise

There is no change to rail volumes associated with the Proposed Modification; therefore, no change in rail noise impact relative to the Approved Development should occur.

2.8 Noise Modelling Methodology

Noise levels were predicted using RTA Technology's Environmental Noise Model (ENM), a computer based environmental noise model, to determine the acoustic impact of operational activities. ENM is approved by the DP&E and EPA as suitable for prediction of industrial noise involving large propagation distances and is currently the industry standard for NIA of this nature. The model takes into account geometric spreading, atmospheric absorption, and, barrier and ground attenuation.

Potential impacts were evaluated using the cumulative distribution of results methodology. This method determines a noise level that is likely to be exceeded 10 percent of the time in each of the four seasons. A range of results is calculated for a comprehensive set of meteorological conditions, and frequency of occurrence of each of these meteorological conditions is calculated from historical meteorological data. The cumulative distribution of these results is analysed to establish a single value for comparison with the limiting criterion. It is considered appropriate to use the 90th percentile result (10 percent of results are higher than this number) to represent intrusive noise impact. Results provided are 90th percentile L_{Aeq} values; that is, a range of L_{Aeq} results (195 meteorological conditions) have been calculated for each receptor, and the 90th percentile L_{Aeq} has been determined based on the percentage distribution of meteorological conditions. From the cumulative distribution, it is possible to determine the percentage of time criteria may be exceeded. Appendix C lists the 195 meteorological conditions included in the assessment.

Shorter duration weather conditions that increase noise may be an insignificant percentage of time if the assessment is based on annual distribution of meteorological conditions. Therefore, results are determined for each season and the worst-case season result is adopted as the predicted level; the worst-case season may not be the same for each receptor.

This methodology requires more calculation than would a procedure involving a smaller set of prevailing meteorological parameters (i.e. INP or NPfI conditions) but represents best available technology and is, in our opinion, one of the most comprehensive methods available to estimate the range of likely noise levels for a receptor. The INP and NPfI procedures only require assessment of potentially enhancing meteorological conditions if they occur more than 30 percent of a time period (day, evening and night) in any season. This could mean conditions that enhance noise and result in unacceptably high levels, and which may occur for significant periods of time (right up to 30 percent), are not assessed.

On the other hand, the cumulative distribution method results in a level being calculated for all possible meteorological conditions. The range of wind speed, wind direction and stability class combinations is actually infinite in the real world. For the purpose of modelling we've broken this down into 195 conditions, which can be considered to be quite a comprehensive analysis. Using historical meteorological data, the percentage of time each condition may occur per period and season is known. For any mining scenario modelled it is then possible to determine the likely percentage occurrence of any noise level. Further, the likely percentage of time a criterion might be exceeded can also be estimated.

Modelled meteorological conditions and frequency distributions are the same as those used for the

Bulga Optimisation Project NIA.

2.9 Mine Plan Development

Modelling for this NIA commenced in February 2017 as part of the initial constraints analysis phase for the Proposed Modification. Since that time, numerous model iterations have been undertaken to achieve the outcomes presented in this report. A series of noise controls and management strategies were developed to ensure all feasible and reasonable mitigation controls were considered and included in the modelling process. Further detail regarding feasible and reasonable mitigation controls is included in Section 4.2 of this report.

Importantly, detailed analysis of potential production impact due to implementation of noise controls was undertaken, and mining production schedules and budgets were adjusted accordingly. BCM have a comprehensive understanding of the implications associated with managing noise emission to maintain compliance with approved noise criteria set out in SSD-4960.

2.10 Noise Contours

Noise contours were produced for assessment areas containing private residences to provide a visual representation of the model results. It should be noted that noise contours are based on interpolation of results determined for individual points, and as such are indicative, and are included for presentation purposes only.

2.11 Land Ownership and Receptors

All known private residential receptors that may be noise impacted by the Proposed Modification were assessed. Figure 7 illustrates land ownership and receptor locations. Details of assessed receptors are included in Appendix D.

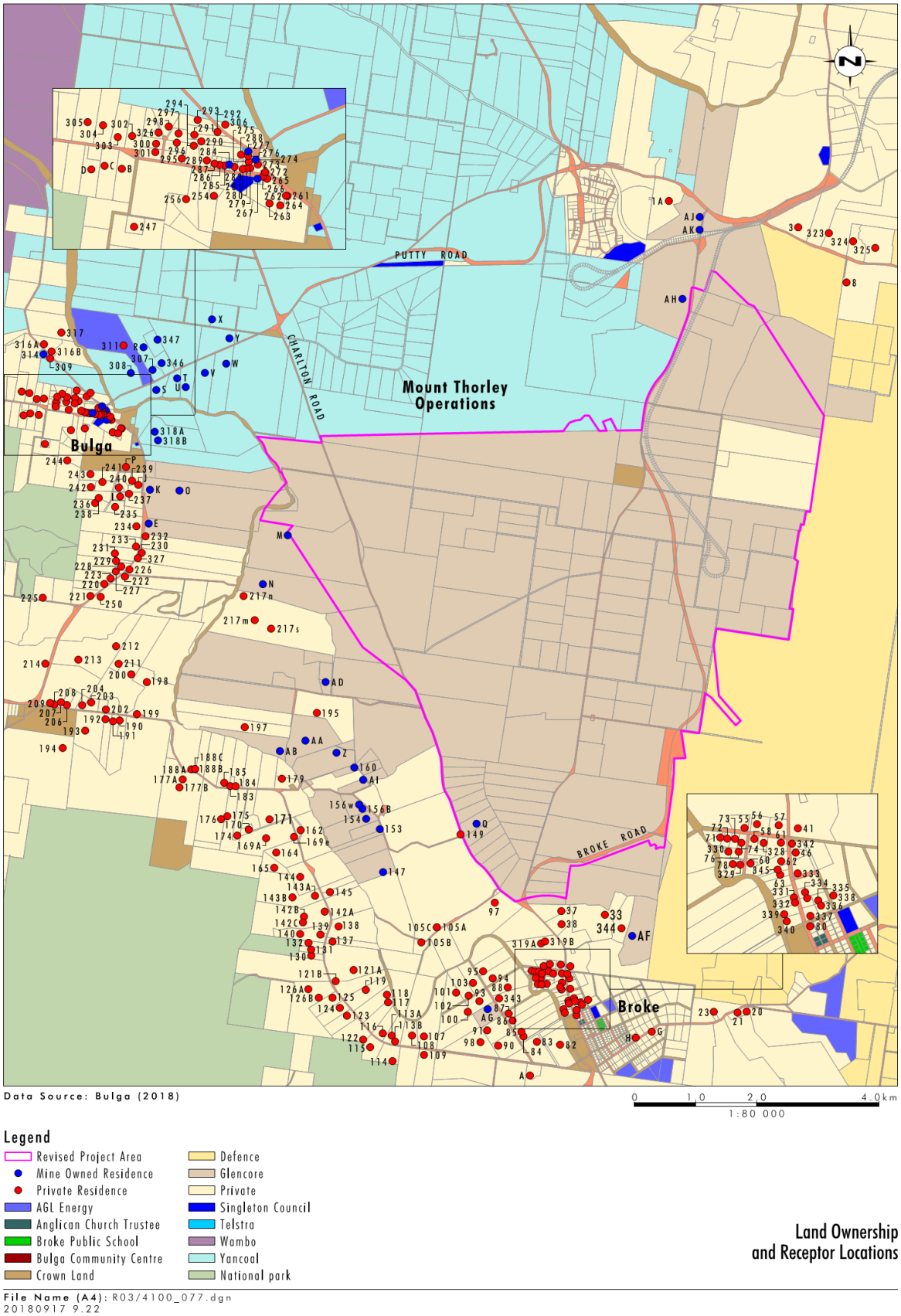

Figure 7 - Land Ownership and Receptor Locations

3 NOISE CRITERIA

BCM are committed to managing noise emission from the Proposed Modification to maintain compliance with the development consent for the Approved Development. Therefore, noise criteria set out in SSD-4960 are adopted in this NIA.

3.1 Existing Consent (SSD-4960)

BCM proposes further changes to the mine plans approved as part of the Bulga Optimisation Project to a more efficient design that allows for access of additional coal resources. A further modification of the BOP Consent is sought under section 4.55(2) of the EP&A Act to obtain approval for the Proposed Modification.

Schedule 3, Conditions 1 to 7 of SSD-4960 outlines environmental performance conditions pertaining to noise.

3.1.1 Intrusive Noise Criteria

Table 3 within Condition 3 of Schedule 3 of the BOP consent (SSD-4960) lists noise criteria applicable for residences on privately-owned land. This table is reproduced below.

Table 3: Noise Criteria dB(A)

Location	Day $L_{Aeq\ (15\ min)}$	Evening $L_{Aeq\ (15\ min)}$	Night $L_{Aeq\ (15\ min)}$	Night $L_{A1\ (1\ min)}$
1A, 8	38	38	38	45
97	38	38	36	45
217n, 230, 232, 234, 323, 324, 325	37	37	37	45
1B, 94, 95,103, 105A, 105C, 142A, 143B, 145, 164, 165, 179, 195, 217s, 217m, 222, 226, 227, 228, 229, 231, 233, 235, 237, 239, 240, 241, 261, 262, 263, 264, 265, 266, 272	36	36	36	45
All other privately-owned residences	35	35	35	45

Appendix 7 of the BOP consent sets out the meteorological conditions for which these criteria apply, and the requirements for evaluating compliance with these criteria. In accordance with Appendix 7, noise criteria are to apply under all meteorological conditions except the following:

- wind speeds greater than 3 m/s at 10 m above ground level; or
- temperature inversion conditions between 1.5 ºC and 3ºC/100m and wind speeds greater than 2 m/s at 10 m above ground level; or
- temperature inversion conditions greater than 3ºC/100m.

Condition 4 of Schedule 3 of the BOP consent states that:

> *At the direction of the Secretary, Table 3 above must be replaced with the Table in Appendix 6.*

Note: This direction will be given following the construction of the proposed noise and visual bund (see the figure in Appendix 2) to a height of 150 m AHD or the start of year 7 of the development under this consent, whichever occurs sooner.

The table listing alternate noise criteria per Appendix 6 of the BOP consent is reproduced below.

Location	Day $L_{Aeq\ (15\ min)}$	Evening $L_{Aeq\ (15\ min)}$	Night $L_{Aeq\ (15\ min)}$	Night $L_{A1\ (1\ min)}$
95,142A, 143B, 164, 165, 195, 217s	36	36	36	45
All other privately-owned residences	35	35	35	45

All mine plan stages assessed follow completion of the noise and visual bund. Therefore, predictions are compared with criteria listed in Appendix 6 of the BOP consent.

3.1.2 Maximum Noise Event Criteria

The table listing alternate noise criteria in Appendix 6 of the BOP consent includes a maximum noise event criterion, provided as a limit on high level noise events that have potential to cause sleep disturbance. The criterion of $L_{A1,1minute}$ 45 dB, applicable during the night period only, is used to assess potential sleep disturbance impact.

3.2 Corrections for Annoying Noise Characteristics (Modifying Factors)

Fact Sheet C of the NPfI outlines procedures for assessing modifying correction factors. These correction factors, also referred to as modifying factor penalties, are applied to predicted/measured noise levels at the receptor before comparison with relevant noise trigger levels/criteria, to account for the additional annoyance caused by these noise characteristics.

Modifying factors, as they are applicable to industrial noise, are described in more detail below.

3.2.1 Tonal and Intermittent Noise

As defined in the NPfI:

Tonal noise contains a prominent frequency and is characterised by a definite pitch.

Intermittent noise is noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.

Open cut mines are not generally tonal or intermittent in nature as per the intent of the NPfI. Whilst individual noise sources, such as machine drives, alarms and hydraulic systems may exhibit tonal characteristics, these sources operate concurrently with the open cut mine, and the resulting combined sound power spectrum is not tonal in nature. The BCC operates 24 hours per day, and therefore does not exhibit intermittent noise characteristics. No further assessment of these characteristics has been

made.

3.2.2 Low Frequency Noise

As defined in the NPfI:

> *Low frequency noise is noise with an unbalanced spectrum and containing major components within the low-frequency range (10 – 160 Hz) of the frequency spectrum.*

The NPfI contains the current method of assessing low frequency noise, which is a 2-step process as detailed below:

> *Measure/assess source contribution C- and A-weighted L_{eq},T levels over the same time period. Correction to be applied where the C minus A level is 15 dB or more and:*
>
> • *where any of the one-third octave noise levels in Table C2 are exceeded by **up to and including** 5 dB and cannot be mitigated, a 2 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period; and*
>
> • *where any of the one-third octave noise levels in Table C2 are exceeded by **more than** 5 dB and cannot be mitigated, a 5 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period and a 2 dB(A) positive adjustment applies for the daytime period.*

Table C2 and associated notes from the NPfI are reproduced below:

Table C2: One-third octave low-frequency noise thresholds.

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:

- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.
- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.
- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

Section 5.6 includes assessment of potential low frequency noise impact.

3.3 Voluntary Land Acquisition and Mitigation Policy

In September 2018, the NSW government published the Voluntary Land Acquisition and Mitigation Policy (the VLAMP) for State Significant Mining, Petroleum and Extractive Industry Developments (NSW Government, 2018). This document describes the NSW Government's policy for voluntary mitigation and land acquisition to address noise impacts from state significant mining, petroleum and extractive industry developments.

3.3.1 Mitigation and Acquisition Criteria

The VLAMP provides the following guidance on the applicability of noise mitigation and acquisition criteria:

A consent authority can apply voluntary mitigation and voluntary land acquisition rights to reduce:

- *operational noise impacts of a development on privately owned land; and*
- *rail noise impacts of a development on privately owned land near a non-network rail line (private rail line), that is on, or exclusively servicing an industrial site (see Appendix 3 of the RING);*

But not:

- *construction noise impacts, as these impacts are shorter term and can be controlled;*
- *noise impacts on the public road or rail network; or*
- *modifications of existing developments with legacy noise issues, where the modification would have beneficial or negligible noise impacts.*

Noise issues for existing premises may be addressed through the site-specific pollution reduction programs under the Protection of the Environment Operations Act 1997.

3.3.2 Voluntary Mitigation Rights

The VLAMP states:

A consent authority should only apply voluntary mitigation rights where, even with the implementation of best practice management at the mine site:

- *the noise generated by the development would meet the requirements in Table 1 (see following page), such that the impacts would be characterised as marginal, moderate or significant, at any residence on privately owned land; or*
- *the development would increase the total industrial noise level at any residence on privately owned land by more than 1 dB(A) and noise levels at the residence are already above the recommended amenity noise levels in Table 2.2 of the Noise Policy for Industry; or*
- *the development includes a private rail line and the use of that private rail line would cause exceedances of the recommended acceptable levels in Table 6 of Appendix 3 of the RING by greater than or equal to 3*

dB(A) at any residence on privately owned land.

All noise levels must be calculated in accordance with the NPfI or RING (as applicable).

3.3.3 Voluntary Land Acquisition Rights

The VLAMP states:

A consent authority should only apply voluntary land acquisition rights where, even with the implementation of best practice management:

- *the noise generated by the development would be characterised as significant, according to Table 1 (see following page), at any residence on privately owned land; or*
- *the noise generated by the development would contribute to exceedances of the acceptable noise levels plus 5dB in Table 2.2 of the NPfI on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls [2]; or*
- *the development includes a private rail line and the use of that private rail line would cause exceedances of the recommended maximum criteria in Table 6 of Appendix 3 of the RING at any residence on privately owned land.*

All noise levels must be calculated in accordance with the NPfI or RING (as applicable).

Table 1 of the VLAMP outlines a procedure for characterising noise impact and provides examples of potential receptor-based treatments that could be used to mitigate residual noise impact; the table is reproduced below.

[2] *Voluntary land acquisition rights should not be applied to address noise levels on vacant land other than to vacant land specifically meeting these criteria.*

Table 1 – Characterisation of noise impacts and potential treatments[16]

If the predicted noise level minus the project noise trigger level[17] is:	And the total cumulative industrial noise level is:	Characterisation of impacts:	Potential treatment:
All time periods 0-2dB(A)	Not applicable	Impacts are considered to be **negligible**	The exceedances would not be discernable by the average listener and therefore would not warrant receiver based treatments or controls
All time periods 3-5dB(A)	• ≤ recommended amenity noise level in Table 2.2 of the NPfI; or • > recommended amenity noise level in Table 2.2 of the NPfI, but the increase in total cumulative industrial noise level resulting from the development is ≤1dB	Impacts are considered to be **marginal**	Provide mechanical ventilation / comfort condition systems to enable windows to be closed without compromising internal air quality / amenity.
All time periods 3-5dB(A)	> recommended amenity noise level in Table 2.2 of the NPfI, and the increase in total cumulative industrial noise level resulting from the development is >1dB	Impacts are considered to be **moderate**	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Day and evening >5dB(A)	≤ recommended amenity noise levels in Table 2.2 of the NPfI	Impacts are considered to be **moderate**	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Day and evening >5dB(A)	> recommended amenity noise levels in Table 2.2 of the NPfI	Impacts are considered to be **significant**	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions above.
Night >5dB(A)	Not applicable	Impacts are considered to be **significant**	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions above.

Figure 8 - Table 1 of the VLAMP (NSW Government, 2018)

3.4 Residual Noise Impacts

Residual noise impacts occur when the best achievable noise levels predicted for a private residential receptor are greater than assessment noise levels, and all source and pathway feasible and reasonable noise mitigation measures have been considered. The significance of any residual impact can be used to assess the need for receptor-based treatment options. In extreme cases, significant levels of residual noise impact may lead to voluntary acquisition.

Both the NPfI and VLAMP provide guidance on how to determine the significance of residual noise impacts. It should be noted that the method of assessing residual noise impact differs between the NPfI and the VLAMP. The VLAMP method has been adopted as it is the more recent. Table 1 of the VLAMP, reproduced above, summarises the assessment method and provides examples of receptor-based treatments that could be used to mitigate residual noise impact.

Residual noise impact assessment outcomes are discussed in Section 0of this report.

3.4.1 Voluntary Mitigation

Table 2 within Condition 2 of Schedule 3 of SSD-4960, reproduced below, lists land subject to additional noise mitigation upon request. BCM will continue to afford noise mitigation rights for this land. It should be noted that this land would no longer be entitled to mitigation rights in accordance with either the NPfI or the VLAMP, as noise emission from the Proposed Modification will be managed to comply with noise criteria prescribed in Appendix 6 of SSD-4960, which are less than the noise mitigation level of $L_{Aeq,15minute}$ 38 dB.

ADDITIONAL MITIGATION UPON REQUEST

2. Upon receiving a written request from the owner of any residence on the land listed in Table 1 (unless the landowner of that land has requested acquisition) or Table 2, the Applicant must implement additional:
   (a) noise mitigation measures (such as double-glazing, insulation and/or air conditioning); and/or
   (b) air quality mitigation measures (such as air filters, a first flush roof water drainage system and/or air conditioning),
   at the residence in consultation with the landowner.

   These measures must be reasonable and feasible, and directed towards reducing the noise and/or air quality impacts of the development on the residence.

   If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

Table 2: Land subject to additional noise and/or air quality mitigation upon request

Mitigation Basis	*Residence*
Noise & Air Quality	8
Noise	1A, 97, 157, 179, 195, 232, 234, 235, 237, 239, 240, 261, 262
Air Quality	3, 323, 324, 325

Note: To interpret the land referred to in Table 2, see the applicable figure in Appendix 5.

3.4.2 Voluntary Acquisition

Table 1 within Condition 1 of Schedule 3 of the BOP consent, reproduced below, lists land subject to acquisition upon request. BCM will continue to afford acquisition rights for this land.

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the owner of the land listed in Table 1, the Applicant must acquire the land in accordance with the procedures in conditions 5 and 6 of schedule 4.

Table 1: Land subject to acquisition upon request

Acquisition Basis	*Land*
Noise	149, 150

Note: To interpret the land referred to in Table 1, see the applicable figure in Appendix 5.

4 NOISE MODEL PARAMETERS

4.1 Meteorology

Under various wind and temperature gradient conditions, noise may be increased or decreased compared with still-isothermal conditions – that is, no wind or temperature gradient. Atmospheric conditions that most affect noise propagation are temperature and wind velocity gradients. They can both enhance or reduce noise propagation from source to receiver due to refraction of sound propagating through the atmosphere, brought about by a change in sound speed with height.

Noise levels are increased when the wind blows from source to receiver or under temperature inversion conditions (both of which are sometimes referred to as 'adverse weather conditions'), and decreased when the wind blows from receiver to the source or under temperature lapse conditions.

One full year of meteorological data (2008) from the BCM weather station was previously analysed to determine the frequency of occurrence of each of the modelled meteorological conditions, by season and time period. This data (from the BCM weather station located on the Blakefield dumps recorded during 2008) was used for previous assessments for BCM, including the Bulga Optimisation Project NIA, 2010 NIA, Western Limit Modification and Blakefield North Modification. As this data is considered representative of weather conditions in the region, and for consistency with previous assessments, it has been retained for this assessment.

There were 52,301 10 minute records out of a possible 52,704 in the 2008 data set, representing 99.2 percent data capture. Sigma-theta data was analysed, in accordance with procedures in Appendix E of the INP, to determine the appropriate stability class and associated vertical temperature gradient for each weather record. A vertical temperature gradient of four degrees Celsius per 100 metres was used for modelling stability class F, which is consistent with the upper end of the range specified in Table D2 of the NPfI.

As described in Section 2.8 of this NIA, model predictions are based on a probabilistic approach based on a cumulative distribution of results. The 90th percentile result (10 percent of results are higher than this number) is used to represent intrusive noise impact. The 90th percentile result represents the upper range of predicted noise levels, and is typically equivalent to predictions for strongly enhancing source to receiver gradient wind conditions, or, strong inversion conditions with light wind. As such, model predictions represent the noise level that may be experienced during relatively worst case enhancing weather conditions. During periods of less enhancing weather conditions, noise levels experienced at receptor locations would be less than those presented in this NIA. It should be noted that regulator expectations are that noise emission will be managed during all weather conditions, even if they are outside the range for which consent criteria apply. BCM has factored this requirement into mine planning and production schedules, and is committed to managing noise to acceptable levels during all weather conditions.

Appendix C lists the meteorological conditions included in the assessment.

4.2 Mining Scenarios and Noise Controls

Four operating scenarios were modelled representing various relevant stages of development throughout the life of mine. They nominally represent years 2022, 2026, 2031 and 2035. Each stage plan modelled is indicative of a typical worst-case operating configuration at a given point in time within a four to five year period. Numerous model iterations and refinements were made for each stage plan to determine the most efficient mine plan layout with regard to managing noise emission. The key objective in this process was to achieve an outcome that provides for continued compliance with approved noise criteria, whilst minimising any impact to production.

To ensure the proposed mine plan progression can be practically implemented whilst maintaining compliance with approved noise criteria, a series of noise controls were identified and incorporated into the stage plan scenarios. These include pit design that maximises shielding provided by the pit shell, alignment of haul roads to achieve the greatest protection, provision of alternate waste emplacement areas and shorter haul roads for use during periods of adverse weather conditions, and use of noise bunds in key areas to increase shielding where the pit shell was not sufficient. Modelling indicates that these controls will be sufficient to allow unrestricted operation of the mining fleet during neutral and non-enhancing weather conditions, and for a significant portion of time during adverse weather conditions. Modelling also indicated that during periods of strongly enhancing weather conditions, further noise control may be required to maintain compliance with approved noise criteria. A series of management strategies were evaluated that involved incremental application of noise management strategies to determine the measures required to achieve compliance. Production impacts associated with implementation of these management controls were quantified, and BCM has incorporated these factors into mine planning, production schedules, and budgets.

Long term noise controls incorporated into the proposed mine plan progression and models developed for each stage include:

1. a 20 metre high earth bund was modelled along the inside face of the NVB adjacent to the long term haul road that will be constructed in that area. This bund improves the performance of the NVB in that area as it has a steeper face angle, and provides a higher degree of shielding to the long term haul road that will connect the southern mining area to the northern waste emplacement areas;

2. 3 metre high earth bunds were modelled in strategic locations on the exposed side of long term haul roads. A sensitivity analysis was completed that showed increasing the bund height above 3 metres provides minimal additional noise reduction. Construction of bunds greater than 3 metres becomes increasingly difficult and expensive;

3. pit design was optimised to provide alternate waste emplacement and hauling options that allow lower elevation and more shielded haulage and dumping during adverse weather conditions;

4. mining schedules were modified to include allowances for reduced production resulting from modified fleet configurations during adverse weather conditions; and

5. major plant and equipment incorporated noise attenuation in line with commitments for the currently Approved Development.

In addition to these long term noise controls, a series of noise management strategies were developed that will be progressively implemented as required to maintain compliance with approved noise criteria. These include:

1. ancillary equipment such as rehabilitation dozers, drill preparation dozers and road/pit maintenance equipment operating in exposed areas will be relocated or shutdown;

2. exposed waste emplacement area dozers will be either replaced with rubber tyre dozers, restricted to first gear operation, relocated, or shutdown;

3. any other dozers operating in exposed areas will be either replaced with rubber tyre dozers, restricted to first gear operation, relocated, or shutdown;

4. haulage to exposed waste emplacement areas will be relocated to use more shielded haul roads and emplacement areas deeper in the pit;

5. blast hole drills may be shut down; and

6. excavators and associated equipment, including haul trucks, will be progressively shutdown or relocated to more shielded pit areas.

Throughout the life of the mine, alternative noise controls and management strategies may be implemented to ensure ongoing compliance with approved noise criteria.

Proactive noise management will be used in the first instance via review of predictive weather forecasts combined with short term mine schedules to implement noise controls in advance of noise issues arising. In the event that higher than anticipated noise levels occur, reactive noise measures will be applied to maintain compliance. Decision making will be informed by data from the real time monitoring system. Further detail regarding the BCC noise management system is included in Section 6 of this NIA.

The BOP consent includes a condition that the applicant must minimise the noise impacts of the development during meteorological conditions for which noise criteria in the consent do not apply (refer to Section 3.1.1 for more detail). Noise controls and management strategies that are implemented to ensure compliance during meteorological conditions for which approved noise criteria are applicable would continue to be implemented when meteorological conditions exceed the applicable range.

4.3 Indicative Mining Fleet

Table 4.1 lists indicative open cut mining equipment types and quantities proposed for each stage during the mining progression. The actual quantity of equipment in service at any time will be dependent on off-site performance, which will be monitored via the real-time monitoring system. Monitoring will allow the appropriate level of noise mitigation controls to be applied to maintain compliance with approved noise criteria. Table 4.2, Table 4.3 and Table 4.4 list indicative CHPP, tailings

management and water management equipment types and quantities respectively. Modelled plant locations and pit shell topography figures are included in Appendix B.

Table 4.1: OPEN CUT EQUIPMENT INCLUDED IN MODELS

	Equipment Quantities			
Description	**2022**	**2026**	**2031**	**2035**
Hitachi EX5600 excavator	4	4	4	4
Hitachi EX3600 excavator	1	1	1	1
Liebherr R9400 excavator	1	1	1	1
Liebherr R9250 excavator	1	1	1	1
P&H 4100XPC electric shovel	1	1	1	0
Caterpillar 797F XQ rear dump truck	7	6	7	0
Caterpillar 793D XQ rear dump truck	50	50	48	51
Caterpillar 789C XQ rear dump truck	5	6	7	8
Caterpillar 789C XQ water truck	4	4	4	3
LeTourneau 1850 front end loader	1	1	1	1
Komatsu WA900 front end loader	1	1	1	1
Caterpillar D11 dozer	9	10	11	7
Caterpillar D10 dozer	5	4	4	5
Caterpillar 854H rubber tyre dozer	3	3	3	3
Caterpillar 24M Grader	4	4	4	3
Terex SKSw75 blast hole drill	3	3	3	2
Sandvik D75K blast hole drill	1	1	1	1

Notes:

1. *Table shows representative typical equipment to allow for assessment.*

Table 4.2: CHPP PLANT ITEMS INCLUDED IN MODELS (all stages)

Description	**Quantity**
Washery building (CPP)	1
Stockpile dozers	3
Locomotives on rail loop (idle)	3
Reject bin	1
Rail load out bin	1
ROM conveyor	1
Reject conveyor	1
CHPP clean coal conveyor	1
Skyline conveyors	2
Rail load out conveyor	1
Transfer stations	5

Table 4.3: UNDERGROUND INFRASTRUCTURE INCLUDED IN MODELS (all stages)

Description	Quantity
Goaf extraction unit/pump (each)	5
Underground ventilation fans (set of 3)	2
4 MW Power Generators (each)	8
3 MW Power Generators (each)	8
Gas compressor	1
Gas flares	7
Underground coal rear dump trucks	3
Caterpillar 992 front end loader	1

Table 4.4: TSF RELOCATION INFRASTRUCTURE INCLUDED IN MODELS

	Equipment Quantities			
Description	2022	2026	2031	2035
Dredge pump 2x 1300 kW (diesel)	2	2	0	0
Tailings pump 2x 1120 kW (electric)	1	1	0	0
Tailings pump 1x 1120 kW (electric)	3	3	0	0
Water return pump 3x 300 kW (electric)	2	2	0	0
Water return pump 1x 300 kW (electric)	2	2	0	0

Table 4.5: WATER MANAGEMENT INFRASTRUCTURE INCLUDED IN MODELS

	Equipment Quantities			
Description	2022	2026	2031	2035
Pit water transfer pumps (diesel)	3	3	0	0
Surge dam pump 1x 250 kW (electric)	1	1	1	1
S6a dam pump 2x 220 kW (electric)	2	2	2	2
S7 dam pump 2x 200 kW (electric)	1	1	1	1

Throughout the life of the mine, equipment type and quantities may be varied in response to changes in technology, and to address technical issues such as geotechnical and geological variables, coal marketing quality requirements etc., however appropriate noise controls and noise management strategies will be implemented to maintain compliance with approved criteria.

4.4 Equipment Sound Power

Sound powers used in modelling, provided in Table 4.6 are generally consistent with those modelled during the Bulga Optimisation Project NIA. BOP sound powers were based on in-service levels of plant operating at the BCC, and have been confirmed via annual sound power screening surveys to remain generally indicative of the current mining fleet. Changes relative to the Bulga Optimisation Project NIA include:

- XPC4100 shovel sound power has reduced from 116 dB(A) to 115 dB(A) to reflect more recent test results; and

- Blast hole drill sound power has reduced from 118 dB(A) to 115 dB(A) for three units and 113 dB(A) for one unit. The new levels reflect the performance of noise attenuation that has been or will be installed on the drills.

Mining equipment and associated sound power levels shown in this NIA are representative of a typical mining equipment fleet as proposed to be used for the Proposed Modification. These sound powers represent current or anticipated fleet average levels. It is normal for plant items within an equipment category to vary, with some having sound power either higher or lower than the fleet average. BCM will review available mining equipment and technology throughout the life of the mine and may update or replace plant from time to time, whilst managing noise impacts to within approved noise criteria.

Dozers operating in exposed locations, such as overburden emplacement areas, will be restricted to 1st gear during periods of adverse meteorological conditions; however, this restriction would not be required during all weather conditions, and this management control will be implemented as required to assist with managing noise levels within approved noise criteria.

Haul truck sound powers were incorporated into strings created for each route. This method distributes the acoustic energy of vehicles along the length of each haul route. Routes comprise a string of segments of fixed length, each having a sound power determined by the following:

- sound power for type of trucks on route. Trucks travelling down ramps greater than 5% grade were allocated a reduced sound power;
- number of each truck type on route in a 15-minute period, based on loading unit load capacity;
- speed of loaded truck on segment grade toward dump/ROM; and
- speed of empty truck on segment grade from dump/ROM.

Truck speeds are relative to grade in direction of travel and were allocated in accordance with truck speed data collected from mine sites in the Hunter Valley. Speed determines the duration required to traverse each segment, an important variable when calculating L_{Aeq} for a specific time period. Graders and water carts were allocated sound powers in a similar manner. Haul truck and watercart sound powers shown in Table 4.6 are uphill loaded, full power levels.

Table 4.6: SOUND POWER DATA

	Representative Sound Power, $L_{eq,15minute}$	
Equipment Category	**Linear (dB)**	**A-weighted (dB(A))**
Hitachi EX5600 excavator	124	118
Hitachi EX3600 excavator	124	118
Liebherr R9400 excavator	121	115
Liebherr R9250 excavator	121	115
P&H 4100XPC electric shovel	121	115
Caterpillar 797F XQ rear dump truck	124	117
Caterpillar 793D XQ rear dump truck	121	115
Caterpillar 789C XQ rear dump truck	121	115

Caterpillar 789C XQ water truck	121	115
LeTourneau 1850 front end loader	125	122
Komatsu WA900 front end loader	124	118
Caterpillar D11/D10 dozer	122	115
Caterpillar 854H rubber tyre dozer	116	111
Caterpillar 16M Grader	114	108
Caterpillar 24M Grader	117	110
Terex SKSw75 blast hole drill	122	115
Sandvik D75K blast hole drill	120	113
Locomotives on rail loop (3 x 90 class idle)	109	106
Reject bin	121	116
Rail load out bin	121	116
ROM conveyor (per 100m length)	109	102
Reject conveyor (per 100m length)	109	102
CHPP clean coal conveyor (per 100m length)	109	102
Skyline conveyor (per 100m length)	109	102
Rail load out conveyor (per 100m length)	109	102
Transfer stations	121	116
CHPP north façade	121	111
CHPP east façade	125	116
CHPP south façade	119	111
CHPP west façade	123	115
Goaf extraction unit/pump (each)	95	94
Underground ventilation fans (per fan)	119	108
4 MW Power Generators (each)	99	98
3 MW Power Generators (each)	99	98
Gas compressor	109	101
Caterpillar 992 front end loader	117	114
Dredge pump 2x 1300 kW (diesel)	118	113
Tailings pump 2x 1120 kW (electric)	105	104
Tailings pump 1x 1120 kW (electric)	102	101
Water return pump 3x 300 kW (electric)	104	103
Water return pump 1x 300 kW (electric)	99	98
Pit water transfer pumps (diesel)	118	113
Surge dam pump 1x 250 kW (electric)	98	95
S6a dam pump 2x 220 kW (electric)	101	98
S7 dam pump 2x 200 kW (electric)	101	98

Notes:

1. *Table shows representative typical sound powers to allow for assessment.*

5 NOISE IMPACT ASSESSMENT

5.1 Operational Noise Assessment

The primary purpose of this NIA was to determine if the Proposed Modification will be able to continue to operate in compliance with approved noise criteria, and to identify any constraints that may apply. Section 4.2 lists long term noise controls incorporated into the proposed mine plan progression, and a hierarchy of noise management strategies that can be progressively implemented to maintain compliance. Noise management strategies should typically only be required during periods of meteorological enhancement, and will be applied based on information obtained from the real-time monitoring system and application of the Bulga Surface Operations Noise Management Procedure. Section 6 outlines noise management procedures and protocols.

Table 5.1 provides a summary of compliance for the Proposed Modification against existing noise criteria prescribed in SSD-4960. Compliance for any given receptor is demonstrated where 90th percentile predictions for an indicative scenario with a feasible and reasonable level of noise mitigation applied is less than or equal to the relevant criterion. Mitigated scenario model predictions for all receptors are included in Appendix A.

Table 5.1: SUMMARY OF PREDICTED COMPLIANCE

Receptor ID	SSD-4960 Criteria [1]	90th Percentile Prediction Complies with Criteria [2]			
	$L_{Aeq,15minute}$ dB	2022	2026	2031	2035
95, 142A, 143B, 164, 165, 195, 217s	36/36/36	y	y	y	y
All other privately-owned residences	35/35/35	y	y	y	y

Notes:

1. *Criteria are in the format day/evening/night, sourced from the table in Appendix 6 of the BOP consent (SSD-4960); and*
2. *"y" indicates the 90th percentile prediction for the relevant feasible and reasonable mitigated scenario complies with SSD-4960 criteria.*

As indicated in Table 5.1, the Proposed Modification will be able to comply with approved noise criteria at all receptor locations throughout the mining progression with an appropriate level of noise mitigation applied during periods of adverse meteorological conditions.

It should be noted that each stage plan modelled is indicative of a typical worst-case operating configuration at a given point in time within a four to five year period. These stages have been selected to represent key stages in the mine progression where mining and waste emplacement occurs in relatively exposed areas. Pit development and mine operating configurations are a dynamic process that will vary over time relative to those modelled, and will, for significant portions of time, operate with less exposure than the configurations modelled. Mitigation controls applied to demonstrate compliance in this NIA are applicable to the stage plans assessed, and provided to demonstrate that the Proposed Modification will be able to achieve compliance with SSD-4960. The actual degree of mitigation controls required will vary throughout the life of the mine as the degree of exposure changes, and will be implemented based on the noise management procedures outlined in Section 6 of this NIA.

5.2 Residual Noise Impacts

5.2.1 Voluntary Mitigation

As described in Section 3.4 of this NIA, BCM will continue to afford voluntary mitigation rights to receptors currently afforded these rights in accordance with Table 2 (Condition 2 of Schedule 3) of SSD-4960. It is again noted that these receptors would no longer be entitled to mitigation rights in accordance with either the NPfI or the VLAMP, as noise emission from the Proposed Modification will be managed to comply with noise criteria prescribed in Appendix 6 of SSD-4960, which are less than the noise mitigation level of $L_{Aeq,15minute}$ 38 dB in all cases.

5.2.2 Voluntary Acquisition

As described in Section 3.4 of this NIA, BCM will continue to afford voluntary acquisition rights to receptors currently afforded these rights in accordance with Table 1 (Condition 1 of Schedule 3) of SSD-4960. These are receptors 149 and 150, which are contiguous lots (effectively one property) and have the same owner.

5.3 Indicative Noise Contours

Figure 9 to Figure 12 present indicative 90th percentile $L_{Aeq,15minute}$ noise contours for each of the modelled stages with a feasible and reasonable level of noise mitigation applied. Noise contours are the maximum envelope of the day, evening and night periods.

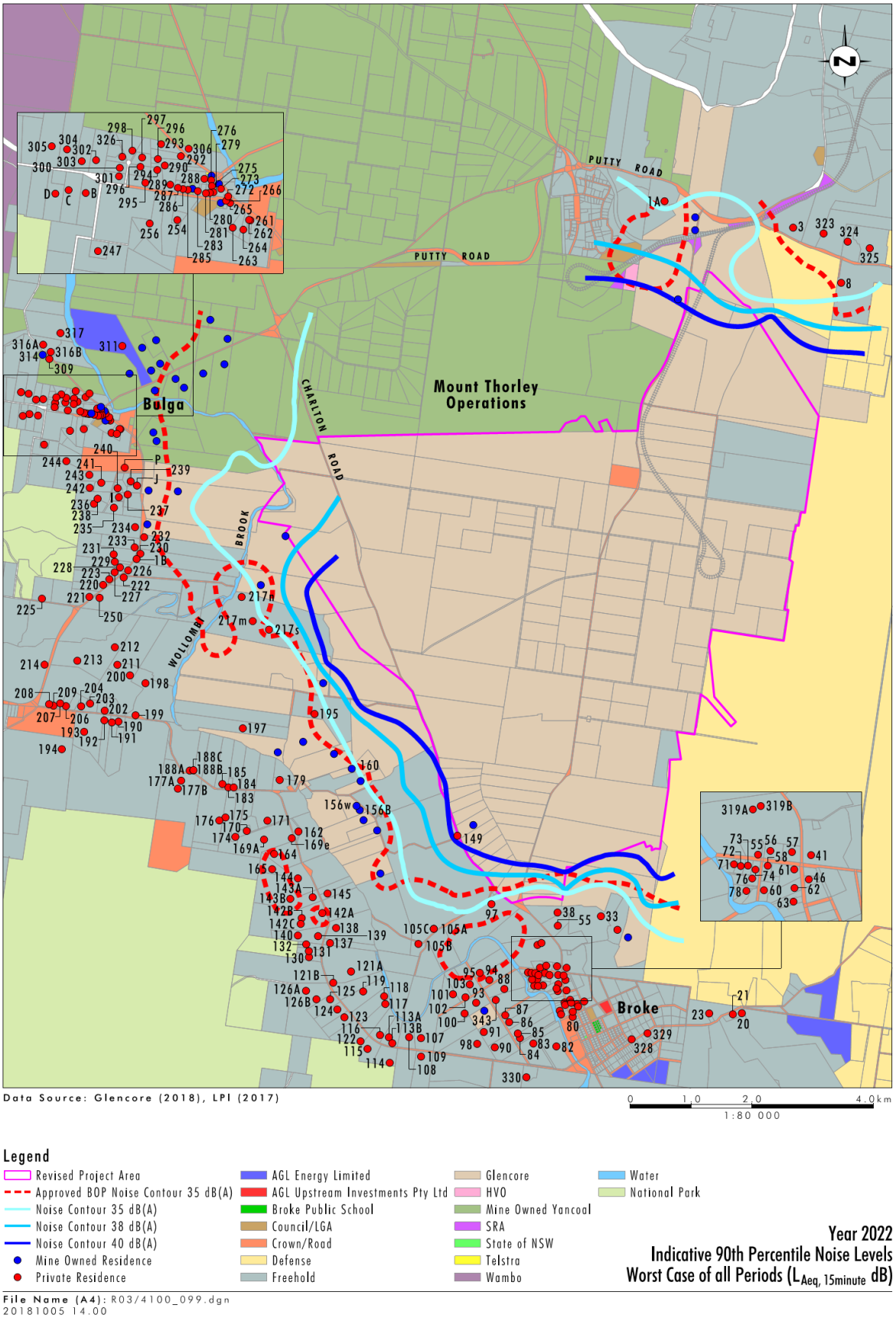

Figure 9 - Indicative 90th Percentile Noise Contours – Maximum Envelope of All Time Periods, 2022

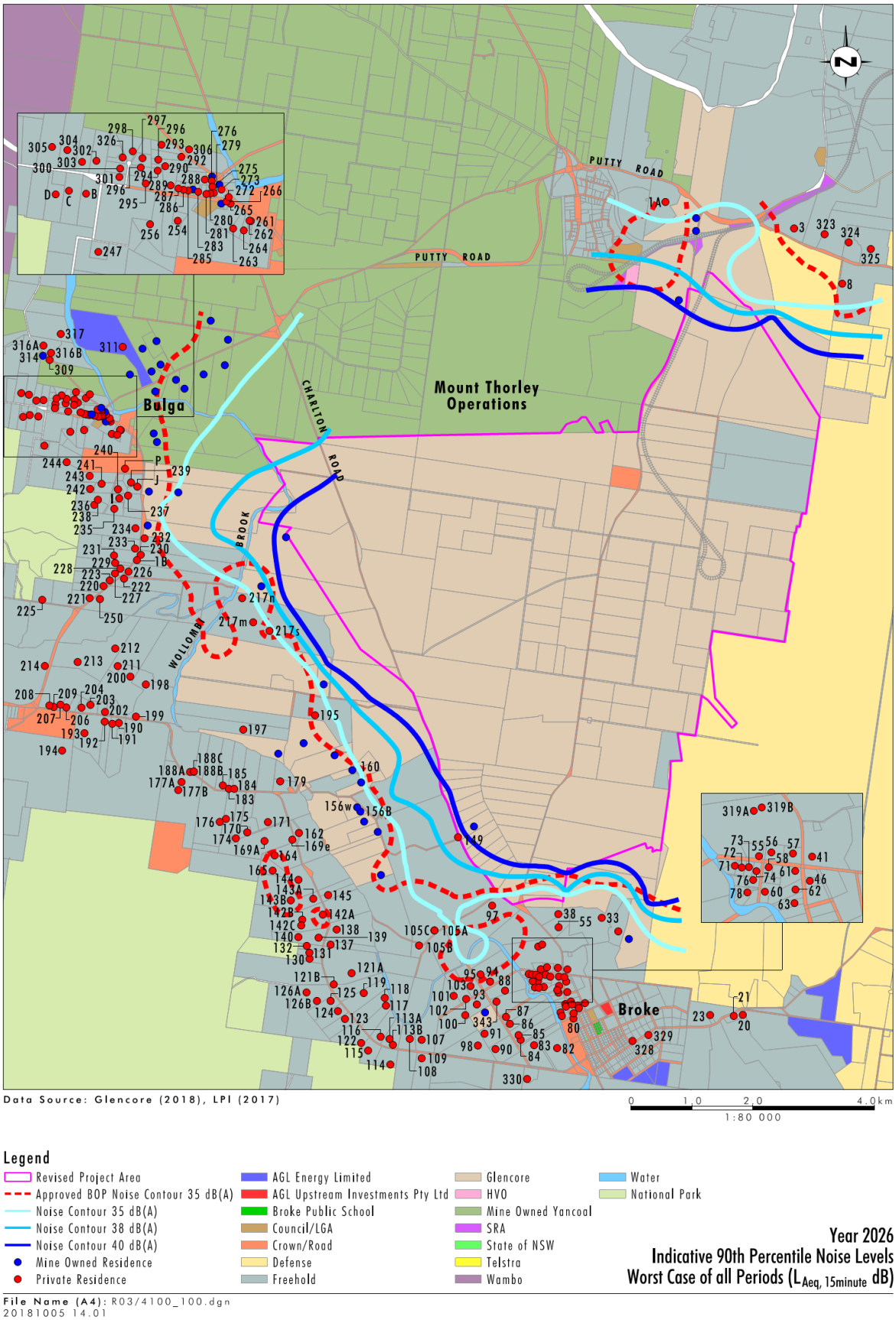

Figure 10 - Indicative 90th Percentile Noise Contours – Maximum Envelope of All Time Periods, 2026

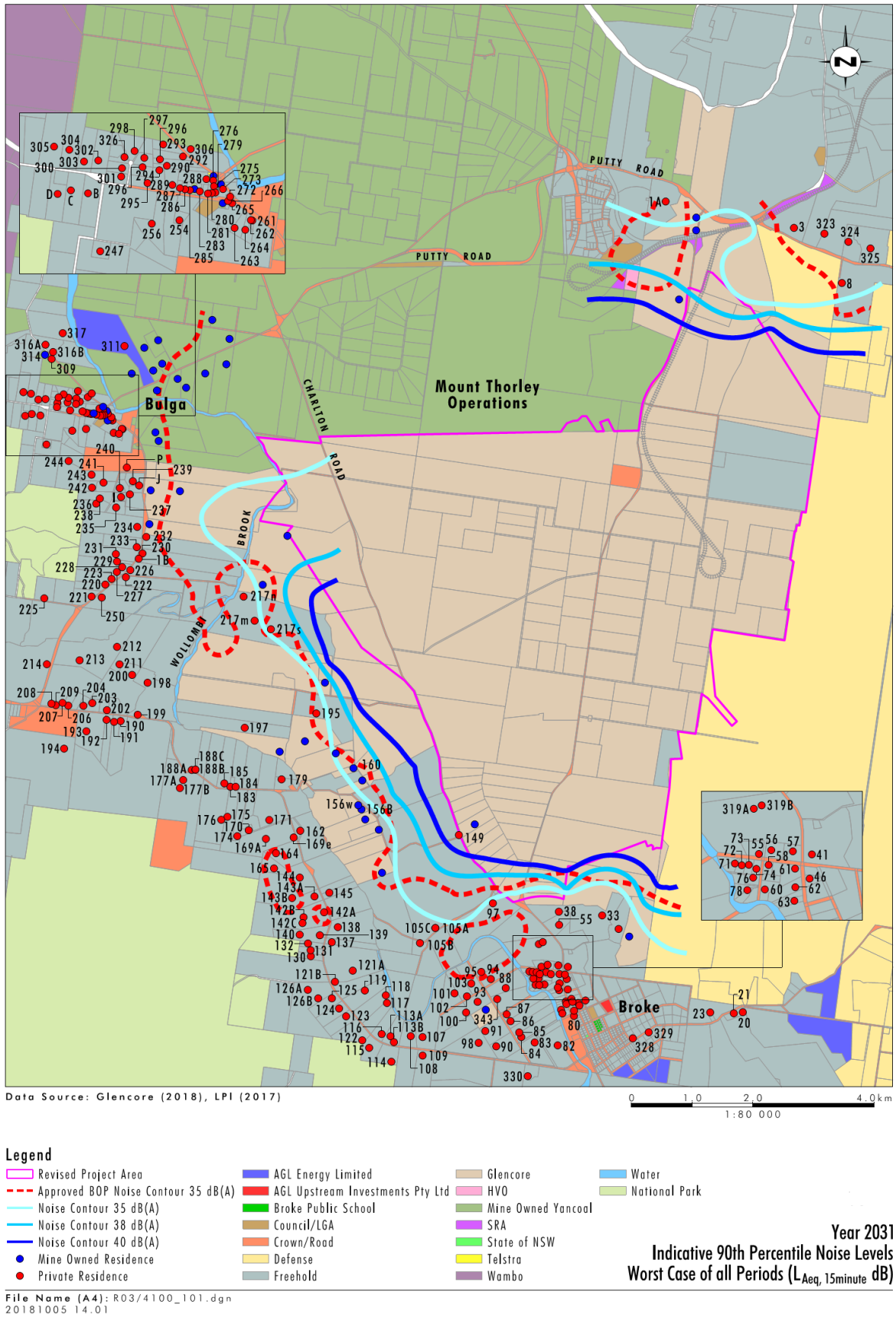

Figure 11 - Indicative 90th Percentile Noise Contours – Maximum Envelope of All Time Periods, 2031

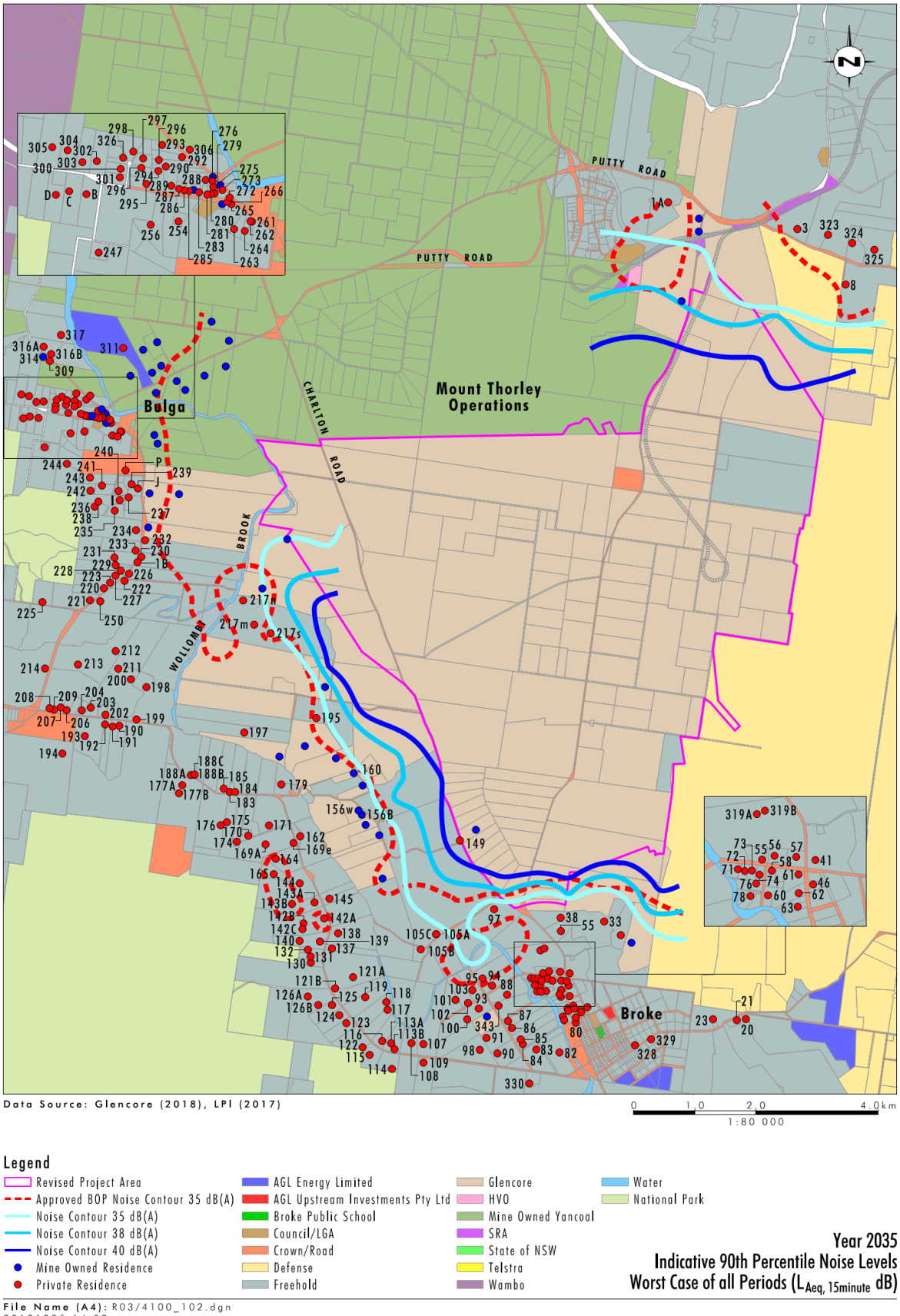

Figure 12 - Indicative 90th Percentile Noise Contours – Maximum Envelope of All Time Periods, 2035

5.4 Private Land Assessment

The VLAMP requires assessment of operational noise impact over privately owned land. With regard to private landholdings, the VLAMP states that a consent authority should only apply voluntary land acquisition rights where, even with the implementation of best practice management:

> *The noise generated by the development would contribute to exceedances of the acceptable noise levels plus 5dB in Table 2.2 of the NPfI on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.*

Noise contours were generated over contiguous private lot areas for each of the four modelled stages with feasible and reasonable noise mitigation controls applied. From these, the maximum envelope of predicted noise emission was determined to evaluate the maximum extent of noise impact over the life of the Proposed Modification.

The percentage of private land exceeding the acceptable amenity noise level plus 5 dB did not exceed 25 percent of any private landholding areas.

5.5 Maximum Noise Level Assessment

Potential sleep disturbance impact was assessed by predicting levels from plant items known to generate noise levels that at times stand out above the general mining continuum. Shovel and excavator bucket noise, first pass loads into empty truck trays, rear dump truck exhaust and dozer track noise are recognised as sources which can generate high, short term noise levels that may cause sleep disturbance.

The following sources were modelled to assess sleep disturbance:

- Impact noise generated by excavator buckets impacting truck bodies or hard ground material, or rocks impacting the bottom of empty haul truck trays was modelled at each dig location. A maximum sound power of L_{WA} 130 dB was adopted for each impact event;
- Dozer track slap was modelled at each exposed dozer operating location, typically overburden emplacement areas. A maximum sound power of L_{WA} 122 dB representing dozer operation in first gear reverse was modelled; and
- Haul truck exhaust surges were modelled by assessing a maximum sound power event of L_{WA} 118 dB at each overburden emplacement area, and at exposed sections along haul routes.

Assessment of sleep disturbance for each model stage involved modelling each of these sources, and then combining the highest prediction with results for the remainder of operational plant to obtain an estimate of possible short-term maximum noise emissions.

Sleep disturbance model predictions are less than the criterion of $L_{A1,1minute}$ 45 dB for all receptors. As such, there is no sleep disturbance impact predicted. This is consistent with the outcome of the Bulga Optimisation Project NIA.

5.6 Low Frequency Noise Assessment

5.6.1 Comparison with the Bulga Optimisation Project NIA

At the time the Bulga Optimisation Project NIA was prepared, the preferred method for evaluation of low frequency noise was the Broner method, which is based on comparison of total predicted C-weighted levels at receptor locations with an upper limit criterion. This method is in accordance with recommendations published in *A Simple Method for Low Frequency Noise Emission Assessment* (Broner, 2010), published in the Journal of Low Frequency Noise, Vibration and Active Control, Volume 29 Number 1 2010. Bulga Optimisation Project NIA total C-weighted predictions, with the exception of receptor 149 which has acquisition rights with BCM, were less than or equal to $L_{Ceq,15minute}$ 50 dB which is at least 10 dB below the Broner desirable low frequency noise limit of $L_{Ceq,15minute}$ 60 dB. Whilst the Broner method has been replaced with the contemporary method outlined in the NPfI (further detail is provided below), it is worth noting that total C-weighted predictions for the Proposed Modification with feasible and reasonable noise controls applied remain at least 10 dB below the Broner desirable limit of $L_{Ceq,15minute}$ 60 dB.

5.6.2 Evaluation of Current Performance Using NPfI Method

The BCC has an attenuated mining fleet, and major fixed plant infrastructure, including the coal processing plant (CPP) includes cladding in accordance with industry best practise. As a result of these mitigation measures, the BCC does not typically attract modifying factor adjustments, as evidenced by the analysis of real-time monitoring data below. Continued use of the existing infrastructure area is proposed, and the same mining fleet will be retained until replacement is required. Replacement mining fleet will have noise mitigation included, which will be consistent with or better than the current fleet. On this basis, low frequency noise emission from the Proposed Modification should not increase relative to the existing situation.

Three months of noise monitoring data measured during the winter months of 2017 at four real-time noise monitoring locations were analysed to evaluate how often low frequency noise modifying factor adjustments, determined in accordance with Fact Sheet C of the NPfI, applied during that period for the existing Approved Development. The four monitoring locations, SX62, SX63, SX65 and SX123 are considered representative of the key receptor areas located south, west and northwest of the BCC. These monitoring locations are shown in Figure 13, which is sourced from the Bulga Open Cut Noise Management Plan.

Weather data and relationships between statistical noise metrics were used to filter records to remove those likely to be affected by extraneous noise sources, and those that were measured during meteorological conditions for which consent criteria were not applicable. Measured 1/3 octave spectra were compared with NPfI low frequency thresholds to determine how often low frequency noise modifying factor adjustments would have applied during winter 2017. It should be noted that despite the filtering process applied, measured noise levels cannot be definitively attributed to the BCC. Other low frequency noise sources such as neighbouring mining operations, breeze on the microphone, road traffic noise and farm machinery may be responsible for some records that were higher than NPfI low frequency noise thresholds.

The analysis focusses on the night period from midnight to 5am, as this period has the greatest potential for noise propagation, and is typically less affected by extraneous noise than the day or evening periods. Road traffic noise often influences measured noise levels prior to midnight and after 5am, so these periods were excluded to minimise any influence from road traffic.

At SX65 and SX123, NPfI low frequency noise thresholds were not exceeded.

At SX62, NPfI low frequency noise thresholds were exceeded 2 percent of the time, which is insignificant. These threshold exceedances cannot be categorically attributed to the BCC.

At SX63, the percentage exceedance of NPfI low frequency noise thresholds was less than 0.5 percent. A relatively constant noise source at the 50 Hz 1/3 octave frequency was found to influence measured data at this location when wind direction was from the west. Such winds would mitigate rather than enhance noise from the BCC, and measured spectra during these periods were atypical of those generated by mining operations. These records were omitted from the analysis.

In addition to analysis of real-time monitor data, a review of attended compliance monitoring records was undertaken. As of December 2018, 135 15-minute attended compliance monitoring measurements were completed around the BCC since the NPfI came into effect. Of these, 2 percent of measurements (3 in total) exceeded NPfI low frequency noise thresholds and resulted in exceedances of consent criteria after application of the low frequency noise adjustment. Only one of these three measurements exceeded consent criteria prior to application of the adjustment.

A low frequency noise modifying factor applicability rate of up to 2 percent is considered insignificant, and demonstrates low frequency noise emission from the Approved Development is neither frequent nor systemic. Therefore, modifying factor adjustments have not been applied to predicted noise levels in this NIA.

Monitoring of the Proposed Modification will continue to include evaluation of low frequency noise modifying factors, and applicable adjustments will be applied to measured results if relevant.

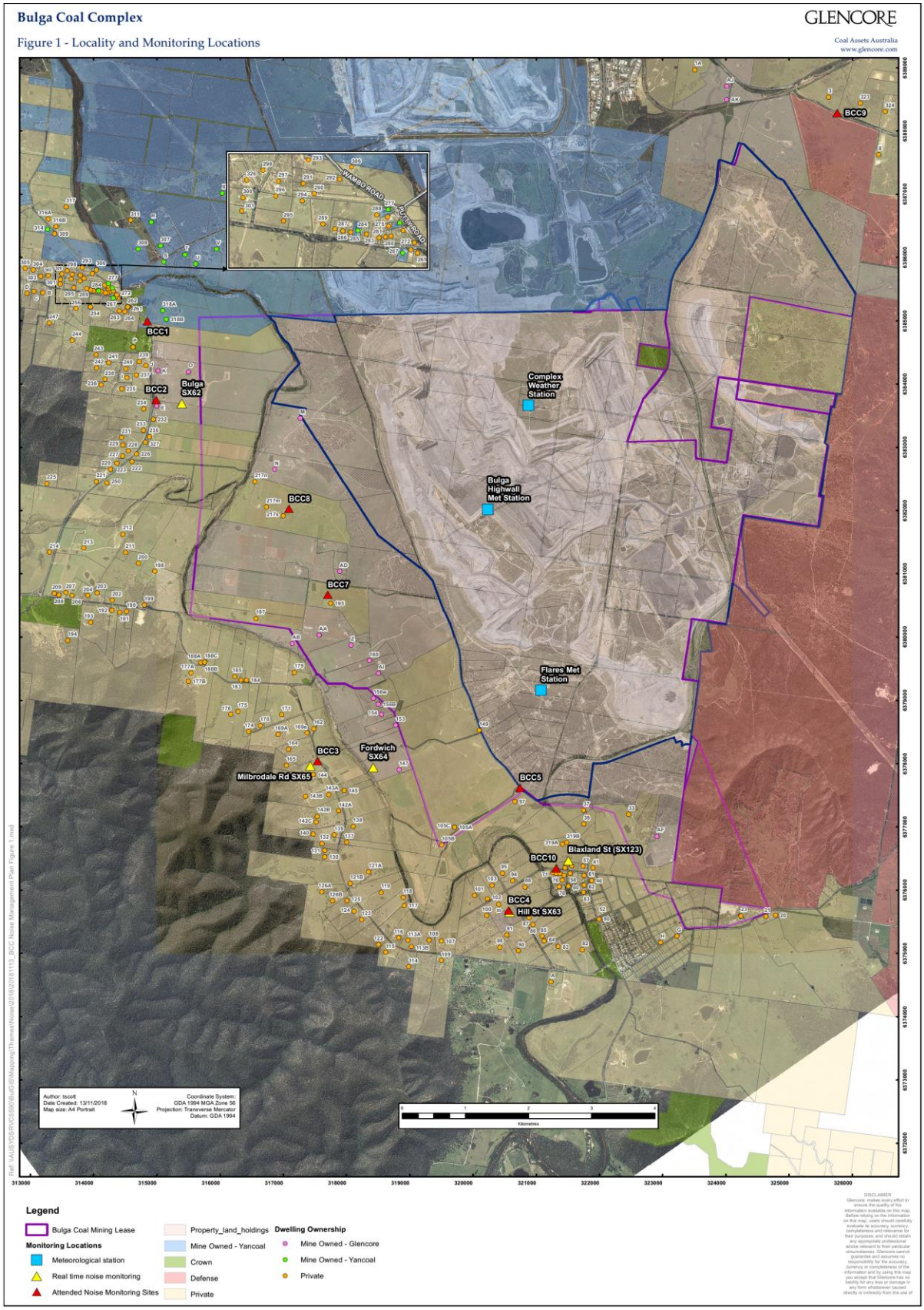

Figure 13 - Noise Monitoring Locations (*Source: Bulga Open Cut Noise Management Plan*)

5.7 Cumulative Noise Assessment

The Bulga Optimisation Project NIA included an assessment of potential cumulative noise impact due to concurrent operation with Mount Thorley Warkworth (MTW) mine. Model predictions for MTW used in that assessment were sourced from two documents prepared by EMGA Mitchell McLennan (EMM):

1. an NIA for the Warkworth Extension Project titled '*Mount Thorley Warkworth Operations – Proposed Warkworth Extension Acoustic Assessment*', (EMM April 2010); and

2. the Warkworth Extension Preferred Project Report titled '*Proposed Warkworth Extension – Preferred Project Report*' (EMM September 2011).

The Bulga Optimisation Project NIA assessment indicated that receptor 1A, which is located in the Mount Thorley area, had predicted exceedance of the night period acceptable amenity noise level. This receptor, and other receptors in this area have acquisition rights with MTW, which was primarily responsible for the predicted cumulative noise level. No exceedances of acceptable amenity noise levels were predicted for the Bulga Village area. Additionally, no exceedances of acceptable amenity noise levels were predicted for receptor 217s, demonstrating compliance at locations further from the MTW complex.

EMM has since prepared an NIA for the Warkworth Continuation Project, titled '*Warkworth Continuation 2014, Noise and Vibration Study*' (EMM 2014). Section 11 of that NIA included a cumulative noise impact assessment, which used Bulga Optimisation Project NIA predictions to assess cumulative noise at receptor locations that may be impacted by both MTW and the BCC. The outcome was that relevant acceptable amenity noise levels would be satisfied at most locations. The exception was one receptor in Warkworth Village, which would not be affected by noise from the BCC.

This NIA demonstrates that the Proposed Modification will be able to continue to operate within approved operational noise criteria prescribed in SSD-4960. Therefore, future contributions to cumulative noise levels from the Proposed Modification should not exceed the model predictions presented in the Bulga Optimisation Project NIA. Outcomes of previously prepared cumulative noise impact assessments for the Bulga Optimisation Project and Warkworth Continuation Project NIAs remain unchanged, and compliance with acceptable amenity noise levels is expected to continue.

6 MANAGEMENT AND MONITORING

The existing noise management system at the BCC is generally consistent with many other mining operations in the Hunter Valley, and is adequate for noise management purposes. Procedures for management and monitoring are outlined in the Bulga Open Cut Noise Management Plan (NMP), which includes sections regarding the following:

- Planning;
- Implementation;
- Measurement and evaluation;
- Review and improvement; and
- Accountabilities.

Section 4.2 of this NIA details noise controls and management strategies that BCM will implement over the life of the Proposed Modification to ensure compliance with approved noise criteria is maintained. The NMP will be updated to reflect any changes to consent and licence conditions resulting from this application, and will include updated management measures to ensure all commitments are implemented, and monitoring is undertaken as required to maintain compliance with approved noise criteria.

Relevant management measures and noise controls have been included in the noise models and stage plan development. Throughout the life of the mine, alternative noise controls and management strategies may be implemented to ensure ongoing compliance with approved noise criteria.

6.1 Noise Management

BCM operates a comprehensive noise management system on site that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of mining operations, and the implementation of both proactive and reactive noise mitigation measures.

6.1.1 Proactive Management

Mine planning includes development of overburden emplacement strategies to minimise noise impacts, including the provision of shielded tipping locations for night period dumping and different day and night period dumping scenarios. Hauls to out of pit or exposed emplacement areas are strategically designed to obtain beneficial topographical shielding from already constructed emplacement areas.

Daily meteorological forecasts are provided to Open Cut Examiners (OCEs) and dispatchers to assist in managing noise levels from the operation. Mining OCEs and dispatchers review the daily weather forecasts, which include a review of the potential noise risk at sensitive receivers, to consider the most appropriate operational responses to reduce noise emission should noise levels from the operation approach or exceed relevant noise criteria. The aim of this predictive forecasting is to generate awareness of noise enhancing conditions, and consider options to reduce noise levels in advance of

issues arising so that impacts are avoided or reduced in a timely manner.

6.1.2 Reactive Management

BCM operate a real-time noise monitoring network with monitors at the five locations shown on Figure 13. These monitoring locations were selected to be representative of Fordwich, Bulga, Broke and Milbrodale. Data are recorded continuously and reported real-time via an internal website. Monitoring results from the real-time noise monitoring network are used to manage operations and minimise potential for adverse noise emissions from the BCC. An alarm system is utilised to notify relevant personnel when noise levels approach approved noise criteria so that noise management controls can be implemented to maintain compliance. Alarm trigger levels are set below consent noise criteria, allowing action to be taken before compliance limits are reached.

Section 4.2 lists noise management strategies that were included in the modelling assessment. These include:

1. ancillary equipment such as rehabilitation dozers, drill preparation dozers and road/pit maintenance equipment operating in exposed areas will be relocated or shutdown;

2. exposed waste emplacement area dozers will be either replaced with rubber tyred dozers, restricted to first gear operation, relocated, or shutdown;

3. any other dozers operating in exposed areas will be either replaced with rubber tyred dozers, restricted to first gear operation, relocated, or shutdown;

4. underground operations surface coal haulage will be shut down;

5. haulage to exposed waste emplacement areas will be relocated to use more shielded haul roads and emplacement areas deeper in the pit;

6. blast hole drills may be shut down; and

7. excavators and associated equipment, including haul trucks, will be progressively shutdown or relocated to more shielded pit areas.

BCM is committed to progressively applying these management strategies to the mining operation to ensure continued compliance with approved noise criteria.

6.1.3 Sound Power Testing

BCM undertake regular sound power screening to assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages. BCM will continue regular inspection and maintenance of noise attenuation packages. The sound power levels of any new equipment purchased for the site will be managed to ensure sound power levels are generally consistent with the existing fleet.

6.2 Evaluation of Impacts and Performance

BCM regularly evaluates the outcomes of noise monitoring results to determine the success of noise mitigation. The performance of the BCC in relation to noise management is evaluated through the following measures:

- undertaking comparisons of monitoring results against SSD-4960 noise criteria and predictions presented in the Bulga Optimisation Project NIA;
- independent environmental audits, which are made available on the BCC website;
- engaging specialists to undertake independent noise investigations as required;
- quarterly monitoring reports, which are made available on the BCC website; and
- the Annual Review which is submitted to the DP&E and relevant agencies.

6.3 Change Management

A change management procedure is implemented by BCM to evaluate potential noise impacts associated with any operational changes. Such changes can include, but are not limited to:

- significant changes to the number of equipment or type of equipment utilised on site, which may result in exceedance of approved noise criteria;
- when the proposed mine plan configuration/orientation or hours of operation is substantially different to that which has been assessed in the relevant environmental assessment; or
- prior to purchase or rental of equipment which has the potential to result in exceedances of approved noise criteria.

Proposed changes to activities are included in the BCC noise model to evaluate potential impact. The noise model results are used to determine whether any additional noise mitigation measures are required.

6.4 Commitments

The Bulga Optimisation Project EIS (Section 5.4.3) outlined commitments BCM made to assist in managing noise emission from the site, and to achieve the predicted noise levels presented in the Bulga Optimisation Project NIA. Some of these commitments are either no longer relevant, or are now complete. BCM intends to operate the Proposed Modification in line with the following commitments:

- Overburden emplacement strategies will be implemented to meet relevant noise criteria. This may include measures such as provision of shielded tipping locations for night period dumping and different day and night period hauling/dumping scenarios;
- Haul road bunds will be constructed to a height of 3 metres above road level, where safe and

practicable, in strategic locations on the exposed side of long-term haul roads. A sensitivity analysis was completed that showed increasing the bund height above 3 metres provides minimal additional noise reduction, but construction becomes increasingly difficult and expensive;

- A 20 metre high earth bund will be formed along the inside face of the noise and visual bund adjacent to the long term haul road that will be constructed in that area to provide a higher degree of shielding to the haul road that will connect the southern mining area to the northern waste emplacement areas. Alternate or additional measures may be used over time to provide equivalent outcomes;
- Operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria;
- Retention of the hydraulic snubber on the face shovel so this noise source will not be a cause of sleep disturbance;
- Continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages;
- Continuous noise monitoring will be continued at strategic off-site locations to provide real time feedback to the mine for noise management;
- Monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management; and
- Reasonable and feasible noise mitigation measures will be offered to landowners listed in Table 2 (Condition 2 of Schedule 3) of SSD-4960.

6.5 Monitoring

Both unattended (real-time) and attended noise monitoring is used to evaluate site noise performance. Unattended monitoring is used for day-to-day management, whilst attended measurement is used to evaluate compliance with approved noise criteria.

6.5.1 Attended Compliance Monitoring

Independent attended compliance monitoring is undertaken one night per month at ten locations around the BCC. These locations are listed in Table 5.2 and shown on Figure 13.

Table 6.1: ATTENDED NOISE MONITORING LOCATIONS

Location Descriptor ID	Monitoring Location
BCC1	Bulga Village
BCC2	2241 Putty Road
BCC3	803 Milbrodale Road

BCC4	115 Hill Street
BCC5	Broke Cemetery
BCC7	179 Cobcroft Road
BCC8	154 Cobcroft Road
BCC9	Mitchell Line Road
BCC10	Blaxland Street

Based on the results of this assessment, it is recommended these locations be retained for continued monitoring of compliance of the Proposed Modification. Changes to the mining footprint are minimal, and the existing monitoring locations are considered representative of noise sensitive receptor areas around the BCC.

6.5.2 Unattended Management Monitoring

The unattended real-time continuous monitoring system is described in Section 6.1.2 of this NIA. The current system is deemed adequate for continued management of operational noise.

7 CONCLUSION

This noise impact assessment demonstrates that the Proposed Modification will be able to continue to operate in accordance with approved noise criteria set out in Appendix 6 of SSD-4960 through implementation of feasible and reasonable noise controls and management strategies.

The existing noise management system is considered comprehensive and consistent with industry best practice. The BCC noise management plan will be updated to incorporate revised noise commitments and noise management procedures.

Global Acoustics Pty Ltd

8 REFERENCES

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Appendix

A OPERATIONAL NOISE RESULTS

Table A.1: 90th PERCENTILE MITIGATED SCENARIO PREDICTIONS- $L_{Aeq,15minute}$ dB

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1A	35	35	35	34	35	35	33	34	34	34	34	34	33	33	33
3	35	35	35	28	28	29	26	26	28	27	26	27	25	24	24
8	35	35	35	31	33	34	30	32	33	34	33	34	31	29	30
20	35	35	35	28	30	31	28	30	32	29	31	32	27	29	29
21	35	35	35	27	30	31	28	30	32	28	31	32	25	29	29
23	35	35	35	22	30	31	20	30	30	23	31	32	22	28	28
33	35	35	35	21	26	24	21	26	25	25	25	24	21	25	24
37	35	35	35	20	20	19	20	22	21	21	22	21	20	20	20
38	35	35	35	22	31	27	22	30	27	25	30	27	23	29	26
41	35	35	35	29	32	32	29	32	32	30	34	34	29	32	31
46	35	35	35	30	32	33	29	32	32	30	34	34	29	32	32
55	35	35	35	31	33	33	29	33	32	31	34	34	30	33	33
56	35	35	35	30	33	33	29	33	32	30	34	34	30	33	33
57	35	35	35	30	33	33	29	33	33	30	34	34	30	33	33
58	35	35	35	31	33	33	29	33	32	31	34	34	30	33	33
60	35	35	35	31	32	32	29	32	32	31	33	34	30	33	33
61	35	35	35	31	32	33	29	33	32	30	34	34	30	33	32
62	35	35	35	31	32	32	29	32	32	31	33	34	30	32	32
63	35	35	35	31	32	32	29	32	32	31	33	34	30	33	32
71	35	35	35	31	33	33	30	33	32	31	34	34	30	33	33
72	35	35	35	31	33	33	30	33	32	31	34	34	30	33	33
73	35	35	35	31	33	33	30	33	32	31	34	34	31	33	33

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
74	35	35	35	31	33	33	29	33	32	31	34	34	31	33	33
76	35	35	35	31	33	33	29	33	32	31	34	34	30	33	33
78	35	35	35	31	32	32	29	33	32	31	33	33	30	33	33
80	35	35	35	30	31	32	28	31	31	31	32	33	29	31	31
82	35	35	35	29	31	31	28	30	30	31	31	32	29	31	31
83	35	35	35	30	31	31	28	32	31	31	32	32	29	31	31
84	35	35	35	30	32	31	29	32	32	31	32	32	29	32	31
85	35	35	35	31	32	32	29	33	32	31	32	32	30	32	32
86	35	35	35	31	33	33	29	33	32	31	32	32	30	32	32
87	35	35	35	31	32	32	28	33	31	30	31	31	28	31	29
88	35	35	35	33	34	34	31	34	34	32	34	33	31	34	34
90	35	35	35	31	32	32	29	33	32	31	32	31	30	32	32
91	35	35	35	30	31	32	29	31	32	31	32	31	30	32	33
93	35	35	35	33	34	34	31	34	34	32	34	33	32	34	35
94	35	35	35	33	34	35	31	35	35	33	34	34	32	35	35
95	36	36	36	33	35	35	31	34	35	33	34	34	32	35	35
97	35	35	35	31	35	34	30	34	33	33	35	35	34	33	32
98	35	35	35	32	32	32	30	33	33	31	32	32	31	33	33
100	35	35	35	26	29	28	25	28	27	27	29	28	26	28	28
101	35	35	35	32	33	33	30	33	34	32	34	33	31	34	34
102	35	35	35	33	34	34	31	34	34	32	34	33	31	34	35
103	35	35	35	33	34	34	31	34	35	33	34	33	32	35	35
105A	35	35	35	33	34	34	33	34	35	34	35	35	34	35	34

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
105B	35	35	35	31	33	33	32	32	33	34	34	34	33	34	33
107	35	35	35	31	32	32	30	32	32	31	32	31	30	32	33
108	35	35	35	31	32	32	30	32	32	31	32	31	30	32	33
109	35	35	35	31	31	32	30	32	32	31	32	31	30	32	32
113A	35	35	35	30	31	31	30	32	32	31	32	31	31	31	31
113B	35	35	35	31	32	31	30	32	32	31	32	31	31	32	32
114	35	35	35	30	31	31	29	32	31	30	32	31	30	31	31
115	35	35	35	30	31	31	30	32	32	31	32	31	31	31	32
116	35	35	35	30	32	31	31	32	32	31	32	31	32	31	31
117	35	35	35	29	30	30	31	30	31	32	32	32	32	31	31
118	35	35	35	29	30	30	31	29	30	31	32	31	32	31	31
119	35	35	35	29	31	31	27	30	28	31	32	31	29	31	29
121A	35	35	35	30	31	31	28	31	30	31	31	31	29	31	29
121B	35	35	35	30	31	30	28	31	29	31	31	30	29	30	28
122	35	35	35	31	31	31	30	32	32	31	32	31	32	32	32
123	35	35	35	29	30	30	30	30	31	32	32	31	32	31	31
124	35	35	35	30	31	31	31	31	31	32	32	31	32	32	32
125	35	35	35	31	32	31	30	32	32	31	32	31	32	32	32
126A	35	35	35	32	31	31	28	32	30	31	31	30	30	31	30
126B	35	35	35	32	31	31	28	32	30	31	31	30	31	31	30
130	35	35	35	33	33	32	30	33	32	32	33	32	32	33	32
131	35	35	35	33	33	32	31	33	32	32	33	32	32	33	33
132	35	35	35	33	33	32	31	33	33	33	33	32	32	33	33

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
137	35	35	35	33	33	32	30	33	33	33	33	32	32	33	33
138	35	35	35	33	34	33	30	34	33	33	33	33	32	34	33
139	35	35	35	33	33	32	32	34	33	33	34	33	32	34	33
140	35	35	35	32	33	32	31	34	32	33	34	32	33	34	33
142A	36	36	36	32	33	32	32	33	33	34	34	33	32	34	33
142B	35	35	35	32	33	32	32	34	32	33	34	33	33	34	33
142C	35	35	35	32	33	32	32	34	32	33	34	33	33	34	33
143A	35	35	35	31	33	32	32	32	33	33	34	34	32	32	32
143B	36	36	36	31	33	32	32	34	32	33	34	33	33	33	33
144	35	35	35	31	33	32	31	32	31	33	34	34	31	32	30
145	35	35	35	30	31	31	31	31	30	32	34	33	31	30	28
149	NA [1]	NA [1]	NA [1]	38	41	40	37	40	39	39	42	40	38	42	39
162	35	35	35	31	32	32	30	32	32	33	33	33	31	31	31
164	36	36	36	32	33	32	31	33	32	33	33	33	32	33	32
165	36	36	36	32	33	32	32	34	33	34	34	34	34	34	33
169A	35	35	35	32	31	31	30	32	32	33	32	32	32	32	31
169e	35	35	35	31	32	32	30	32	31	33	33	33	32	31	31
170	35	35	35	31	31	31	29	32	32	33	31	32	32	33	32
171	35	35	35	30	32	32	30	31	32	34	32	32	32	31	31
174	35	35	35	33	32	31	29	32	32	33	31	31	32	32	32
175	35	35	35	32	31	32	29	31	32	33	31	31	32	32	32
176	35	35	35	33	31	31	29	31	32	33	31	31	32	33	33
177A	35	35	35	32	30	30	29	31	32	32	30	30	32	31	31

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
177B	35	35	35	32	31	31	29	31	32	32	30	30	32	31	32
179	35	35	35	33	34	34	33	34	33	35	34	35	34	33	33
183	35	35	35	31	31	31	29	30	32	33	31	32	32	30	30
184	35	35	35	31	31	32	30	30	32	33	31	32	32	31	30
185	35	35	35	31	31	31	29	30	31	33	31	31	32	30	30
188A	35	35	35	31	30	31	29	30	31	32	31	31	31	30	31
188B	35	35	35	31	30	31	29	30	31	33	31	31	31	30	31
188C	35	35	35	31	30	31	29	30	31	33	31	31	31	30	31
190	35	35	35	29	30	30	27	29	30	30	29	29	29	29	29
191	35	35	35	30	30	30	29	30	30	31	30	30	30	30	30
192	35	35	35	30	30	30	28	30	30	31	30	30	30	29	30
193	35	35	35	29	30	30	28	30	31	31	30	29	30	29	29
194	35	35	35	10	10	10	10	10	10	10	10	10	10	10	10
195	36	36	36	32	33	34	31	33	34	34	34	34	34	32	31
197	35	35	35	31	31	32	30	31	33	34	32	33	33	30	30
198	35	35	35	30	30	30	29	30	31	32	31	31	31	30	30
199	35	35	35	30	30	30	29	30	31	32	30	30	31	30	30
200	35	35	35	31	31	31	29	30	31	32	30	30	31	30	30
202	35	35	35	29	29	29	27	28	29	30	29	29	28	27	27
203	35	35	35	29	30	30	27	29	29	30	29	29	29	29	29
204	35	35	35	23	24	25	22	24	25	25	26	26	24	23	23
206	35	35	35	24	24	25	23	25	25	26	26	27	24	23	23
207	35	35	35	24	24	25	23	25	26	26	26	26	24	23	23

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
208	35	35	35	24	24	25	23	25	26	27	26	26	25	23	23
209	35	35	35	24	24	25	23	25	26	27	26	26	25	23	23
211	35	35	35	31	31	31	29	30	31	32	30	30	31	29	30
212	35	35	35	32	31	31	29	30	31	32	30	31	31	29	30
213	35	35	35	31	31	31	28	30	31	31	30	30	30	29	30
214	35	35	35	30	30	30	28	30	31	30	29	30	30	28	29
217m	35	35	35	31	34	35	30	33	34	35	33	34	34	32	32
217n	35	35	35	29	34	34	29	33	34	34	33	33	33	31	32
217s	36	36	36	32	35	35	31	33	35	36	34	34	35	32	32
220	35	35	35	32	32	32	30	32	33	32	30	30	31	28	29
221	35	35	35	32	31	32	30	32	32	32	30	30	31	29	30
222	35	35	35	33	33	33	30	33	33	32	31	31	31	29	29
223	35	35	35	32	32	32	30	33	33	32	31	31	31	28	29
225	35	35	35	31	30	30	29	31	31	31	29	30	30	28	29
226	35	35	35	33	33	33	30	33	33	33	31	31	31	29	30
227	35	35	35	32	32	32	30	33	33	32	31	31	31	29	29
228	35	35	35	32	32	33	30	33	33	32	31	31	31	29	30
229	35	35	35	32	32	32	30	33	33	32	31	31	31	29	30
230	35	35	35	33	33	33	31	33	34	33	31	32	31	31	32
231	35	35	35	32	32	32	30	32	33	32	31	31	31	30	31
232	35	35	35	33	33	33	32	33	34	33	33	33	32	31	32
233	35	35	35	33	32	33	30	33	34	33	31	32	31	30	31
234	35	35	35	33	33	33	32	33	34	33	32	33	33	31	32

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
235	35	35	35	33	32	33	33	34	35	33	33	33	32	31	32
236	35	35	35	32	32	32	32	33	34	32	32	32	32	30	31
237	35	35	35	34	32	33	34	34	35	33	33	33	33	31	32
238	35	35	35	33	32	32	32	33	34	32	32	32	32	30	31
239	35	35	35	30	31	32	28	30	31	31	29	30	29	27	28
240	35	35	35	33	32	33	33	33	34	33	33	33	33	31	32
241	35	35	35	33	32	32	33	33	34	33	32	32	32	30	31
242	35	35	35	33	31	32	32	33	33	32	32	32	32	30	31
243	35	35	35	33	31	32	32	32	33	32	32	32	32	30	31
244	35	35	35	32	31	31	32	32	32	32	31	31	31	29	30
247	35	35	35	31	30	30	31	31	32	31	30	30	31	28	29
250	35	35	35	32	32	32	30	32	32	32	30	30	31	29	29
254	35	35	35	32	31	31	32	31	32	32	31	31	31	29	30
256	35	35	35	32	30	31	32	31	32	32	31	31	31	29	30
261	35	35	35	33	31	32	32	32	33	33	32	32	32	30	31
262	35	35	35	33	31	32	32	32	33	33	32	32	32	30	31
263	35	35	35	33	31	32	32	32	33	33	32	32	32	30	31
264	35	35	35	33	31	32	33	32	33	33	32	32	32	30	31
265	35	35	35	33	31	32	32	32	33	32	31	32	31	30	31
266	35	35	35	33	31	32	32	32	33	32	31	32	31	30	30
272	35	35	35	33	31	32	32	32	33	32	31	32	31	30	31
273	35	35	35	33	31	31	32	32	33	32	31	31	31	30	30
275	35	35	35	33	31	31	32	32	33	32	31	31	31	29	30

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
276	35	35	35	33	31	31	32	32	32	32	31	31	31	29	30
279	35	35	35	33	31	31	32	32	33	32	31	31	31	29	30
280	35	35	35	33	31	31	32	32	33	32	31	31	31	29	30
281	35	35	35	33	31	31	32	32	33	32	31	31	31	29	30
283	35	35	35	33	31	31	32	31	32	32	31	31	31	29	30
285	35	35	35	32	31	31	32	31	32	32	31	31	31	29	30
286	35	35	35	32	30	31	32	31	32	32	31	31	31	29	30
287	35	35	35	32	30	31	32	31	32	32	31	31	31	29	30
288	35	35	35	33	30	31	32	31	32	32	31	31	31	29	30
289	35	35	35	32	30	31	31	31	32	32	31	31	31	29	30
290	35	35	35	32	30	30	31	31	32	32	30	31	31	29	30
291	35	35	35	32	30	30	31	31	32	31	30	31	31	28	29
292	35	35	35	32	30	31	31	31	32	32	30	31	31	29	30
293	35	35	35	32	30	30	31	31	32	31	30	31	30	28	29
294	35	35	35	32	30	30	31	31	32	32	30	31	31	29	29
295	35	35	35	32	30	30	31	31	32	32	30	31	31	29	29
296	35	35	35	32	30	30	31	30	31	31	30	30	31	28	29
297	35	35	35	32	29	30	31	30	31	31	30	30	30	28	29
298	35	35	35	27	27	28	25	26	27	28	25	26	26	24	24
300	35	35	35	24	24	24	22	23	24	25	22	23	23	21	22
301	35	35	35	24	23	23	22	23	24	25	22	22	23	20	21
302	35	35	35	25	25	26	24	25	26	25	24	25	24	23	24
303	35	35	35	28	28	28	26	27	28	29	26	27	27	25	26

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
304	35	35	35	31	29	29	30	30	31	31	29	30	30	27	28
305	35	35	35	31	29	29	30	30	30	31	29	29	30	27	28
306	35	35	35	32	30	31	31	31	32	31	30	31	31	29	30
309	35	35	35	31	29	29	30	29	30	30	29	29	30	27	28
311	35	35	35	31	30	31	31	31	32	31	30	31	30	28	29
316A	35	35	35	30	28	29	29	29	30	30	29	29	29	27	28
316B	35	35	35	31	29	29	30	29	30	30	29	29	29	27	28
317	35	35	35	30	29	29	29	29	30	30	29	29	29	27	28
319A	35	35	35	31	34	34	30	33	33	30	34	33	30	33	33
319B	35	35	35	30	33	34	29	33	33	30	34	33	30	33	33
323	35	35	35	32	34	35	33	34	35	34	34	34	32	33	33
324	35	35	35	29	30	31	29	31	32	31	30	32	27	26	28
325	35	35	35	33	34	35	30	31	33	33	33	34	30	29	30
326	35	35	35	23	22	22	22	22	23	25	21	22	22	19	20
327	35	35	35	33	33	33	31	33	34	33	31	32	31	29	30
328	35	35	35	31	32	33	29	33	32	31	34	34	30	33	33
329	35	35	35	31	33	33	29	33	32	31	33	34	30	33	33
330	35	35	35	31	33	33	30	33	32	31	34	34	30	33	33
331	35	35	35	30	32	32	29	32	31	31	33	33	30	32	32
332	35	35	35	30	32	32	29	32	31	31	33	33	30	32	32
333	35	35	35	30	32	32	29	32	32	31	33	34	29	32	32
334	35	35	35	30	32	32	29	32	32	31	33	33	30	32	31
335	35	35	35	30	31	32	29	31	31	30	32	33	29	31	31

Receptor ID	Criteria			2022			2026			2031			2035		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
336	35	35	35	30	31	32	28	31	31	30	32	33	29	31	31
337	35	35	35	30	32	32	29	31	31	31	32	33	29	31	31
338	35	35	35	29	31	31	28	31	31	30	32	33	29	31	30
339	35	35	35	30	32	32	29	31	31	31	32	33	29	32	32
340	35	35	35	30	32	32	29	31	31	31	32	33	30	32	32
341	35	35	35	30	32	32	29	32	32	31	33	33	30	31	31
342	35	35	35	30	33	33	29	33	32	30	34	34	29	32	32
343	35	35	35	33	34	34	31	34	34	32	34	33	31	35	35
344	35	35	35	29	32	31	29	32	31	30	32	31	30	31	30
345	35	35	35	31	32	32	29	32	32	31	33	34	30	33	32
A	35	35	35	29	31	31	28	31	31	30	31	31	29	32	31
B	35	35	35	30	28	29	28	28	29	31	29	30	30	27	28
C	35	35	35	23	24	24	21	23	24	25	23	24	22	21	22
D	35	35	35	25	26	27	24	26	27	27	25	26	25	23	23
G	35	35	35	27	30	31	27	30	31	28	31	32	27	30	29
H	35	35	35	29	30	31	27	30	31	29	30	31	28	30	30
I	35	35	35	33	32	33	33	34	35	33	33	33	33	31	32
J	35	35	35	27	29	29	26	28	29	29	28	29	27	26	27
P	35	35	35	34	32	32	33	33	34	33	33	33	33	31	32

Notes:

1. *Criteria not applicable as property subject to acquisition on request.*

APPENDIX

B MODELLED SOURCE LOCATIONS

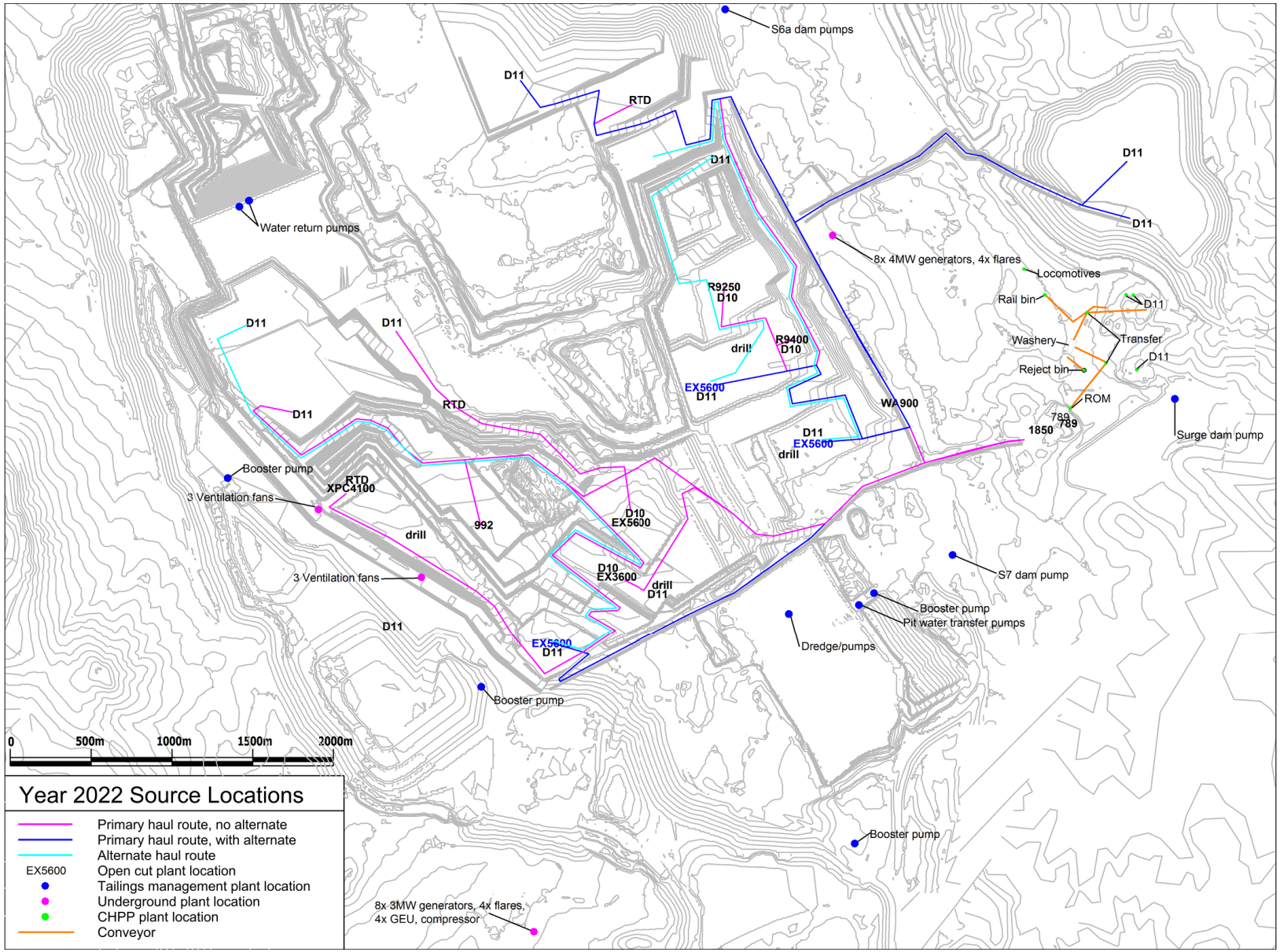
Each of the mine progression stage plans modelled included open cut mining equipment, CHPP infrastructure, underground mining surface infrastructure, and equipment required for tailing relocation. The following four figures show pit shell topography and haul road alignments for each of the four stage plans. Each figure shows modelled source locations, including alternate haul alignments where more than one was assessed for any given excavator. Mitigated scenarios that considered various operating configurations were developed from the available source options.

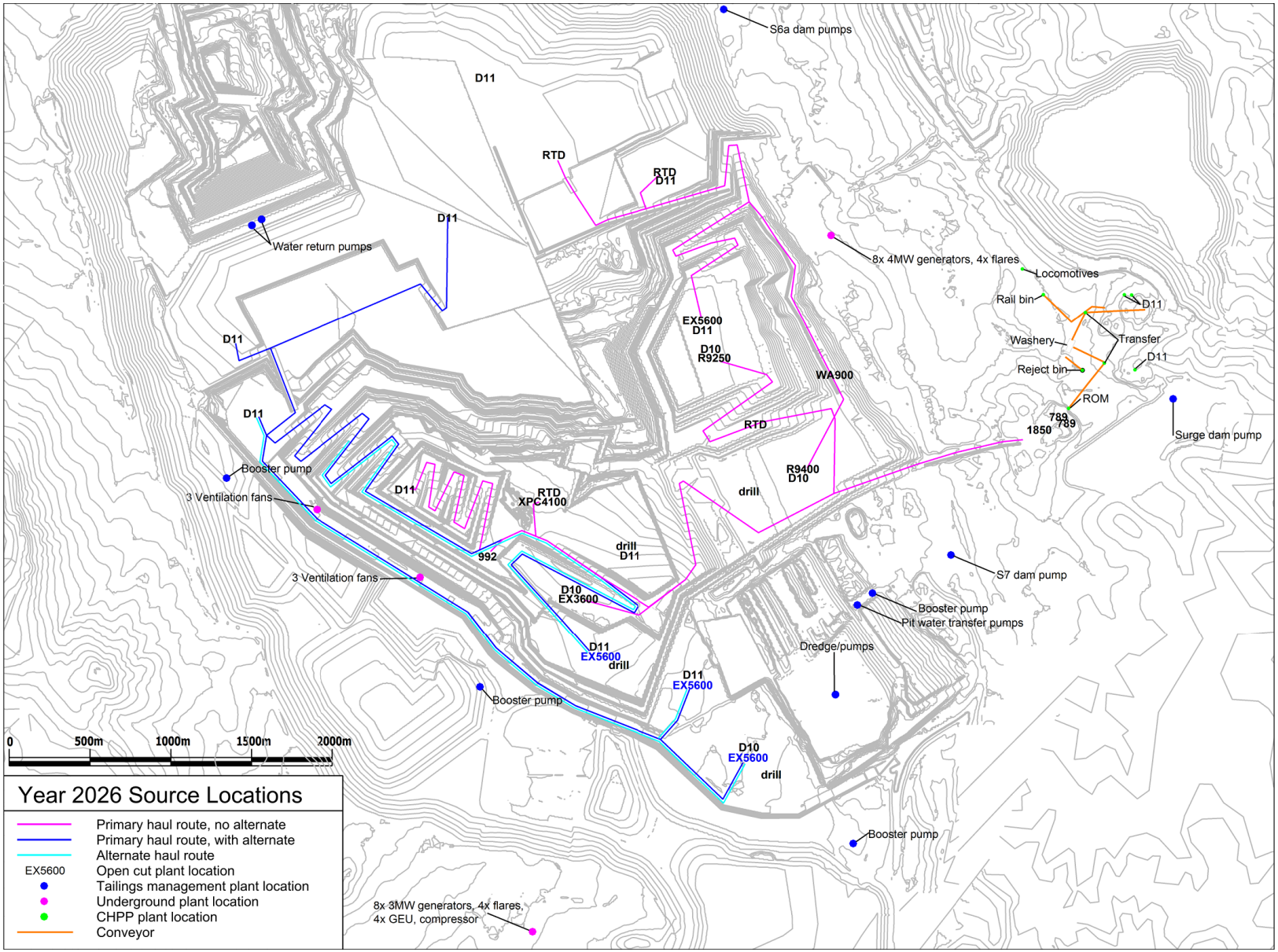
Open cut equipment is shown using identification tags located at the modelled location. Table 8.1 relates identification tags to equipment type.

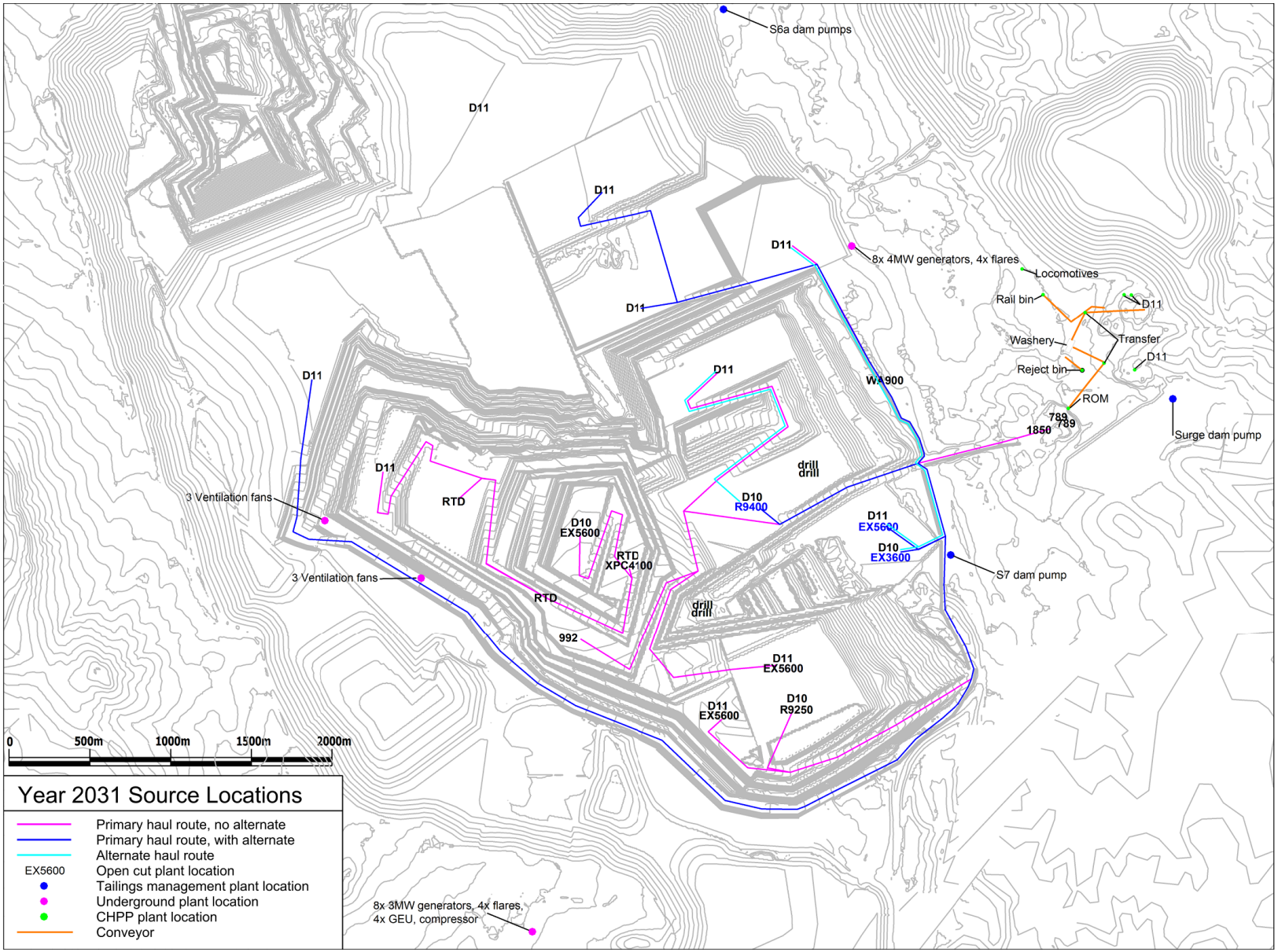
Primary haul routes where no shielded alternative was considered are shown in magenta. Primary haul routes where an alternate, more shielded, haul route option was considered are shown in dark blue. Light blue lines show alternate haul alignments where relevant.

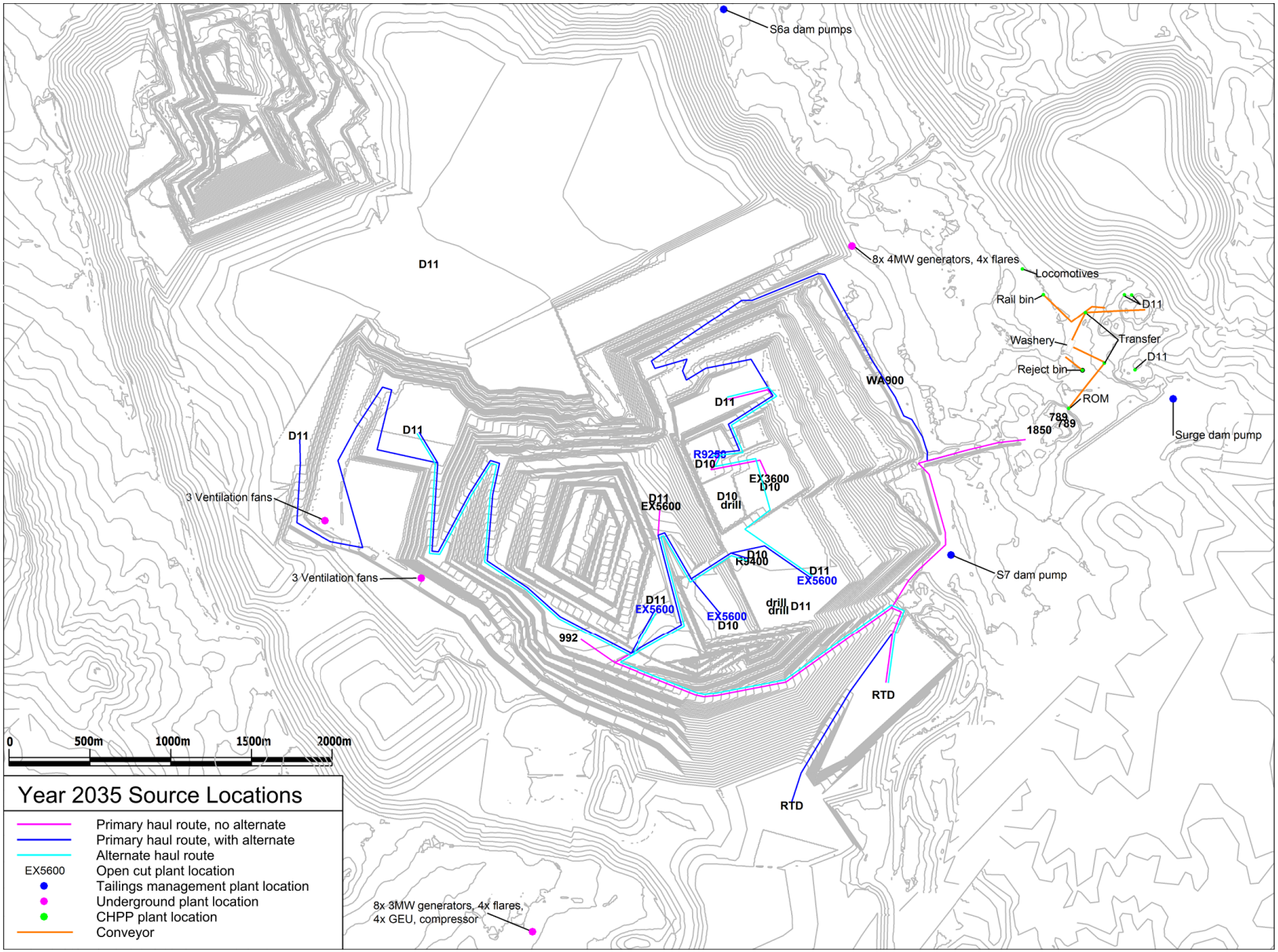
Table 8.1: OPEN CUT EQUIPMENT INCLUDED IN MODELS

Identification Tag	Description
EX5600	Hitachi EX5600 excavator
EX3600	Hitachi EX3600 excavator
R9400	Liebherr R9400 excavator
R9250	Liebherr R9250 excavator
XPC4100	P&H 4100XPC electric shovel
789	Caterpillar 789C XQ water truck
1850	LeTourneau 1850 front end loader
WA900	Komatsu WA900 front end loader
992	Caterpillar 992 front end loader
D11	Caterpillar D11 dozer
D10	Caterpillar D10 dozer
RTD	Caterpillar 854H rubber tyre dozer
drill	Sandvik D75K blast hole drill


S6a dam pumps
D11
RTD
D11
D11
D11
Water return pumps
8x 4MW generators, 4x flares
Locomotives
Rail bin
D11
R9250
D10
D11
D11
R9400
D10
drill
Washery
Transfer
D11
Reject bin
EX5600
D11
WA900
ROM
789
789
1850
Surge dam pump
D11
RTD
D11
EX5600
drill
Booster pump
RTD
XPC4100
3 Ventilation fans
D10
EX5600
992
drill
S7 dam pump
D10
EX3600
drill
D11
3 Ventilation fans
Booster pump
Pit water transfer pumps
D11
EX5600
D11
Dredge/pumps
Booster pump
Booster pump
0
500m
1000m
1500m
2000m
Year 2022 Source Locations
Primary haul route, no alternate
Primary haul route, with alternate
Alternate haul route
EX5600
Open cut plant location
Tailings management plant location
Underground plant location
CHPP plant location
Conveyor
8x 3MW generators, 4x flares,
4x GEU, compressor


S6a dam pumps
D11
RTD
RTD
D11
D11
Water return pumps
8x 4MW generators, 4x flares
Locomotives
Rail bin
D11
EX5600
D11
D10
R9250
WA900
Washery
Transfer
D11
Reject bin
D11
ROM
789
789
1850
Surge dam pump
RTD
Booster pump
R9400
D10
3 Ventilation fans
D11
RTD
XPC4100
drill
992
drill
D11
S7 dam pump
3 Ventilation fans
D10
EX3600
Booster pump
Pit water transfer pumps
D11
EX5600
drill
Dredge/pumps
D11
EX5600
Booster pump
0
500m
1000m
1500m
2000m
D10
EX5600
drill
Booster pump
Year 2026 Source Locations
Primary haul route, no alternate
Primary haul route, with alternate
Alternate haul route
EX5600
Open cut plant location
Tailings management plant location
Underground plant location
CHPP plant location
Conveyor
8x 3MW generators, 4x flares,
4x GEU, compressor


S6a dam pumps
D11
D11
D11
D11
D11
D11
8x 4MW generators, 4x flares
Locomotives
Rail bin
D11
Washery
Transfer
D11
Reject bin
ROM
789
789
1850
Surge dam pump
WA900
3 Ventilation fans
3 Ventilation fans
D11
RTD
RTD
D10
EX5600
RTD
XPC4100
drill
drill
D10
R9400
D11
EX5600
D10
EX3600
S7 dam pump
RTD
drill
drill
992
D11
EX5600
D11
EX5600
D10
R9250
0
500m
1000m
1500m
2000m
Year 2031 Source Locations
Primary haul route, no alternate
Primary haul route, with alternate
Alternate haul route
EX5600
Open cut plant location
Tailings management plant location
Underground plant location
CHPP plant location
Conveyor
8x 3MW generators, 4x flares,
4x GEU, compressor


S6a dam pumps
8x 4MW generators, 4x flares
Locomotives
Rail bin
D11
Washery
Transfer
D11
Reject bin
ROM
789
789
1850
Surge dam pump
WA900
D11
D11
D11
3 Ventilation fans
3 Ventilation fans
R9250
D10
EX3600
D10
D11
EX5600
D10
drill
D10
R9400
D11
EX5600
D11
EX5600
drill
drill
D11
EX5600
D10
992
S7 dam pump
RTD
RTD
0
500m
1000m
1500m
2000m
Year 2035 Source Locations
Primary haul route, no alternate
Primary haul route, with alternate
Alternate haul route
EX5600
Open cut plant location
Tailings management plant location
Underground plant location
CHPP plant location
Conveyor
8x 3MW generators, 4x flares,
4x GEU, compressor

APPENDIX

C MODELLED METEOROLOGICAL CONDITIONS

Table C.1: MODELLED METEOROLOGICAL CONDITIONS

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	0	0	-1.6
10	80	0	0	1
10	80	0	0	4
10	80	0.75	0	-1.6
10	80	0.75	22.5	-1.6
10	80	0.75	45	-1.6
10	80	0.75	67.5	-1.6
10	80	0.75	90	-1.6
10	80	0.75	112.5	-1.6
10	80	0.75	135	-1.6
10	80	0.75	157.5	-1.6
10	80	0.75	180	-1.6
10	80	0.75	202.5	-1.6
10	80	0.75	225	-1.6
10	80	0.75	247.5	-1.6
10	80	0.75	270	-1.6
10	80	0.75	292.5	-1.6
10	80	0.75	315	-1.6
10	80	0.75	337.5	-1.6
10	80	0.75	0	1
10	80	0.75	22.5	1
10	80	0.75	45	1
10	80	0.75	67.5	1
10	80	0.75	90	1
10	80	0.75	112.5	1
10	80	0.75	135	1
10	80	0.75	157.5	1
10	80	0.75	180	1
10	80	0.75	202.5	1
10	80	0.75	225	1
10	80	0.75	247.5	1
10	80	0.75	270	1
10	80	0.75	292.5	1
10	80	0.75	315	1
10	80	0.75	337.5	1
10	80	0.75	0	4
10	80	0.75	22.5	4

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	0.75	45	4
10	80	0.75	67.5	4
10	80	0.75	90	4
10	80	0.75	112.5	4
10	80	0.75	135	4
10	80	0.75	157.5	4
10	80	0.75	180	4
10	80	0.75	202.5	4
10	80	0.75	225	4
10	80	0.75	247.5	4
10	80	0.75	270	4
10	80	0.75	292.5	4
10	80	0.75	315	4
10	80	0.75	337.5	4
10	80	1.5	0	-1.6
10	80	1.5	22.5	-1.6
10	80	1.5	45	-1.6
10	80	1.5	67.5	-1.6
10	80	1.5	90	-1.6
10	80	1.5	112.5	-1.6
10	80	1.5	135	-1.6
10	80	1.5	157.5	-1.6
10	80	1.5	180	-1.6
10	80	1.5	202.5	-1.6
10	80	1.5	225	-1.6
10	80	1.5	247.5	-1.6
10	80	1.5	270	-1.6
10	80	1.5	292.5	-1.6
10	80	1.5	315	-1.6
10	80	1.5	337.5	-1.6
10	80	1.5	0	1
10	80	1.5	22.5	1
10	80	1.5	45	1
10	80	1.5	67.5	1
10	80	1.5	90	1
10	80	1.5	112.5	1
10	80	1.5	135	1
10	80	1.5	157.5	1

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	1.5	180	1
10	80	1.5	202.5	1
10	80	1.5	225	1
10	80	1.5	247.5	1
10	80	1.5	270	1
10	80	1.5	292.5	1
10	80	1.5	315	1
10	80	1.5	337.5	1
10	80	1.5	0	4
10	80	1.5	22.5	4
10	80	1.5	45	4
10	80	1.5	67.5	4
10	80	1.5	90	4
10	80	1.5	112.5	4
10	80	1.5	135	4
10	80	1.5	157.5	4
10	80	1.5	180	4
10	80	1.5	202.5	4
10	80	1.5	225	4
10	80	1.5	247.5	4
10	80	1.5	270	4
10	80	1.5	292.5	4
10	80	1.5	315	4
10	80	1.5	337.5	4
10	80	2.25	0	-1.6
10	80	2.25	22.5	-1.6
10	80	2.25	45	-1.6
10	80	2.25	67.5	-1.6
10	80	2.25	90	-1.6
10	80	2.25	112.5	-1.6
10	80	2.25	135	-1.6
10	80	2.25	157.5	-1.6
10	80	2.25	180	-1.6
10	80	2.25	202.5	-1.6
10	80	2.25	225	-1.6
10	80	2.25	247.5	-1.6
10	80	2.25	270	-1.6
10	80	2.25	292.5	-1.6

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	2.25	315	-1.6
10	80	2.25	337.5	-1.6
10	80	2.25	0	1
10	80	2.25	22.5	1
10	80	2.25	45	1
10	80	2.25	67.5	1
10	80	2.25	90	1
10	80	2.25	112.5	1
10	80	2.25	135	1
10	80	2.25	157.5	1
10	80	2.25	180	1
10	80	2.25	202.5	1
10	80	2.25	225	1
10	80	2.25	247.5	1
10	80	2.25	270	1
10	80	2.25	292.5	1
10	80	2.25	315	1
10	80	2.25	337.5	1
10	80	2.25	0	4
10	80	2.25	22.5	4
10	80	2.25	45	4
10	80	2.25	67.5	4
10	80	2.25	90	4
10	80	2.25	112.5	4
10	80	2.25	135	4
10	80	2.25	157.5	4
10	80	2.25	180	4
10	80	2.25	202.5	4
10	80	2.25	225	4
10	80	2.25	247.5	4
10	80	2.25	270	4
10	80	2.25	292.5	4
10	80	2.25	315	4
10	80	2.25	337.5	4
10	80	3	0	-1.6
10	80	3	22.5	-1.6
10	80	3	45	-1.6
10	80	3	67.5	-1.6

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	3	90	-1.6
10	80	3	112.5	-1.6
10	80	3	135	-1.6
10	80	3	157.5	-1.6
10	80	3	180	-1.6
10	80	3	202.5	-1.6
10	80	3	225	-1.6
10	80	3	247.5	-1.6
10	80	3	270	-1.6
10	80	3	292.5	-1.6
10	80	3	315	-1.6
10	80	3	337.5	-1.6
10	80	3	0	1
10	80	3	22.5	1
10	80	3	45	1
10	80	3	67.5	1
10	80	3	90	1
10	80	3	112.5	1
10	80	3	135	1
10	80	3	157.5	1
10	80	3	180	1
10	80	3	202.5	1
10	80	3	225	1
10	80	3	247.5	1
10	80	3	270	1
10	80	3	292.5	1
10	80	3	315	1
10	80	3	337.5	1
10	80	3	0	4
10	80	3	22.5	4
10	80	3	45	4
10	80	3	67.5	4
10	80	3	90	4
10	80	3	112.5	4
10	80	3	135	4
10	80	3	157.5	4
10	80	3	180	4
10	80	3	202.5	4

Temperature ^{0}C	Humidity %	Wind Speed m/s	Wind Direction (degrees)	VTG ^{0}C/100m
10	80	3	225	4
10	80	3	247.5	4
10	80	3	270	4
10	80	3	292.5	4
10	80	3	315	4
10	80	3	337.5	4

APPENDIX

D MODELLED RECEPTOR LOCATIONS

Table D.1: MODELLED RECEPTOR LOCATIONS

ID	Surname	Lot	DP	Easting	Northing
1A	Hedley	40	1147419	323510	6388970
3	Tipping	1	741554	325626	6388535
8	Marland	600	1045097	326416	6387627
20	Bosco	2	793013	324782	6375605
21	McNaught	1	793013	324634	6375588
23	Hungerford	2	986831	324245	6375602
33	Howard and Seaglove	11	1069011	322464	6377201
37	Earl	4	248448	321750	6377262
38	Parkes	3	248448	321754	6377045
41	Darcy Byron Pty Ltd	1	1007798	321898	6376352
46	Gleave	12	1077786	321880	6376152
55	Crowe	3	703353	321461	6376356
56	Lambkin	2	703353	321563	6376387
57	Wilson	1	703353	321741	6376377
58	Stafa	312	1058914	321541	6376264
60	Poile	315	1123086	321511	6376063
61	Larkin	1	194003	321759	6376234
62	Sanger	2	194003	321761	6376081
63	O'Toole	14	1077786	321753	6375969
71	Blake and Smith	4	1082385	321263	6376277
72	Matley	3	1082385	321320	6376267
73	McCardle	2	1082385	321384	6376265
74	Towers and Maviglia	1	1082385	321435	6376233
76	Thraves	320	1123084	321414	6376160
78	Smolenaers	325	1123085	321366	6376058
80	Duggan	5	758164	321998	6375545
82	McDonald	371	878038	321730	6375059
83	Nightingale Wines	372	878038	321351	6375107
84	Leslie	4	702093	321130	6375196
85	Towns	3	702093	321096	6375272
86	Schragg	2	702093	320953	6375458
87	Connolly	1	702093	320889	6375571
88	Hilliard	241	1131144	320874	6376004
90	Tsiolkas	2	758164	320717	6375043
91	Dunn	1	758164	320536	6375295
93	Danks	1	758164	320410	6375777
94	Rozene Pty Limited	101	631740	320628	6376153

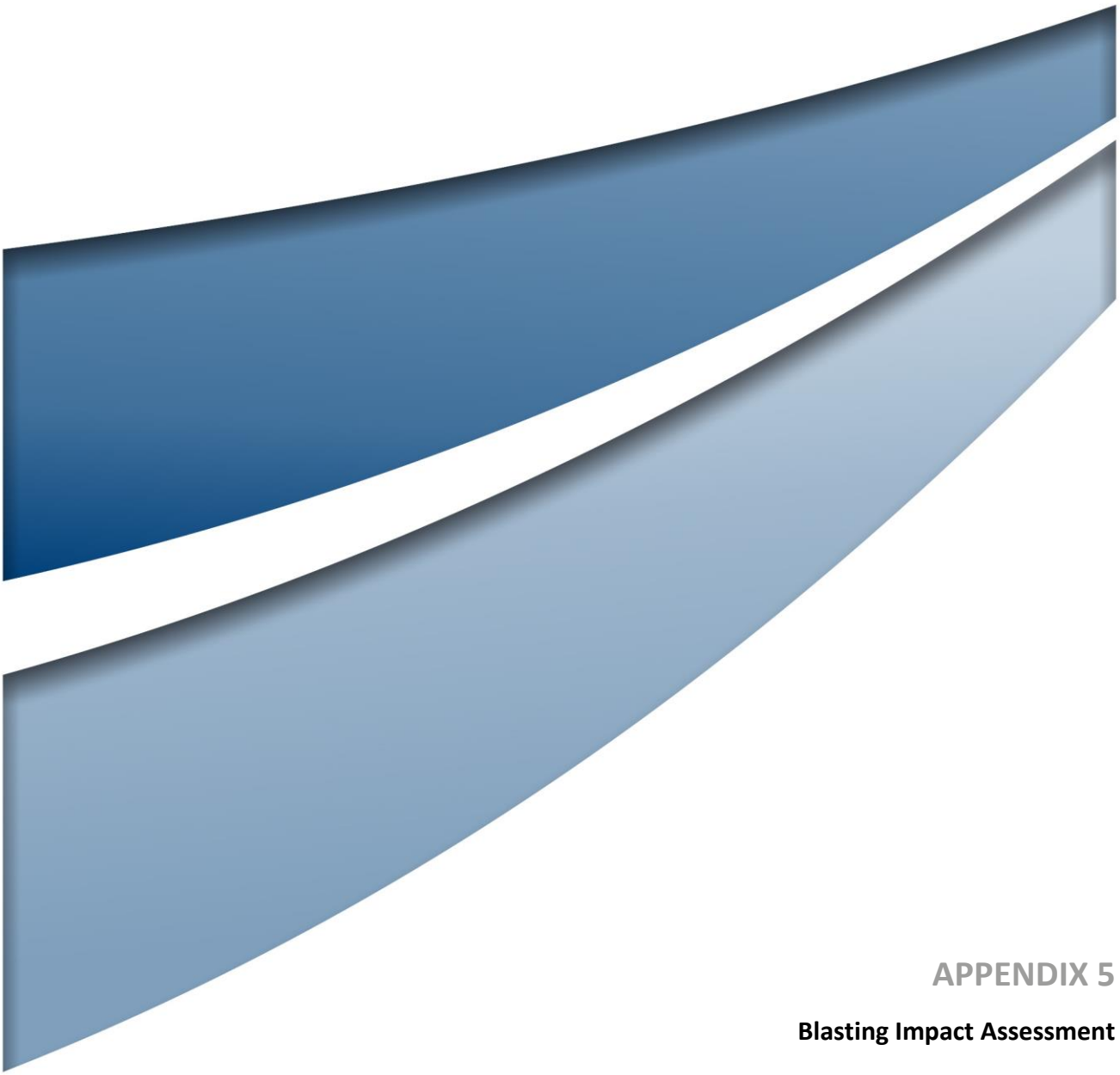
ID	Surname	Lot	DP	Easting	Northing
95	Rozene Pty Limited	100	631740	320470	6376270
97	Bird and Lambkin	3	1105582	320662	6377402
98	Fromberg	103	631740	320427	6375101
100	Calcott-McKenzie	4	758164	320220	6375600
101	Dragsund	1	195633	320028	6375917
102	Morsillo	2	758164	320234	6375867
103	Bell	1	758164	320304	6376078
105A	Bird and Lambkin	120	755270	319713	6376994
105B	Bird and Lambkin	120	755270	319459	6376746
107	Glenguin Wines	8	249778	319502	6375195
108	Cowan	9	249778	319308	6375211
109	Romke	102	841900	319503	6374891
113A	Cowan	10	249778	318975	6375209
113B	Cowan	10	249778	319030	6375112
114	Palmer	7	249778	318988	6374789
115	Goldfinch	6	249778	318622	6375018
116	Houtzaager	11	249778	318828	6375246
117	Tolson	12	249778	318916	6375757
118	McManus	13	249778	318897	6375884
119	Hann-Devries	14	249778	318551	6375964
121A	Hope	2	1119309	318351	6376291
121B	Hope	2	1119309	318058	6376107
122	Warr	5	249778	318508	6375142
123	Jackson	4	249778	318242	6375537
124	Kearns	3	249778	318126	6375667
125	Little	2	249778	318007	6375834
126A	Coranton Pty Limited	2	821163	317610	6375974
126B	Coranton Pty Limited	2	821163	317781	6375834
130	Wood	3	707382	317659	6376528
131	Gittoes	2	707382	317657	6376628
132	McLaughlin	1	707382	317613	6376740
137	Mu	1	633080	318006	6376759
138	McDougall	41	830744	318106	6377008
139	Tout	46	883523	317809	6376874
140	Meredith	47	883523	317476	6376884
142A	Ewen	48	883523	317878	6377253
142B	Ewen	48	883523	317540	6377171
142C	Ewen	48	883523	317523	6377075
143A	Lawson	2	773940	317720	6377514

ID	Surname	Lot	DP	Easting	Northing
143B	Lawson	2	773940	317351	6377488
144	Bevan	3	773940	317477	6377825
145	Elsmore	5	773940	317965	6377575
149	McInerney	122	755270	320101	6378526
162	Lamaro	893	606261	317485	6378596
164	Sharrock	892	606261	317086	6378227
165	Ellis	1	773940	317053	6377976
169A	McCraw	891	606261	316919	6378463
169e	McCraw	891	606261	317377	6378486
170	Emmerig	3	1004963	316636	6378604
171	Emmerig	41	1211300	316975	6378775
174	Beech	49	755229	316448	6378507
175	Bainton	34	755229	316285	6378827
176	Bainton	351	785908	316183	6378778
177A	Trickey	36	755229	315555	6379433
177B	Trickey	36	755229	315501	6379301
179	McAlpine	46	755229	317177	6379444
183	Foster	101	712789	316334	6379322
184	Tan	102	712789	316421	6379321
185	Poulos	28	660332	316234	6379378
188A	Broke Fordwich Vineyards Pty Ltd	1	1022016	315696	6379599
188B	Broke Fordwich Vineyards Pty Ltd	1	1022016	315758	6379602
188C	Broke Fordwich Vineyards Pty Ltd	1	1022016	315758	6379606
190	Gallagher	4	630834	314524	6380405
191	Robards and Myers	2	1153945	314416	6380391
192	Crawford	1	1153945	314292	6380426
193	Hulme	23	1050944	313959	6380237
194	Smith	83	722270	313592	6379950
195	Kennedy	3	861535	317751	6380531
197	Kennedy	2	861535	316570	6380295
198	Orton	22	877447	314968	6381037
199	Emmett	1	344187	314806	6380509
200	Benchoam	19	877447	314713	6381166
202	Price	15	846311	314298	6380585
203	Louise	14	846311	314058	6380702
204	Leonard	13	846311	313910	6380657
206	Myer	11	846311	313661	6380660
207	Carr Thompson and Shearim	3	626477	313565	6380705
208	Leslie	2	626477	313455	6380667

ID	Surname	Lot	DP	Easting	Northing
209	Leslie	1	626477	313383	6380691
211	Japheth	20	877447	314506	6381340
212	Destoop	2	1212027	314465	6381628
213	Destoop	2	1212027	313848	6381407
214	Hedley	51	601485	313308	6381342
217m	Russell	18	10022	316733	6382059
217n	Russell	18	10022	316551	6382456
217s	Russell	18	10022	317002	6381919
220	Purser	143	1065494	314272	6382655
221	Brasington	141	1065494	314045	6382458
222	Vassallo	115	618648	314610	6382776
223	Jackson	114	618648	314374	6382748
225	Harris	1	715668	313265	6382429
226	Vassallo	112	606531	314684	6382894
227	Beavis	1	414868	314462	6382864
228	Lamb	111	606531	314549	6382942
229	Ritchie	2	414868	314464	6383035
230	Cant	11	1118291	314885	6383168
231	Dawson	22	622057	314445	6383157
232	Medhurst	9	10022	314947	6383440
233	Vikas	21	622057	314791	6383272
234	Thompson	1	596910	314798	6383606
235	Caban	1	1139637	314450	6383926
236	Krey	108	1022048	314121	6383989
237	Ryan and Harrison	105	1022048	314676	6384143
238	Topham	109	1022048	314181	6384074
239	Williamson and Highett	1010	1078119	314726	6384359
240	Godyn	4	1174954	314511	6384246
241	Kaizer	1041	1023122	314242	6384337
242	Bridge	1042	1023122	314052	6384253
243	Neville	103	790093	314044	6384465
244	Caban	62	1082123	313667	6384692
247	Upward	C	342082	313301	6384964
250	Ellison	142	1065494	314214	6382442
254	Mitchell	8	512223	313954	6385220
256	Cameron	41	1120930	313727	6385192
261	Smith	1	591732	314556	6385217
262	Smith	2	591732	314543	6385221
263	Yancoal	32	601802	314409	6385156

ID	Surname	Lot	DP	Easting	Northing
264	Yancoal	31	601802	314497	6385141
265	Turnbull	301	869120	314389	6385360
266	Hedley	1	312800	314355	6385378
272	Bulga Community Centre Incorporated	1	195107	314373	6385414
273	Silk	43	1045046	314313	6385477
275	Dragicevic	41	1045046	314239	6385500
276	Yancoal	2	557872	314234	6385548
279	Bendall	2	731921	314251	6385448
280	Octaviani	1	731921	314222	6385444
281	Harris and Ferguson	1	555234	314189	6385440
283	Cagney and Albert	5	263446	314122	6385458
285	Harris	3	263446	314040	6385469
286	McLachlan	2	263446	314001	6385475
287	McLaughlin	1	263446	313959	6385485
288	Ford	6	263446	314176	6385559
289	Sales and Bellamy	1	788503	313896	6385511
290	Thompson and Jackson	43	778127	313851	6385669
291	Adamthwaite	3	252777	313794	6385722
292	Evans	2	252777	313983	6385746
293	Gallagher	1	252777	313821	6385845
294	Horn	2	788503	313789	6385632
295	Carnevale Testa Angelatos	3	788503	313691	6385527
296	Burgess	6	788503	313650	6385658
297	Fogwell	71	1155233	313664	6385734
298	Player	8	788503	313584	6385791
300	Street	5	788503	313481	6385649
301	Powell and Shannon	4	788503	313474	6385580
302	Harrison	1	749688	313285	6385713
303	McKenzie	2	749688	313168	6385704
304	Banks	3	749688	313047	6385801
305	Anderson	4	749688	312921	6385827
306	Gregory	5	252777	314047	6385806
309	Louis	211	573198	313387	6386374
311	AGL Energy Limited	547	589662	314587	6386587
316A	Caban	103	857834	313285	6386609
316B	Caban	103	857834	313409	6386489
317	Lancaster	1	790963	313570	6386800
319A	Tolson	1	1146108	321419	6376728
319B	Tolson	1	1146108	321485	6376761

ID	Surname	Lot	DP	Easting	Northing
323	Poulsen	13	1144104	326127	6388439
324	Wood	711	1085797	326523	6388306
325	Ancich	712	1085797	326886	6388196
326	McNaught	91	1142359	313501	6385740
327	Baker and Powell	10	1118291	314822	6383082
328	Perry	311	1058914	321618	6376232
329	Bushell	324	1123085	321427	6376052
330	Higgins	321	1123084	321329	6376160
331	Brett	301	617801	321865	6375782
332	Boticki	302	617801	321874	6375740
333	Claridge	2	826836	321896	6375981
334	McTaggart	2	758164	321956	6375826
335	Fox	3	758164	322065	6375757
336	Jordan	4	758164	322088	6375716
337	Minnis	5	758164	322000	6375631
338	Bailey	5	758164	322188	6375799
339	Cook	2	758164	321786	6375644
340	Pappin	1	758164	321807	6375586
341	Phillips	3A	758164	321974	6375777
342	Jeffcoat/Johnson	11	1077786	321850	6376226
343	Melville	242	1131144	320732	6375822
344	Blackie	12	1069011	322735	6376978
345	Ben and Jaclyn	13	1077786	321732	6376012
A	Nightingale Cottage	22	848116	321237	6374551
B	Kolatchew	101	863455	313201	6385442
C	Roser	102	863455	313060	6385467
D	Anderson	2	1084483	312950	6385437
G	Hungerford	4	758164	323231	6375274
H	Poole	1	758164	322969	6375175
I	Davis	1061	1096454	314531	6384098
J	Jacques	1011	1078119	314829	6384289
P	Crown Land	9	616882	314627	6384585



APPENDIX 5

Blasting Impact Assessment

ENVIRO STRATA CONSULTING Pty Ltd
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M.I.S.E.E.,
M.EFEE.

UMWELT AUSTRALIA ON BEHALF OF BULGA COAL MANAGEMENT PTY LIMITED

BLASTING IMPACT ASSESSMENT FOR THE BULGA OPTIMISATION PROJECT MODIFICATION 3

FINAL

REPORT NO. UM-1811-110619

Thomas Lewandowski
11th June 2019

EXECUTIVE SUMMARY

OVERVIEW

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located in the Hunter Valley, NSW). The BCC consists of two existing coal mining operations: the open cut operations (Bulga Open Cut) and the underground operations (Bulga Underground Operations) using shared coal washing and rail loading infrastructure.

Mining operations have been occurring at the site for over 30 years with Bulga Coal Management Pty Ltd (BCM) currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (SSD-4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD-4960 was subsequently modified (SSD-4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy. Approval was granted by the Planning Assessment Commission (under delegation from the Minister for Planning) on 17 January 2017. A second modification was approved in August 2018 (SSD-4960 Mod 2) to extend the period for construction of the outer face of the noise and visual bund by an additional nine months.

Currently, Bulga Open Cut is seeking approval to amend the approved mining plans in order to optimize extraction of mining resources in the south. The Proposed Modification 3 (Mod 3) (the Proposed Modification) is an extension of the approved BOP. The Proposed Modification will be developed to the south-east of the BOP approved area of extraction, including the Deep Pit area currently used as a Tailings Storage Facility (TSF).

The Proposed Modification will continue with the same open cut coal seam extraction method utilising the same mining equipment, blasting methods and existing procedures as currently used at Bulga Open Cut for the BOP Project.

Operations within the Proposed Modification aim to extract 8 main coal seams, down to Bayswater seam. The maximum extraction depth could be in the order of approximately 400 m from the surface.

The Blast Impact Assessment (BIA) for the Proposed Modification was undertaken in accordance with the Australian and New Zealand Environment and Conservation Council Guidelines and the Australian and British Standards. The BIA addresses the impact of the Proposed Modification in terms of ground vibration, overpressure and flyrock on the surrounding environment including private residential receivers, heritage sites and infrastructure.

BLAST DESIGN

The assessment incorporated the actual geological model of the area, which identified the main geological features, including Mount Thorley Monocline, which divides the extraction area into a flat seam section to the west and a steeply dipping seam section to the east. For the western section, there are highly variable interburden thicknesses, (material scheduled for blasting) resulting in variable bench sizes ranging from 3.6 to 46.4 m. For the eastern steeply dipping strata section, the proposed bench sizes are in the order of 15 - 22 m depth. Based on the proposed drill rig sizes of 203 to 270 mm hole diameter and the proposed explosive products, the estimated charge masses could be in the order of 26 - 2,810 kg and 290 - 1,168 kg for the eastern and western sections respectively. The blast design parameters are in line with the current blast design at BOP.

ASSESSMENT METHODOLOGY

The assessment utilised conceptual stage plans for the representative years of operation (2022, 2026, 2031 and 2035) as well as the final mining area boundary of the Proposed Modification.

For the purpose of the assessment, ground vibration and airblast overpressure predictive models specific for Bulga conditions were developed. The models generated are based on the data collected during the 2016 - 2017 monitoring period. The models were used to identify potential worst-case scenario impacts from ground vibrations and airblast overpressure on the sensitive receivers, generated when undertaking blasting within the Proposed Modification.

The estimated ground vibration and airblast exposure levels are discussed in the context of applicable ground and air vibration criteria as stated in the BOP Development Consent (SSD-4960) or recommended by the Australian Standard (AS 2187.2-2006) and other relevant studies.

RESULTS OF BLAST IMPACT ASSESSMENT

- **Impact on Private Residential Receivers:**
  - The assessment identified a high level of variability from the blasting impacts for both the ground vibration and airblast overpressure dependent upon the charge mass; with negligible impact for low charge masses.
  - The modelling revealed that the ground vibration impacts for all private residential receivers can be managed below the allowable limit of 5 mm/s (for 95% of blasts) via the application of lower charge masses. Considering the worst-case scenario (i.e. blasting from the edge of the Proposed Modification's blasting boundary), blasting using a maximum instantaneous charge (MIC) of 1,168 kg (equivalent of a 22 m bench height) will result in impacts no higher than 2.7 mm/s for any private residential receiver. For further distances, greater MIC values will be applicable.
  - The modelling revealed that the airblast overpressure impacts for all private residential receivers can be managed below the allowable limit of 115 dBL (for 95% of blasts) via the application of lower charge masses. Considering the worst-case scenario (i.e. blasting from the edge of the Proposed Modification's blasting boundary), blasting using an MIC of 69 kg will result in impacts no greater than 108 dBL for any private residential receiver. For further distances, greater MIC values will be applicable.
  - The assessment determined that both ground vibration and airblast overpressure emissions can be managed in order to remain below the imposed criteria by the use of lower charge masses (i.e. MIC). This can be achieved by either blasting smaller benches or through the application of deck charges; both techniques already used at BOP.
  - The assessment determined that the potential risks due to flyrock are considered negligible. This is due to substantial distances between the private residences and the Proposed Modification, with the closest residence located at 2,530 m distance.

- **Impact on Heritage Sites and Infrastructure:**
  - The ground vibration exposures for the heritage items assessed are below the applicable criteria of 5 mm/s.
  - The assessment determined that the impact on the 330 kV power line (located at 300 m distance), can be managed effectively to remain below the applicable vibration limit criteria of 50 mm/s for tension and 100 mm/s for suspension pylons, via the application

of lower charge masses and appropriate flyrock management. Bulga Coal will continue with the already developed blasting system around the 330 kV power lines.

- The modelling identified that the prescribed water and tailings dams will be exposed to vibration levels below the applicable vibration limits of 50 mm/s, where applicable.
- The assessment determined that ground vibration exposure for the public roads, Broke Fordwich PID / Broke potable water pipeline and Telstra fibre optics all located within a 77 - 110 m distance of the Proposed Modification can be managed effectively to below the 100 mm/s vibration limit via the application of lower charge masses. To manage risks, the mine will continue with the application of the approved Road Closure Management Plan, when blasting within 500 m of the public roads.
- The impact of flyrock on the closest infrastructure (i.e. less than 500 m), that is, the public roads / bridges / culverts, water pipelines and the 330 kV power line, can be managed effectively according to blast management measures similar to the current system already developed when blasting in the proximity of public roads and power lines.
- The impacts on the mine-owned infrastructure will be managed in order to maintain safe work practices in consultation with the relevant infrastructure operators, following a well-developed management system.

BLAST MANAGEMENT AND MONITORING

Blast management for the Proposed Modification will continue to be conducted in accordance with the Bulga Blast Management Plan (BMP 2016). The document covers a number of blast control measures designed to minimise blast impacts and to comply with the relevant criteria.

The currently implemented blast management system at Bulga Open Cut is efficient and effective, as a result no significant modifications (besides three minor improvements) to the blast control measures were recommended.

UMWELT AUSTRALIA ON BEHALF OF BULGA COAL MANAGEMENT PTY LIMITED

BLASTING IMPACT ASSESSMENT FOR THE BULGA MODIFICATION 3

FINAL

REPORT NO. UM-1811-110619

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1.0 INTRODUCTION

Enviro Strata Consulting Pty Limited (ESC) was engaged by Umwelt (Australia) Pty Limited (Umwelt) to undertake a Blasting Impact Assessment (BIA) for the proposed Bulga Optimisation Project Modification 3 (Mod3) (the Proposed Modification) on behalf of Bulga Coal Management, as subsidiary of Glencore (Australia) Pty Ltd (Glencore).

The Bulga Open Cut is located in the Hunter Valley of New South Wales (NSW), approximately 12 km south-west of Singleton, 4 km north of Broke and 4 km south-east of Bulga.

Previously Bulga Coal Management Pty Limited (BCM) applied for an expansion of mining activities (within the existing mining lease) under the Bulga Optimisation Project (BOP). BCM received Development Consent (SSD-4960) from the NSW Planning Assessment Commission for the Bulga Optimisation Project on the 1 December 2014. Modifications Mod1 and Mod2 were approved on 17 January 2017 and 18 August 2018 respectively. The Bulga Open Cut Blast Management Plan was approved by the Department of Planning and Environment (DPE) on te 8 July 2016.

A review of the BOP mine plan revealed a potential for an improved utilisation of the available resources, hence an alternative extraction scenario has been developed. Therefore, the Proposed Modification is an extension of the approved BOP. The proposed extension will be developed to the south-east of the BOP approved area of extraction including the Deep Pit area currently used as a tailings storage facility (TSF).

The Proposed Modification will include the continuation of open cut mining activities, including drill and blasting, as well as extraction activities below the Deep Pit TSF area. A major component of the Proposed Modification will be located to the south-east of the BOP (accessing deeper coal seams down to the Bayswater coal seam), located below the Deep Pit TSF area.

This BIA has been prepared by ESC on behalf of Umwelt as part of the Statement of Environmental Effects (SEE) prepared in support of the Proposed Modification application.

The BIA will assess the impact of the Proposed Modification on the following:

- adjacent community; including residential receivers,
- heritage / historic points of interest,
- existing and proposed infrastructure; and
- adjacent mines.

The BIA includes ground vibration and airblast overpressure modelling, utilising parameters representative of the Bulga conditions. The results of the assessment are presented in the context of relevant vibration and overpressure limits for the local community, heritage / historical sites and infrastructure.

2.0 PROJECT DETAILS

The Proposed Modification will maximise resource recovery within the approved Bulga Optimisation Project Area by an extension of the open cut operations to the southeast into a former open cut mining area occupied by the current TSFs known as Deep Pit and Bayswater Pit. The extension of the pit to the southeast also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Mtpa ROM while enabling the extraction of an additional approximately 63 Mt of coal.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Surface Operations will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- an additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east by accessing deeper resources within the approved pit and proposed extension area;
- revised mining sequence to integrate mining in the approved mine with access to the modified and deeper mining areas;
- utilisation of existing coal handling and coal processing infrastructure;
- removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSFs to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings;
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure;
- construction of new water management facilities to manage site surface water catchments;
- the use of all existing or approved infrastructure and equipment for the Bulga Coal mine with some minor additions to the existing mobile equipment fleet over the life of the operation.

The key aspects of the Proposed Modification are shown on Figure 1 and a summary of the key modifications are provided in Table 1.

Table 1: Comparison of Approved Development and Proposed Modification

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Extraction rate limit	Extraction limit of 12.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal	No change to currently approved extraction limit 12.2 Mtpa
Total Recoverable Resource (ROM)	162 Mt	An additional 63 Mt
Project life	Mining operations on site until 31 December 2035	Extension to the life of mine until 31 December 2039 (an additional 4 years)
Project boundary / Schedule of Lands	Per SSD_4960 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit Mining undertaken within existing ML1547	Extension of mining areas to the south and west. Revised mining stage plans to enable access to deeper resources within the approved pit and the proposed extension area Mining undertaken within existing ML1547
Disturbance Areas	Approved mining disturbance footprint (3,786 hectares)	Additional disturbance area of approximately 20.2 hectares not currently part of the approved mining disturbance footprint
Key Infrastructure	Realignment of Broke Road (Complete) Relocation of 330kV transmission lines (Complete) Construction of new water storage dam (Complete) Upgrade to CHPP to improve yield and plant efficiency (Ongoing) Relocation of sections of Broke-Fordwich Private Irrigation District pipeline and Telstra infrastructure (Complete)	Relocation of some mine owned open cut and underground infrastructure Demolishing of some open cut and underground infrastructure to accommodate proposed mining Replacement/relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop Installation of tailings relocation infrastructure (pumps and pipelines, power lines, access tracks, etc.)
Coal Handling and Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput	Potential upgrade of CHPP to reprocess additional tailings No changes to CHPP throughput, ROM or product stockpiles

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Coal Transport	20 million tonnes of product coal transported in any calendar year	No change
Equipment Fleet	Mining fleet generally remained unchanged however replacement mining equipment is required during the project life	Minor increases to fleet numbers to provide flexibility for mining operations
Overburden, coarse reject	Where feasible, overburden to be placed in-pit. Overburden waste is likely to go into establishing haul roads, bunds for visual abatement, noise abatement and water management	No change to overburden and coarse reject management Expansion of existing approved TSF in northern end of pit to accommodate life of mine tailings
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF. Main Pit TSF approved in SSD-4960 Mod 1	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining. Increased capacity of Main Pit to cater for relocated tailings and ongoing tailings production
Final void	One void at the end of mining operations	One void proposed to be of similar size to the approved void
Rehabilitation and final landform	Conceptual final landform is shown in SSD-4960 (Appendix 13) and includes 1 final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing Increases to typical overburden emplacement heights from 150 mAHD to 160 mAHD Revised conceptual final landform includes 1 final void
Employee Numbers	Approximately 700 FTE employees	No change

The Proposed Modification does not preclude the ability to access approved underground mining resources to the south and west of the proposed pit in the future.

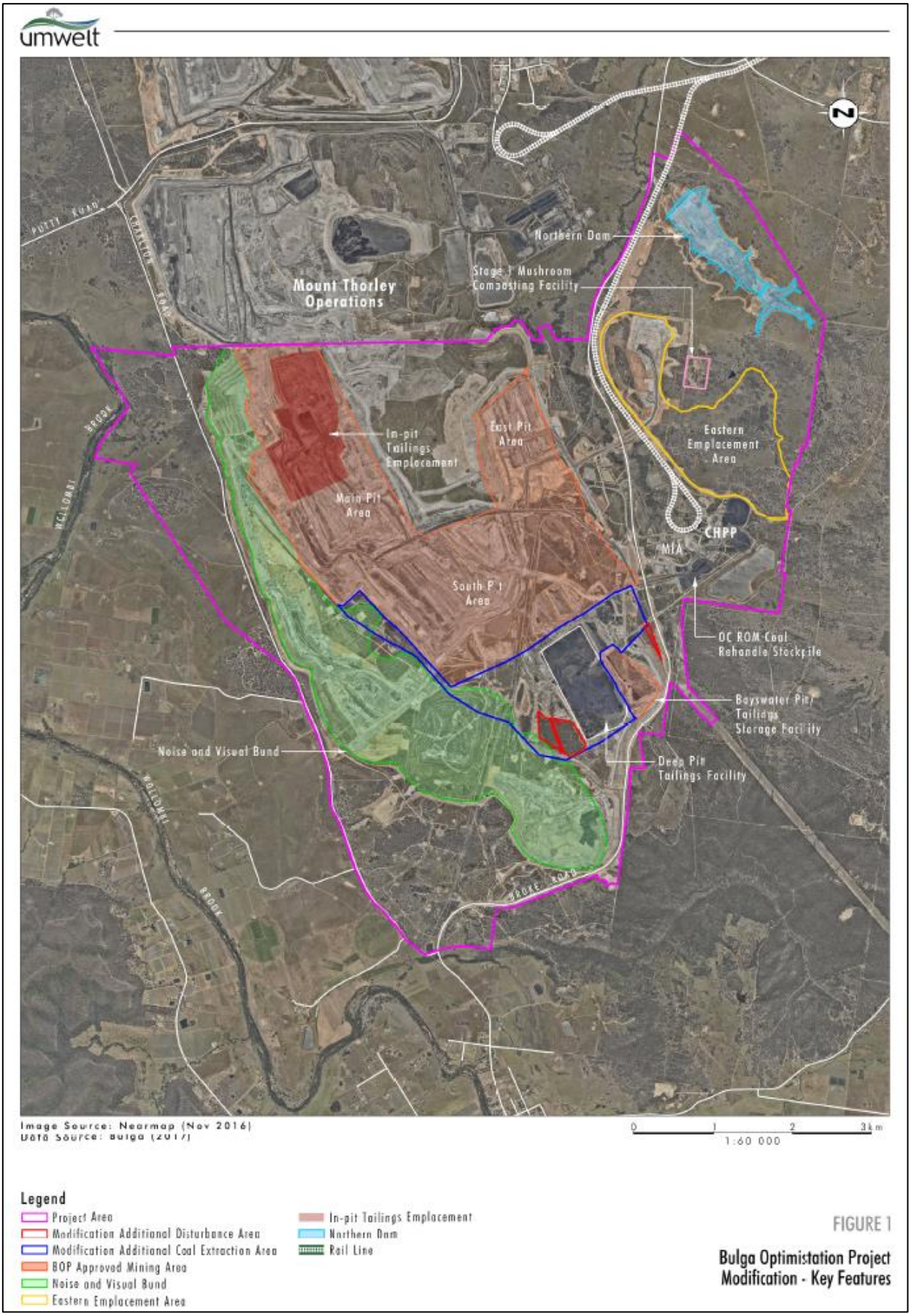

Figure 1 – Proposed Bulga Modification (after Umwelt, 2018)

3.0 CONCEPTUAL BLAST DESIGN

Mining Stages

The proposed layout of the Proposed Modification is shown in **Figure 1**. The anticipated pit shells for Stage 1, Stage 2, Stage 3 and Stage 4 (corresponding to years 2022, 2026, 2031 and 2035 respectively), are highlighted in **Figure 2**. The conceptual mine stage plans (Stage 1 to Stage 4) are representative of the mine plans for the life of the Proposed Modification; the corresponding boundaries capture the potential worst-case impacts associated with the Proposed Modification.

The conceptual mine stage plans were selected as they are considered to be representative of the key features of the proposed mining progression for the Proposed Modification as outlined below:

- **Stage 1**: Represents the continuation of mining activities in a south-easterly direction, i.e. the original direction of extraction of the East Pit area. The extent of Stage 1 (corresponding to the year 2022) is marked in blue. This stage will allow for an efficient continuation of mining in the southern portion of the East Pit. During this stage the mining / blasting operations will include activities adjacent to the western most boundaries of the proposed overall extraction area. Therefore, a potential increase in blast impacts is to be expected for the scattered western residences. Also, with the pit progression to the south / south-east potentially higher blast impacts may be expected to the south towards the residents of Broke.
- **Stage 2**: Stage 2 outlined in red corresponds to the year 2026. Stage 2 represents the southern-most extent of the East Pit shell and the closest point where blasting will be undertaken with respect to private residences. This will therefore have the most impact on the residents, in particular to the south affecting Broke residents.
- **Stage 3**: Stage 3 outlined in yellow corresponds to the year 2031. To a large extent Stage 3 covers the same area as Stage 2 however it extends fully to the eastern boundary of the extraction area. Therefore, as for Stage 2, this will have the most impact on the residents, in particular to the south affecting Broke residents.
- **Stage 4:** Stage 4 outlined in white corresponds to the year 2035. Blasting during Stage 4 will lessen the impact for Broke residents as mining activities retreat towards the centre of the pit. The greatest potential impact is expected on the closest privately owned residents in to the south-west and west.

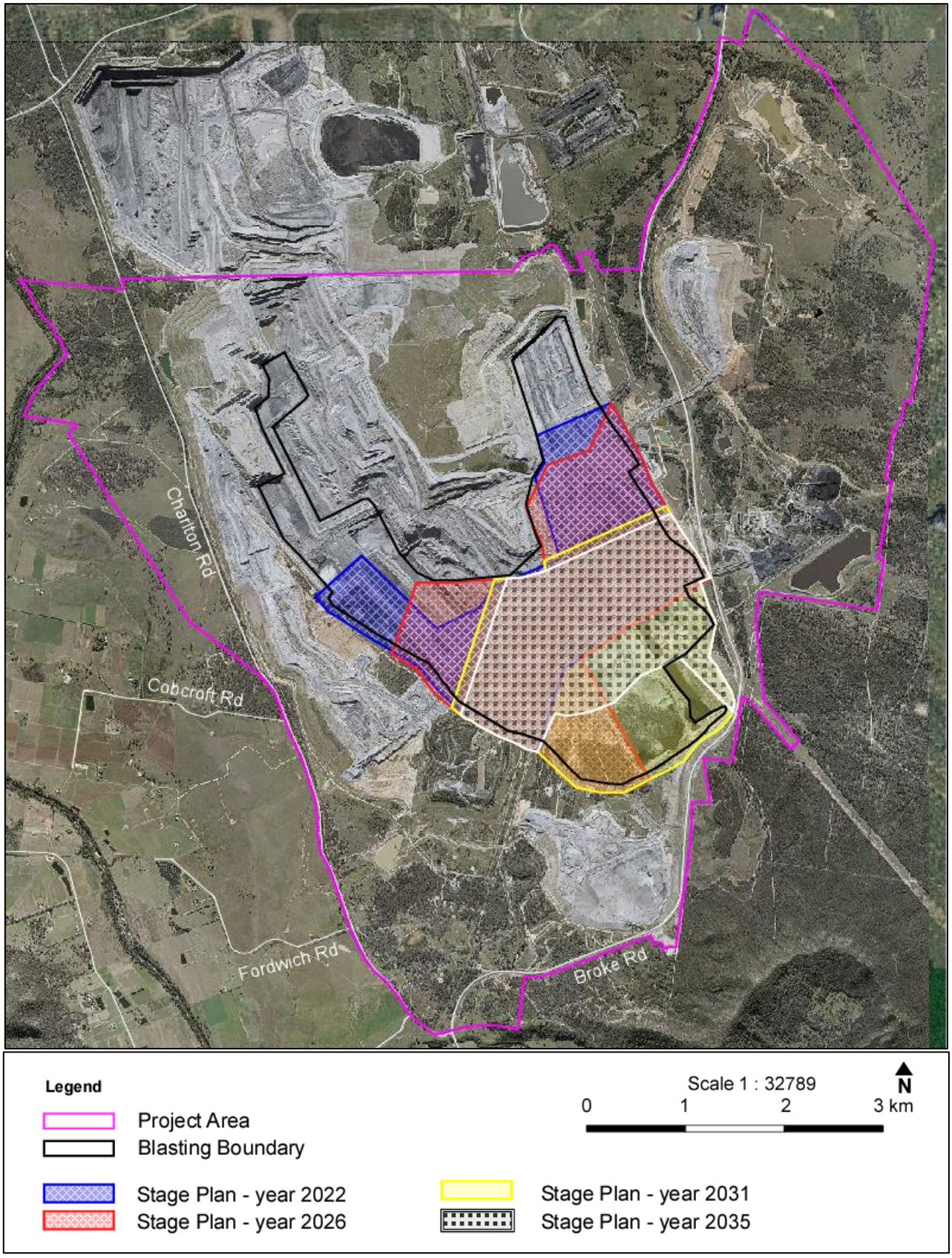

Figure 2 – The Proposed Modification Area and Pit Shell Boundaries by Selected Modelling Year

Typical Blast

The coal recovery at Bulga Open Cut includes drilling and blasting activities followed by excavation and rock / coal haulage for further disposal or processing.

The operation sequence commences with an initial blast design followed by a bench survey and bench drilling using a drill rig. A typical bench is rectangular in shape with a uniform drilling pattern. The holes are loaded with explosive material (either emulsion type to allow for the presence of water and to minimise the possibility of fume generation or ANFO product for dry strata conditions) and then the top part of the hole is filled with a gravel material (i.e. stemming) to contain the energy and maintain a low airblast emission (i.e. low environmental impact).

Due to the steeply dipping strata in the East Pit precision blasting such as through-seam blasting is also undertaken at Bulga Open Cut. For through-seam blasting typically the loaded explosives are initiated through an electronic detonator system which delivers a signal to the primer / booster placed within each hole. The primer / booster then initiates the explosives. Since an electronic detonator system is employed, precise timing is delivered which allows for single hole initiation allowing for a small and precise delay between each blasted hole. This particular system controls the ground and air vibration impacts to the highest degree (i.e. facilitates lower environmental impact).

Following firing of the blast, the fractured rock strata is then removed using a truck and shovel method for further coal processing in the coal processing plant or direct disposal as waste rock.

Blasting Frequency

The current Bulga Optimisation Project Conditions of Consent (SSD-4960) limit blasting times to 9 am to 5 pm (EST) Monday to Saturday inclusive and allow for up to 3 blasts per day and up to 5 blasts a week, averaged over a calendar year. No blasting is allowed on Sundays and public holidays or any other time unless written approval of the Secretary is obtained.

The exception to these conditions applies to blasts that generate vibration levels less than 0.5 mm/s at any private residence, blast misfires, or blasts required for the safety of the mine, workers and general public.

It is proposed that the same conditions will continue to apply to the Proposed Modification.

Geology of the Area and Blasting Implications

For the purpose of the assessment, a review of the geological model of the area was undertaken, see **Figures 3A** and **3B**. There is substantial variation in the local geology of the Proposed Modification area (i.e. the presence of the Mount Thorley monocline) resulting in a flat coal seam section in the west and a steeply dipping coal seam section in the east. Because of this, there will be a need to extract different bench heights for each mining area to maximise coal recovery.

The schematic cross section of the proposed pit is presented in **Figure 3B.** As shown, the maximum extraction depth for the proposed pit area could be in the order of 400 m.

The Proposed Modification's target is to extract a number of coal seams, including 8 main coal seams down to the Bayswater seam and up to 32 working sections covering split seams (see **Figure 4**).

The geological model for the Proposed Modification area revealed that the main geological feature present is the Mount Thorley monocline running in a north-west / south–east direction dividing the area into the flat and steeply dipping coal seam sections. In addition, other less significant faulting was identified in the area. This includes three main faults; Whybrow, South Bulga and Bayswater

faults. Furthermore, there are two other inferred fault lines (to be confirmed as indicated in the diagram), see **Figure 3A**.

The identified faults do not extend into the inhabited areas around the mine, such as Broke and Bulga townships, nor towards any private residences of concern. Typically, some magnification in vibration levels around the fault area can be expected as vibrations are transmitted more freely along such features. However, based on the location and extent of these faults, there is no indication that blasting within the Proposed Modification would generate any unusual elevated vibration levels for the local communities.

Western Section

In summary, based on the geological model for the western section, it was concluded that bench heights could range from 3.6 to 46.4 m.

Eastern Section

An assessment of the geological model for the eastern section revealed steeply dipping seams, which will require the implementation of a through-seam blasting method. The proposed bench sizes for the eastern section will be in the order of 15 to 22 m with the majority representing 20 m benches.

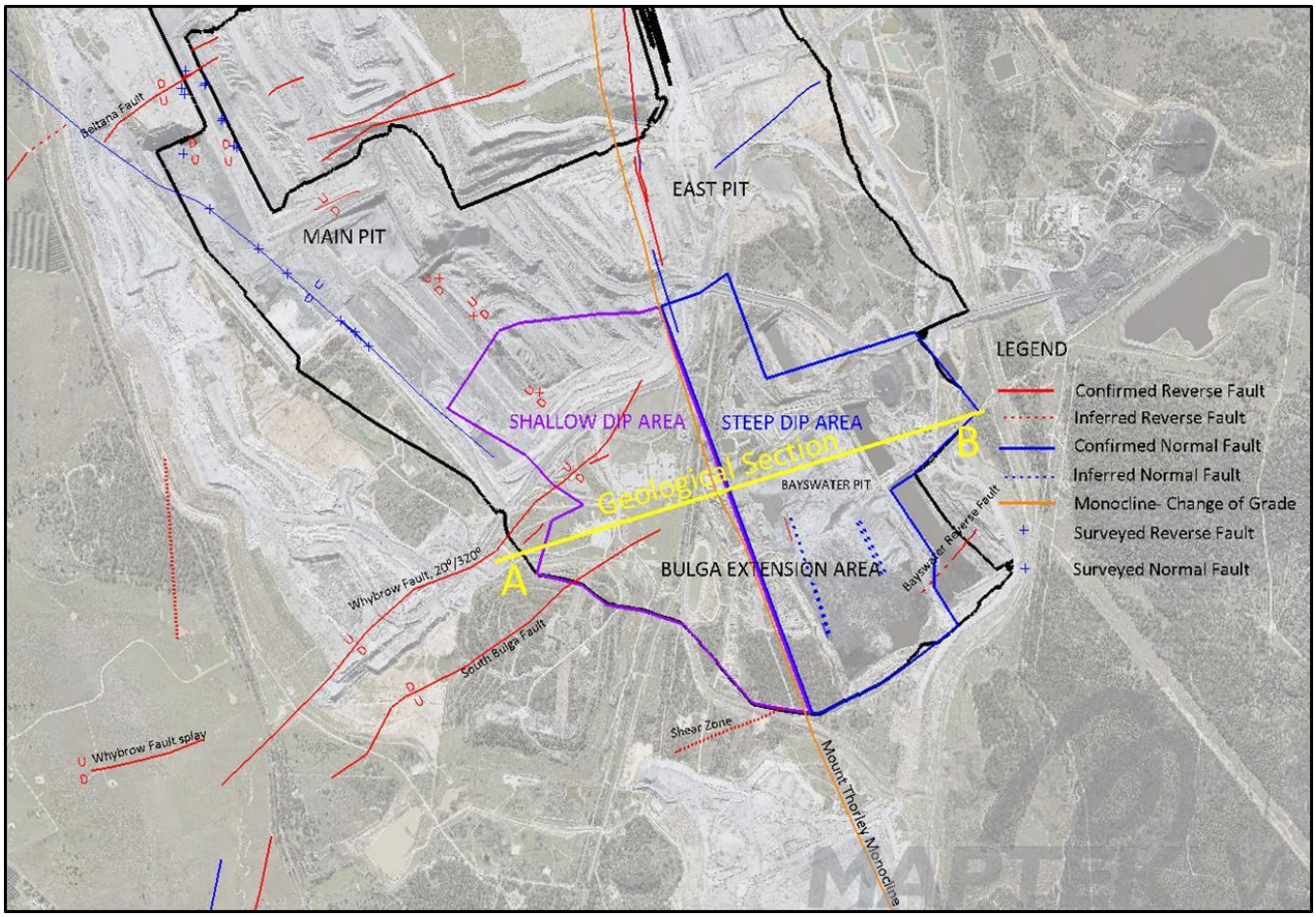

Figure 3A – Geology of the Area – the Proposed Modification

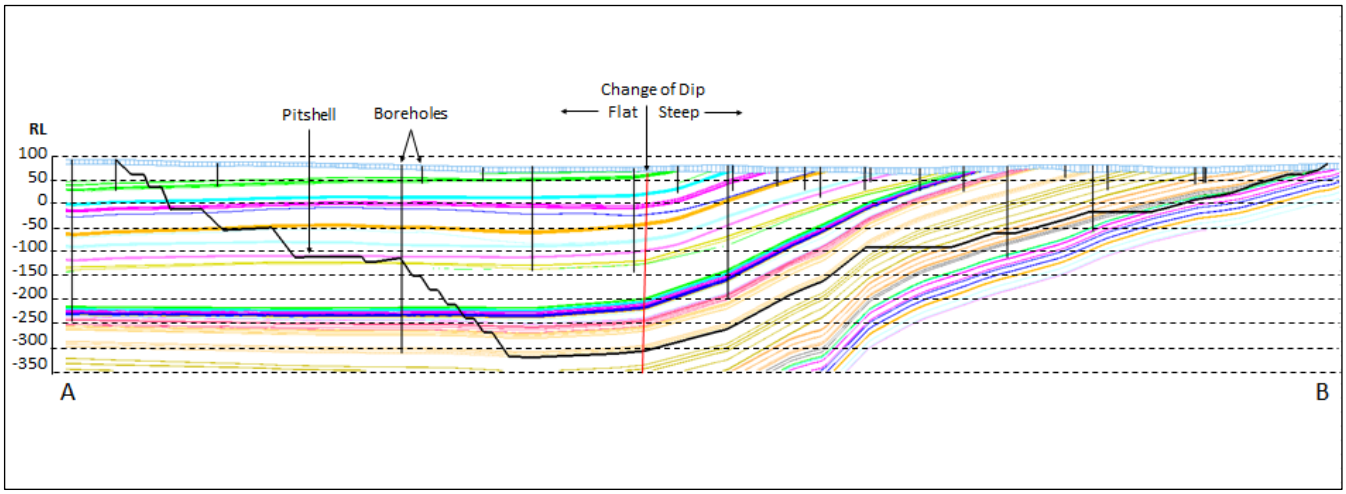

Figure 3B – Cross Section AB - the Proposed Modification

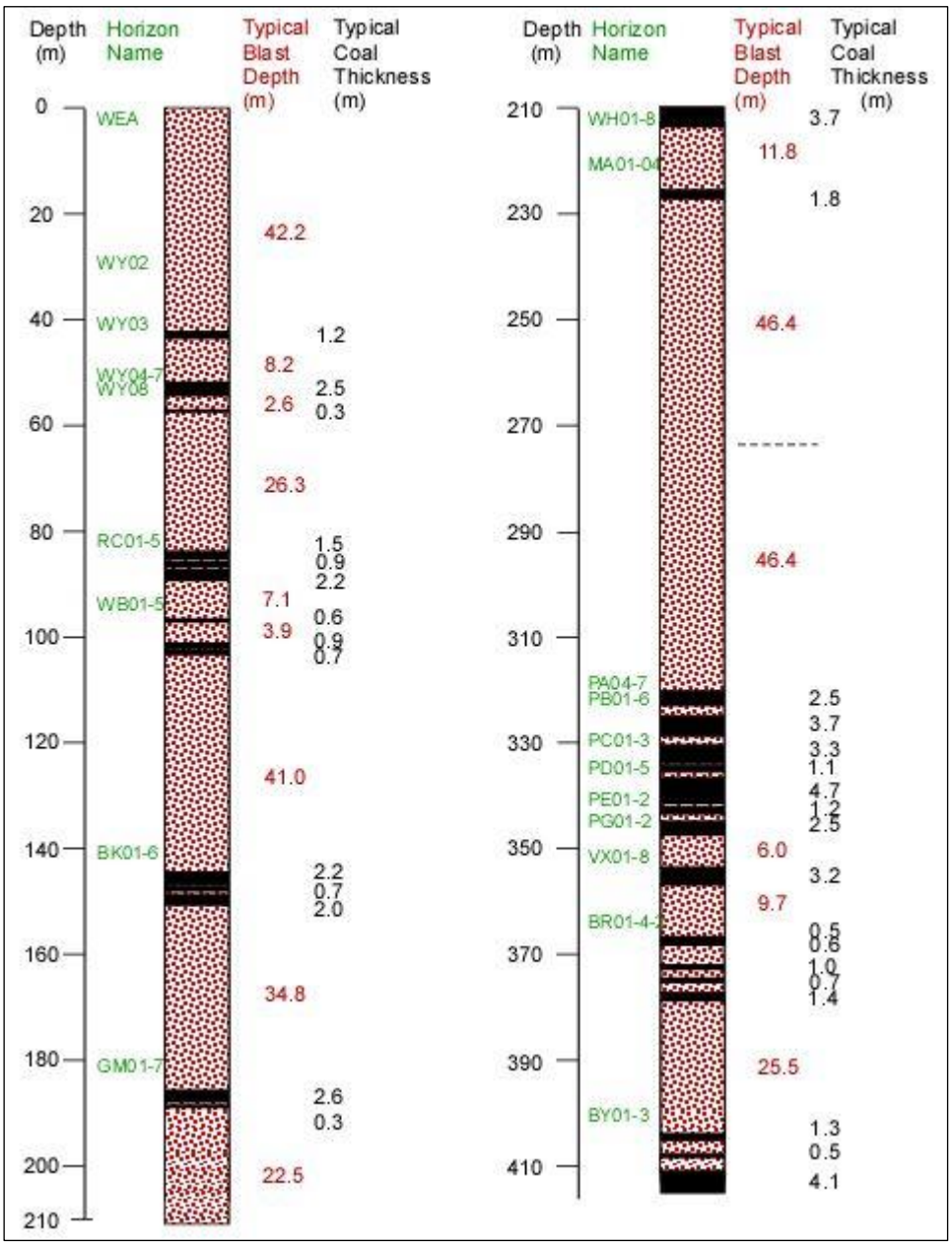

Figure 4 – Schematic of Coal Seams and Bench Heights for the Proposed Modification Area

Blast Details

The drill and blasting activities for the Proposed Modification will be consistent with the current blasting activities undertaken by Bulga Open Cut. The primary focus of the drill and blasting activities will be to uncover coal material by blasting the interburden rock strata material for further handling. The Proposed Modification will continue with open cut extraction activities utilising the drill and blasting method as part of the mining operation.

As shown in the cross section (see **Figure 3B**), the Proposed Modification will continue the extraction of a number of coal seams (i.e. 8 major coal seams and up to 32 working sections) down to the Bayswater seam (i.e. approximately 400 m from the surface or to an approximate R.L. of -320 m).

Blasting is to be conducted in accordance with an approved Bulga Open Cut Blast Management Plan (BMP) (2016). The BMP enables the design of each blast to minimise dust, fumes, ground vibration and airblast overpressure on the surrounding environment, while at the same time allowing to maximise blast efficiency. The blasting activities are undertaken according to the conditions of consent for the Bulga Optimisation Project Approval (SSD-4960). The blasting is undertaken conforming to the specified limits of 5 and 10 mm/s (for ground vibrations) and 115 and 120 dBL (for airblast overpressure), as indicated in the Blast Emission Criteria (see Section 4.2). This will enable compliance with the site specific blasting conditions.

Blasting activities at the Bulga Open Cut utilise combinations of products specific for a given site's conditions. Typically, the blasting products include standard ammonium nitrate fuel oil (ANFO) for dry conditions and emulsion blends for wet conditions, with variable product densities. The same explosive materials are proposed to be used for the Proposed Modification. Typical blasting parameters used at Bulga Open Cut are summarised in **Table 2**.

Table 2: Typical Blasting Parameters used at Bulga Open Cut

Parameter	Value
Drilling Capacity	5 Rigs – 2 to 50 m, 2 to 62 m, 1 to 72 m
Drill Rig Hole Diameter (mm)	200 to 270
Number of Holes per Blast	Avg. 550, Min. 11, Max. 1900
Hole depth range (min / max)	2 to 55
Burden x Spacing (m)	(5x5) to (6.5x10)
Product Type / density (g/cm^3)	ANFO at 0.8 to emulsion at 1.2 density; mostly emulsion at 1.2 density
Powder Factor (kg/m^3)	Avg. 0.57, Min. 0.2, Max. 0.95
Initiation system (nonel or electronic)	50% nonel, 50% electronics (electronics for all through seam blasting)
Bench Height (m)	Avg. 19.7, Min 2, Max 55
Blast types	All types
Stemming Height (m)	3.8 to 5.0
MIC (kg) - DRY MIC (kg) – WET	20 to 2,500 20 to 2,500
Blast Volume Range (bcm)	Avg. 470,000, Min 47,000, Max. 1,170,000
Operational Period	52 weeks / year

Parameter	Value
Blasting Frequency	~3 blasts per week average

Bulga Open Cut utilises four drill rig sizes, i.e. 203, 229, 251 and 270 mm diameters. Due to the variation in the local geology for the eastern and western sections of the Proposed Modification, different bench sizes will be blasted. The blasting parameters for both the western and eastern sections are specified in **Table 3**. These parameters were used in the modelling of the blast impacts of the Proposed Modification, including minimum and maximum charge masses for dry and wet conditions.

Western Section

Based on the geological model for the western section of the Proposed Modification (including the flat seam section), the mine will undertake variable height overburden / interburden blasting. For this section the blasted benches could vary between 3.6 and 46.4 m.

The projected charge masses could therefore be in the order of 26 to 2,810 kg (depending on the choice of drill rig), see **Table 3**. The charge masses are based on ANFO and emulsion blend products of 0.8 and 1.2 g/cm^3 density respectively. These estimations are based on the blasting bench height derived from the geological model and the proposed hole diameter (i.e. 203, 229, 251 and 270 mm diameter).

Eastern Section

Based on the geological model for the eastern section (including the steeply dipping seam section) the mine will undertake through-seam blasting. In this section 15 to 22 m benches (i.e. typically using a 20 m bench size) are to be blasted to maximise efficiency of extraction and minimise coal losses.

The projected charge masses could therefore be in the order of 290 to 1,168 kg (depending on the hole diameter), see **Table 3**. This is using ANFO and emulsion blend products of 0.8 and 1.2 g/cm^3 density respectively.

Table 3: Blasting Parameters for Proposed Modification

Hole Diameter	203 mm		229 mm		251 mm		270 mm	
Hole	MIC (kg)		MIC (kg)		MIC (kg)		MIC (kg)	
Depth (m)	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
WESTERN SECTION								
3.6	26	39	33	49	40	59	46	69
22	466	699	577	865	693	1,039	778.6	1,168
46.4	1,072	1,608	1,364	2,046	1,619	2,429	1,873	2,810
EASTERN SECTION – Through Seam Blasting								
15	290	435	356	534	427	641	481	721
22	466	699	577	865	693	1,039	779	1,168

4.0 GROUND VIBRATION AND AIRBLAST PREDICTIVE MODELS

4.1 PREDICTIVE MODELS

4.1.1 Ground Vibration Predictive Model for Surface Conditions

To estimate the potential vibration levels generated from the Proposed Modification for the assessment locations including residential receivers, heritage / historic items and infrastructure, a site law formula (specific for Bulga conditions) has been developed. The site law formula recommended by the Australian Standard (AS 2187.2-2006) is accepted by relevant NSW Government agencies as being appropriate for mining blast assessments.

The site law formula is specified as follows:

$$PPV = k\left(\frac{D}{\sqrt{m}}\right)^{a}$$

where:
- ***PPV*** = Ground vibration as vector Peak Particle Velocity (mm/s)
- ***D*** = Distance between charge and point of measurement (m)
- ***m*** = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)
- ***a*** = Site exponent
- ***k*** = Site constant

The ground vibration predictive model used in the analysis is based on the model developed for Bulga conditions. To optimise the accuracy of the vibration predictions for the Proposed Modification a review of the vibration monitoring results from the southern section of Bulga operations was undertaken. This included a review of the vibration monitoring results from blasting in Bayswater Pit (representative for the eastern section of the Proposed Modification, i.e. steeply dipping strata) and Southern Extension Pit (representative for the western section of the Proposed Modification, i.e. the flat seam section).

BAYSWATER PIT MODEL

For the purpose of analysis, vibration monitoring data from a number of different blasts fired in the Bayswater Pit was extracted. The mine utilised a number of surface monitoring stations located at close range (i.e. less than 1 km) as well as far range permanent monitoring stations (i.e. located in excess of 4 km).

The collated data comprised of vibration measurements from a variety of blasts (i.e. including presplit, overburden, and interburden blasts) and is therefore representative of the actual ground vibration behaviour for the steeply dipping section. The collected monitoring results were plotted using a standard log / log plot, see **Figure 5A**. The undertaken site law analysis is based on a sample of 101 vibration monitoring results.

The parameters governing ground vibration behaviour for Bayswater Pit derived through the site law analysis (corresponding to the 95% confidence level) are specified as follows:

- site exponent a = -1.6
- site constant *k* = 1,760

Therefore, the formula used for vibration modelling for the eastern part of the Proposed Modification (including the steeply dipping section) is:

$$PPV = 1{,}760\left(\frac{D}{\sqrt{m}}\right)^{-1.6}$$

Where: ***PPV*** = Ground Vibration as vector Peak Particle Velocity (mm/s)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

The 95% confidence level, advocated by the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (1990), allows for an inherent variation in emission levels. This is by allowing for a 5% exceedance of general criterion.

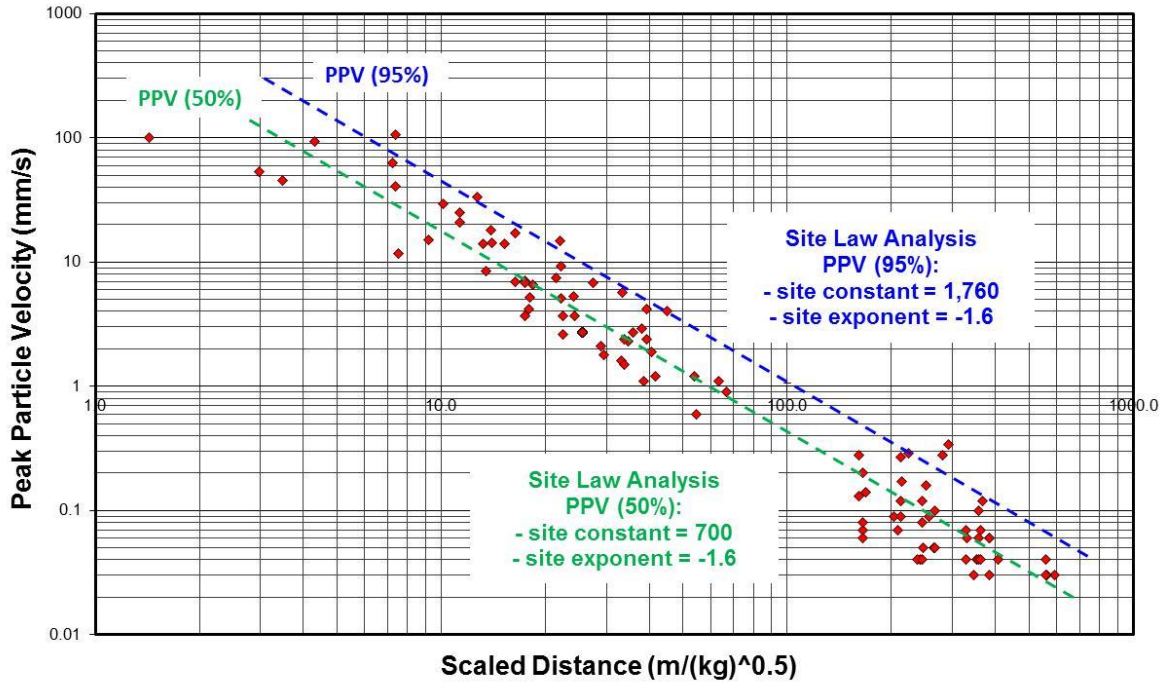

Figure 5A – Site Law Analysis for Bayswater Pit

SOUTHERN EXTENSION PIT MODEL

The ground vibration monitoring data was collated from various blasts undertaken within the Southern Extension Pit, representative of strata behaviour for the flat seam section in the western side of the Proposed Modification.

For the purpose of analysis, vibration monitoring data from a number of different blasts fired in the Southern Extension Pit was extracted. The collated data included vibration monitoring results from permanent monitoring stations and contained a sample of over 500 results collected within 2016 – 2017 monitoring period.

The collated data included vibration measurements from a variety of blasts (i.e. including overburden and interburden blasts) and is therefore representative of the actual ground vibration behaviour for the area when exposed to different blast impacts. The collected monitoring results were plotted using a standard log / log plot, see **Figure 5B**.

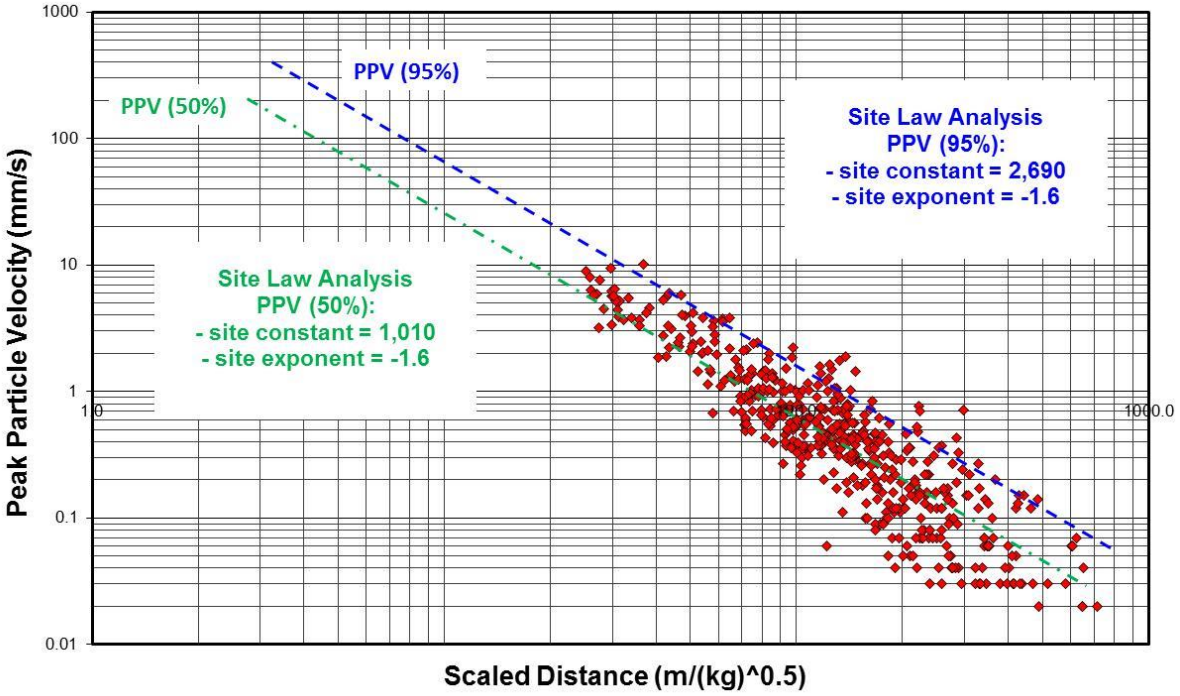

Figure 5B – Site Law Analysis for Southern Extension Pit

The parameters governing ground vibration behaviour for Southern Extension Pit derived through the site law analysis (corresponding to the 95% confidence level) are specified as follows:

- site exponent a = -1.6
- site constant k = 2,690

Therefore, the formula used for modelling of vibrations for the western part of the Proposed Modification (including the flat strata section) is:

$$PPV = 2{,}690 \left(\frac{D}{\sqrt{m}} \right)^{-1.6}$$

Where: ***PPV*** = Ground Vibration as vector Peak Particle Velocity (mm/s)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

4.1.2 Airblast Overpressure Predictive Model

To estimate the potential airblast (or air vibration) impacts from the Proposed Modification on the adjacent area including residential receivers, heritage / historic sites and infrastructure, an airblast overpressure predictive model (specific for Bulga conditions) has been developed.

It is important to note that the impact of the generated airblast levels from the source of the blast is generally guided by the sonic decay law as recommended in the Australian Standard (AS 2187.2-2006). For the airblast impact assessment, the cube-root scaled distance is more appropriate than the square root used for ground vibration as detailed in the Australian Standard (AS 2187.2-2006).

The sonic decay formula is specified as follows:

$$P = k \left(\frac{D}{\sqrt[3]{m}} \right)^{a}$$

Where: ***P*** = Peak Pressure (kPa)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge Mass per delay (kg)
a = Site exponent
k = Site constant

As in the case of the ground vibration predictive model, the actual airblast monitoring data has been sought from the southern part of Bulga operations including Bayswater Pit (representative for the steeply dipping section of the Proposed Modification) and Southern Extension Pit (representative for the flat seam section of the Proposed Modification). This is to establish sonic decay law parameters.

BAYSWATER PIT MODEL

The analysed sample of data covered various blasts including presplit, overburden and interburden blasts undertaken in Bayswater Pit in 2016. For each blast multiple vibration readings were collected (from various stations) and produced a sample of over 90 monitoring results. The results were recorded primarily by residential monitoring stations (located at distances in excess of 4 km) and some infrastructure monitoring stations (located within a 1 km radius).

The airblast monitoring results were plotted and together with other parameters gave rise to the airblast predictive model shown in **Figure 6A.** The presented sonic decay law analysis features two lines corresponding to the median of the measured data set (marked as Sound Pressure Level (SPL) 50%) and SPL 95% corresponding to 95% of the total population of data. Note that the 95%

criterion is utilised following ANZECC guidelines (1990), which allow for an inherent variation in emission levels, by allowing a 5% exceedance of general criterion.

To facilitate the accuracy of the assessment the forced exponent of -1.45 has been used, which corresponds to an attenuation rate of 8.6 dBL with a doubling of distance, as specified in Australian Standard, Explosives – Storage and use, Part 2 – Use of explosives (AS 2187.2-2006).

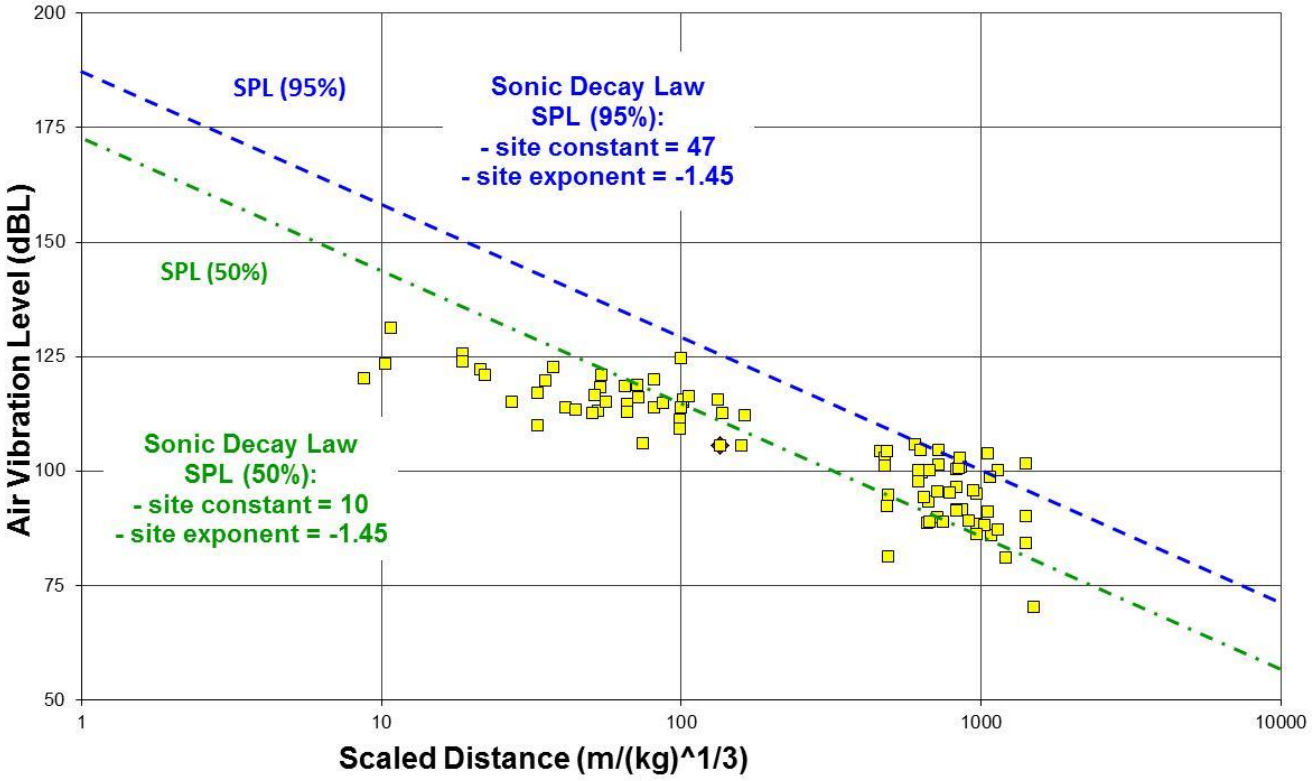

Figure 6A – Sonic Decay Law for Bayswater Pit

Therefore, based on the above assessment, the estimated sonic decay parameters (using the 95% confidence level), for Bayswater Pit, are as follows:

- site exponent a = -1.45
- site constant k = 47

The formula used for modelling purposes is therefore:

$$\boldsymbol{P} = 47\left(\frac{D}{\sqrt[3]{m}}\right)^{-1.45}$$

Where:

$\boldsymbol{P}$	=	Peak Pressure (kPa)
$\boldsymbol{D}$	=	Distance between charge and point of measurement (m)
$\boldsymbol{m}$	=	Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

SOUTHERN EXTENSION PIT MODEL

The airblast monitoring data was collated from various blasts undertaken within the Southern Extension Pit which is representative of strata behaviour for the flat seam section in the western side of the Proposed Modification.

The collated data included airblast monitoring results from the permanent monitoring stations collected within 2016 – 2017 period and constitutes a sample of over 700 results.

The airblast monitoring results were plotted and together with other parameters gave rise to the airblast predictive model shown in **Figure 6B.** The presented sonic decay law analysis features two lines corresponding to the median of the measured data set (marked as Sound Pressure Level (SPL) 50%) and SPL 95% corresponding to 95% of the total population of data. Note that the 95% criterion is utilised following ANZECC guidelines (1990), which allow for an inherent variation in emission levels, by allowing a 5% exceedance of general criterion.

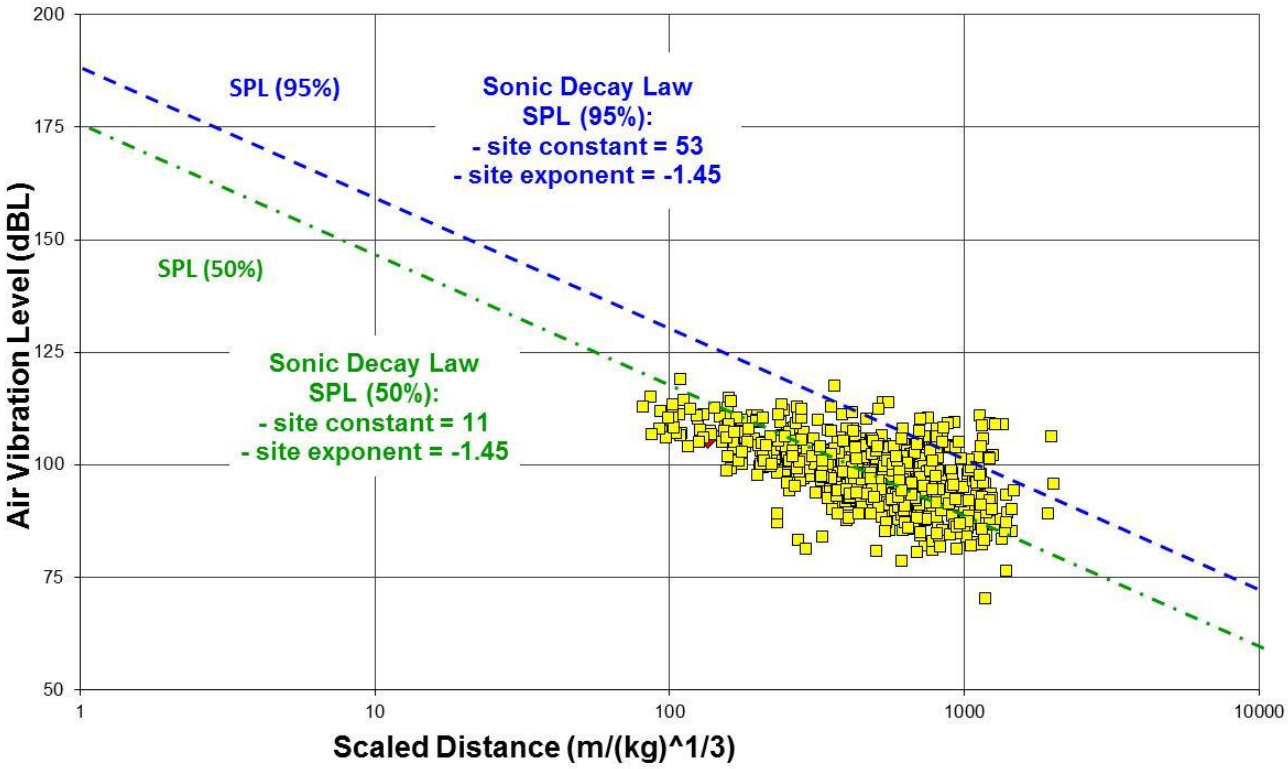

Figure 6B – Sonic Decay Law for Southern Extension Pit

Therefore, based on the above assessment, the estimated sonic decay parameters (using the 95% confidence level), used for the flat seam section, are as follows:

- site exponent a = -1.45
- site constant k = 53

The formula used for modelling purposes is therefore:

$$P = 53\left(\frac{D}{\sqrt[3]{m}}\right)^{-1.45}$$

Where: P = Peak Pressure (kPa)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

In summary, both models produced similar results with a minor variation in the site constants i.e. 47 versus 53. This indicates similar airblast emission from both sections of the mine, independent of strata conditions. Therefore, to model the airblast emissions for sensitive receivers due to the Proposed Modification, in most cases the more conservative Southern Extension Pit Model corresponding to the western section has been used.

4.2 BLAST EMISSION CRITERIA

4.2.1 Criteria for Private Residential Receivers

The existing ground vibration and airblast overpressure emission criteria for private residential receivers are specified in the Bulga Open Cut BMP (2016) and are based on the BOP Development Consent (SSD-4960, Schedule 3 Condition 8).The criteria are presented below and summarised in **Table 3**.

- The PPV of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The upper PPV level of 10 mm/s should not be exceeded at any time.
- The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The airblast level should not exceed 120 dBL at any time.

These vibration limits are used as the assessment criteria for the Proposed Modification.

4.2.2 Criteria for Heritage Items / Historical Sites, Infrastructure and Adjacent Mines

The current ground vibration and airblast emission criteria for the identified heritage items / historical sites, infrastructure and adjacent mines are presented below. These are also summarised in **Table 3**. The location of these items / sites together with the outline of the Proposed Modification are presented in **Figure 8**.

HERITAGE ITEMS / HISTORICAL SITES

'Mt Leonard' Homestead, St Andrew's Anglican Church, BH6 Broke Cemetery, Murinbin House Group, BH14 – Charlton and BH13 Stone Wall alongside Monkey Place Creek

There are six heritage items included in the BOP Development Consent (SSD-4960) with imposed vibration limits, including:

- 'Mt Leonard' Homestead - a historic complex comprising of a homestead and several associated out-buildings; located on the outskirts of Bulga township,
- St Andrew's Anglican Church - located in the central part of Broke township,

- BH6 – Broke Cemetery - located on the outskirts of Broke township next to Charlton Road,
- Murinbin House Group - located to the east of Broke township
- BH14 – Charlton – located to the west of BOP
- BH13 Stone Wall alongside Monkey Place Creek

The vibration limit for these items, listed in the BOP Development Consent (SSD-4960) in Schedule 3 Condition 41 of Heritage Management Measures (Appendix 10 Table 3) is 3 mm/s, unless a structural assessment is conducted which confirms tolerance for higher vibration levels.

The structural assessments (Arkhill Engineers, 2014, 2015) undertaken by a structural engineer found that none of the above-listed structures is expected to experience any global stability problems or collapse by commonly occurring ground vibrations of 3 mm/s, or infrequent ground vibrations of up to 5 mm/s as expected from the BOP, as they stand in their current form. Thus a maximum vibration limit of 5 mm/s was adopted for these sites and included in the approved Bulga Blast Management Plan (2016).This vibration limit (5 mm/s) is used for the above-listed heritage items as the assessment criteria for the Proposed Modification

'Mt Leonard' Homestead, Mt Leonard Public School (Scout Hall), BH14 – Charlton, Bulga Bridge, St Andrew Anglican Church

The Operating Conditions (Condition 13 (b)) of the BOP Development Consent SSD4960 require blasting to be conducted in such way as to 'ensure that blasting on site does not damage the 'Mount Leonard' Homestead, Mt Leonards Public School (Scout Hall), Charlton (BH14), Bulga Bridge, St Andrews Anglican Church'.

The same condition applies for the Proposed Modification.

Bulga Bridge over Wollombi Brook

The Bulga Bridge over Wollombi Brook is a timber truss road bridge of state heritage significance. The bridge is classed under the 'other public infrastructure' category. The recommended vibration limit specified in the Bulga Optimisation Project Development Consent (SSD-4960, schedule 3 condition 8) is 50 mm/s.

This vibration limit is used as the assessment criterion for the Proposed Modification.

INFRASTRUCTURE

330 kV Power line

The power line and transmission towers are owned by Transgrid (NSW electricity grid operator).

The BOP Development Consent (SSD-4960, Schedule 3 Condition 8) specifies 100 mm/s as a ground vibration criterion for suspension towers. The Bulga Open Cut BMP (2016) references a written agreement with Transgrid; as a result of the agreement ground vibrations of 100 mm/s (for free-standing towers) and 50 mm/s (for tension towers) are applicable.

These vibration limits are used as the assessment criterion for the Proposed Modification.

Public Roads

There are a number of public roads in the vicinity of Bulga Open Cut including the closest Broke and Charlton Roads. A vibration limit criterion of 100 mm/s (applicable to public roads) is

specified in the Bulga Open Cut BMP (2016). This is based on the Bulga Optimisation Project Development Consent (SSD-4960, schedule 3 condition 8).

This vibration limit is used as the assessment criterion for the Proposed Modification.

Broke Fordwich PID Pipeline and Broke Potable Water Pipeline

There is the Broke Fordwich PID Pipeline and Broke Potable Water Pipeline. Both of these are located along the realigned Broke Road easement.

A vibration limit criterion of 100 mm/s (applicable to the PID Pipeline) is specified in the Bulga Open Cut BMP (2016). This is based on the Bulga Optimisation Project Development Consent (SSD-4960, schedule 3 condition 8).

This vibration limit is used as the assessment criterion for the Proposed Modification.

Other Public Infrastructure

An applicable vibration limit criterion for other public infrastructure including Telstra fibre optic cables located in the vicinity of the BOP is 50 mm/s. This limit is specified in the Bulga Open Cut BMP (2016) and is based on the Bulga Optimisation Project Development Consent (SSD-4960, schedule 3 condition 8).

This vibration limit is used as the assessment criterion for the Proposed Modification.

Mushroom Composters Facility

Mushroom Composters Facility represents a privately-owned production facility located to the north-east of Bulga Open Cut operations.

Guidelines regarding vibration limits for occupied non-sensitive sites are provided in Australian Standard AS 2187.2-2006 'Explosives - Storage and Use - Part 2: Use of Explosives'. The relevant vibration limits include:

- 25 mm/s for occupied non-sensitive sites, such as factories and commercial premises
- 133 dBL - recommended airblast limit for damage control; this limit is recommended as a safe level that will prevent structural / architectural damage from blasting

Adjacent Mines – Mount Thorley Warkworth Infrastructure

The Mount Thorley Warkworth mine represents the closest non-Glencore owned open cut mining operation. There is a range of infrastructure including offices, processing plants, workshops and others.

Guidelines in regards to vibration limits for mine infrastructure are provided in Australian Standard AS 2187.2-2006 'Explosives - Storage and Use - Part 2: Use of Explosives'. The relevant vibration limits include:

- 25 mm/s for occupied non-sensitive sites, such as factories and commercial premises
- 100 mm/s for unoccupied structures of reinforced concrete or steel construction
- 133 dBL - recommended airblast limit for damage control; this limit is recommended as a safe level that will prevent structural / architectural damage from blasting

These vibration limits are used as the assessment criteria for the Proposed Modification.

Mine Owned Dams

Northern Dam and Clean Water Diversion Dam

There are two water dams outside of the mine extraction boundaries including Northern Dam (prescribed dam) and Clean Water Diversion Dam, which are located to the north-east of the Proposed Modification. The storage capacity of the Northern Dam is 2 GL. The vibration limit applicable to the dam walls as used in the original Blasting Impact Assessment (Wilkinson and Murray (2012)) for the Bulga Optimisation Project is 25 mm/s. The NSW Dam Safety Committee (DSC) imposes a condition of notification when commencing blasting within a 1 km zone of the dam wall.

The same 25 mm/s vibration limit is used as the assessment criterion for the Proposed Modification.

North Pit Tailing Dam, Vaux Pit Water Dam and Deep Pit Tailings Dam

There are water and tailings dams within the mine boundary with applicable internal vibration limits. These include North Pit Tailings Dam (prescribed dam) with the vibration limit of 12 mm/s, Vaux Pit Water Dam and Deep Pit Tailings Dam both with the limit of 35 mm/s as specified in the Blast Design Procedure (2018).

The Vaux Pit Water Dam and Deep Pit Tailings Dam will eventually be mined through. Blast impacts for these infrastructure facilities will be managed internally (according to the BMP (2016)) to maintain safe working practices.

Old Tailings Dam

The Old Tailings Dam located in the southern most section of Bulga operations is a prescribed dam with the applicable DSC notification area. The dam underwent rehabilitation in 2016 and most likely is to be de-prescribed in 2019/2020. There is no imposed vibration limit for the dam.

CHPP Surge Dam

The CHPP Surge Dam located adjacent to Bulga CHPP facility is a prescribed dam (with the applicable DSC notification area) with the storage capacity of 3 GL. There is no imposed vibration limit for the dam.

Bulga Underground Mine – Glencore Underground Mine

Bulga Underground Operations (BUO) ceased mining in May 2018 and has since been sealed. This included the sealing of the two ventilation shafts, men and material and conveyor drifts. The Bulga Underground Operations Pit Top facilities have also be demolished.

The BUO 9 MW gas fired power station, Blakefield North gas drainage infrastructure, Goaf plant and selected goaf wells will remain operational.

The blast impacts for the remaining BUO surface infrastructure will be managed internally (according to the BMP (2016)) to maintain safe working practices.

A summary of blast emission criteria used in the assessment is presented in **Table 3.**

Table 3: Summary of Blast Emission Criteria used in the Assessment

Receiver	Peak Particle Velocity (mm/s)	Allowable Exceedance	Overpressure (dBL)	Allowable Exceedance
Residence on privately-owned land	5	5% of the total number of blasts over 12 months	115	5% of the total number of blasts over 12 months
	10	0%	120	0%
Historic Buildings and Structures				
'Mt Leonard' Homestead	5	0%	n/a	
St Andrew's Anglican Church	5	0%	n/a	
BH6 – Broke Cemetery	5	0%	n/a	
Murinbin House Group	5	0%	n/a	
BH14 – Charlton	5	0%	n/a	
BH13 – Stone wall alongside Monkey Place Creek	5	0%	n/a	
Bulga Bridge over Wollombi Brook	50	0%	n/a	
Infrastructure				
330 kV Suspension Towers	100	0%	n/a	
330 kV Tension Towers	50	0%	n/a	
Public Roads	100	0%	n/a	
Broke Fordwich PID pipeline	100	0%	n/a	
Broke Potable Water Pipeline	100	0%	n/a	
Telstra Fibre Optic Cable	50	0%	n/a	
Other Public Infrastructure	50	0%	n/a	
Mushroom Composting Facility	25	0%	133	0%
Mt Thorley Warkworth Mine Infrastructure –occupied	25	0%	133	0%
Mt Thorley Warkworth Mine Infrastructure -unoccupied	100	0%	133	0%
Northern Dam and Clean Water Diversion Dam	25	0%	n/a	
North Pit Tailings Dam	12	0	n/a	
Vaux Pit Water Dam and Deep Pit Tailings Dam	35	0	n/a	

5.0 BLAST IMPACT ASSESSMENT

The BIA addresses the impact of the Proposed Modification in terms of ground vibration, overpressure and flyrock on the surrounding environment including private residential receivers, heritage sites and infrastructure.

The aim of the assessment is to show that the emissions due to blasting from the Proposed Modification can be maintained below the imposed vibration criteria, therefore ensuring the safety of people and public or private infrastructure/property as required by Operating Conditions (Section 13) of SSD-4960.

The purpose of this section is to estimate potential ground vibration and airblast exposure, as well as flyrock impacts, which will be generated when undertaking blasting within the Proposed Modification blasting boundary. The analysis is based on vibration modelling utilising the relevant vibration predictive models, see Section 4.1. The estimated exposure levels are discussed in the context of the applicable ground and air vibration limits.

The modelled estimates present the worst-case scenario, i.e. when blasting is undertaken from the edge of the extraction area of the Proposed Modification. This corresponds to blasting at the minimum distance between the blasting area and the assessed receivers.

5.1 COMMUNITY

5.1.1 **Location of Private Residential Receivers**

The outline of the Proposed Modification blasting boundary, including the location of the adjacent private and mine owned residential receivers, is highlighted in **Figure 7.** The distribution of the privately-owned residential receivers is summarised as follows:

- The Proposed Modification is located in the southern most section of the Bulga Open Cut Mine providing the highest impact mainly for the southern and scattered south-western and western residences.
- The closest private residences are located to the south-west and west and correspond to residential receivers ID 149 and 195 respectively. Both receivers are located within 2.6 km of the proposed blasting boundary. There is a private mining impacts agreement applicable to residence ID149 that permits ground vibration and overpressure from blasting of up to 20 mm/s and 140 dBL respectively.
- There are also a number of widely spaced residences located to the south-west and west of the Proposed Modification area; they are located at highly variable distances.
- With the exception of the Broke community (approximately 4 km distance) and scattered residences along Milbrodale Road, the Proposed Modification is located away from any significant cluster of private residential receivers. The second closest, Bulga community, is located to the north-west of the Proposed Modification, in excess of 5 km.

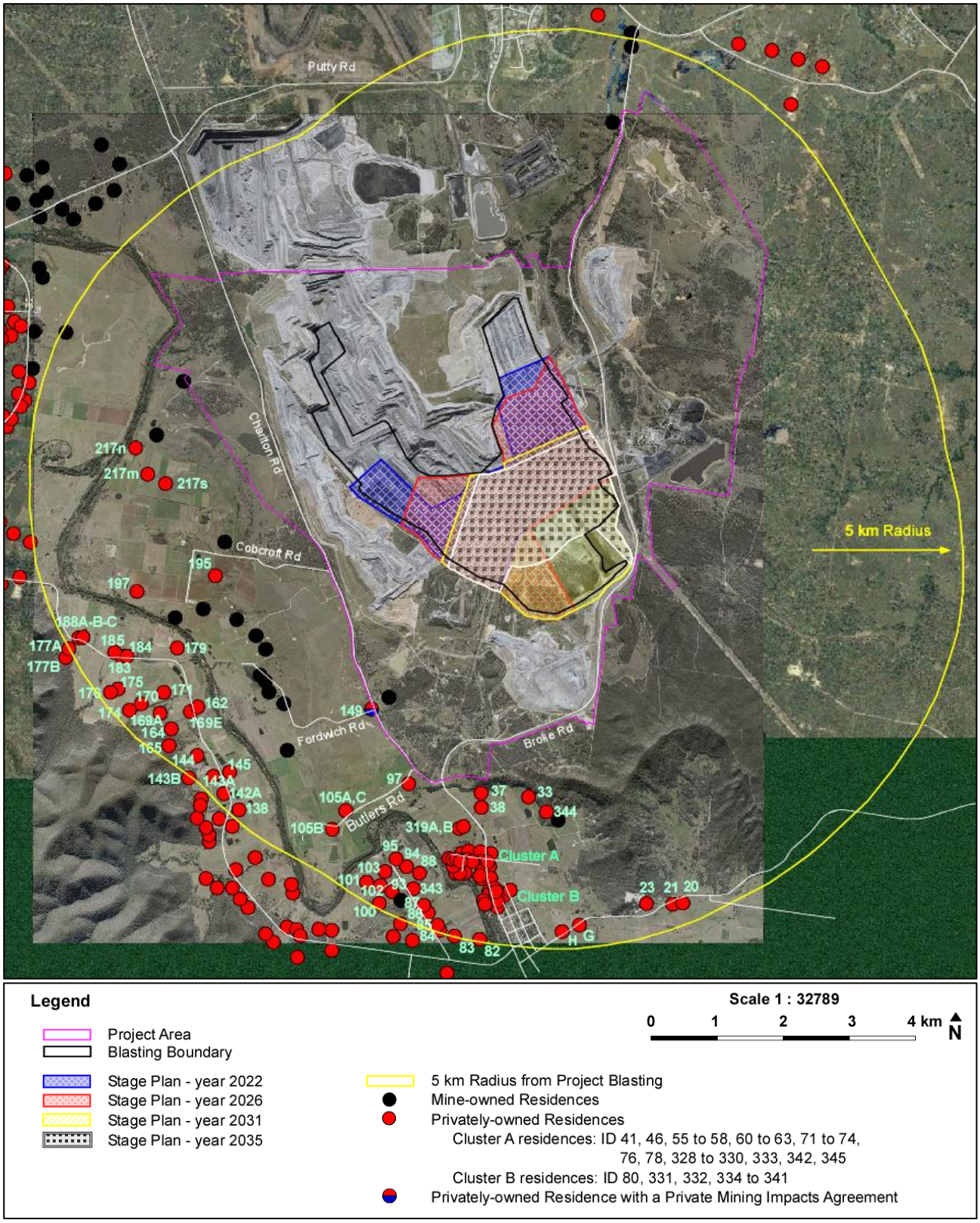

Figure 7 - Locations of Private Residential Receivers and the Proposed Modification Blasting Boundary

5.1.2 Assessment Results

5.1.2.1 Ground Vibration

The estimated impact of ground vibrations from the Proposed Modification on the private residential receivers was assessed in detail using ground vibration modelling. The modelling utilised the site law formula representative for Bulga conditions as explained in Section 4.1.1.

The ground vibration modelling provides ground vibration estimates for residential receivers located within a 5 km radius of the Proposed Modification, see **Figure 7**. The 5 km radius has been chosen as the impact of blasting on residential receivers located further than this is considered negligible (i.e. generally beyond a human perception level for majority of blasts).

To gauge the potential blast impacts there were several different simulations performed involving charge masses ranging from 26 to 2,810 kg, representative of the range of MIC's to be used during the Proposed Modification's lifetime (according to the proposed bench heights). Modelling results for twelve cases of different charge masses are presented in **Table 4**.

In addition, **Table 4** shows the distances for each private residential receiver within a 5 km radius and the estimated vibration using variable charge masses. As the shortest distance in all cases corresponds to the western blasting section (which also will be blasted with the higher MIC), therefore impacts due to blasting in the western section only are presented in the table.

Table 4: Results of Ground Vibration Modelling for Privately-owned Residential Receivers – Maximum Vibration Estimates – within a 5 km Radius

Residential ID	Min. Distance[1] (m)	Estimated Max Ground Vibration (mm/s)											
	Hole Depth (m):	3.6 m			22 m				46.4 m				
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270
		MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
20	4,750	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0
21	4,710	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.2	1.6	1.8	2.1
23	4,570	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.7	1.9	2.2
33	2,790	0.1	0.2	0.2	1.1	1.8	2.1	2.3	2.2	2.7	3.7	4.2	4.7
37	2,850	0.1	0.2	0.2	1.1	1.8	2.1	2.3	2.1	2.6	3.6	4.1	4.6
38	3,060	0.1	0.2	0.2	1.0	1.6	1.8	2.0	1.9	2.3	3.2	3.6	4.1
41	3,700	0.1	0.1	0.2	0.7	1.2	1.4	1.5	1.4	1.7	2.3	2.7	3.0
46	3,910	0.1	0.1	0.1	0.7	1.1	1.2	1.4	1.3	1.5	2.1	2.5	2.8
55	3,780	0.1	0.1	0.2	0.7	1.1	1.3	1.4	1.3	1.6	2.3	2.6	2.9
56	3,730	0.1	0.1	0.2	0.7	1.2	1.3	1.5	1.4	1.7	2.3	2.7	3.0
57	3,700	0.1	0.1	0.2	0.7	1.2	1.4	1.5	1.4	1.7	2.3	2.7	3.0
58	3,870	0.1	0.1	0.1	0.7	1.1	1.3	1.4	1.3	1.6	2.2	2.5	2.8
60	4,060	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.0	2.3	2.6
61	3,840	0.1	0.1	0.1	0.7	1.1	1.3	1.4	1.3	1.6	2.2	2.5	2.8
62	3,990	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.1	2.4	2.7
63	4,100	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.4	2.0	2.3	2.6
71	3,930	0.1	0.1	0.1	0.7	1.1	1.2	1.4	1.3	1.5	2.1	2.4	2.7
72	3,920	0.1	0.1	0.1	0.7	1.1	1.2	1.4	1.3	1.5	2.1	2.4	2.8
73	3,910	0.1	0.1	0.1	0.7	1.1	1.2	1.4	1.3	1.5	2.1	2.5	2.8
74	3,920	0.1	0.1	0.1	0.7	1.1	1.2	1.4	1.3	1.5	2.1	2.4	2.8
76	3,980	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.1	2.4	2.7
78	4,100	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.4	2.0	2.3	2.6

Residential ID	Min. Distance[1] (m)	Estimated Max Ground Vibration (mm/s)											
	Hole Depth (m):	3.6 m			22 m				46.4 m				
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270
		MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
80	4,490	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.2	1.7	2.0	2.2
82	5,010	<0.1	0.1	0.1	0.4	0.7	0.8	0.9	0.9	1.0	1.4	1.7	1.9
83	5,030	<0.1	0.1	0.1	0.4	0.7	0.8	0.9	0.9	1.0	1.4	1.6	1.8
84	4,990	<0.1	0.1	0.1	0.4	0.7	0.8	0.9	0.9	1.0	1.5	1.7	1.9
85	4,950	<0.1	0.1	0.1	0.4	0.7	0.9	0.9	0.9	1.1	1.5	1.7	1.9
86	4,800	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0
87	4,720	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0
88	4,300	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.3	1.8	2.1	2.4
93	4,710	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.2	1.6	1.8	2.1
94	4,270	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.3	1.9	2.1	2.4
95	4,240	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.4	1.9	2.2	2.4
97	3,180	0.1	0.2	0.2	0.9	1.5	1.7	1.9	1.8	2.2	3.0	3.4	3.8
100	4,960	<0.1	0.1	0.1	0.4	0.7	0.9	0.9	0.9	1.1	1.5	1.7	1.9
101	4,770	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0
102	4,720	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0
103	4,500	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.2	1.7	2.0	2.2
138	4,920	<0.1	0.1	0.1	0.5	0.7	0.9	0.9	0.9	1.1	1.5	1.7	1.9
144	4,660	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	1.0	1.2	1.6	1.9	2.1
145	4,600	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.7	1.9	2.1
149[2]	2,530	0.1	0.2	0.3	1.3	2.2	2.5	2.7	2.6	3.1	4.3	4.9	5.5
162	4,050	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.0	2.3	2.6
164	4,560	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.7	1.9	2.2
165	4,780	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0
170	4,590	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.7	1.9	2.1

Residential ID	Min. Distance[1] (m)	Estimated Max Ground Vibration (mm/s)												
	Hole Depth (m):	3.6 m			22 m				46.4 m					
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270	
		MIC (kg)												
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO			
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810	
171	4,220	0.1	0.1	0.1	0.6	1.0	1.1	1.2	1.1	1.4	1.9	2.2	2.4	
174	4,790	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0	
175	4,700	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	1.0	1.2	1.6	1.8	2.1	
176	4,830	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0	
179	3,620	0.1	0.1	0.2	0.7	1.2	1.4	1.5	1.4	1.8	2.4	2.8	3.1	
183	4,380	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.1	1.3	1.8	2.0	2.3	
184	4,310	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.3	1.8	2.1	2.4	
185	4,430	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.3	1.8	2.0	2.3	
195	2,530	0.1	0.2	0.3	1.3	2.2	2.5	2.7	2.6	3.1	4.3	4.9	5.5	
197	3,680	0.1	0.1	0.2	0.7	1.2	1.4	1.5	1.4	1.7	2.4	2.7	3.0	
328	3,870	0.1	0.1	0.1	0.7	1.1	1.3	1.4	1.3	1.6	2.2	2.5	2.8	
329	4,090	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.4	2.0	2.3	2.6	
330	4,020	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.0	2.4	2.6	
331	4,250	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.4	1.9	2.2	2.4	
332	4,300	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.3	1.8	2.1	2.4	
333	4,070	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.0	2.3	2.6	
334	4,210	0.1	0.1	0.1	0.6	1.0	1.1	1.2	1.1	1.4	1.9	2.2	2.5	
335	4,240	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.4	1.9	2.2	2.4	
336	4,290	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.3	1.8	2.1	2.4	
337	4,400	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.1	1.3	1.8	2.0	2.3	
338	4,210	0.1	0.1	0.1	0.6	1.0	1.1	1.2	1.1	1.4	1.9	2.2	2.5	
339	4,420	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.1	1.3	1.8	2.0	2.3	
340	4,470	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.3	1.7	2.0	2.2	
341	4,240	0.1	0.1	0.1	0.6	0.9	1.1	1.2	1.1	1.4	1.9	2.2	2.4	

Residential ID	Min. Distance[1] (m)	Estimated Max Ground Vibration (mm/s)												
	Hole Depth (m):	3.6 m			22 m				46.4 m					
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270	
		MIC (kg)												
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO			
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810	
342	3,840	0.1	0.1	0.1	0.7	1.1	1.3	1.4	1.3	1.6	2.2	2.5	2.8	
343	4,540	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.7	1.9	2.2	
344	2,990	0.1	0.2	0.2	1.0	1.7	1.9	2.1	2.0	2.4	3.3	3.8	4.2	
345	4,060	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.5	2.0	2.3	2.6	
105 A	4,090	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.4	2.0	2.3	2.6	
105 B	4,430	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.3	1.8	2.0	2.3	
105 C	4,090	0.1	0.1	0.1	0.6	1.0	1.2	1.3	1.2	1.4	2.0	2.3	2.6	
142 A	4,890	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.7	1.9	
143 A	4,790	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0	
169 A	4,490	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.0	1.2	1.7	2.0	2.2	
169 E	4,180	0.1	0.1	0.1	0.6	1.0	1.1	1.2	1.1	1.4	1.9	2.2	2.5	
177 A	4,990	<0.1	0.1	0.1	0.4	0.7	0.8	0.9	0.9	1.0	1.5	1.7	1.9	
188 A	4,790	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0	
188 B	4,730	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0	
188 C	4,730	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.6	1.8	2.0	
217 M	3,170	0.1	0.2	0.2	0.9	1.5	1.7	1.9	1.8	2.2	3.0	3.4	3.9	
217 N	3,390	0.1	0.1	0.2	0.8	1.4	1.6	1.7	1.6	1.9	2.7	3.1	3.5	
217 S	2,900	0.1	0.2	0.2	1.1	1.7	2.0	2.2	2.1	2.5	3.5	4.0	4.5	
319 A	3,450	0.1	0.1	0.2	0.8	1.3	1.5	1.7	1.6	1.9	2.6	3.0	3.4	
319 B	3,400	0.1	0.1	0.2	0.8	1.3	1.6	1.7	1.6	1.9	2.7	3.1	3.5	
G	4,700	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	1.0	1.2	1.6	1.8	2.1	
H	4,790	<0.1	0.1	0.1	0.5	0.8	0.9	1.0	0.9	1.1	1.5	1.8	2.0	

1 - Minimum distance to the pit over the lifetime of the Proposed Modification;

2 - Bulga Coal Management has a private mining impacts agreement applicable to residence ID 149 that permits:
'(b) ground vibration peak particle velocity from blasting exceeds 10 mm/s but does not exceed 20 mm/s at any time; or
(c) overpressure from blasting exceeds 120 dB(L) but does not exceed 140 dB(L) at any time'

Shaded cells – ground vibration estimate equal to or exceeds the applicable limit; however, compliance is achievable through the application of an appropriate blast design.

The results of the ground vibration modelling are summarised as follows:

- Negligible impact (i.e. below a human perception level (0.8 mm/s)) is predicted for charge masses in the order of 26 - 69 kg for any residential distance and for up to 466 kg for residential distances greater than 3.4 km. The impacts of vibration will increase for higher charge masses.
- The impacts of vibration for the analysed residential receivers will be highly variable dependent upon the charge mass. The estimated maximum vibration exposure for the residences using proposed charge masses of 26 to 2,810 kg is in the order of 0.1 to 5.5 mm/s.
- The results of the modelling show that impacts on the neighbouring private residential receivers can be managed effectively (to remain below the imposed ground vibration criteria) by using lower charge masses. This can be achieved either by blasting smaller benches, using smaller hole diameters, or by the application of deck charges, together with the application of exact initiation timing. For example, based on the table above, the predicted maximum ground vibration level for the property ID 195 is 5.5 mm/s, at 2.53 km to the blast (this distance corresponds to the minimum distance over the lifetime of the Proposed Modification). The ground vibration level can be managed by decreasing the charge mass (to for example approximately 1,168 kg) to achieve a predicted vibration value of 2.7 mm/s which is below the 5 mm/s limit (for 95% of blasts).

5.1.2.2 Airblast Overpressure

For the airblast overpressure modelling the sonic decay formula, as specified in Section 4.1.2 was utilised. The modelling provides estimations of airblast levels using the proposed charge masses as used for ground vibration modelling.

The results of airblast overpressure estimates are presented in **Table 5**. These include estimations for all private residential receivers located within a 5 km radius of the Proposed Modification blasting boundary.

As stated earlier, the modelling accounts for the worst-case scenario, i.e. blasting from the edge of the proposed extraction area boundary. As the shortest distance for all private residences corresponds to the western blasting section (which also will be blasted with the higher MIC), therefore impacts due to blasting in the western section only are presented in **Table 5**. The table therefore, highlights the maximum airblast levels that will be generated during the lifetime of the Proposed Modification.

Table 5: Results of Airblast Modelling for Privately-owned Residential Receivers – Maximum Airblast Estimates - within a 5 km Radius

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL)											
Hole Depth (m):		3.6 m			22 m				46.4 m				
Hole ø (mm):		203	229	270	203	229	251	270	203	229	229	251	270
		MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
20	4,750	96	98	100	108	110	111	111	111	112	114	115	115
21	4,710	96	98	100	108	110	111	112	111	112	114	115	115
23	4,570	96	99	100	108	111	111	112	112	113	114	115	116
33	2,790	102	105	106	114	117	118	118	118	119	121	121	122
37	2,850	102	105	106	114	117	117	118	118	119	120	121	122
38	3,060	101	104	105	113	116	117	117	117	118	119	120	121
41	3,700	99	101	103	111	113	114	115	114	115	117	118	118
46	3,910	98	101	102	110	113	113	114	114	115	116	117	118
55	3,780	98	101	102	111	113	114	114	114	115	117	117	118
56	3,730	99	101	103	111	113	114	115	114	115	117	118	118
57	3,700	99	101	103	111	113	114	115	114	115	117	118	118
58	3,870	98	101	102	110	113	114	114	114	115	116	117	118
60	4,060	97	100	102	110	112	113	113	113	114	116	117	117
61	3,840	98	101	102	110	113	114	114	114	115	117	117	118
62	3,990	98	100	102	110	112	113	114	113	114	116	117	117
63	4,100	97	100	101	109	112	113	113	113	114	116	116	117
71	3,930	98	101	102	110	113	113	114	114	115	116	117	118
72	3,920	98	101	102	110	113	113	114	114	115	116	117	118
73	3,910	98	101	102	110	113	113	114	114	115	116	117	118
74	3,920	98	101	102	110	113	113	114	114	115	116	117	118
76	3,980	98	100	102	110	112	113	114	113	114	116	117	117
78	4,100	97	100	101	109	112	113	113	113	114	116	116	117
80	4,490	96	99	100	108	111	112	112	112	113	115	115	116

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL)											
	Hole Depth (m):	3.6 m			22 m				46.4 m				
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270
		MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
82	5,010	95	98	99	107	110	110	111	110	111	113	114	115
83	5,030	95	97	99	107	110	110	111	110	111	113	114	114
84	4,990	95	98	99	107	110	110	111	111	112	113	114	115
85	4,950	95	98	99	107	110	110	111	111	112	113	114	115
86	4,800	95	98	99	108	110	111	111	111	112	114	114	115
87	4,720	96	98	100	108	110	111	112	111	112	114	115	115
88	4,300	97	99	101	109	111	112	113	112	113	115	116	116
93	4,710	96	98	100	108	110	111	112	111	112	114	115	115
94	4,270	97	100	101	109	112	112	113	112	113	115	116	117
95	4,240	97	100	101	109	112	112	113	113	114	115	116	117
97	3,180	101	103	105	113	115	116	117	116	117	119	120	120
100	4,960	95	98	99	107	110	110	111	111	112	113	114	115
101	4,770	95	98	100	108	110	111	111	111	112	114	115	115
102	4,720	96	98	100	108	110	111	112	111	112	114	115	115
103	4,500	96	99	100	108	111	112	112	112	113	115	115	116
138	4,920	95	98	99	107	110	111	111	111	112	113	114	115
144	4,660	96	98	100	108	110	111	112	111	112	114	115	115
145	4,600	96	99	100	108	111	111	112	112	113	114	115	116
149[2]	2,530	103	106	108	116	118	119	119	119	120	122	122	123
162	4,050	98	100	102	110	112	113	114	113	114	116	117	117
164	4,560	96	99	100	108	111	112	112	112	113	114	115	116
165	4,780	95	98	100	108	110	111	111	111	112	114	114	115
170	4,590	96	99	100	108	111	111	112	112	113	114	115	116
171	4,220	97	100	101	109	112	112	113	113	114	115	116	117

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL)											
	Hole Depth (m):	3.6 m			22 m				46.4 m				
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270
		MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
174	4,790	95	98	100	108	110	111	111	111	112	114	114	115
175	4,700	96	98	100	108	110	111	112	111	112	114	115	115
176	4,830	95	98	99	107	110	111	111	111	112	114	114	115
179	3,620	99	102	103	111	114	114	115	115	116	117	118	119
183	4,380	97	99	101	109	111	112	113	112	113	115	116	116
184	4,310	97	99	101	109	111	112	113	112	113	115	116	116
185	4,430	96	99	100	109	111	112	112	112	113	115	115	116
195	2,530	103	106	108	116	118	119	119	119	120	122	123	123
197	3,680	99	101	103	111	113	114	115	114	115	117	118	118
328	3,870	98	101	102	110	113	114	114	114	115	116	117	118
329	4,090	97	100	102	110	112	113	113	113	114	116	116	117
330	4,020	98	100	102	110	112	113	114	113	114	116	117	117
331	4,250	97	100	101	109	112	112	113	113	114	115	116	117
332	4,300	97	99	101	109	111	112	113	112	113	115	116	116
333	4,070	97	100	102	110	112	113	113	113	114	116	117	117
334	4,210	97	100	101	109	112	113	113	113	114	115	116	117
335	4,240	97	100	101	109	112	112	113	113	114	115	116	117
336	4,290	97	99	101	109	112	112	113	112	113	115	116	116
337	4,400	96	99	101	109	111	112	112	112	113	115	116	116
338	4,210	97	100	101	109	112	113	113	113	114	115	116	117
339	4,420	96	99	101	109	111	112	112	112	113	115	115	116
340	4,470	96	99	100	108	111	112	112	112	113	115	115	116
341	4,240	97	100	101	109	112	112	113	113	114	115	116	117
342	3,840	98	101	102	110	113	114	114	114	115	117	117	118

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL)												
	Hole Depth (m):	3.6 m			22 m				46.4 m					
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270	
		MIC (kg)												
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO			
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810	
343	4,540	96	99	100	108	111	112	112	112	113	114	115	116	
344	2,990	101	104	105	113	116	117	117	117	118	120	120	121	
345	4,060	97	100	102	110	112	113	113	113	114	116	117	117	
105 A	4,090	97	100	102	110	112	113	113	113	114	116	116	117	
105 B	4,430	96	99	100	109	111	112	112	112	113	115	115	116	
105 C	4,090	97	100	102	110	112	113	113	113	114	116	116	117	
142 A	4,890	95	98	99	107	110	111	111	111	112	113	114	115	
143 A	4,790	95	98	100	108	110	111	111	111	112	114	114	115	
169 A	4,490	96	99	100	108	111	112	112	112	113	115	115	116	
169 E	4,180	97	100	101	109	112	113	113	113	114	115	116	117	
177 A	4,990	95	98	99	107	110	110	111	111	112	113	114	115	
188 A	4,790	95	98	100	108	110	111	111	111	112	114	114	115	
188 B	4,730	96	98	100	108	110	111	112	111	112	114	115	115	
188 C	4,730	96	98	100	108	110	111	112	111	112	114	115	115	
217 M	3,170	101	103	105	113	115	116	117	116	117	119	120	120	
217 N	3,390	100	102	104	112	114	115	116	115	116	118	119	119	
217 S	2,900	102	104	106	114	116	117	118	117	118	120	121	121	
319 A	3,450	100	102	104	112	114	115	116	115	116	118	119	119	
319 B	3,400	100	102	104	112	114	115	116	115	116	118	119	119	
G	4,700	96	98	100	108	110	111	112	111	112	114	115	115	
H	4,790	95	98	100	108	110	111	111	111	112	114	114	115	

1 - Minimum distance to the pit over the lifetime of the Proposed Modification;

2 - Bulga Coal Management has a private mining impacts agreement applicable to residence ID 149 that permits:

'(b) ground vibration peak particle velocity from blasting exceeds 10 mm/s but does not exceed 20 mm/s at any time; or
(c) overpressure from blasting exceeds 120 dB(L) but does not exceed 140 dB(L) at any time'

Shaded cells – overpressure estimate equal to or exceeds the applicable limit; however, compliance is achievable through the application of an appropriate blast design

The results of the airblast overpressure modelling are summarised as follows:

- The airblast impacts will be highly variable dependent upon the charge mass and distance. The results of the modelling show that airblast impacts on the surrounding residential receivers can be managed effectively (to remain below the imposed airblast criteria) by using lower charge masses. This can be achieved either by blasting smaller benches, using smaller hole diameters or by the application of deck charges, together with the application of exact initiation timing.
- There are six residential receivers located within a 2 - 3 km radius of the Proposed Modification blasting boundary. The study identified that the airblast exposure for these residential receivers can be managed via the application of lower charge masses. To achieve compliance (levels below the 115 dBL limit), blasting of smaller benches equivalent to 22 m i.e. an MIC up to 466 kg or lower can provide sufficient airblast control. In case of residence ID 195 a lower MIC of up to 360 kg will be required for the minimum distance (i.e. when blasting at the western boundary of the Proposed Modification). At further distances higher charge masses will be allowed.
- Due to the above-mentioned residences being located in close proximity to the Proposed Modification blasting area, all blast designs will be such that emissions at all other residences (located further away) will automatically comply with the airblast limit of 115 dBL (for 95% of blasts).
- In general, blasting close to the edge of the blasting boundary will require lower charge masses to achieve compliance. As the distance increases a wider range of modelled charge masses will be adequate (e.g. at 4 km distance MIC up to 1,364 kg will be acceptable) to provide sufficient airblast control (i.e. levels below the 115 dBL limit).
- As the Proposed Modification reaches greater depths, some topographical shielding will emerge due to a change in the contours of the area. This will assist to lessen the airblast impacts on the surrounding communities.

5.1.2.3 Flyrock

Bulga Open Cut operates using a standard 0.5 km exclusion zone for personnel and 0.3 km for equipment (Blast Clearance and Firing Procedure (2018)). This distance is considered appropriate for managing the risk of flyrock as it is used widely across the mining industry.

The closest private residential receivers (i.e. ID 149 and 195 in south-western and western directions) are both located approximately 2.53 km from the Proposed Modification blasting boundary and as such the potential risk of flyrock on the surrounding residential receivers is considered negligible. Also, the majority of land within a 0.5 km radius of the Proposed Modification blasting boundary is owned by either Bulga Open Cut (majority) or the Commonwealth.

5.2 HERITAGE ITEMS / HISTORICAL SITES, INFRASTRUCTURE AND ADJACENT MINES

5.2.1 Location of Heritage Sites, Infrastructure and Adjacent Mines

The heritage sites, infrastructure and adjacent mines specified below were assessed in this report. Refer to **Figure 8A** which shows the locations of the identified heritage sites, while **Figure 8B**

highlights the locations of the infrastructure. The heritage sites, infrastructure and adjacent mines assessed in this report include:

- Heritage Sites:
  - 'Mt Leonard' Homestead,
  - St Andrew Anglican Church,
  - BH6 - Broke Cemetery,
  - Murinbin House Group,
  - BH14 – Charlton,
  - BH13 - Monkey Place Creek Stone Wall'
  - Mt Leonard Public School (now Scout Hall),
  - Bulga Bridge over Wollombi Brook.
- Infrastructure:
  - 330 kV Power line including Tension and Suspension Towers,
  - Water dams including Northern Dam, Clean Water Diversion Dam, Vaux Pit Water Dam (to be mined through) and CHPP Surge Dam
  - Tailings dams including North Pit Tailings Dam and Old Tailings Dam and Deep Pit Tailings Dam (to be mined through),
  - Broke Fordwich PID Pipeline,
  - Broke Potable Water Pipeline,
  - Telstra Fibre Optic Cable,
  - Local roads and bridges including Broke Road and Charlton Roads,
  - Mushroom Composters Facility.
- Adjacent mines:
  - Mount Thorley Warkworth Mine.

The identified heritage sites and infrastructure are located at variable distances with respect to the Proposed Modification ranging from 77 m for Broke Fordwich PID Pipeline (infrastructure) to 6.7 km for Bulga Bridge over Wollombi Brook (heritage site).

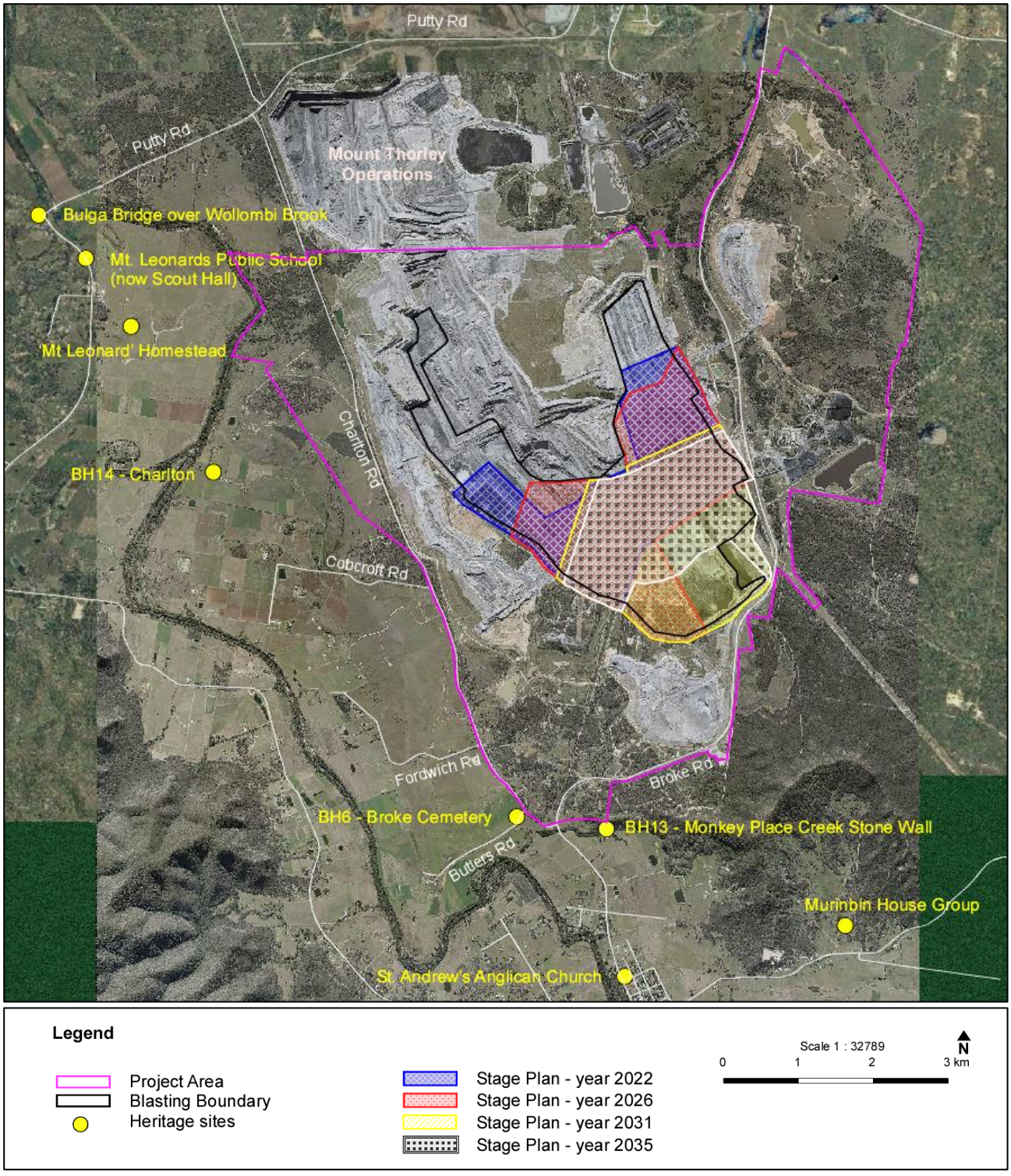

Figure 8A – Locations of the Heritage Sites in Relation to the Proposed Modification

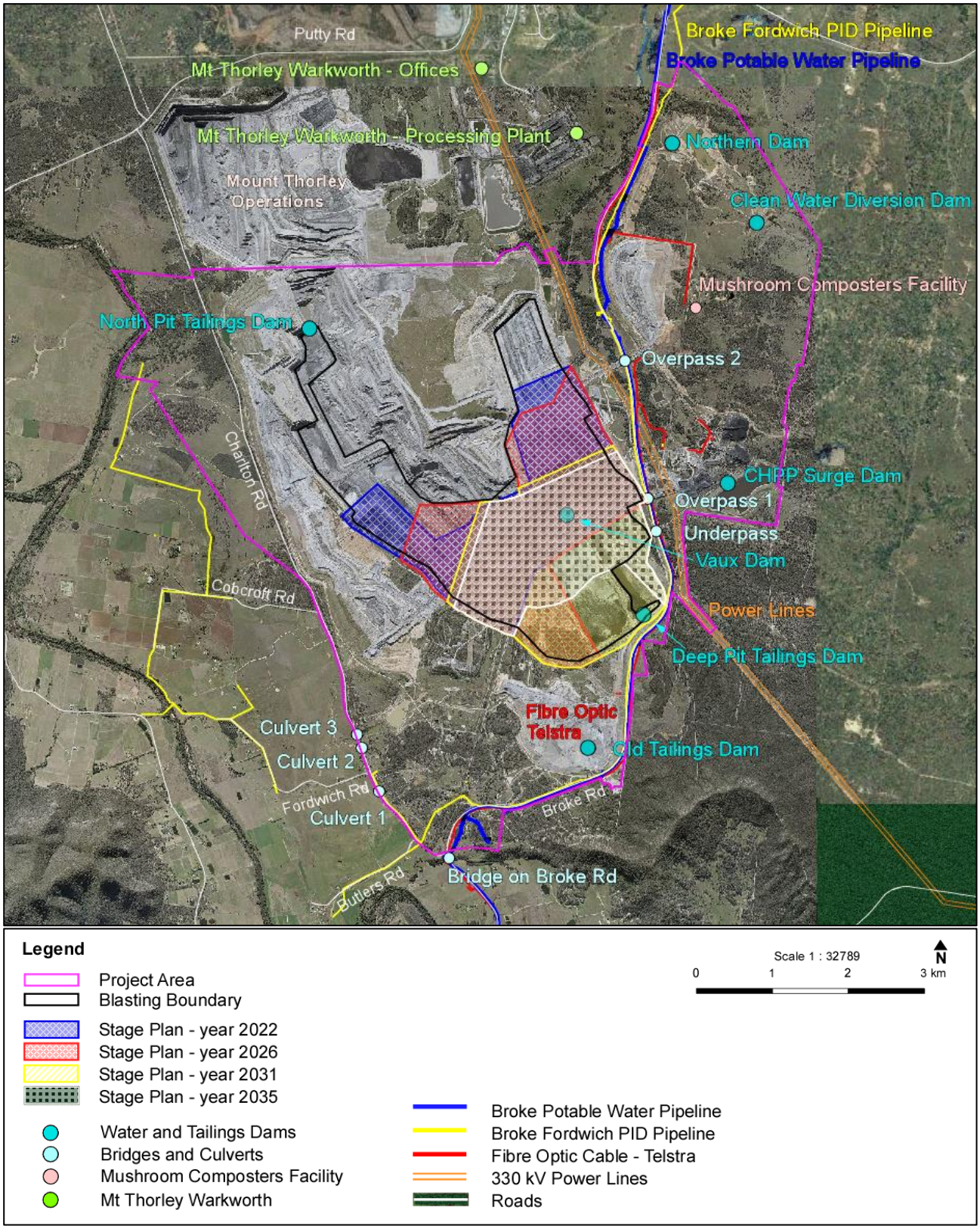

Figure 8B – Locations of the Infrastructure in Relation to the Proposed Modification

5.2.2 Assessments Results

5.2.2.1 Ground Vibration

The assessment undertaken included twelve different blasting simulations, incorporating three different bench sizes, various hole diameters and different blasting products (i.e. for dry and wet conditions) to be used in the Proposed Modification. The assessed items located to the west and south-west of the Proposed Modification were modelled using parameters determined suitable for blasting in the western section of the mine; that is Southern Extension Pit model. Items located to the east or south-east of the Proposed Modification were modelled using parameters based on Bayswater Pit model. The vibration modelling has been performed according to the formulas specified in Section 4.1.1. The results of the modelling are presented in **Table 6**.

The results of the analysis are summarised as follows:

Heritage Sites

- All heritage sites are located in excess of 2.7 km from the Proposed Modification blasting boundary. Vibration exposures for the heritage sites are no higher than 4.9 mm/s, which is below the applicable criteria of 5 mm/s. This is for all modelled charge masses.

Infrastructure and Adjacent Mines

- The 330 kV power line (with the closest distance being 300 m) will be exposed to maximum vibration levels of 55 mm/s. This is below the applicable criteria of 100 mm/s. The maximum modelled charge mass was 1,168 kg as applicable to blasting in the eastern section of the mine.
- Both Northern Dam (3.29 km distant) and Clean Water Diversion Dam (3.2 km distant) will be exposed to vibration levels no higher than 2 mm/s, which is well below the applicable vibration criterion of 25 mm/s.
- The vibration impacts on Broke Fordwich PID and Broke Potable Water Pipeline, located at 77 and 87 m at the closest distance from the extraction area respectively, can be managed effectively to a level below the applicable vibration limit criteria of 100 mm/s via the application of lower charge masses (i.e. 26 – 69 kg). When blasting at further distances the application of higher charge masses will be allowed. This applies to blasting in the eastern section of the mine. There are no restrictions for blasting in the western section.
- The vibration impacts on the Telstra fibre optic cable, located approximately 110 m from the extraction area, can be managed effectively to a level below the applicable vibration limit criteria of 50 mm/s via the application of lower charge masses, i.e. 26 – 69 kg. When blasting at further distances the application of higher charge masses will be allowed. This applies to blasting in the eastern section of the mine. There are no restrictions for blasting in the western section.
- The vibration impact on the closest public roads including Broke Road, overpass No1 and the underpass on Broke Road (located at their closest 80, 85 and 115 m from the extraction area), can be managed effectively to a level below the applicable vibration limit criteria of 100 mm/s via the application of lower charge masses, For the specified criteria, the estimated allowable MIC for the closest distance could be in the order of 26 - 69 kg.
- All other public roads and infrastructure are located in excess of 0.9 km from the edge of the Proposed Modification and will be exposed to maximum vibration levels of 27 mm/s which is below any of the applicable criteria.
- The maximum predicted vibration for the closest Mount Thorley Warkworth Mine infrastructure (i.e. located within 3.0 km) is no higher than 2 mm/s. This is below the

applicable vibration limits of 25 and 100 mm/s for occupied and unoccupied structures respectively.

Table 6: Results of Ground Vibration Modelling for Heritage Items, Infrastructure and Adjacent Mines for the Proposed Modification

		Estimated Max Ground Vibration (mm/s)												
	Hole Depth (m):	**3.6 m**			**22 m**				**46.4 m**					
	Hole ø (mm):	**203**	**229**	**270**	**203**	**229**	**251**	**270**	**203**	**229**	**229**	**251**	**270**	
Residential ID	**Min. Distance[1] (m)**	**MIC (kg)**												
		ANFO	**Heavy ANFO**		**ANFO**	**Heavy ANFO**			**ANFO**		**Heavy ANFO**			
		26	**49**	**69**	**466**	**865**	**1,039**	**1,168**	**1,072**	**1,364**	**2,046**	**2,429**	**2,810**	
HERITAGE ITEMS														
'Mt Leonard' Homestead	4,910	< 0.1	0.1	0.1	0.5	0.7	0.9	1.0	0.9	1.1	1.5	1.7	1.9	
St Andrews Anglican Church	4,610	0.1	0.1	0.1	0.5	0.8	1.0	1.1	1.0	1.2	1.6	1.9	2.1	
BH6 - Broke Cemetery	3,080	0.1	0.2	0.2	1.0	1.6	1.8	2.0	1.9	2.3	3.1	3.6	4.0	
Murinbin House Group	4,410	0.1	0.1	0.1	0.5	0.9	1.0	1.1	1.1	1.3	1.8	2.0	2.3	
BH14 – Charlton	3,330	0.1	0.1	0.2	0.8	1.4	1.6	1.8	1.7	2.0	2.8	3.2	3.6	
BH13 - Monkey Place Creek Stone Wall	2,720	0.1	0.2	0.3	1.2	2.0	2.3	2.4	2.3	2.8	3.8	4.4	4.9	
Mt Leonards Public School (now Scout Hall)	5,860	< 0.1	0.1	0.1	0.3	0.6	0.7	0.7	0.7	0.8	1.1	1.3	1.4	
Bulga Bridge over Wollombi Brook	6,710	< 0.1	< 0.1	0.1	0.3	0.5	0.5	0.6	0.5	0.7	0.9	1.0	1.2	
INFRASTRUCTURE														
Power Line														
330 kV Power Line[2]	300	2.6	4.3	5.7	26	43	50	55	n/a	n/a	n/a	n/a	n/a	
Prescribed Dams														
Northern Dam[2]	3,290	0.1	0.1	0.1	0.6	0.9	1.1	1.2	n/a	n/a	n/a	n/a	n/a	
Clean Water Diversion Dam[2]	3,200	0.1	0.1	0.1	0.6	1.0	1.1	1.2	n/a	n/a	n/a	n/a	n/a	
CHPP Surge Dam[2]	860	0.5	0.8	1.1	4.8	7.9	9.2	10	n/a	n/a	n/a	n/a	n/a	
North Pit Tailings Dam	2,220	0.2	0.3	0.4	1.6	2.7	3.1	3.4	3.2	3.9	5.4	6.2	6.9	
Old Tailings Dam	760	0.9	1.5	2.0	9.0	15	17	19	18	21	30	34	38	
Pipelines, Cables														

		Estimated Max Ground Vibration (mm/s)											
Hole Depth (m):		**3.6 m**			**22 m**				**46.4 m**				
Hole ø (mm):		**203**	**229**	**270**	**203**	**229**	**251**	**270**	**203**	**229**	**229**	**251**	**270**
Residential ID	**Min. Distance[1] (m)**	**MIC (kg)**											
		ANFO	**Heavy ANFO**		**ANFO**	**Heavy ANFO**			**ANFO**		**Heavy ANFO**		
		26	**49**	**69**	**466**	**865**	**1,039**	**1,168**	**1,072**	**1,364**	**2,046**	**2,429**	**2,810**
Broke Fordwich PID Pipeline[2]	77	23	38	50	230	377	437	480	n/a	n/a	n/a	n/a	n/a
Broke Potable Water Pipeline[2]	87	19	31	41	189	310	359	395	n/a	n/a	n/a	n/a	n/a
Fibre Optic Telstra[2]	110	13	22	28	130	213	247	271	n/a	n/a	n/a	n/a	n/a
Roads, Bridges and Culverts													
Broke Rd[2]	80	22	36	47	216	355	411	451	n/a	n/a	n/a	n/a	n/a
Charlton Rd	940	0.6	1.1	1.4	6.4	11	12	13	13	15	21	24	27
Cobcroft Rd	1,250	0.4	0.7	0.9	4.1	6.7	7.7	8.5	7.9	9.6	13	15	17
Fordwich Rd	2,520	0.1	0.2	0.3	1.3	2.2	2.5	2.8	2.6	3.1	4.3	5.0	5.6
Butlers Rd	2,960	0.1	0.2	0.2	1.0	1.7	1.9	2.1	2.0	2.4	3.3	3.8	4.3
Overpass No1 on Broke Rd[2]	85	20	32	43	196	322	373	410	n/a	n/a	n/a	n/a	n/a
Overpass No2 on Broke Rd[2]	740	0.6	1.0	1.3	6	10	12	13	n/a	n/a	n/a	n/a	n/a
Underpass on Broke Rd[2]	115	12	20	26	121	199	230	253	n/a	n/a	n/a	n/a	n/a
Bridge on Broke Rd	2,940	0.1	0.2	0.2	1.0	1.7	2.0	2.2	2.0	2.4	3.4	3.9	4.4
Culvert 1 On Charlton Rd	2,680	0.1	0.2	0.3	1.2	2.0	2.3	2.5	2.3	2.8	3.9	4.5	5.1
Culvert 2 On Charlton Rd	2,310	0.2	0.3	0.3	1.5	2.5	2.9	3.2	3.0	3.6	5.0	5.7	6.4
Culvert 3 On Charlton Rd	2,200	0.2	0.3	0.4	1.6	2.7	3.1	3.4	3.2	3.9	5.4	6.2	6.9
Industrial Infrastructure													
Mushroom Composters Facility[2]	1,900	0.1	0.2	0.3	1.4	2.2	2.6	2.8	n/a	n/a	n/a	n/a	n/a
Adjacent Mines													
Mt Thorley Warkworth Mine:													
Processing plant[2]	3,040	0.1	0.1	0.1	0.6	1.1	1.2	1.3	n/a	n/a	n/a	n/a	n/a
Offices[2]	4,060	< 0.1	0.1	0.1	0.4	0.7	0.8	0.8	n/a	n/a	n/a	n/a	n/a

1 - Minimum distance to the pit over the lifetime of the Proposed Modification;

2 - Estimates calculated based on blasting in the eastern section using the corresponding maximum MIC

n/a – not applicable

Shaded cells – ground vibration estimate equal to or exceeds the applicable limit; however, compliance is achievable through the application of an appropriate blast design.

5.2.2.2 Airblast

Typically, heritage / historic items and infrastructure items are not assessed in terms of airblast exposure as levels required to inflict damage are not applicable and/or not reached.

Occasionally however, heritage items can be assessed when applicable airblast limits are imposed. This is not the case for Bulga mine i.e. there are no applicable airblast limits imposed on heritage items and infrastructure. However, to ensure completeness of the analysis all heritage items were assessed for potential airblast exposure and results were compared to the potential safe airblast level of 133 dBL criteria (as explained in section 4.2.1). The estimated airblast exposures were derived from the airblast predictive models (as specified in section 4.1.2), using the proposed range of MIC's of 26 to 2,810 kg. The results are summarised as follows:

- The estimated airblast overpressures exposure for all heritage items are predicted to be in the order of 87 to 122 dBL for all tested MIC's. This is below the considered safe airblast criterion of 133 dBL.
- The estimated airblast overpressure exposure for the privately owned industrial infrastructure (Mushroom Composters Facility (2016)) is predicted to be no higher than 122 dBL. This is below the considered safe airblast criterion of 133 dBL
- Site offices of the adjacent mine (Mount Thorley Warkworth Mine) will be exposed to a maximum of 112 dBL which is below the applicable criterion of 133 dBL.

Table 7: Results of Airblast Modelling for Relevant Heritage Items, Infrastructure and Adjacent Mines for the Proposed Modification

		Estimated Max. Airblast (dBL)											
	Hole Depth (m):	3.6 m			22 m				46.4 m				
	Hole ø (mm):	203	229	270	203	229	251	270	203	229	229	251	270
Residential ID	Min. Distance[1] (m)	MIC (kg)											
		ANFO	Heavy ANFO		ANFO	Heavy ANFO			ANFO		Heavy ANFO		
		26	49	69	466	865	1,039	1,168	1,072	1,364	2,046	2,429	2,810
HERITAGE ITEMS													
'Mt Leonard' Homestead	4,910	95	98	99	107	110	111	111	111	112	113	114	115
St Andrews Anglican Church	4,610	96	99	100	108	111	111	112	112	113	114	115	116
BH6 - Broke Cemetery	3,080	101	104	105	113	116	116	117	117	118	119	120	121
Murinbin House Group	4,410	96	99	101	109	111	112	112	112	113	115	116	116
BH14 – Charlton	3,330	100	103	104	112	115	115	116	116	117	118	119	120
BH13 - Monkey Place Creek Stone Wall	2,720	103	105	107	115	117	118	119	118	119	121	122	122
Mt Leonards Public School (now Scout Hall)	5,860	93	96	97	105	108	108	109	108	109	111	112	113
Bulga Bridge over Wollombi Brook	6,710	91	94	95	103	106	107	107	107	108	109	110	111
INFRASTRUCTURE													
Mushroom Composters Facility[2]	1,900	106	109	110	118	121	121	122	n/a	n/a	n/a	n/a	n/a
Mt Thorley Warkworth – offices[2]	4,060	96	99	101	109	111	112	112	n/a	n/a	n/a	n/a	n/a

1 - Minimum distance to the pit over the lifetime of the Proposed Modification;

2 - Estimates calculated based on blasting in the eastern section using the corresponding maximum MIC

n/a – not applicable

5.2.2.3 Flyrock

As indicated above, the Proposed Modification will operate using an appropriate exclusion zone to manage the risk of flyrock, i.e. 0.5 km exclusion zone as indicated in the (Blast Clearance and Firing Procedure (2018)). The 0.5 km distance is used as a standard exclusion zone for flyrock control.

Based on the above assessment, the heritage sites are located in excess of 2.7 km from the Proposed Modification. As none of the heritage sites are located within the 0.5 km exclusion zone, the risk of flyrock is negligible.

The impact on public roads, pipelines and adjacent power line (when located within a 0.5 km radius) will be managed in accordance with Clearance and Firing Procedure and Blast Management Plan (developed in consultation with the relevant infrastructure owners as part of the Proposed Modification).

Other infrastructure facilities identified are located in excess of 0.8 km. As none of these infrastructure facilities are located within the 0.5 km exclusion zone of the Proposed Modification area, the risk of flyrock is negligible.

6.0 DATA GAP ANALYSIS

A detailed data gap analysis was undertaken by ESC (ESC (2017)) and included a review of ground vibration and airblast overpressure monitoring results for the 2014 - 2017 period. The results were analysed in the context of airblast overpressure and ground vibration limits imposed on the mine. A summary of the data gap analysis is presented in **Table 7**. Additionally, the analysis aimed to assess the adequacy of coverage of the existing monitoring system.

Table 7: Data Gap Analysis for Years 2014 to 2017 (Bulga Open Cut)

Assessment Type / Criterion	Strategic Objective	Current Standing	Deficiency	Action Plan
Private Residences				
Quantitative: Ground Vibration **Criterion 1**	No more than 5% of all yearly blasts may produce vibration values between 5 mm/s and 10 mm/s	Year 2014 – 0.7% Year 2015 – 0% Year 2016 – 0% Year 2017 – 0% percentage of yearly blasts with ground vibration values between the specified limits	None	Continue mining operations without any major procedural or operational alterations
Quantitative: Ground Vibration **Criterion 2**	No blast may exceed 10 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural or operational alterations

Assessment Type / Criterion	Strategic Objective	Current Standing	Deficiency	Action Plan
Quantitative: Airblast **Criterion 3**	No more than 5% of all yearly blasts may produce overpressure values between 115 dBL and 120 dBL	Year 2014 – 0% Year 2015 – 1.1% Year 2016 – 0% Year 2017 – 0% percentage of yearly blasts with overpressure values between the specified limits	None	Continue mining operations without any major procedural or operational alterations
Quantitative: Airblast **Criterion 4**	No blast may exceed 120 dBL	One blast exceeded the 120 dBL limit. Year 2015 – 1blast	Exceeded airblast limit. 2015 – localised weather condition contributed to reinforcement, which resulted in high airblast reading.	Take caution with all future blasts in order to conform to the 120 dBL airblast criterion and minimise elevated airblast results. This may be achieved through ongoing optimisation of blast design, wavefront reinforcement analysis and verifying atmospheric conditions.
Heritage Site: 'Mt Leonard' Homestead; (Bulga Monitor)				
Quantitative: Ground Vibration **Criterion 5**	No blast may exceed 5 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural or operational alterations
Heritage Sites: BH6-Cemetery, BH13 - Stone Wall, St Andrew Church, Murinbin House Group, BH7- McNamara's Dairy Cottage; (Charlton Monitor)				
Quantitative: Ground Vibration	No blast may exceed 5 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural or operational alterations
330 kV Suspension Towers				
Quantitative: Ground Vibration **Criterion 6**	No blast may exceed 100 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural or operational alterations
Public Road (Broke Road)				
Quantitative:	No blast may	No blast has	None	Continue mining

Assessment Type / Criterion	Strategic Objective	Current Standing	Deficiency	Action Plan
Ground Vibration **Criterion 7**	exceed 100 mm/s	exceeded the vibration limit		operations without any major procedural or operational alterations
Water Dams (Vaux Dam and Deep Pit Dam)				
Quantitative: Ground Vibration **Criterion 8**	No blast may exceed 35 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural or operational alterations

The data gap analysis concluded the following:

- The assessment concluded a good overall blast performance with a low impact on the local community. In more detail, the data indicated low blast impacts for the calendar years of 2014, 2016 and 2017. However, during the 2015 calendar year, there was one instance of under-performance caused by a single airblast exceedance event (in excess of 120 dBL). This event was caused by localised weather conditions which contributed to an airblast reinforcement.
- The current multi-station vibration monitoring system at the Bulga Open Cut consists of a total of eight permanent and two periodic stations, placed strategically in relevant directions. Four of the stations provide coverage for private residences and historical sites whilst the other four stations are dedicated to infrastructure including the suspension towers, dams and public roads. It was concluded that the current monitoring system is considered to provide adequate coverage to monitor vibration impacts for private residences, infrastructure and historic sites.

7.0 MANAGEMENT AND MITIGATION MEASURES

There are various blast control measures and technologies available which can minimise blast impacts (including ground vibration, airblast and flyrock) on the surrounding environment and enable blasts to be designed to comply with the relevant blast criteria.

Bulga Open Cut currently utilises a number of such blast control measures and technologies (detailed in the approved BMP (2016)). As blasting at the Proposed Modification is to be conducted in accordance with the existing BMP (2016) any associated blast impacts can be effectively managed through the application of the BMP (2016).

The most essential blast control measures (BMP (2016)) already in place include:

Pre-Blast Assessment Protocol

The weather conditions can potentially affect the blast impact outcomes (especially noise distribution and intensity), as well as post-blast fume and dust dispersion.

Bulga Open Cut operates using a well-developed pre-blast assessment protocol (BMP 2016). This utilises the following:

- Weather monitoring station - allows for the assessment of wind speed and wind direction,
- EnvMet weather assessment system - allows for the assessment of inversion and wind shear conditions,
- Pre-blast fume assessment - allows for the assessment of potential fume generation for each blast,
- Pre-blast dust assessment – allows for the assessment of dust generation for each blast,
- Pre-blast community and stakeholder notification,
- Completion of a pre-blast checklist - an operational procedure integrating all of the above elements.

As stated above, there is a comprehensive pre-blast management system in place. This allows for a thorough assessment of conditions on the day of a proposed blast, when a decision on whether to blast or not needs to be made. This is in the format of an operational procedure, which needs to be addressed by a number of operators.

The system operates effectively and therefore no changes to the system are recommended.

The Proposed Modification will result in the extension of blasting operations to the south, which is closer to the Broke residences than the currently approved blasting operation. Based on the proposed plans, and due to the substantial change in distances to the southern residences with time, it is recommended that a review of the pre-blast assessment protocol be undertaken.

Blast Monitoring System

The assessment identified a number of sensitive receivers surrounding the Proposed Modification area, including private residential receivers, heritage items / historic sites and infrastructure.

The current multi-station vibration monitoring system at Bulga includes a total of eight permanent stations and two periodic stations, placed strategically in all directions, see **Figure 9**. There are four monitoring stations for monitoring private residential receivers and historic sites, and four for infrastructure. The current monitoring system is considered to provide adequate coverage for monitoring vibration impacts from the Proposed Modification.

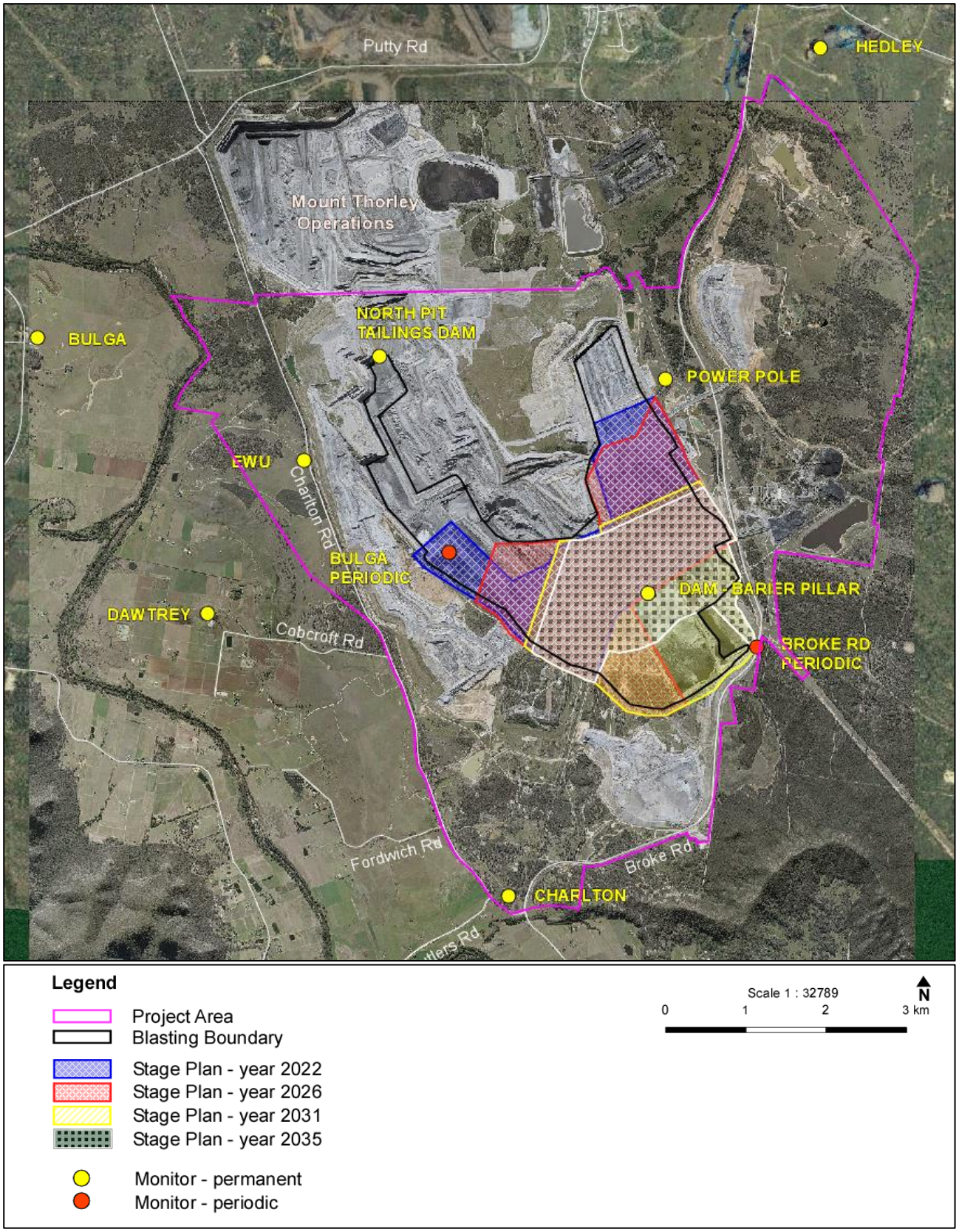

Figure 9 – Locations of the Monitoring Stations

Interaction with Nearby Mines

Bulga Open Cut is adjacent to the Mount Thorley Warkworth Open Cut Mine.

There is a well-developed system of notification and interaction with this mine already in place (as specified in Development Consent (SSD 4960), condition 13). This system is used to avoid concurrent blasts and therefore minimise blast impacts on the adjacent community. The system operates effectively and therefore no changes to the system are recommended.

Based on the modelling results, blasts can be managed to meet the specified emission criteria by utilising the methods outlined above.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The report presents an assessment of blast impacts associated with the Proposed Modification on the surrounding environment, including residential receivers, heritage items / historical sites, infrastructure, and adjacent mines. The results of the assessment are summarised as follows:

- The Proposed Modification is to be located to the south / south-east of the current approved Bulga Optimisation Project. The Proposed Modification will allow for the optimisation of resource recovery from the approved BOP. The review of the geological model of the area allowed for an estimation of the blasting parameters. For the assessment, blasting benches were identified as ranging between 3.6 and 46.4 m for the western section and 15 to 22 m for the eastern section (through seam blasting only due to the steeply dipping seam section). The charge masses were identified and are in the order of 26 to 2,810 kg and 290 to 1,168 kg for the western and eastern sections respectively.
- To facilitate the accuracy of the vibration predictions, ground vibration and airblast overpressure predictive models were developed for Bulga conditions. The models were used to assess the impacts of ground vibrations and airblast overpressure on the surrounding environment including residential receivers, heritage items / historical sites, infrastructure and adjacent mines.

- DATA GAP ANALYSIS:
  - The analysis included a review of ground vibration and airblast overpressure monitoring results for the 2014 to mid-2017 period. The assessment concluded a good overall blast performance with a low impact on the local community. The current multi-station vibration monitoring system was determined to provide adequate coverage of the vibration monitoring impacts for residential receivers, historical sites and infrastructure.

- IMPACT ON PRIVATE RESIDENTIAL RECEIVERS:
  - The existing imposed vibration limit criteria for private residential receivers specified in Development Consent (SSD-4960) will be maintained. The imposed operational vibration limits for the Bulga Optimisation Project are specified as 5 mm/s allowed for 95% of blasts and 10 mm/s not to be exceeded. The operational airblast limits are 115 dBL allowed for 95% of blasts and 120 dBL not to be exceeded. The assessment was undertaken using the same criteria.
  - The ground vibration modelling for private residential receivers confirmed that vibration impacts can be managed effectively within the specified blasting parameters. The modelling shows that via controlling the MIC the vibration impacts can be managed to below the 5 mm/s vibration limit (applicable when blasting close to the western and

southern borders) e.g. blasting with an MIC of 1,168 kg will results in impact no higher than 2.7 mm/s for all private residential receivers. This can be achieved by blasting smaller benches, using smaller hole diameters or by the application of deck charges and the use of precise initiation timing.

- The airblast modelling for private residential receivers indicates that airblast impacts can be managed effectively (to remain below the imposed airblast criteria of 115 dBL) by using lower charge masses, especially applicable to residential receivers located within a 2 – 3 km range. The modelling shows that blasting using an MIC of 69 kg will result in impacts no greater than 108 dBL for all private residential receivers. This can be achieved by blasting smaller benches, using smaller hole diameters or by the application of deck charges and the use of precise initiation timing.
- The Proposed Modification will operate using a standard 0.5 km exclusion zone for flyrock management. Due to the substantial distances to private residential receivers (i.e. in excess of 2.5 km) the issue of flyrock impact on the residential receivers is considered to be fully managed and the potential risks are considered negligible.

- IMPACT ON HERITAGE ITEMS AND INFRASTRUCTURE:
  - The existing imposed vibration limits criteria for heritage items and infrastructure specified in the Development Consent (SSD-4960) will be maintained. The vibration limits for the Bulga Optimisation Project vary between 5 and 100 mm/s.
  - The assessment identified 19 heritage items (including 6 with an already imposed vibration limit of 5 mm/s) located in the proximity of the Proposed Modification with the closest being in excess of 2,7 km. Ground vibration and airblast modelling identified that the predicted vibrations for all heritage sites will be below the imposed limit criteria and/or damage levels.
  - The assessment identified that the closest infrastructure including Broke Road, adjacent pipelines, fibre optic cable and the 330 kV power line will be located within 0.5 km of the Proposed Modification. The ground vibration modelling for these items shows that the ground vibration impact can be managed effectively below the applicable vibration limit criteria of 50 and 100 mm/s via the application of lower charge masses.
  - Ground vibration modelling for all other infrastructure facilities which are located in excess of 0.8 km identified that the predicted vibrations will be well below the imposed limit criteria and/or damage levels.
  - The vibration exposures for Mount Thorley Warkworth Mine infrastructure (adjacent mine) are below the applicable ground vibration criteria of 25 and 100 mm/s (for occupied and unoccupied structures respectively) and the 133 dBL airblast criterion.
  - The Proposed Modification will operate using a standard 0.5 km exclusion zone for flyrock management. The impact of flyrock on the closest infrastructure (i.e. less than 0.5 km), including public roads, and adjacent pipelines and fibre optic cable will be managed effectively using a Blast Clearance and Firing Procedure implemented and currently in use. Similarly, the impact of flyrock on the adjacent 330 kV power line (when located within 0.5 km radius) will be managed according to blast management measures similar to the current system already developed when blasting in the proximity of a power line. The other public infrastructure will be in excess of 0.8 km and the closest heritage site will be in excess of 2.7 km from the Proposed Modification's blasting boundary. The issue of flyrock impact is therefore considered to be fully managed and the potential risks are considered negligible.

- IMPACT ON MINE-OWNED INFRASTRUCTURE AND BULGA UNDERGRGROUND MINE:

- The impacts on the mine-owned infrastructure and Bulga Underground will be managed internally in order to maintain safe work practices. This will be done in consultation with the relevant infrastructure owners and management. The development of such a protocol has previously taken place in consultation with the relevant operators with a commitment to maintaining safe work practices between the operations and will continue.

- INTERACTIONS WITH NEARBY MINES:
  - Bulga Open Cut has already implemented a successful system of liaising with the operators of nearby mines (i.e. Mount Thorley Warkworth Operations) in relation to the coordination of blast time to avoid concurrent blasting. No changes to the system are recommended.

- MANAGEMENT AND MITIGATION MEASURES:
  - Blast management for the Proposed Modification will continue to be conducted in accordance with the Bulga Open Cut BMP (2016). The approved BMP covers a number of blast control measures designed to minimise blast impacts and to comply with the relevant criteria.

Thomas Lewandowski
Enviro Strata Consulting
11th June 2019

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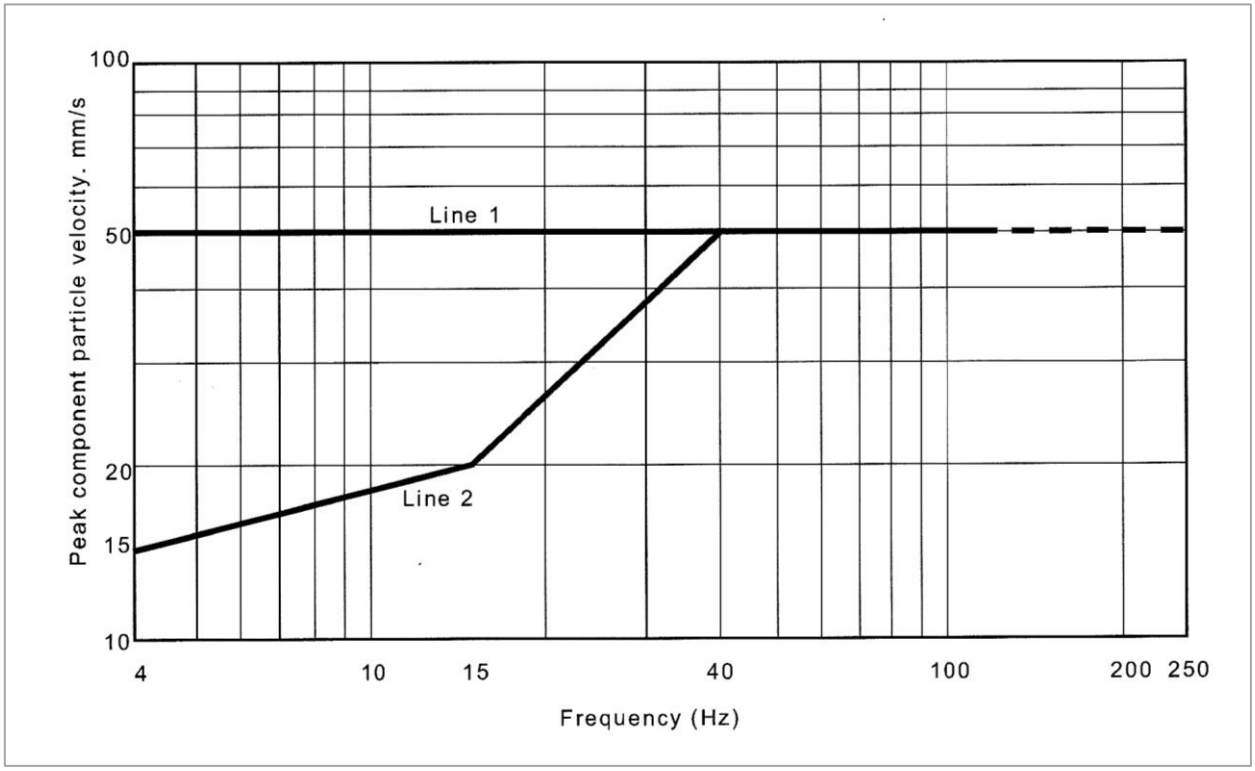
APPENDICES

Appendix 1A – Transient Vibration Guide Values for Cosmetic Damage - British Standard (BS 7385-2:1993)



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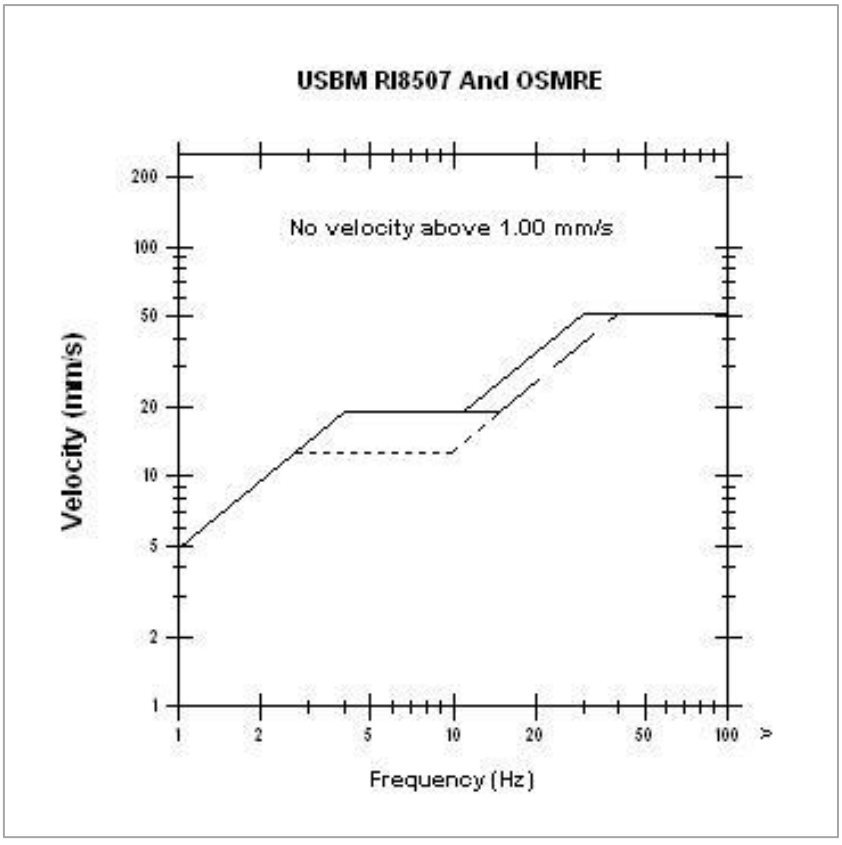

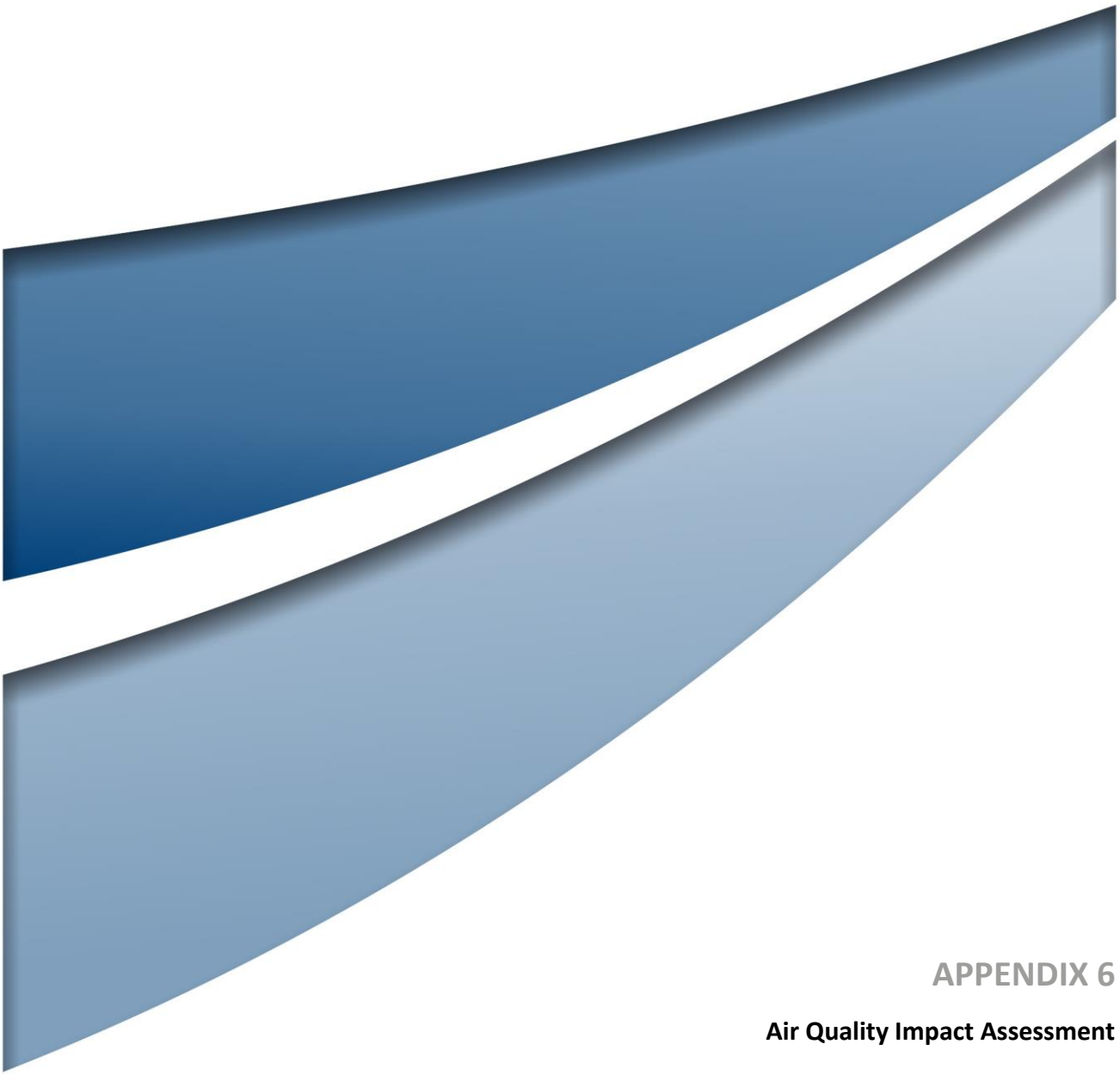

APPENDIX 6

Air Quality Impact Assessment

Bulga Coal Complex Modification 3

Bulga Coal Management Pty Ltd

Air Quality Impact Assessment

Final | Revision 0

10 June 2019

Umwelt 4100

Bulga Coal Complex Modification 3

Project No:	IA127300
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Document No.:	Final
Revision:	Revision 0
Date:	10 June 2019
Client Name:	Bulga Coal Management Pty Ltd
Client No:	Umwelt 4100
Project Manager:	Shane Lakmaker
Author:	Shane Lakmaker
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Document history and status

Revision	Date	Description	By	Review	Approved
D1R0	17/10/18	Draft report	SL	MD	MV
D2R0	29/11/18	Draft report	SL	Umwelt	MV
D3R0	21/1/19	Draft report	SL	Umwelt	MV
Final	10/06/19	Final report	SL	BCM	PH

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Executive Summary

This report provides an assessment of the air quality impacts of the Bulga Coal Complex Modification 3. The air quality impact assessment has been carried out in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016). The 2016 version of the EPA's "Approved Methods" introduces revised, more stringent criteria for particulate matter concentrations, compared to the criteria used to assess the Approved Development.

The potential air quality issues for the Proposed Modification were identified as:

- Dust from the general mining activities;
- Fume from blasting; and
- Emissions of substances from machinery exhausts.

A detailed review of the existing environment was carried out. The following conclusions were made in relation to the existing air quality and meteorological conditions:

- Wind patterns in the vicinity of Bulga Coal Complex are similar to other parts of the Hunter Valley, with the prevailing winds being from either the northwest or southeast. Winds from the south are also common for this area.
- There are seasonal variations in particulate matter concentrations, with PM_{10} levels higher in spring and $PM_{2.5}$ levels higher in winter.
- In terms of PM_{10}, air quality conditions can be regarded as good, with annual average concentrations well below the EPA's assessment criterion. Most monitoring sites in the vicinity of the Bulga Coal Complex have experienced at least one day above the EPA's 50 µg/m^3 criterion in the past five years. This is not uncommon for most locations in NSW, including in rural and urban areas.
- In terms of $PM_{2.5}$, annual averages have been below the recently introduced assessment criterion (8 µg/m^3) in the vicinity of the Bulga Coal Complex.
- TSP, dust deposition and NO_2 levels are below their relevant EPA criteria.

The computer-based dispersion model known as CALPUFF was used to predict the potential air quality impacts of the Proposed Modification, including cumulative impacts. The dispersion modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts.

The main conclusions of the assessment were as follows:

- Estimated annual emissions to air for Bulga Coal Complex (as modified) are expected to be lower than those estimated for the Bulga Optimisation Project.
- Maximum 24-hour average PM_{10} concentrations may continue to exceed the EPA's 50 µg/m^3 criterion at various locations in the vicinity of the Bulga Coal Complex (including private properties), due to contributions from the Bulga Coal Complex (as modified), Mt Thorley Warkworth mine and background (other) sources of particulate matter. Specifically, the model predictions indicated that there may be up to two days each year when the Bulga Coal Complex (as modified) would contribute to an exceedance of 50 µg/m^3 at the nearest locations to the west of the Bulga Coal Complex. These predictions did not highlight any significant change in air quality as they were within the range of historical measured conditions. It is concluded that 24-hour average PM_{10} concentrations will continue to be variable from day-to-day, due to existing conditions and sources, and that operations will need to be managed in a way which minimises the contribution to off-site PM_{10} levels, as is done under the existing approved operation.
- There is one property (1A to the north of the Bulga Coal Complex) where annual average PM_{10} concentrations are predicted to exceed the EPA's 25 µg/m^3 criterion in one or more future years. Compliance with the EPA's annual average PM_{10} criterion is predicted at all other private sensitive receptors. The results indicate that property 1A would be entitled to voluntary mitigation and acquisition rights under the VLAMP, based on cumulative PM_{10} levels that are predicted to exceed the 25 µg/m^3

VLAMP criterion in 2022, 2026 and 2031 with approximately equal contributions from the Proposed Modification and from Mt Thorley Warkworth.

- As for PM_{10}, concentrations of $PM_{2.5}$ will continue to be variable from day-to-day. There are typically a few days each year when $PM_{2.5}$ concentrations exceed the recently introduced assessment criterion of 25 µg/m^3. This trend is expected to continue with or without the Proposed Modification.
- There are no private sensitive locations which are predicted to experience exceedances of the annual average $PM_{2.5}$, TSP or dust deposition criteria at any stage of the Proposed Modification.
- There would be no change to the extent of potential impact of post-blast fume due to the Proposed Modification.
- Emissions from diesel exhausts associated with off-road vehicles and equipment are not expected to result in any adverse air quality impacts, based on model predictions which show compliance with air quality criteria.

Finally, it was noted that there is a relatively low potential for material change in the magnitude of air quality impacts from the Proposed Modification, given that it is only increasing the total area of proposed disturbance by 0.5%. In addition, there is no proposed increase to the maximum annual production rate, and equipment types and utilization remain very similar to that assessed for the Approved Development. Nevertheless, the modelling for the assessment has been based on the most up-to-date information on existing conditions, mining operations, and model setup.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts of the proposed modification to the Bulga Coal Complex in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

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1. Introduction

Jacobs Group (Australia) Pty Ltd (Jacobs) has been engaged by Umwelt Australia Pty Ltd (Umwelt) on behalf of Bulga Coal Management Pty Ltd (BCM) to complete an air quality impact assessment for a proposed modification to the Bulga Coal Complex (BCC). The purpose of the assessment is to form part of an environmental assessment being prepared by Umwelt to support an application for approval of the proposed modification. **Figure 1** shows the regional location of the BCC.

The air quality impact assessment has been carried out in accordance with relevant guidelines published by the Environment Protection Authority (EPA), namely, the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016). The 2016 version of the EPA's "Approved Methods" introduced revised, more stringent criteria for particulate matter concentrations, compared to the criteria used to assess the existing approved development.

The main objectives of this assessment were to:

- Identify potential air quality issues;
- Quantify existing and potential air quality impacts; and
- Identify suitable air quality management measures, as appropriate, to minimise impacts.

The assessment was based on the use of an air dispersion model, CALPUFF, to predict concentrations of substances emitted to air due to the proposed modified mining activities. Model predictions have been compared with air quality criteria referred to by the EPA in order to assess the effect that the proposed modification may have on the existing air quality environment.

In summary, the report provides information on the following:

- Approved and proposed mining activities (**Section 2**);
- Potential air quality issues (**Section 3**);
- Relevant air quality criteria (**Section 4**);
- Existing meteorological and air quality conditions (**Section 5**);
- Emissions to air from approved and proposed mining activities (**Section 6**);
- Methods used to predict air quality impacts (**Section 7**);
- Expected air quality impacts, as determined by a comparison of model results with air quality assessment criteria (**Section 8**); and
- Management measures to be implemented and monitoring of potential impacts (**Section 9**).



Figure 1 Regional locality plan

2. Modification Description

The BCC is an open cut and underground coal mining operation located in the Hunter Valley, NSW (refer to **Figure 1**). The BCC consists of two existing coal mining operations: the open cut operations (Bulga Open Cut) and the underground operations (Bulga Underground Operations) using shared coal washing and rail loading infrastructure. The BCC is located approximately 4 kilometres (km) to the south-east of Bulga village, approximately 4 km to the north of Broke village, and approximately 12 km south-west of the township of Singleton.

Mining operations have been occurring at the site for over 30 years with Bulga Coal Management Pty Ltd (BCM) currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014 which allowed ongoing operation of the Bulga Open Cut until 31 December 2035. SSD 4960 was subsequently modified (SSD 4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailings management strategy. Modification 2, approved in August 2018, involved an extension to the period of construction for the outer face of the noise and visual bund. The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). BCM also operates the BCC in accordance with Environment Protection and Biodiversity Conservation (EPBC) Approval 2012/6637 (as modified).

BCM is proposing a modification to SSD 4960 to maximise resource recovery within the approved Bulga Optimisation Project Area by a relatively small extension of the open cut operations to the southeast into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit (the Proposed Modification).

The extension of the pit to the southeast will also enable extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Mtpa ROM while enabling the extraction of an additional approximately 63 Mt of coal.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Open Cut will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- an additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east by accessing deeper resources within the approved pit and proposed extension area.
- utilisation of existing coal handling and coal processing infrastructure
- removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSFs to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings.
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure.
- construction of new water management facilities to manage site surface water catchments.
- the use of all existing or approved infrastructure and equipment for the Bulga Coal mine with some minor additions to the existing mobile equipment fleet over the life of the operation.

The key aspects of the Proposed Modification are shown on **Figure 2** and a summary of the key modifications is provided in **Table 1**.

Table 1 Comparison of Approved Development and Proposed Modification

Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Extraction rate limit	Extraction limit of 12.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal	No change to currently approved extraction limit 12.2 Mtpa
Total Recoverable Resource (ROM)	162 Mt	An additional 63 Mt
Project life	Mining operations on site until 31 December 2035	Extension to the life of mine until 31 December 2039 (an additional 4 years)
Project boundary / Schedule of Lands	Per SSD_4960 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit Mining undertaken within existing ML1547	Extension of mining areas to the south and west. Accessing deeper resources within the approved pit and the proposed extension area Mining undertaken within existing ML1547
Disturbance Areas	Approved mining disturbance footprint (3,786 hectares)	Additional disturbance area of approximately 20.2 hectares not currently part of the approved mining disturbance footprint
Key Infrastructure	Realignment of Broke Road (Complete) Relocation of 330kV transmission lines (Complete) Construction of new water storage dam (Complete) Upgrade to CHPP to improve yield and plant efficiency (Ongoing) Relocation of sections of Broke-Fordwich Private Irrigation District pipeline and Telstra infrastructure (Complete)	Relocation of some mine owned open cut and underground infrastructure Demolishing of some open cut and underground infrastructure to accommodate proposed mining Replacement / relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop Installation of tailings relocation infrastructure (pumps and pipelines, power lines, access tracks, etc.)
Coal Handling and Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput	Potential upgrade of CHPP to reprocess additional tailings No changes to CHPP throughput, ROM or product stockpiles
Coal Transport	20 million tonnes of product coal transported in any calendar year	No change
Equipment Fleet	Mining fleet generally remained unchanged however replacement mining equipment is required during the project life	Minor increases to fleet numbers to provide flexibility for mining operations
Overburden, coarse reject	Where feasible, overburden to be placed in-pit. Overburden waste is likely to go into establishing haul roads, bunds for visual abatement, noise abatement and water management	No change to overburden and coarse reject management Expansion of existing approved TSF in northern end of pit to accommodate life of mine tailings
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF. Main Pit TSF approved in SSD 4960 Mod 1	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining. Increased capacity of Main Pit TSF from approximately 7.5Mm^3 to approximately 62Mm^3 to cater for relocated tailings and ongoing tailings production
Final void	One void at the end of mining operations	One void proposed to be of similar size to the approved void

Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Rehabilitation and final landform	Conceptual final landform is shown in SSD 4960 (Appendix 13) and includes 1 final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing Increases to typical overburden emplacement heights from 150 mAHD to 160 mAHD Revised conceptual final landform includes 1 final void
Employee Numbers	Approximately 700 FTE employees	No change

The Proposed Modification will not preclude the ability to access approved underground mining resources to the south and west of the proposed pit in the future.

Figure 3 shows the location of nearest sensitive receptors.

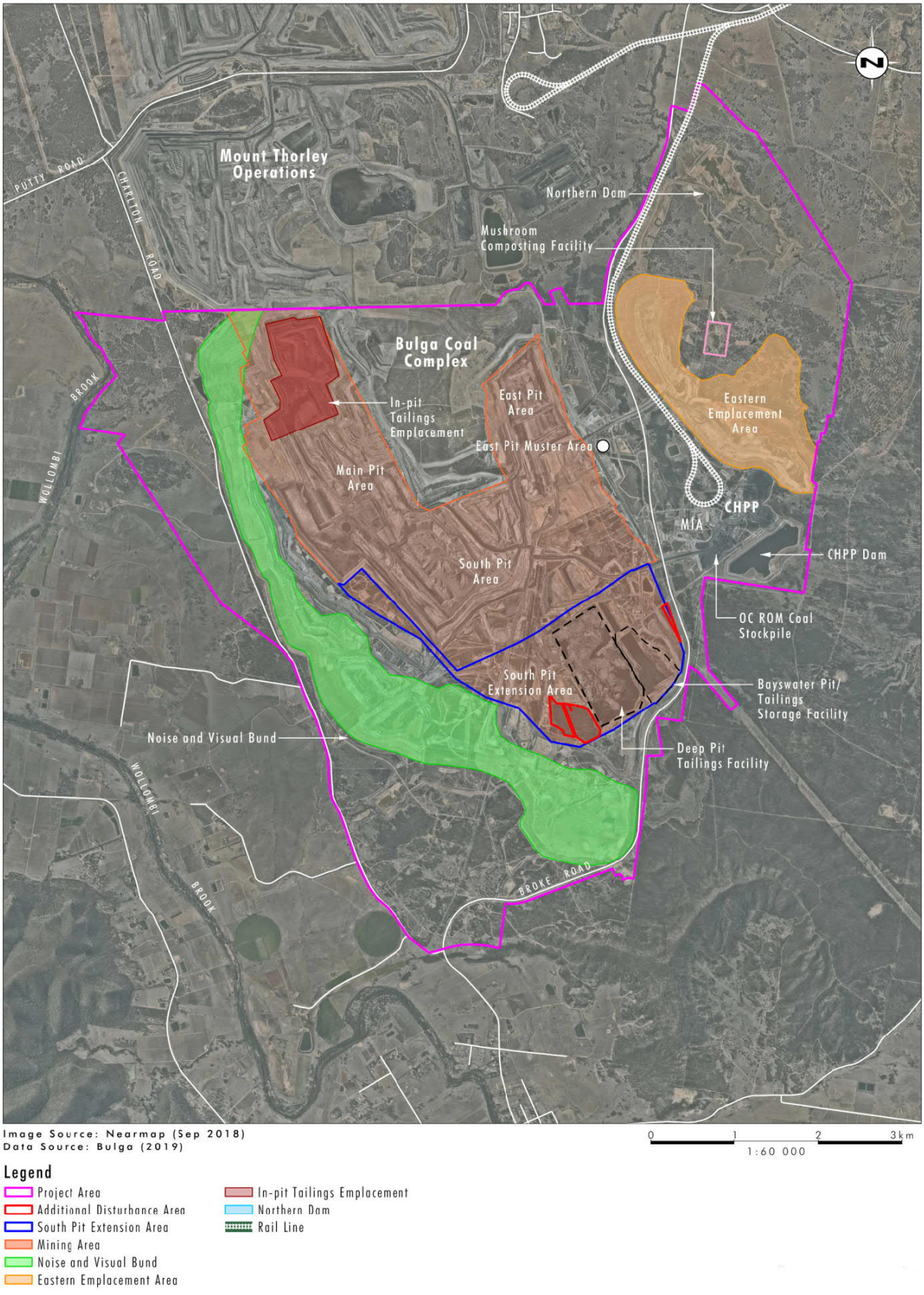

Figure 2 Key aspects of the Proposed Modification

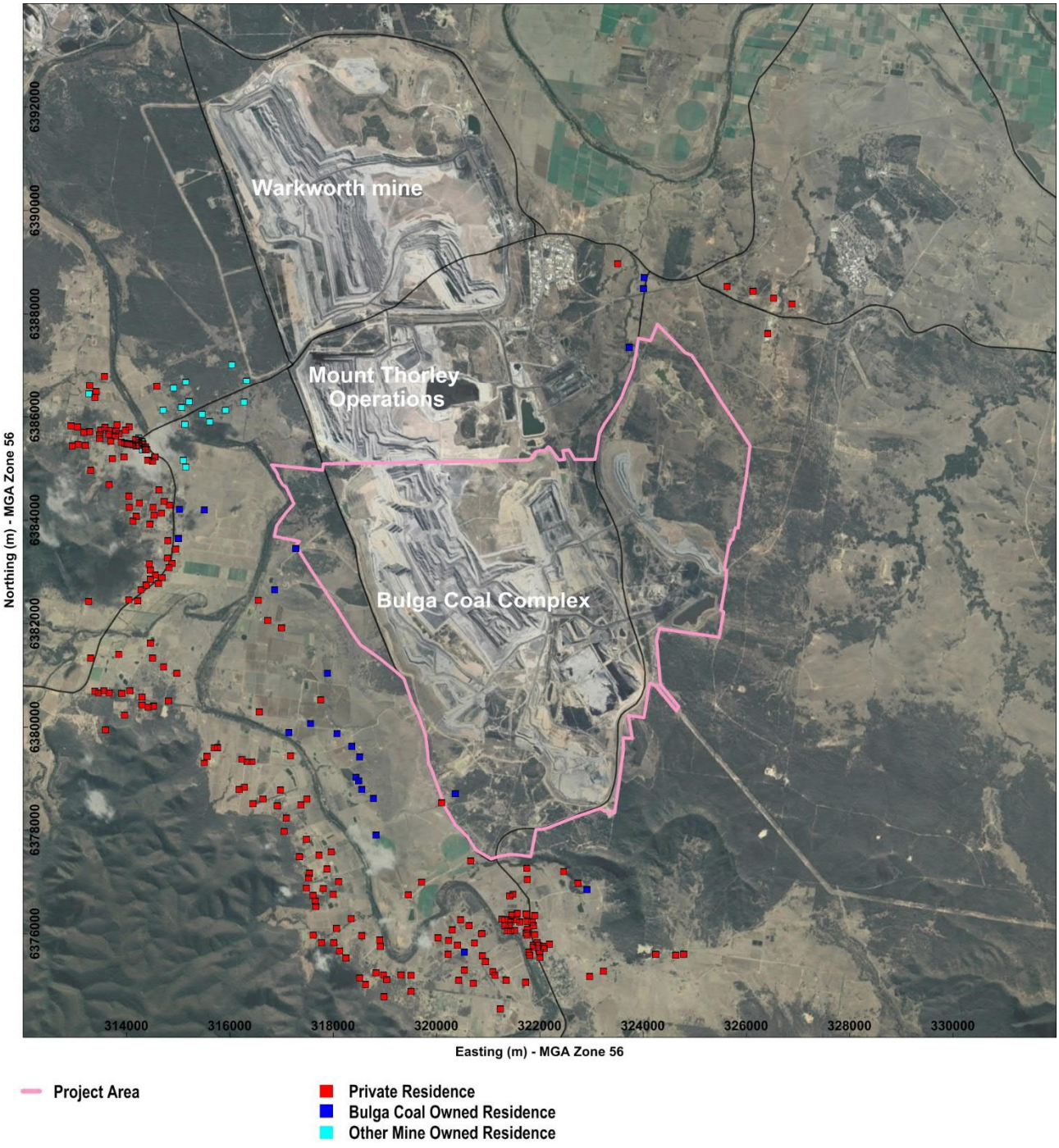

Figure 3 Location of nearest sensitive receptors

3. Air Quality Issues

Air quality issues can arise when emissions from an industry or activity lead to deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the Proposed Modification and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air will occur from a variety of activities including material handling, material transport, processing, wind erosion, blasting and potentially, from the spontaneous combustion of coal. These emissions would mainly comprise of particulate matter in the form of total suspended particulates (TSP), particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}) and particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter, and to a lesser extent sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and potentially odour and other substances from the spontaneous combustion of coal. However, spontaneous combustion of coal has historically not been an issue at BCC.

In summary, the potential air quality issues associated with the approved and proposed mining activities have been identified as:

- Dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from the general mining activities;
- Fume (that is, NO_x emissions) from blasting;
- Emissions of substances from machinery exhausts, that is, diesel exhaust emissions.

The issues identified above are the focus of this assessment.

The issues above are similar to the issues identified for the Approved Development, as assessed for the Bulga Optimisation Project (PEL 2013) and are the focus of this assessment.

It should be noted that there is a relatively low potential for material change in the magnitude of air quality impacts from the Proposed Modification, given that:

- It is only increasing the total area of proposed disturbance by 0.5%; and
- There is no proposed increase to the maximum annual production rate, and equipment types and utilization remain very similar to that assessed for the Approved Development.

As discussed in **Sections 5** and **6**, updates have been made to the relevant existing environment data for assessment purposes, in addition to a number of refinements to the modelling process to take account of feedback received during the assessment of the Approved Development.

4. Air Quality Criteria

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of substances known to cause health, nuisance and/or environmental effects, exceeds a certain level. With regard to human health and nuisance effects, the air pollutants most relevant to the Proposed Modification are particulate matter emissions from blasting, excavation works and material handling, transport and processing activities (see **Section 3**).

There are various classifications of particulate matter and the EPA has developed assessment criteria for:

- TSP, to protect against nuisance amenity impacts;
- PM_{10}, to protect against health impacts;
- $PM_{2.5}$, to protect against health impacts; and
- Deposited dust, to protect against nuisance amenity impacts.

Most of the EPA criteria are drawn from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPM). To measure compliance with ambient air quality criteria, the Office of Environment and Heritage (OEH) has established a network of monitoring stations across the State and up-to-date records are published on the OEH website.

Air quality impacts from the Proposed Modification have been determined by the level of compliance with the air quality criteria set by the EPA as part of their "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016). These criteria are outlined in **Table 2** and apply to existing and potential sensitive receptors such as such as residences, schools and hospitals. It should be noted that the assessment to support the existing Approved Development was based on an earlier version of the "Approved Methods" (see DEC 2005). The 2016 version introduced a revised, more stringent criterion for PM_{10} as well as new criteria for 24-hour and annual average $PM_{2.5}$. In addition, the impact assessment criteria for the existing Approved Development, as prescribed in SSD 4960, are numerically identical to the criteria in the 2005 version of the Approved Methods. The impact assessment criteria from SSD 4960 are included in **Table 2** for comparison.

Table 2 EPA air quality assessment criteria

Substance	Averaging time	Criterion	Criteria from SSD 4960
Particulate matter (PM_{10})	24-hour	50 µg/m^3	50 µg/m^3
	Annual	25 µg/m^3	30 µg/m^3
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	Nil
	Annual	8 µg/m^3	Nil
Particulate matter (TSP)	Annual	90 µg/m^3	90 µg/m^3
Deposited dust	Annual (maximum increase)	2 g/m^2/month	2 g/m^2/month
	Annual (maximum total)	4 g/m^2/month	4 g/m^2/month
Nitrogen dioxide (NO_2)	1-hour	246 µg/m^3	Nil
	Annual	62 µg/m^3	Nil

The EPA air quality assessment criteria relate to the total concentration of air pollutant in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess the potential impacts. Further discussion of background levels in the study area is provided in **Section 5**.

In situations where background levels are elevated, the proponent must "demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best

management practices will be implemented to minimise emissions of air pollutants as far as is practical" (EPA 2016).

In December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via the following main actions:

- The introduction of emission standards for new non-road spark ignition engines and equipment.
- Measures to reduce air pollution from wood heaters.
- Strengthened ambient air quality reporting standards for particle pollution.

The strengthening of ambient air quality reporting standards for particle pollution is relevant to the Proposed Modification. Specifically, and at the time, the following was agreed:

> *"Taking into account the latest scientific evidence of health impacts, Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. Ministers agreed to adopt reporting standards for annual average and 24-hour $PM_{2.5}$ particles of 8 µg/m^3 and 25 µg/m^3 respectively, aiming to move to 7 µg/m^3 and 20 µg/m^3 respectively by 2025. Ministers also agreed to establish an annual average standard for PM_{10} particles of 25 µg/m^3. Victoria and the Australian Capital Territory will set, and South Australia will consider setting, a more stringent annual average PM_{10} standard of 20 µg/m^3 in the state, while ensuring nationally consistent monitoring and reporting against the agreed National Environment Protection Measure standards. The decision was also taken to review PM_{10} standards in 2018. The review will be co-led by the NSW and Victorian governments, in discussion with other jurisdictions."*

On 25 February 2016 an amendment to the NEPM entered into force and introduced the new national air quality standards for PM_{10} and $PM_{2.5}$, as noted above. The EPA subsequently revised their PM_{10} and $PM_{2.5}$ assessment criteria as part of an update to the "Approved Methods for the Modelling and Assessment of Air Pollutants NSW" (EPA 2016). These revised criteria are reflected in **Table 2**. There is currently no NSW legislation regarding the aim to move to more stringent $PM_{2.5}$ criteria by 2025. Accordingly, the Proposed Modification is assessed against the current criteria detailed in the Approved Methods (2016) as these criteria would be applied by the consent authority in accordance with the provisions of Clause 12AB of the S*tate Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) (2018 amendment).

The NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) includes the NSW Government's policy for voluntary mitigation and land acquisition to address dust (particulate matter) impacts from state significant mining, petroleum and extractive industry developments. The current VLAMP (2018) brings the air quality criteria in line with the NEPM standards and EPA criteria.

From this Policy, voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3** at any residence or workplace.

Table 3 Mitigation criteria for particulate matter from the VLAMP

Substance	Averaging time	Mitigation criterion	Impact type
Particulate matter ($PM_{2.5}$)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM_{10})	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

** Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).*
*** Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.*

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4** at any residence or workplace on privately owned land, or on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls. The mitigation criteria incremental impact does not provide for any exceedances of the criteria, whereas the acquisition criteria allows for five exceedances.

Table 4 Acquisition criteria for particulate matter from the VLAMP

Substance	Averaging time	Acquisition criterion	Impact type
Particulate matter ($PM_{2.5}$)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM_{10})	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

** Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).*
*** Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.*

The particulate matter levels for comparison with the criteria in **Table 3** and **Table 4** must be calculated in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016).

5. Existing Environment

This section provides a description of the environmental characteristics in the area, including a review of the local meteorological and ambient air quality conditions. The review considers data collected from existing meteorological and air quality monitoring networks, the locations of which are shown in **Figure 4**. One of the objectives for reviewing these data was to develop an understanding of existing air quality issues as well as the meteorological conditions which typically influence the local air quality conditions.

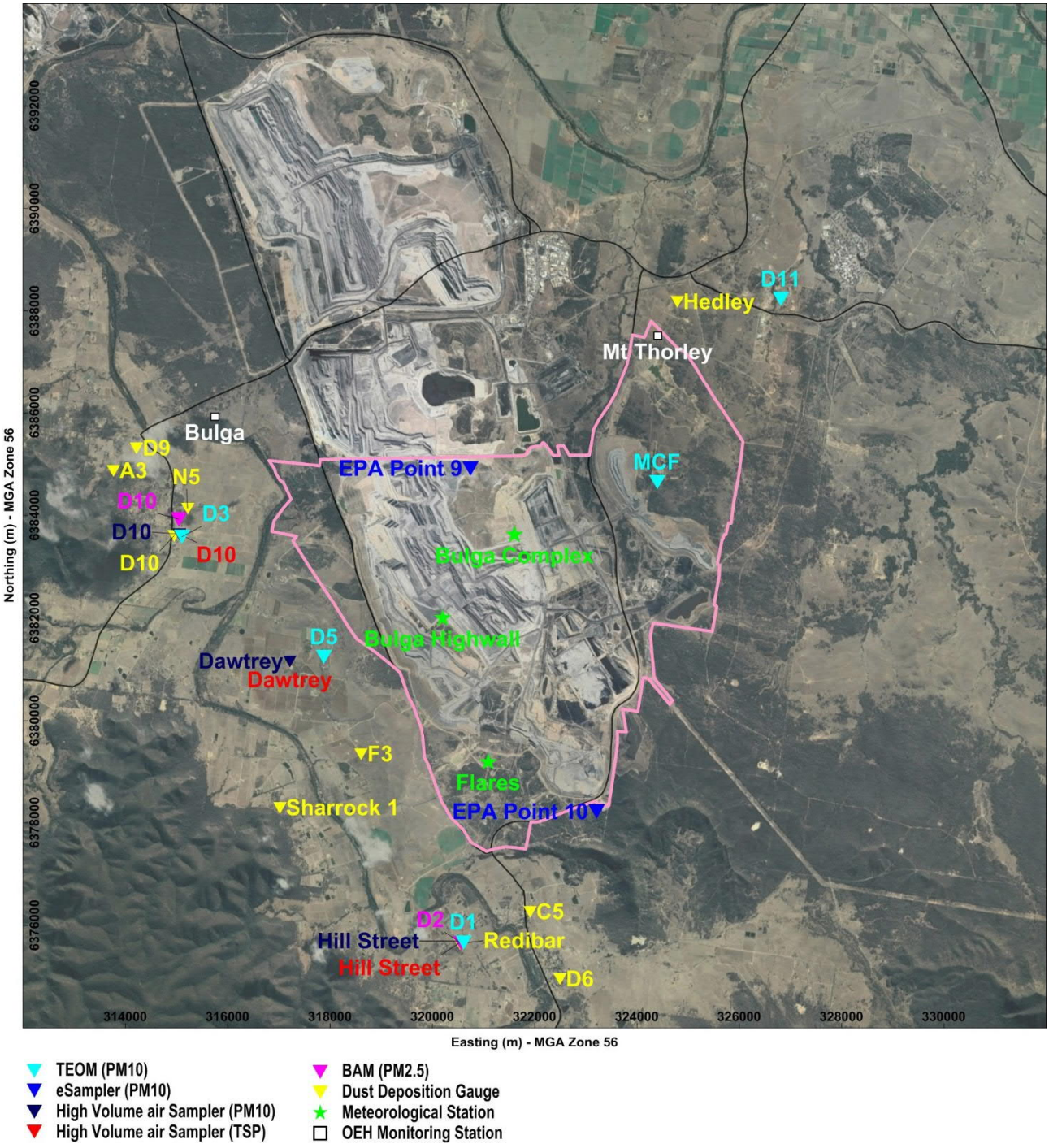

Figure 4 Location of air quality and meteorological monitoring sites

5.1 Meteorological Conditions

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature, and atmospheric stability. For air quality assessments, a minimum one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the model simulations.

Five meteorological stations have been identified in a 20 km by 20 km domain around the BCC. These stations, shown in **Figure 4**, are referred to as:

- Bulga Complex, operated by BCM;
- Bulga Highwall, operated by BCM;
- Flares, operated by BCM;
- Bulga, operated by the OEH; and
- Mt Thorley, operated by the OEH.

Yancoal also operates meteorological stations for the Warkworth and Mt Thorley mines however the data from the five stations listed above are sufficient for characterising the variations in conditions around the BCC.

Meteorological data from five recent years (2013 to 2017 inclusive) have been analysed in order to identify a representative year for the modelling. Hourly records of temperature, wind speed and wind direction were obtained, among other parameters. The procedure for identifying a representative meteorological year involved selecting a meteorological monitoring station and comparing wind patterns for each of the 2013 to 2017 calendar years. Data from the “Bulga Complex” have been chosen for identifying a representative year since this station is well exposed and near the centre of the area of interest.

Figure 5 shows the annual wind patterns for 2013, 2014, 2015, 2016 and 2017. It can be seen from these wind-roses that the most common winds in the area are from the northwest, south and southeast. The northwest and southeast pattern of winds is common for many parts of the Hunter Valley and reflects the northwest-southeast alignment of the valley. The southerly winds are a feature of the Bulga area and reflect the influence of the valley to the south, tracking Wollombi Road.

It is also clear from **Figure 5** that wind patterns were similar in all of the past five years, with only subtle differences. This suggests that wind patterns do not vary significantly from year to year, and potentially the data from any of the years presented could be used as a representative year for modelling purposes.



Figure 5 Annual wind-roses for data collected at Bulga Complex meteorological station

Figure 6 shows the wind speed data from the Bulga Complex meteorological station, as well as rainfall data from Singleton. In terms of wind conditions, the average and maximum wind speeds exhibited similar ranges across all five years. Maximum wind speeds reached around 17 m/s (as an hourly average) and these winds typically occurred in spring.

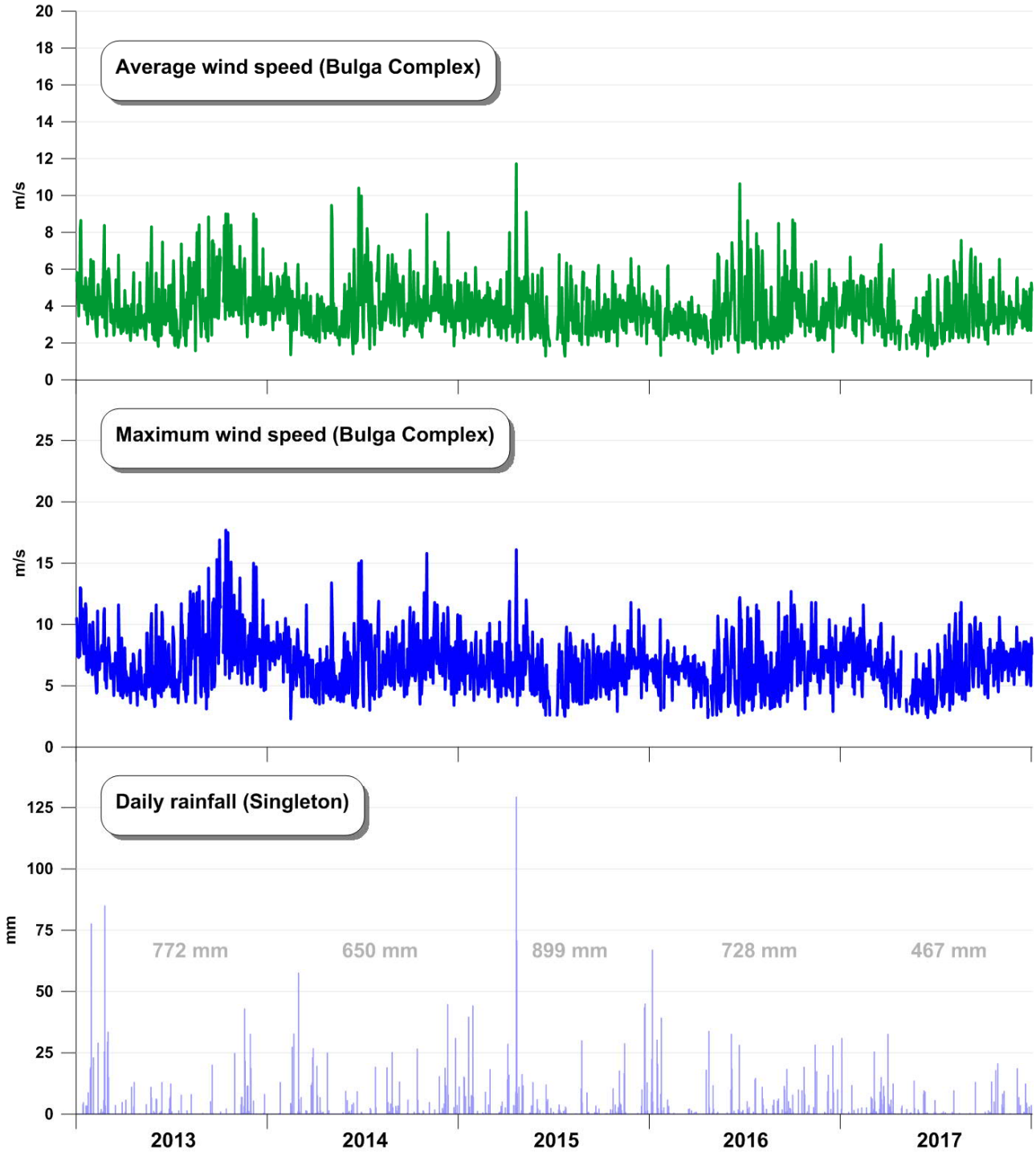

Figure 6 Daily wind speed and rainfall statistics for data collected between 2013 and 2017

As can be seen from **Figure 6**, rainfall can occur at any time of the year and with varying intensity. Statistically, the annual rainfall (2013 to 2017) has ranged from 467 mm in 2017 to 899 mm in 2015. These annual values can be compared to the longer-term record which is as follows:

- Singleton STP (Bureau of Meteorology) 2002 to 2017 = 659 mm

Finally, the annual data statistics for the past five years have been examined to assist with identifying a representative meteorological year. **Table 5** shows the statistics.

Table 5 Annual statistics from meteorological data collected between 2012 and 2016

Location	Statistic	2013	2014	2015	2016	2017
Bulga Complex	Percent complete (%)	96	98	92	94	90
Bulga Complex	Mean wind speed (m/s)	4.2	4.0	3.7	3.6	3.7
Bulga Complex	99th percentile wind speed (m/s)	11.5	10.3	9.4	10.0	9.0
Bulga Complex	Percentage of calms (%)	1.5	0.6	0.5	1.3	0.6
Bulga Complex	Percentage of winds >6 m/s (%)	19.5	16.8	12.3	13.8	12.7
Singleton	Rainfall (mm)	772	650	899	728	467

Over these five years, the mean annual wind speed has ranged from 3.6 to 4.2 m/s, and the percentage of calms has ranged from 1 to 2 per cent. None of these years appear to be significantly different to the other years and again, data from any of the years may be considered as representative for the purposes of modelling.

For this assessment the 2014 calendar year has been selected as the meteorological modelling year, based on:

- High data capture rate, relative to other years
- Similar wind patterns to other years
- Rainfall being slightly below the long-term average, and the preference was for a slightly drier than average year
- Air quality conditions which showed similarities to other years and not adversely influenced by bushfire activity (as will be seen in **Section 5.2**)
- Consistency with other recent air quality impact assessments (see for example, Jacobs [2016] and Jacobs [2018])

Methods used for incorporating the 2014 data into the meteorological modelling (CALMET) and air dispersion modelling (CALPUFF) are discussed in detail in **Section 7**. Annual and seasonal wind-roses from all meteorological stations used in the modelling are provided in **Appendix A**.

5.2 Air Quality Conditions

The EPA air quality criteria refer to levels of substances which generally include the project of interest and existing sources, not just the contribution from local mining activities. To fully assess impacts against all the relevant air quality criteria (see **Section 4**) it is necessary to have information or estimates of the existing air quality conditions. This section provides a description of the existing air quality.

Air quality in the vicinity of BCC is monitored by BCM and by the OEH. This monitoring includes the measurement of:

- Particulate matter as PM_{10};
- Particulate matter as $PM_{2.5}$;
- Particulate matter as TSP; and
- Dust deposition.

Concentrations of NO_2 have not been measured in the vicinity of BCC, however the OEH measures this substance at other locations as part of its Upper Hunter Air Quality Monitoring Network. **Sections 5.2.1** to **5.2.5** describe the existing air quality conditions, based on a review of monitoring results for the substances listed above, as well as for NO_2.

It should be noted that the measurement data represent the contributions from all sources that have at some stage been upwind of each monitor. In the case of particulate matter (as PM_{10}) for example, the background concentration may contain emissions from many sources such as from mining activities, construction works, bushfires and 'burning off', industry, vehicles, roads, wind-blown dust from nearby and remote areas, fragments of pollens, moulds, and so on.

5.2.1 Particulate Matter (as PM_{10})

Figure 4 shows the location of monitors which are used to measure PM_{10} concentrations. The concentrations are measured by a variety of instruments including Tapered Element Oscillating Microbalance (TEOM), high volume air sampler (HVAS) and eSamplers.

Figure 7 shows the measured 24-hour average PM_{10} concentrations from each TEOM monitoring site for data collected between 2013 and 2017. The EPA's air quality assessment criteria for PM_{10} (50 µg/m^3) has also been shown on these graphs. It can be seen from **Figure 7** that all monitors have recorded at least one day above the 50 µg/m^3 criterion in the past five years. There is a seasonal variation in the air quality conditions, with most exceedances of the 50 µg/m^3 criterion occurring in the warmer months.

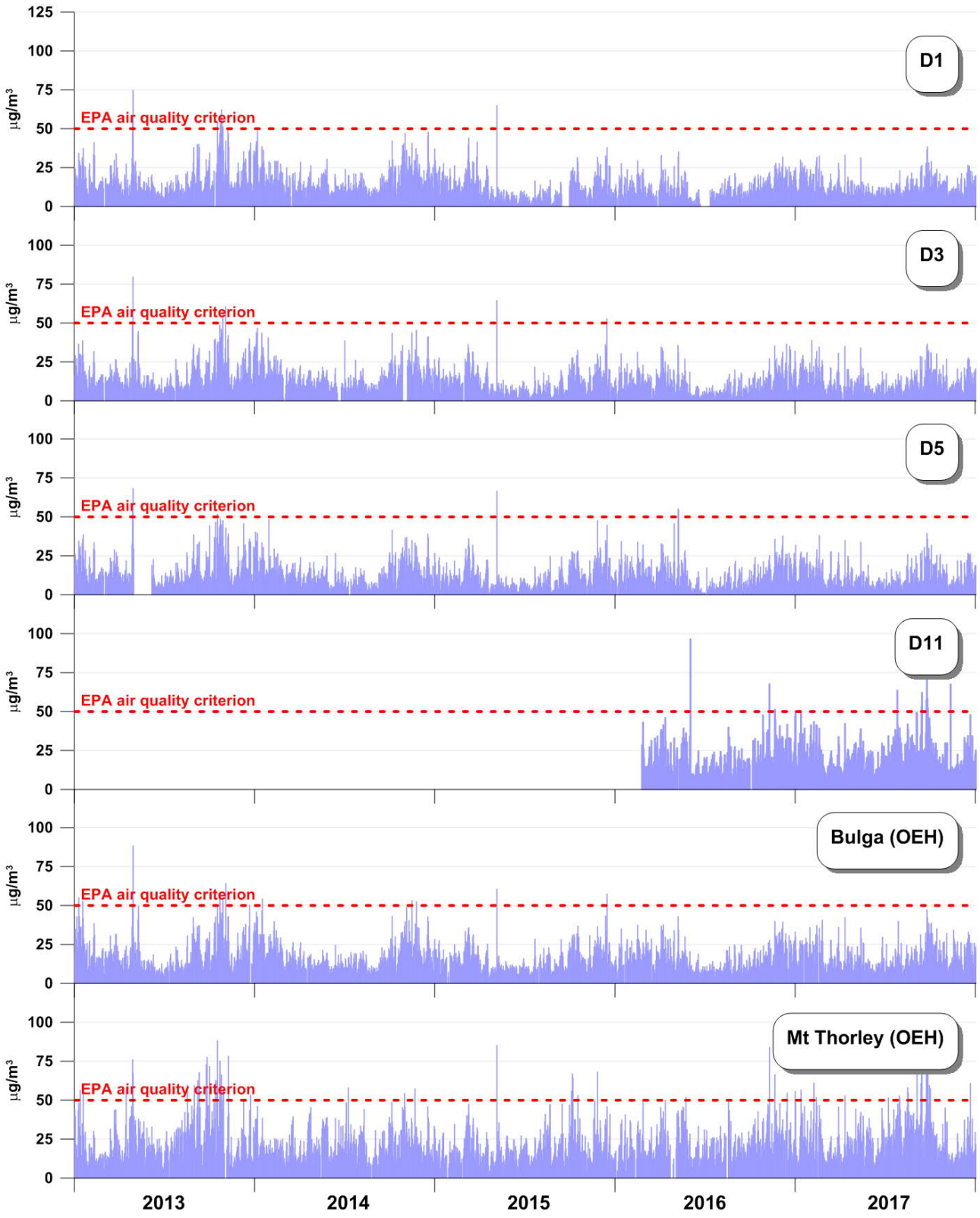

Figure 7 Measured 24-hour average PM_{10} concentrations

Table 6 summarises the measured PM_{10} concentration data for each monitor, for 24-hour and annual average periods, and for comparison with the respective EPA criteria. As noted above, most monitors have measured at least one day per year above the 50 µg/m^3 criterion in the past five years. Annual average PM_{10} concentrations have not exceeded the 30 µg/m^3 criterion (applicable up to 20 January 2017) or the now current 25 µg/m^3 criterion at any monitor.

The data from **Table 6** suggest good air quality conditions in the vicinity of BCC, with respect to PM_{10}. This conclusion is based on annual average PM_{10} concentrations which, excluding the Mt Thorley Industrial Estate monitor, have ranged between 11 and 22 µg/m^3 and, on average, nearly half the current assessment criterion (25 µg/m^3). There are occasional exceedances of the 24-hour average PM_{10} criterion, 50 µg/m^3, however this not uncommon for most parts of NSW, including rural and urban areas.

Table 6 Summary of measured PM_{10} concentrations

Year	D1	D3	D5	D11	Bulga (OEH)	Mt Thorley (OEH)	Criterion
Maximum 24-hour average in µg/m^3							
2013	75	80	68	-	88	88	50
2014	49	47	48	-	54	58	
2015	65	65	67	-	61	85	
2016	35	36	55	97	43	84	
2017	38	39	40	73	47	97	
Number of days above 24-hour average criteria							
2013	7	3	3	-	7	26	-
2014	0	0	0	-	3	3	
2015	1	2	1	-	2	7	
2016	0	0	2	4	0	5	
2017	0	0	0	8	0	21	
Annual average in µg/m^3							
2013	18	17	17	-	19	25	30 (now 25)
2014	17	16	14	-	18	22	
2015	12	12	11	-	15	20	
2016	12	12	13	20	16	23	
2017	14	13	12	22	17	25	

The results for the 2014 calendar year appear to be typical of the longer-term conditions experienced at each monitoring site which supports the earlier suggestion (**Section 5.1**) of 2014 being a typical or representative year. As noted in the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016) the selection of a "representative" year for modelling is primarily based on meteorological conditions.

The potential conditions which led to elevated PM_{10} concentrations at D1, D3 and D5 for 2014 have been analysed by the preparation of the following graphs:

- Hourly PM_{10} concentrations by time of day and wind speed (**Figure 8**).
- Hourly PM_{10} concentrations by wind direction and wind speed (**Figure 9**).

The information from **Figure 8** shows that, for these monitoring sites in 2014, the highest short-term (1-hour average) PM_{10} concentrations could be at any time of day. However, on average, the PM_{10} concentrations are

typically highest in the morning (around 9 am) and evening (around 8 pm). This pattern may be explained by poorer dispersion conditions in the morning and evening whereby any dust emissions disperse more slowly and allow higher concentrations to exist for extended periods of time. Also, the higher average concentrations in the morning and evening may be associated with increased anthropogenic (human) activity at these times, for example the use of wood heaters.

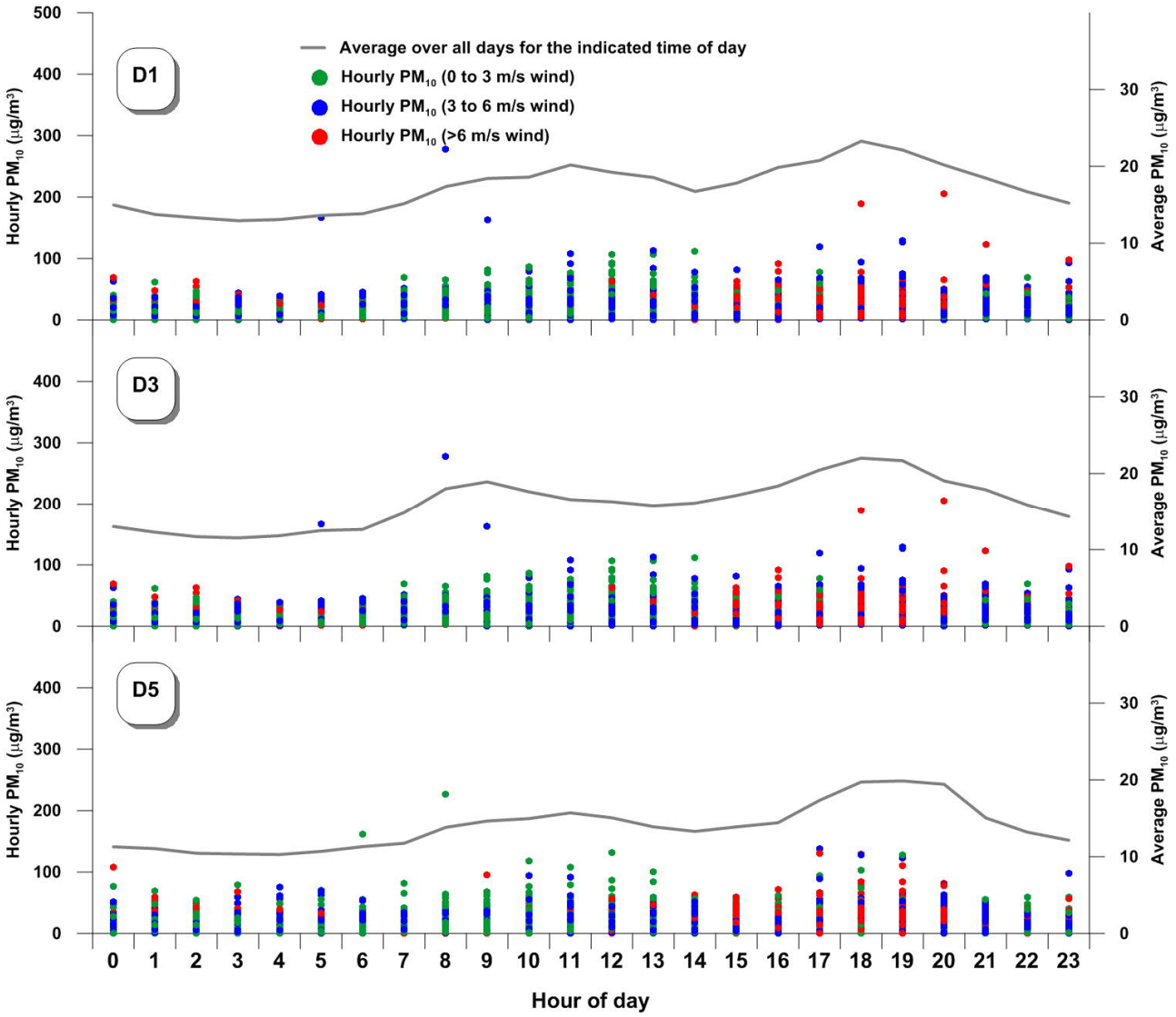

Figure 8 Measured PM_{10} concentrations by time of day and wind speed (2014 data)

Figure 9 shows the measured hourly average PM_{10} concentrations by wind direction and wind speed, from 2014 data. It can be seen from these figures that, at D1, the highest hourly average PM_{10} concentrations were associated with winds various directions including the northeast, south, west and northwest. Based on the location of D1 it would not be unreasonable to infer that the measured concentrations when winds were from the northeast were influenced to some degree by emissions from BCC. At D3, the highest concentrations coincided with a wind from the northwest and, at D5, the highest concentrations coincided with a wind from the north. These winds were not in the direction of BCC relative to each monitor.

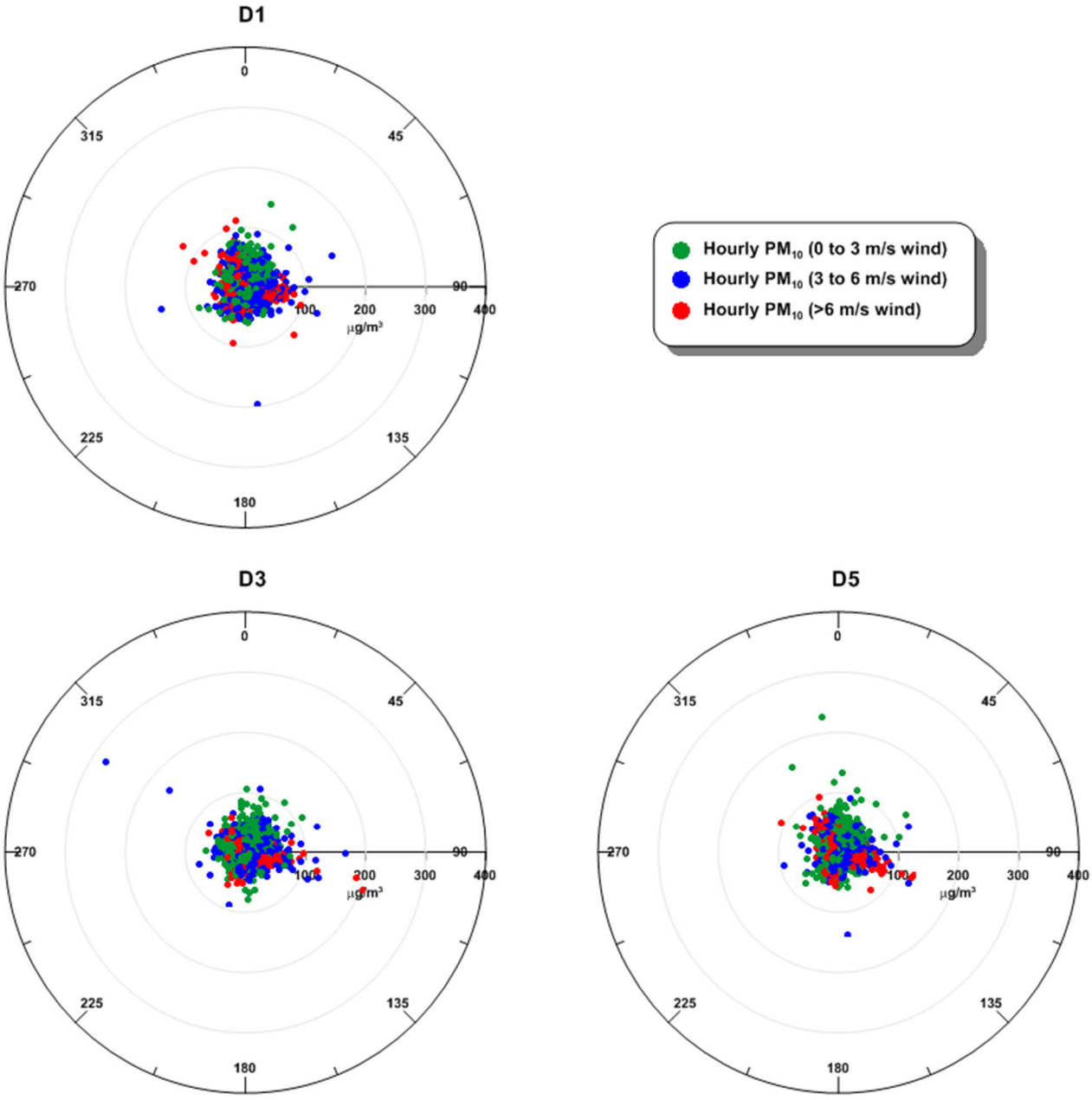

Figure 9 Measured PM_{10} concentrations by wind direction and wind speed (2014 data)

5.2.2 Particulate Matter (as $PM_{2.5}$)

BCM monitors $PM_{2.5}$ concentrations at two locations, D2 and D10, and the OEH has a $PM_{2.5}$ monitoring site at Singleton. These stations use Beta Attenuation Monitors (BAM) for the measurement of $PM_{2.5}$.

Figure 10 shows the measured 24-hour average $PM_{2.5}$ concentrations from each of the three monitoring sites for data collected between 2013 and 2017. The EPA's current air quality assessment criteria for $PM_{2.5}$ (25 µg/m^3) has also been shown, but it should be noted that this criterion came into effect from 20 January 2017 onwards and was therefore not applicable to the data being collected between 2013 and 2016.

$PM_{2.5}$ concentrations have been below the EPA criterion for the majority of the time. There have however been days when the $PM_{2.5}$ concentration exceeded 25 µg/m^3 at all three monitors. A seasonal variation is also evident, especially at Singleton, with the higher concentrations tending to occur in winter.

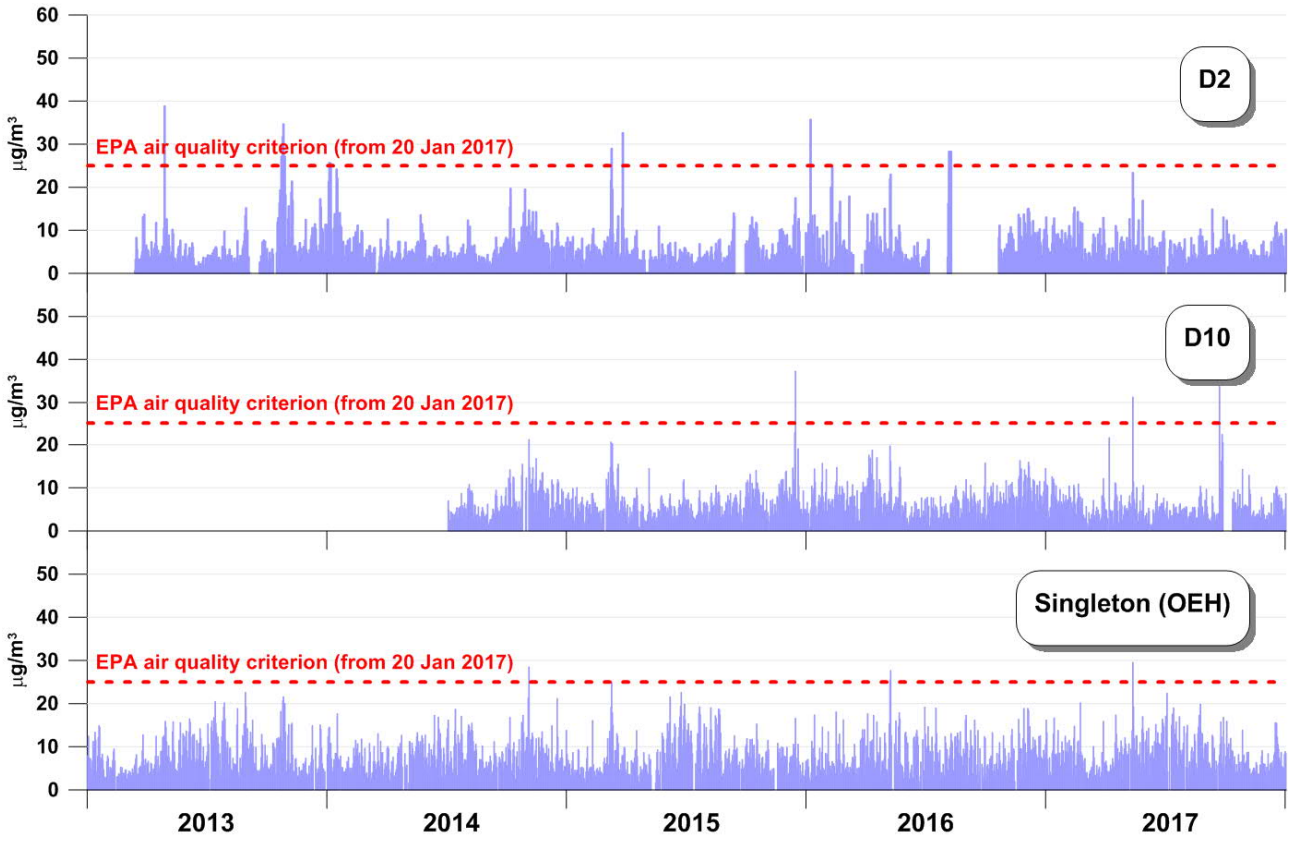

Figure 10 Measured 24-hour average $PM_{2.5}$ concentrations

Table 7 summarises the measured $PM_{2.5}$ results for data collected between 2013 and 2017. It can be seen from these data that the highest 24-hour average $PM_{2.5}$ concentrations have exceeded 25 µg/m^3 on at least one occasion in the past five years, but at that time the 25 µg/m^3 criterion was referred to as an advisory reporting goal and not an EPA air quality impact assessment criterion.

Annual averages exceeded 8 µg/m^3 at Singleton in 2017. Again, the 8 µg/m^3 level only came into effect as an assessment criterion from 20 January 2017, prior to which it was referred to as an advisory reporting goal.

It is also useful to compare the Hunter Valley data with information from other locations. At Cape Grimm, a site in rural Tasmania that is used as a global "baseline" reference for unpolluted air entering Australia, the mean $PM_{2.5}$ concentration was 5.6 µg/m^3 for data collected between 1998 and 2008 (ANSTO 2008). The results from D2 and D10 have ranged from between 2% lower to 23% higher than the Cape Grimm records. Most of Cape Grimm's particulate matter mass is from sea salt.

The Upper Hunter Fine Particle Characterisation Study (OEH, 2013) investigated the factors which contributed to elevated $PM_{2.5}$ concentrations in the Hunter Valley. This study identified a clear seasonal trend with higher $PM_{2.5}$ concentrations occurring in the cooler months, and predominantly due to wood smoke from domestic heating. Specifically, in Singleton, wood smoke accounted for an average of approximately 14% of the total $PM_{2.5}$, peaking at around 38% in winter.

Table 7 Summary of measured $PM_{2.5}$ concentrations

Year	D2	D10	Singleton (OEH)	Criterion
Maximum 24-hour average in µg/m^3				
2013	39	-	23	25 (came into effect as an assessment criterion from 20 Jan 2017 onwards)
2014	26	21	29	
2015	33	37	25	
2016	36	20	28	
2017	23	40	30	
Number of days above 24-hour average criteria				
2013	5	-	0	-
2014	2	0	1	
2015	2	1	0	
2016	5	0	2	
2017	0	2	1	
Annual average in µg/m^3				
2013	5.8	-	7.9	8 (came into effect as an assessment criterion from 20 Jan 2017 onwards)
2014	5.6	6.5	7.8	
2015	4.9	6.2	7.6	
2016	6.7	6.9	7.9	
2017	5.4	5.5	8.2	

5.2.3 Particulate Matter (as TSP)

TSP concentrations have been measured at three locations by high volume air sampler (HVAS). **Figure 4** shows the location of the current monitoring sites and **Table 8** shows the annual average concentrations from data collected in the past five years, for comparison with the EPA's 90 µg/m^3 criterion. None of the monitoring sites have recorded TSP concentrations above 90 µg/m^3.

Table 8 Summary of measured TSP concentrations

Year	Dawtrey	D10	Hill Street	Criterion
Annual average in µg/m^3				
2013	30	32	-	90
2014	35	40	-	
2015	28	31	-	
2016	32	37	-	
2017	30	37	26	

5.2.4 Deposited Dust

Table 9 shows the annual average deposited dust levels for each gauge from data collected in the past five years, for locations representative of private properties. **Figure 4** shows the location of the monitoring sites. The results in **Table 9** can be compared with the EPA's 4 g/m^2/month criterion. Contaminated monthly samples were excluded from the calculation of these annual averages.

Table 9 Summary of measured deposited dust levels

Year	A3	D9	D10	Sharrock 1	D6	Hedley	C5	N5	F3	Redibar	Criterion
Annual average expressed as g/m^2/month											
2013	2.0	2.4	1.5	1.3	2.2	-	2.7	1.7	-	2.3	4
2014	1.7	1.7	1.6	1.3	2.3	-	1.8	2.0	2.2	1.9	
2015	1.6	1.5	1.4	1.4	1.5	-	1.4	2.5	2.0	1.8	
2016	1.4	1.2	1.3	1.8	1.4	-	1.7	2.0	1.9	2.6	
2017	1.4	1.5	1.3	0.9	1.1	1.5	1.1	1.3	2.1	2.0	

It can be seen from **Table 9** that no locations experienced deposition levels above the EPA's 4 g/m^2/month criterion, from data collected between 2013 and 2017.

5.2.5 Nitrogen Dioxide (NO_2)

Table 10 provides a summary of the measured NO_2 concentrations from Singleton (the closest known air quality monitoring site which records this substance). These data show that the maximum NO_2 concentrations have been well below the EPA's 1-hour average criterion of 246 µg/m^3. Annual averages have also been well below the EPA's annual average criterion of 62 µg/m^3.

Table 10 Summary of measured NO_2 concentrations

Year	Singleton (OEH)	Criterion
Maximum 1-hour average in µg/m^3		
2013	84	246
2014	74	
2015	66	
2016	66	
2017	74	
Annual average in µg/m^3		
2013	18	62
2014	16	
2015	16	
2016	16	
2017	17	

5.3 Summary of the Existing Environment

The following conclusions have been made from the review of local meteorological and ambient air quality monitoring data:

- Wind patterns in the vicinity of BCC Mine are similar to other parts of the Hunter Valley, with the prevailing winds being from either the northwest or southeast. Winds from the south are also common for this area.
- There are seasonal variations in particulate matter concentrations, with PM_{10} levels higher in spring and $PM_{2.5}$ levels higher in winter.
- In terms of PM_{10}, and aside from the OEH's Mt Thorley monitoring location, air quality conditions can be regarded as good, with annual average concentrations well below the revised assessment criterion of 25 µg/m^3. Most monitoring sites in the vicinity of BCC have experienced at least one day above the EPA's 50 µg/m^3 criterion in the past five years. This is not uncommon for most locations in NSW, including in rural and urban areas.
- In terms of $PM_{2.5}$, annual averages have been below the recently introduced assessment criterion (8 µg/m^3) at both BCM monitoring locations. Results from Singleton were above 8 µg/m^3 in one of the past five years. A study by the OEH (2013) found that wood smoke from domestic heating was one of the main factors that influenced $PM_{2.5}$ concentrations in the Singleton area, especially in winter.
- TSP, dust deposition and NO_2 levels are below their relevant EPA criteria.
- Conditions in 2014 were representative of the longer-term air quality and meteorological conditions.

5.4 Assumed Background Levels

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts, that is, mining contribution plus non-mining contribution. For this objective, the approach was to make use of data collected from all real-time air quality monitors in the vicinity of BCC and, at the same time, minimise the potential for adding model predictions to measurements which may already contain contributions from those sources being modelled (i.e. to avoid double counting).

The adopted approach involved developing an hourly variable background dataset that was added to the model predictions. This dataset (for PM_{10}) was created by using the minimum measured non-zero 24-hour average concentration from D1, D3 and D5 for each day in the 2014 calendar year. A key assumption to this approach was that the minimum value from these sites reflected a location that was not being influenced by emissions from the sources / operation to be modelled. The statistics of the resultant dataset (included in **Table 11**) indicate that this approach, and its inherent assumption, produce estimated background levels which are similar to actual measurements in the region. **Figure 11** shows a graphical representation of the assumed background PM_{10} and $PM_{2.5}$ concentrations that were used in this assessment and added to the model predictions of concentrations due to the Project. As can be seen from **Figure 11** these background concentrations have been inferred from the measurement data.

The estimated background levels that apply at sensitive receptors are shown below in **Table 11**. These levels (or adopted approach) have been added to model predictions to determine the potential cumulative impacts.

Table 11 Assumed non-modelled background levels that apply at sensitive receptors

Substance	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (PM_{10})	24-hour and annual	Variable by hour of day	The adopted approach involved developing an hourly variable background dataset that was added to the model predictions. This dataset was created by using the minimum measured non-zero 24-hour average concentration from D1, D3 and D5 for each day in the 2014 calendar year. Statistics from the resultant dataset are as follows: - Maximum 24-hour average = 41 µg/m^3 - Annual average = 13 µg/m^3
Particulate matter ($PM_{2.5}$)	24-hour and annual	Variable by hour of day	The adopted approach involved developing an hourly variable background dataset that was added to the model predictions. This dataset was created by using the minimum measured non-zero 24-hour average concentration from D2, D10 and Singleton for each day in the 2014 calendar year. Statistics from the resultant dataset are as follows: - Maximum 24-hour average = 18 µg/m^3 - Annual average = 4.9 µg/m^3 It should be noted that the approach of adopting the minimum measured non-zero 24-hour average concentration from D2, D10 and Singleton for each day is may over-estimate background levels under low wind conditions. This is because, in low or still wind conditions, there may be some contribution from the mining sources being modelled to measured levels at D2 and D10.
Particulate matter (TSP)	Annual	40 µg/m^3	Highest annual average concentration measured from Dawtrey, D10 and Hill Street in 2014.
Deposited dust	Annual	2.3 g/m^2/month	Highest annual average deposition level from A3, D9, D10, Sharrock 1, D6, Hedley, C5, N5, F3, Redibar in 2014.
Nitrogen dioxide (NO_2)	1-hour	74 µg/m^3	Maximum 1-hour average from Singleton in 2014.
	Annual	16 µg/m^3	Annual average from Singleton in 2014.

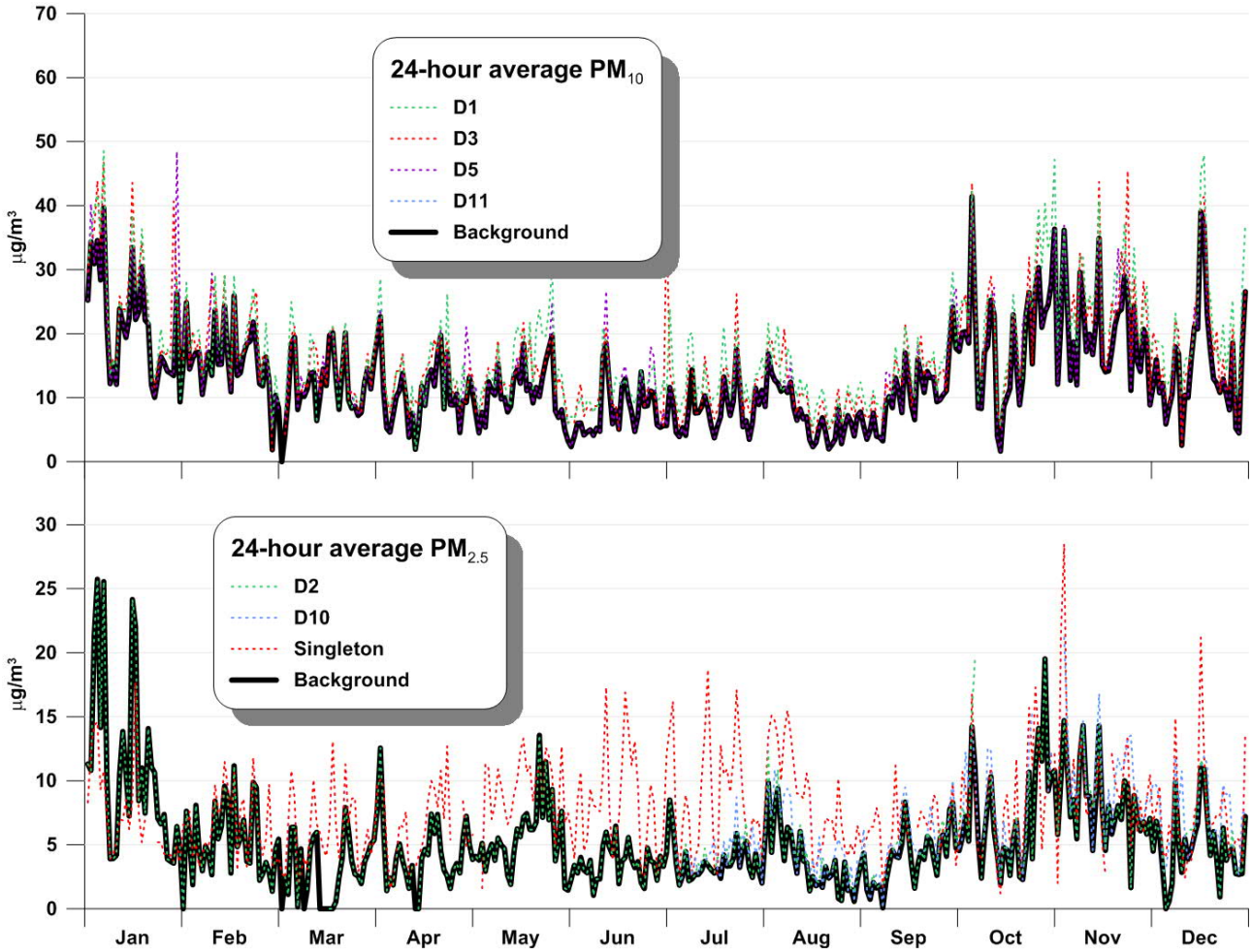

Figure 11 Assumed background PM_{10} and $PM_{2.5}$ concentrations as inferred from the measurement data

6. Emissions to Air

The most significant emission to air from the Project will be dust (particulate matter) due to material handling, material transport, processing, wind erosion, and blasting. Estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and mine plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- AP 42 (US EPA, 1985 and updates).

Dust emission inventories have been developed for each of the modelled scenarios, namely:

- 2014, representing "existing" conditions (with the operations approved at that time) and for model performance evaluations.
- Years 2022, 2026, 2031 and 2035, representing proposed future conditions, and assuming maximum production.

The "existing" scenario has been developed to evaluate the performance of the model. In this case the model predictions were compared to monitored results to determine the level of confidence that can be assumed for the future scenarios. The assessment focusses primarily on the performance of the model for predicting PM_{10} concentrations. This approach was driven by the outcome of the existing air quality review (see **Section 5.2**) which showed that PM_{10} is one of the key air quality issues due to a higher number of historical exceedances of the EPA air quality criteria than other substances. It was not possible to evaluate the performance of the model for predicting $PM_{2.5}$ or NO_2 as there are insufficient $PM_{2.5}$ or NO_x monitors in the model domain to allow for a comparison between measured and predicted levels.

The four future scenarios have been selected to represent various mine stages in the life of the mine, including at maximum production and for times when operations are close to sensitive receptors. There are no specific guidelines or procedures which define an adequate level of information to demonstrate that selected scenarios are representative of worst-case impacts. The selection of 2022, 2026, 2031 and 2035 was therefore based on a review of material handling quantities, haul distances, and location of activities for each year in the proposed mine life and selecting four years for assessment.

Table 12, **Table 13** and **Table 14** show the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions, respectively, due to the Proposed Modification. Estimates for 2014 were based on production and material handling quantities contained in the Annual Environmental Management Report (AEMR) produced by BCM (2015). Estimates for future years were based on estimated production quantities for the Proposed Modification, provided by BCM, based on expected mine production schedules.

It should be noted that the main intent of the inventories is to capture the most significant emission sources that may affect off-site air quality. Not every source will be captured. However, the contribution of emissions from sources not identified will be captured in the air quality monitoring data and these data have been added to the predicted project contributions. **Appendix B** provides details of the dust emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations.

Table 12 Estimated TSP emissions due to the BCC (as modified)

Activity	Annual TSP emissions (kg/y)				
	2014	2022	2026	2031	2035
Stripping topsoil (dozers)	65870	0	184758	0	0
Drilling overburden (Main Pit)	2455	13745	10872	6142	4550
Drilling overburden (South Pit)	3715	0	2718	6142	4550
Blasting overburden (Main Pit)	23684	131525	104034	58777	43538
Blasting overburden (South Pit)	23684	0	26009	58777	43538
Dragline working on overburden	229104	0	0	0	0
Excavators loading overburden to trucks (Main Pit)	143986	365318	288962	163255	120929
Excavators loading overburden to trucks (South Pit)	143986	0	72240	163255	120929
Hauling overburden from Main Pit to Main Dump	944054	2592488	2306954	1385217	478061
Hauling overburden from South Pit to Main Dump	749690	0	702116	1605593	478061
Hauling overburden from Main/South Pit to EEA	0	760839	403996	0	0
Unloading overburden to Main Dump	287971	219191	325082	326510	241858
Unloading overburden to EEA	0	73064	36120	0	0
Dozers shaping overburden (Main dump)	380184	773272	869931	380184	380184
Dozers shaping overburden (EEA)	0	193318	96659	586406	586406
Dozers working on overburden for rehabilitation	142569	142569	142569	142569	142569
Dozers working on coal (Main Pit)	116258	232515	186012	116258	116258
Dozers working on coal (South Pit)	116258	0	46503	116258	116258
Loading ROM coal to trucks (Main pit)	326712	706648	543737	410237	328716
Loading ROM coal to trucks (South pit)	326712	0	135934	410237	328716
Hauling ROM coal from Main pit to hopper / ROM pad	232145	319524	245860	185496	58392
Hauling ROM coal from South pit to hopper / ROM pad	204006	0	61465	185496	58392
Unloading ROM coal to hopper ROM pad (from all pits)	14509	15691	15092	18218	14598
ROM coal rehandle to hopper	10000	10461	10061	12146	9732
Transferring ROM coal by conveyor to CHPP	1686	1824	1754	2118	1697
Conveyor unloading to hopper / ROM pad (underground)	605	0	436	436	0
Dozers on ROM stockpile (underground)	58129	0	0	0	0
Dozers on ROM stockpile (open cut)	58129	58129	58129	58129	58129
Dozers on product coal stockpiles	65901	65901	65901	65901	65901
Handling coal at CHPP	6772	6079	9334	10545	5656
Conveyer transfer to product stockpiles	1152	1034	1587	1793	962
Conveyor unloading to product stockpiles	480	431	661	747	401
Loading product coal from stockpiles to trains	3839	3446	5291	5978	3206
Wind erosion from active pits	456667	496692	522972	475668	318864
Wind erosion from active dumps	365292	762996	720948	652620	657000
Wind erosion from inactive or partially rehabed dumps	99952	224431	212780	199903	164338
Wind erosion from ROM coal stockpiles	4380	4380	4380	4380	4380
Wind erosion from product coal stockpiles	3942	3942	3942	3942	3942
Grading roads	79691	79691	79691	79691	79691
Total	**5694167**	**7231922**	**7968717**	**7312618**	**4453993**

Table 13 Estimated PM_{10} emissions due to the BCC (as modified)

Activity	Annual PM_{10} emissions (kg/y)				
	2014	2022	2026	2031	2035
Stripping topsoil (dozers)	16036	0	44979	0	0
Drilling overburden (Main Pit)	1290	7222	5712	3227	2391
Drilling overburden (South Pit)	1952	0	1428	3227	2391
Blasting overburden (Main Pit)	12273	68154	53909	30457	22561
Blasting overburden (South Pit)	12273	0	13477	30457	22561
Dragline working on overburden	50311	0	0	0	0
Excavators loading overburden to trucks (Main Pit)	68101	172785	136671	77215	57196
Excavators loading overburden to trucks (South Pit)	68101	0	34168	77215	57196
Hauling overburden from Main Pit to Main Dump	278976	766102	681724	409343	141271
Hauling overburden from South Pit to Main Dump	221540	0	207481	474466	141271
Hauling overburden from Main/South Pit to EEA	0	224834	119384	0	0
Unloading overburden to Main Dump	136203	103671	153755	154431	114392
Unloading overburden to EEA	0	34557	17084	0	0
Dozers shaping overburden (Main dump)	92554	188250	211781	92554	92554
Dozers shaping overburden (EEA)	0	47062	23531	142758	142758
Dozers working on overburden for rehabilitation	34708	34708	34708	34708	34708
Dozers working on coal (Main Pit)	33701	67403	53922	33701	33701
Dozers working on coal (South Pit)	33701	0	13481	33701	33701
Loading ROM coal to trucks (Main pit)	43101	93224	71732	54120	43366
Loading ROM coal to trucks (South pit)	43101	0	17933	54120	43366
Hauling ROM coal from Main pit to hopper / ROM pad	68601	94422	72654	54816	17255
Hauling ROM coal from South pit to hopper / ROM pad	60286	0	18163	54816	17255
Unloading ROM coal to hopper ROM pad (from all pits)	6094	6590	6339	7652	6131
ROM coal rehandle to hopper	4200	4393	4226	5101	4087
Transferring ROM coal by conveyor to CHPP	798	863	830	1002	803
Conveyor unloading to hopper / ROM pad (underground)	286	0	206	206	0
Dozers on ROM stockpile (underground)	16851	0	0	0	0
Dozers on ROM stockpile (open cut)	16851	16851	16851	16851	16851
Dozers on product coal stockpiles	19104	19104	19104	19104	19104
Handling coal at CHPP	3203	2875	4415	4988	2675
Conveyer transfer to product stockpiles	545	489	751	848	455
Conveyor unloading to product stockpiles	227	204	313	353	190
Loading product coal from stockpiles to trains	1816	1630	2502	2827	1516
Wind erosion from active pits	228334	248346	261486	237834	159432
Wind erosion from active dumps	182646	381498	360474	326310	328500
Wind erosion from inactive or partially rehabed dumps	49976	112216	106390	99952	82169
Wind erosion from ROM coal stockpiles	2190	2190	2190	2190	2190
Wind erosion from product coal stockpiles	1971	1971	1971	1971	1971
Grading roads	28175	28175	28175	28175	28175
Total	**1840071**	**2423334**	**2643899**	**2427938**	**1531384**

Table 14 Estimated $PM_{2.5}$ emissions due to the BCC (as modified)

Activity	Annual $PM_{2.5}$ emissions (kg/y)				
	2014	2022	2026	2031	2035
Stripping topsoil (dozers)	3,294	0	9,238	0	0
Drilling overburden (Main Pit)	123	687	544	307	227
Drilling overburden (South Pit)	186	0	136	307	227
Blasting overburden (Main Pit)	1,184	6,576	5,202	2,939	2,177
Blasting overburden (South Pit)	1,184	0	1,300	2,939	2,177
Dragline working on overburden	11,455	0	0	0	0
Excavators loading overburden to trucks (Main Pit)	7,199	18,266	14,448	8,163	6,046
Excavators loading overburden to trucks (South Pit)	7,199	0	3,612	8,163	6,046
Hauling overburden from Main Pit to Main Dump	47,203	129,624	115,348	69,261	23,903
Hauling overburden from South Pit to Main Dump	37,484	0	35,106	80,280	23,903
Hauling overburden from Main/South Pit to EEA	0	38,042	20,200	0	0
Unloading overburden to Main Dump	14,399	10,960	16,254	16,326	12,093
Unloading overburden to EEA	0	3,653	1,806	0	0
Dozers shaping overburden (Main dump)	19,009	38,664	43,497	19,009	19,009
Dozers shaping overburden (EEA)	0	9,666	4,833	29,320	29,320
Dozers working on overburden for rehabilitation	7,128	7,128	7,128	7,128	7,128
Dozers working on coal (Main Pit)	5,813	11,626	9,301	5,813	5,813
Dozers working on coal (South Pit)	5,813	0	2,325	5,813	5,813
Loading ROM coal to trucks (Main pit)	16,336	35,332	27,187	20,512	16,436
Loading ROM coal to trucks (South pit)	16,336	0	6,797	20,512	16436
Hauling ROM coal from Main pit to hopper / ROM pad	11,607	15,976	12,293	9,275	2,920
Hauling ROM coal from South pit to hopper / ROM pad	10,200	0	3,073	9,275	2,920
Unloading ROM coal to hopper ROM pad (from all pits)	725	785	755	911	730
ROM coal rehandle to hopper	500	523	503	607	487
Transferring ROM coal by conveyor to CHPP	84	91	88	106	85
Conveyor unloading to hopper / ROM pad (underground)	30	0	22	22	0
Dozers on ROM stockpile (underground)	2,906	0	0	0	0
Dozers on ROM stockpile (open cut)	2,906	2,906	2,906	2,906	2,906
Dozers on product coal stockpiles	3,295	3,295	3,295	3,295	3,295
Handling coal at CHPP	339	304	467	527	283
Conveyer transfer to product stockpiles	58	52	79	90	48
Conveyor unloading to product stockpiles	24	22	33	37	20
Loading product coal from stockpiles to trains	192	172	265	299	160
Wind erosion from active pits	34,250	37,252	39,223	35,675	23,915
Wind erosion from active dumps	27,397	57,225	54,071	48,947	49,275
Wind erosion from inactive or partially rehabed dumps	7,496	16,832	15,959	14,993	12,325
Wind erosion from ROM coal stockpiles	329	329	329	329	329
Wind erosion from product coal stockpiles	296	296	296	296	296
Grading roads	3,985	3,985	3,985	3,985	3,985
Total	**307,964**	**398,907**	**435,061**	**399,044**	**251,413**

Additionally, BCM is committed to the continued implementation of operational emission controls during adverse weather conditions in order to minimise off-site impacts. The operational controls will result in reduced levels of activity at BCC relative to the capacity considered as part of the current air quality modelling.

In practice these operational controls, which will vary on a daily basis, will lead to lower emissions to air than for unconstrained activities. Consequently the estimated emissions in **Table 12**, **Table 13** and **Table 14** should represent conservative estimates, as these further detailed operational controls are not included, and it follows that the predicted impacts of the Proposed Modification will also be conservative. That is, the predicted impacts are likely to over-state actual impacts to some extent.

It is also useful to compare the estimated emissions from BCC (as modified) with previous estimates for the site. **Table 15** provides this comparison. The estimated annual PM_{10} emissions for BCC (as modified) are 24 per cent lower than those for the Bulga Optimisation Project. Approval for the Bulga Optimisation Project was granted on 1 December 2014. This approval was conditional on the development of a revised air dispersion model for the BCC. The current emission estimates were developed from a Technical Review Committee that was established to, among other functions, update the BCC model.

Table 15 Comparison of historical estimated PM_{10} emissions due to the BCC

Assessment	Highest annual PM_{10} emissions from all years assessed (kg/y)
Bulga Optimisation Project (Revised and Amended Project Report) – PEL (2013)	3,466,180
Bulga Open Cut Eastern Emplacement Area Modification - Jacobs (2016)	2,139,089
BCC (as modified) – this report	2,643,899

Emissions from other mining operations are also important for quantifying the potential cumulative effects. Two approaches were considered for estimating emissions from other mining operations. These approaches included:

- Deriving emission estimates from previously published EIS data, and
- Recalculating emissions from other mines in the model domain specifically for this assessment.

The approach of recalculating emissions from other mines in the model domain has been chosen for this assessment. This approach has been favoured because it maintains consistency in the emission calculation methods for all mining operations. It also has the following advantages over recent EIS data:

- TSP, PM_{10} and $PM_{2.5}$ can be separated for each activity for each mining operations. To date, most EIS air quality assessments have only calculated TSP emissions, with PM_{10} and $PM_{2.5}$ emissions derived from regional ratios such as those published by the SPCC (1986).
- The proportions of wind sensitive, wind insensitive and wind erosion activities can be more accurately defined. Historical assessments have often applied fixed ratios of these three activity types, usually based on information from the Mt Arthur mine EIS (URS 2000).
- Pit retention can be modelled and the adjusted emissions can be made specific to each activity and the hourly wind speed.
- Triggered control factors can be modelled. For example, the effect of rainfall for suppressing dust from exposed areas can be simulated for relevant hours in the year.

There are also disadvantages to the approach of recalculating emissions from other mines. The main disadvantages are potential inconsistencies between the emission estimates and other published EIS emissions data, and the inability to precisely match source locations to future mine plans. However, it will be seen later, in **Section 8**, that the emission estimation approach (combined with model setup assumptions etc.) has produced results which do not underestimate concentrations at the key sensitive receptor locations.

Table 16 shows the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions due to the Mt Thorley Warkworth mine, the only other mine in the model domain. These emissions have been included in the modelling.

Table 16 Estimated TSP, PM_{10} and $PM_{2.5}$ emissions due to the Mt Thorley Warkworth mine

Activity	Annual emissions (kg/y)					
	TSP		PM_{10}		$PM_{2.5}$	
	2014	2022-2035	2014	2022-2035	2014	2022-2035
Stripping topsoil by scraper	1450	1450	365	365	73	73
Drilling overburden (All Pits)	31294	31294	16273	16273	939	939
Blasting overburden (All Pits)	137518	137518	71509	71509	4126	4126
Excavators loading overburden to trucks (All Pits)	548911	868678	259620	410861	39314	62216
Hauling overburden from All Pits to dump	3936247	6229295	1163194	1840808	118087	186879
Unloading overburden to dump (from All Pits)	548911	868678	259620	410861	39314	62216
Dozers shaping overburden (all dumps)	879609	879609	214137	214137	92359	92359
Dozers working on overburden for rehabilitation	219902	219902	53534	53534	23090	23090
Drilling coal (All Pits)	15647	15647	8136	8136	469	469
Blasting coal (All Pits)	48620	48620	25282	25282	1459	1459
Dozers working on coal (All Pits)	788784	788784	251444	251444	17353	17353
Loading ROM coal to trucks (All Pits)	846294	1339301	121710	192613	16080	25447
Hauling ROM coal from All Pits to hopper / ROM pad	650357	1029221	192186	304143	19511	30877
Unloading ROM coal to ROM pad	53079	84000	22293	35280	1009	1596
ROM coal rehandle to hopper	17693	28000	7431	11760	336	532
Transferring ROM coal by conveyor to CHPP	2062	3263	975	1543	148	234
Handling coal at CHPP, inc UG	10309	16315	4876	7717	148	234
Dozers on ROM coal stockpiles	131464	131464	41907	41907	2892	2892
Dozers on product coal stockpiles	56212	56212	16198	16198	1237	1237
Conveyer to product stockpiles	890	2089	421	988	64	150
Loading product coal to trains	4772	11200	2028	4760	239	560
Wind erosion from active pits	671016	671016	335508	335508	50326	50326
Wind erosion from active dumps	989004	989004	494502	494502	74175	74175
Wind erosion from partially rehabilitated dumps	0	0	0	0	0	0
Wind erosion from ROM coal stockpiles	8760	8760	4380	4380	657	657
Wind erosion from product coal stockpile	2190	2190	1095	1095	164	164
Grading roads	18464	18464	6528	6528	202	202
Dragline working on overburden	311435	492860	68390	108230	15572	24643
Total	**10930896**	**14972834**	**3643545**	**4870365**	**519340**	**665103**

7. Approach to Assessment

7.1 Overview

This assessment has followed the EPA's "Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales" (EPA, 2016), which specifies how assessments based on the use of air dispersion models should be undertaken. The "Approved Methods" include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

The CALPUFF computer-based air dispersion model has been used to predict ground-level concentrations and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality criteria. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions.

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model. The model comprises meteorological modelling as well as dispersion modelling, both of which are described below.

7.2 Meteorological Modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radio-sondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

There are no known meteorological stations in the Upper Hunter region that collect suitable upper air data for CALMET. The closest station with suitable data is operated by the Bureau of Meteorology at Williamtown, approximately 100 km to the east-southeast of BCC. The necessary upper air data were therefore generated by TAPM, using influence from the surface observations at the BCC meteorological station. CALMET was then set up with three surface observations stations (Bulga Complex, OEH Bulga and OEH Mt Thorley) and one upper air station (based on TAPM output for the Bulga Complex meteorological station). The meteorological modelling followed the guidance of TRC (2011) and adopted the "observations" mode. A "hybrid" mode was also tested but found to produce unrealistic wind-fields because of too much weighting towards the prognostic data.

Key model settings for TAPM are shown below in **Table 17**.

Table 17 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 300 m). Output from the 1 km grid was used.
Number of grids point	30 x 30 x 25
Year(s) of analysis	2014, with one “spin-up” day.
Centre of analysis	BCC (32°41’ S, 151°06’ E)
Terrain data source	Shuttle Research Topography Mission (SRTM)
Land use data source	Default
Meteorological data assimilation	Bulga Complex meteorological station. Radius of influence = 10 km. Number of vertical levels for assimilation = 4

Table 18 lists the model settings and input data for CALMET. This information has been provided so that the user can reproduce the results if required.

Table 18 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	SRTM and Project Digital Elevation Model (DEM)
Land-use data source(s)	Digitized from aerial imagery
Meteorological grid domain	20 km x 20 km
Meteorological grid resolution	0.2 km
Meteorological grid dimensions	100 x 100 x 9
Meteorological grid origin	312000 mE, 6374000 mN. MGA Zone 56
Surface meteorological stations	Bulga Complex (Observations of wind speed, wind direction, temperature and relative humidity. TAPM for ceiling height, cloud cover and air pressure) OEH Bulga (Observations of wind speed and wind direction) OEH Mt Thorley (Observations of wind speed and wind direction)
Upper air meteorological stations	Upper air data file for the location of Bulga Complex met station derived by TAPM Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8760 hours (1 Jan 2014 to 31 Dec 2014)
R1, R2	0.5, 1
RMAX1, RMAX2	5, 20
TERRAD	5

Terrain information was extracted from the NASA Shuttle Research Topography Mission database which has global coverage at approximately 30 metre resolution (in addition to the Project Digital Elevation Model). Land use data were extracted from aerial imagery. **Figure 12** shows the model grid, land-use and terrain information, as used by CALMET. It is noted that the extent of some land-uses will change over time, such as mining areas, however the model sensitivity has been tested and changes from grassland to barren land (i.e. mining areas) were found to have very little influence on the dispersion modelling results.

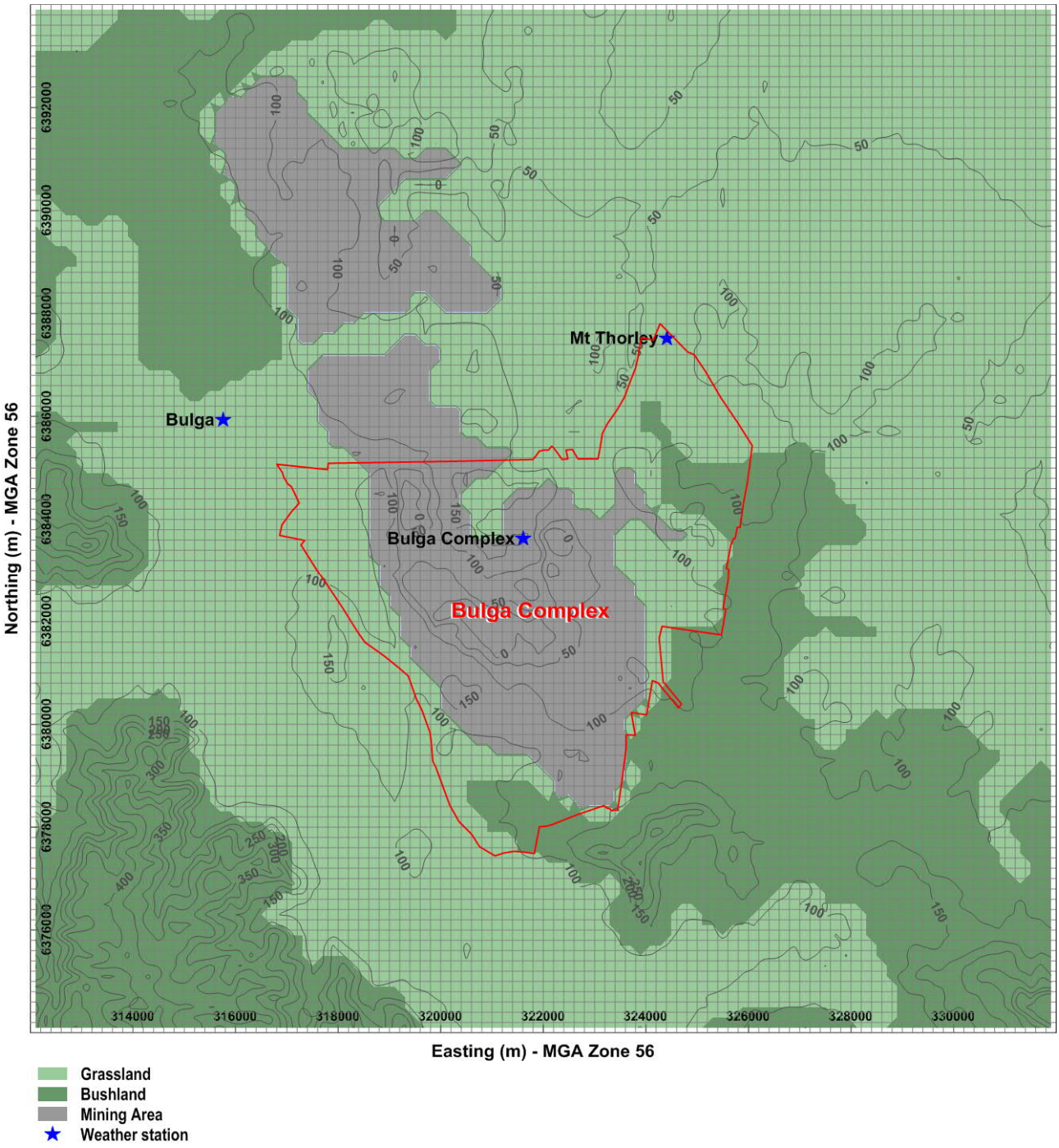

Figure 12 Model grid, land-use and terrain information

Figure 13 shows a snapshot of winds at 10 metres above ground-level as simulated by the CALMET model under stable conditions. This plot shows the effect of the topography on local winds (for this particular hour), and highlights the non-uniform wind patterns in the area, which further supports the use of a non-steady-state model such as CALPUFF.

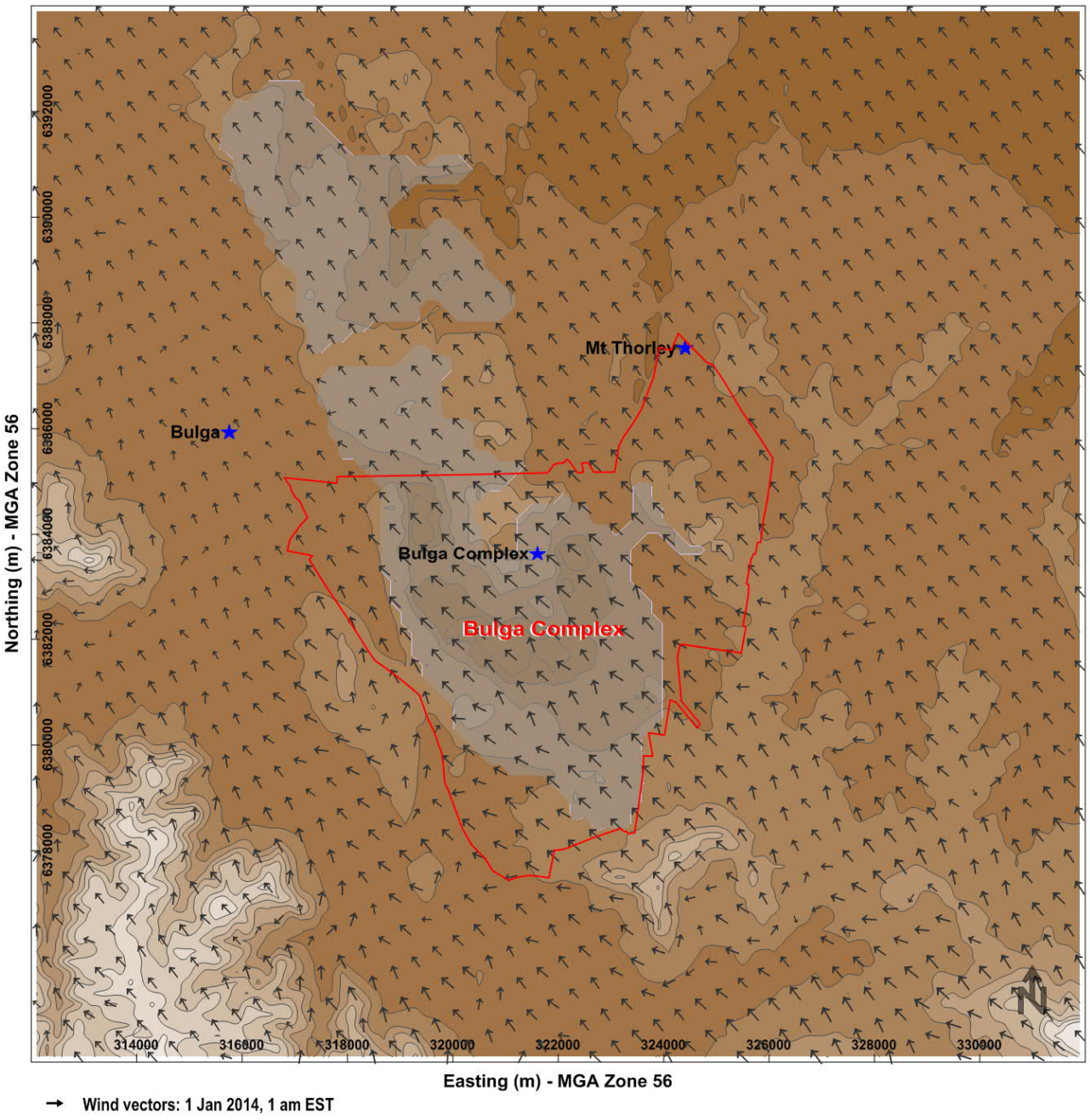

Figure 13 Example of CALMET simulated ground-level wind flows

7.3 Dispersion Modelling

Ground-level concentration and deposition levels due to the emission sources have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. It is the preferred model of the United States Environmental Protection Agency for the long-range transport of pollutants and for complex terrain (TRC 2007). CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. CALPUFF is an air dispersion model which has been approved by the EPA for these types of assessments (EPA 2016).

The modelling was performed using the emission estimates from **Section 6** and using the meteorological information provided by the CALMET model, described in **Section 7.2**. Predictions were made at 994 discrete receptors (including sensitive receptors and monitoring locations) to allow for contouring of results. The locations of the model receptors are shown in **Appendix C**.

Mining operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. **Figure 14** and **Figure 15** show the location of the modelled sources for 2014 and future years respectively, where the emissions from the dust generating activities summarised in **Table 12** to **Table 14** were assigned to one or more of these source locations (refer to **Appendix B** for details of the allocations). **Figure 16** shows the location of the modelled sources for Mt Thorley Warkworth mine.

Dust emissions for all modelled mine-related sources have been considered to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions are relatively insensitive to wind speed (for example, dozers).
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3, a generic relationship published by the US EPA (1987). This relationship has been applied to sources such as loading and unloading of waste to/from trucks and results in increased emissions with increased wind speed.
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3, a generic relationship published by Skidmore (1998). This relationship has been applied to sources including wind erosion from stockpiles, overburden dumps or active pits, and results in increased emissions with increased wind speed.

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

Blasting activities and associated emissions were assumed to take place only during daylight hours (9 am to 5 pm for the purposes of the modelling) while all other activities have been modelled for 24 hours per day.

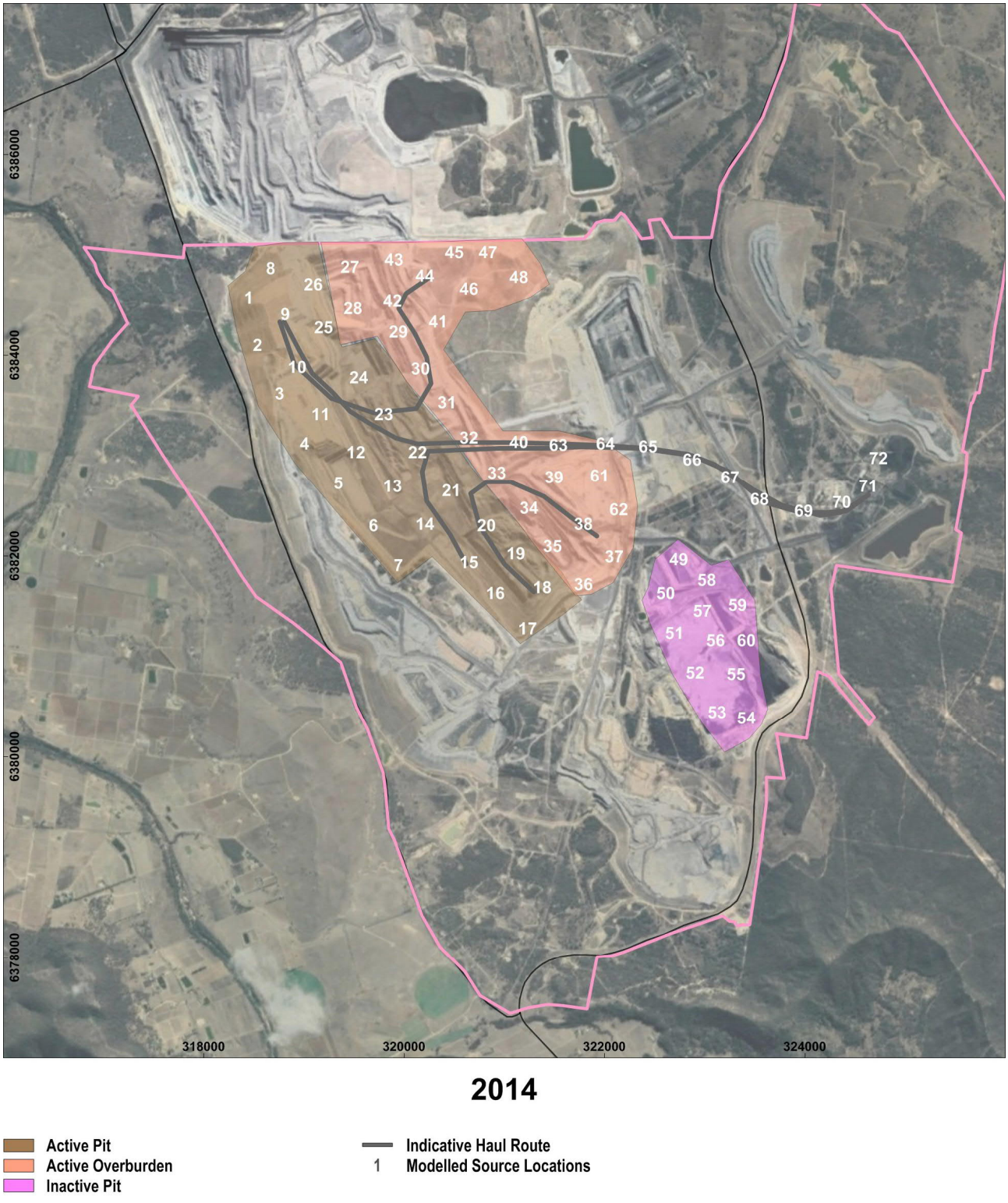

Figure 14 Location of modelled sources for the BCC in 2014



Figure 15 Location of modelled sources for the BCC (as modified) in future years

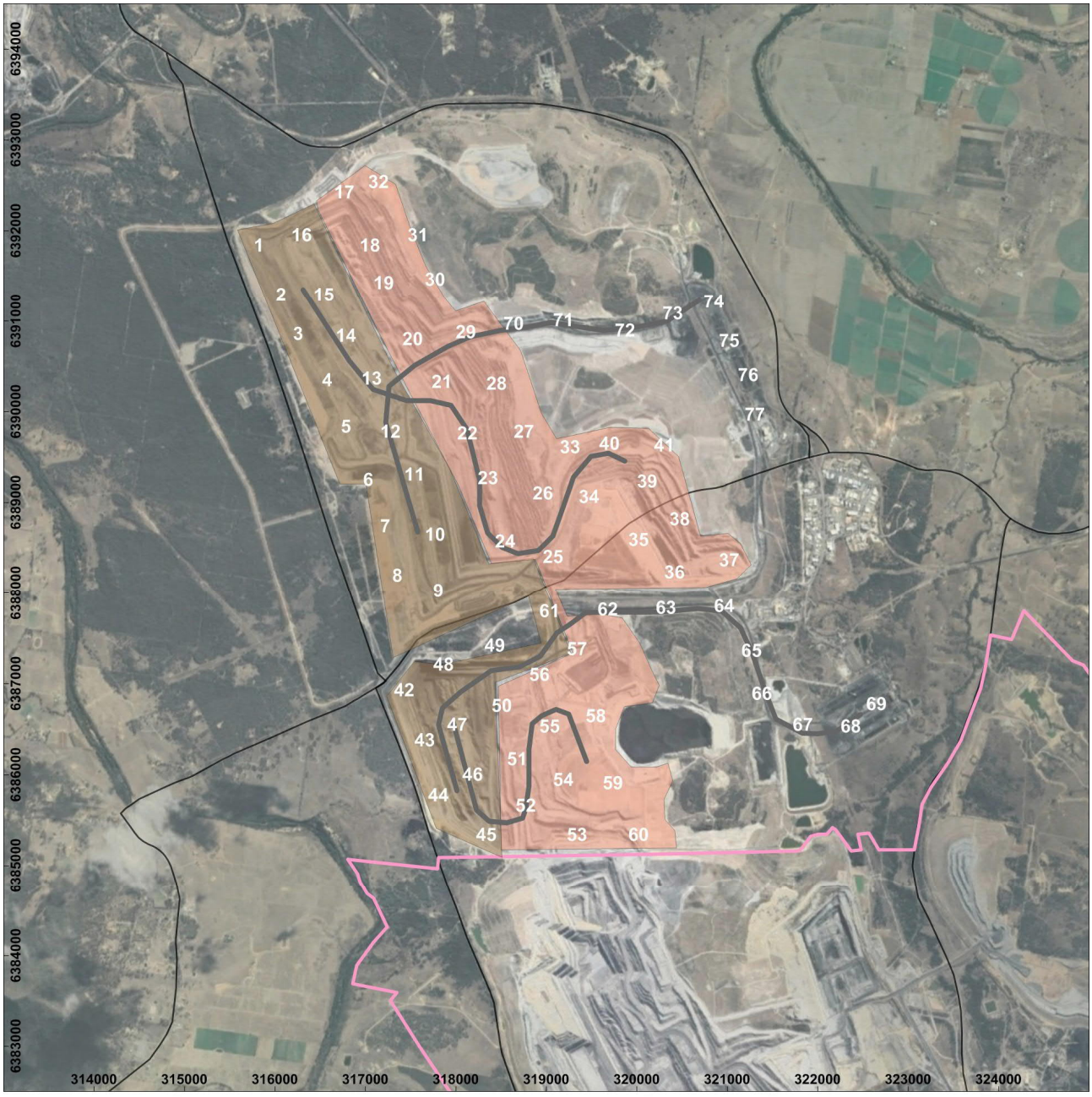

Figure 16 Location of modelled sources for the Mt Thorley Warkworth mine in 2014 and future years

Pit retention (that is, retention of dust particles within the open pits) has been included in the model simulations. The pit retention calculation determines the fraction of dust emitted in the pit that may escape the pit. The "escaped fraction" is a function of the gravitational settling velocity of the particles and the wind speed and is shown by the following relationship (US EPA, 1995).

Equation 1:

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{(\alpha U_r)}\right)}$$

where:

ε = escaped fraction for the particle size category
V_g = gravitational settling velocity (m/s)

U_r = approach wind speed at 10 m (m/s)

α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

To model the effect of pit retention, the emissions from mining sources within the open pits have been reduced, as per the calculation above. This approach means that much of the coarser dust would remain trapped in the pits. Typically, five per cent of the PM_{10} emissions are trapped in the pit using this calculation.

The effect of rainfall for suppressing dust from exposed areas has also been simulated. For each hour of rainfall above 0.254 mm (i.e. 0.1 inch) a 50% control on emissions has been applied to wind erosion from active pits and active dumps.

Key model settings and inputs for CALPUFF are provided in **Table 19**.

Table 19 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	100 x 100
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	See Appendix B. Height = 5m, SY = 20 m, SZ = 10 m
Number of discrete receptors	994. See Appendix C.

Finally, the model predictions at identified sensitive receptors were then compared with the EPA air quality criteria, previously discussed in **Section 4**. Contour plots have also been created to show the spatial distribution of model predictions. Where possible, the results for each substance and averaging time were presented as a series of figures showing:

- Model performance, based on measurements and predictions for a recent year (2014).
- Model predictions for future operational scenarios, as BCC only (as modified) contributions.
- Model predictions for future operational scenarios, due to the BCC (as modified) and other sources.

8. Assessment of Impacts

This section provides an assessment of the key air quality issues associated with the Proposed Modification, primarily based on model predictions and comparisons to air quality criteria. One objective of this study was to predict the extent of air quality impacts due to the Proposed Modification, and to identify potential changes in air quality over existing levels, recognising that the BCC currently exists and the Proposed Modification represents the progression of mining. For this objective, comparisons with predictions for 2014 are useful.

The complete list of tabulated results is provided in **Appendix D**. Contour plots have also been prepared and are discussed below. Additional information on the model performance is provided in **Appendix E**.

8.1 Particulate Matter (as PM_{10})

Figure 17 shows the predicted maximum 24-hour average PM_{10} concentrations for existing conditions (that is, 2014). These results have been compared to the measurement data to highlight the model performance. This comparison is useful for determining the confidence in the model predictions for future operations. It should be noted that only one data point is shown for each location (that is, the highest value) and more detailed comparisons between measured and predicted results for all percentiles is provided in **Appendix E**.

Figure 17 shows that the model predictions are between 15 per cent lower to 20 per cent higher than the measured result, depending on the location. These results have been interpreted to represent very good model performance, with slight over-prediction at all locations except for at the Mt Thorley Industrial Estate monitor.

Figure 18 and **Figure 19** show the predicted maximum 24-hour average PM_{10} concentrations for the BCC (as modified) only and cumulative scenarios respectively. **Figure 18** shows that the contribution of the BCC (as modified) will not exceed 50 µg/m^3 at any private properties. The 24-hour average concentration 50 µg/m^3 PM_{10} is applied as an incremental criterion in the VLAMP, for the purposes of determining land acquisition.

Figure 19 shows that the maximum 24-hour average PM_{10} concentrations may exceed 50 µg/m^3 at various private properties, due to contributions from the BCC (as modified), Mt Thorley Warkworth mine and background (other) sources of particulate matter. The potential contributions of each source to cumulative concentrations at three locations (195, 217s and 311) have been examined. **Figure 20**, **Figure 21** and **Figure 22** show the predicted 24-hour average PM_{10} concentrations at properties 195, 217s and 311, including the background, Mt Thorley Warkworth mine and BCC (as modified) contributions. There are days predicted when the background levels plus the contribution from Mt Thorley Warkworth mine would be below 50 µg/m^3 and the contribution of the BCC (as modified) may contribute to an exceedance of 50 µg/m^3. Specifically:

- Up to two days in the vicinity of property 195, with a maximum contribution from the BCC of 24 µg/m^3.
- Up to one day in the vicinity of property 217s, with a maximum contribution from the BCC of 6 µg/m^3.
- Up to two days in the vicinity of property 311, with a maximum contribution from the BCC of 9 µg/m^3.

There are two additional factors to consider where assessing these results. Firstly, the comparisons between model predictions and measured results for the existing (2014) operations highlighted a potential for over-prediction of the very highest concentrations in the locations of interest. Secondly, the monitoring data has shown that, in the past five years, there have been between 0 and 7 days above 50 µg/m^3 at locations to the west of the BCC. With this information it can be anticipated that 24-hour average PM_{10} concentrations will continue to be variable from day-to-day, due to existing conditions and sources, and that operations will need to be managed in a way which minimises the contribution to off-site PM_{10} levels, as is done under the existing approved operation.

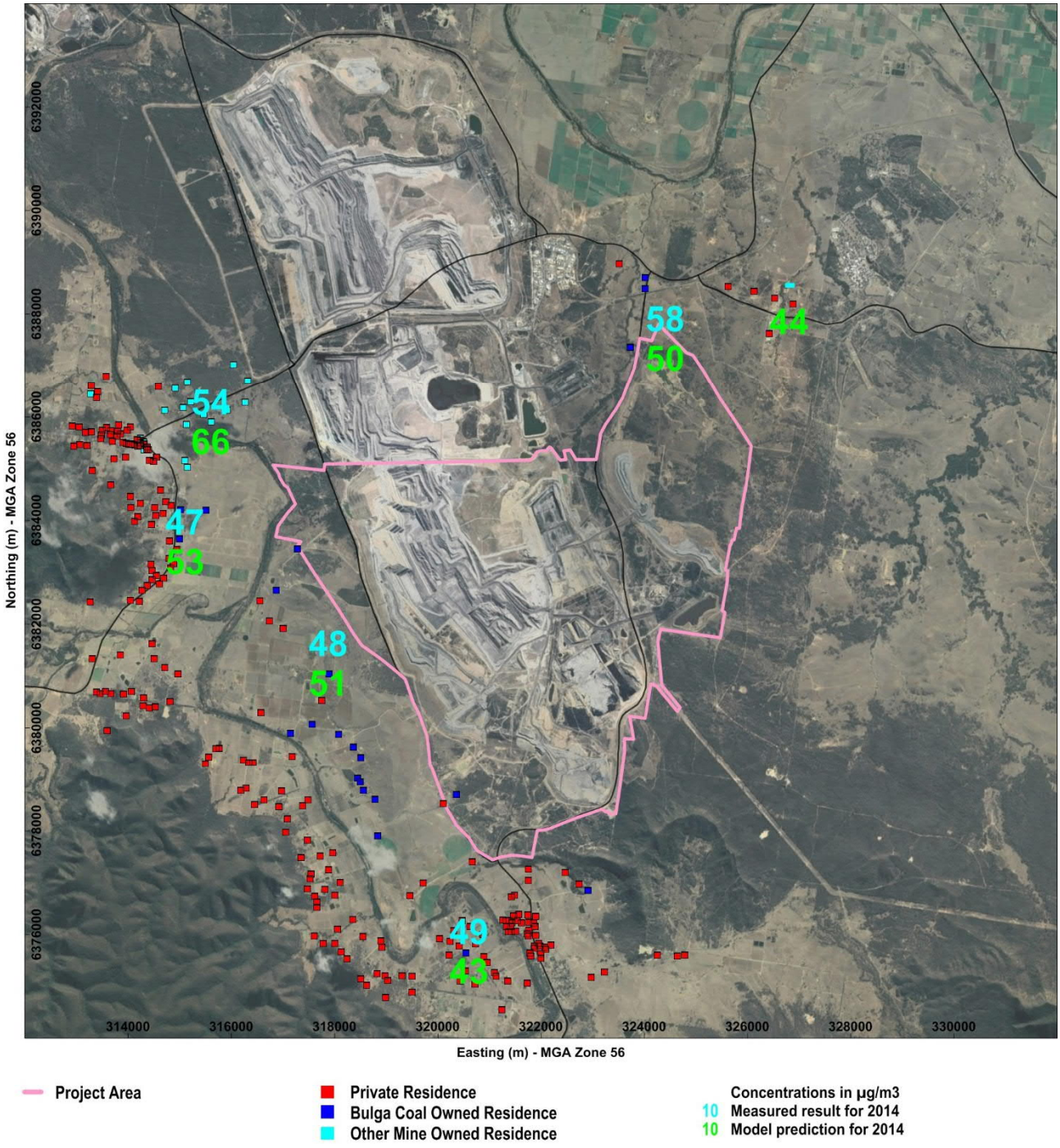

Figure 17 Predicted maximum 24-hour average PM_{10} concentrations due to all sources (cumulative) in 2014

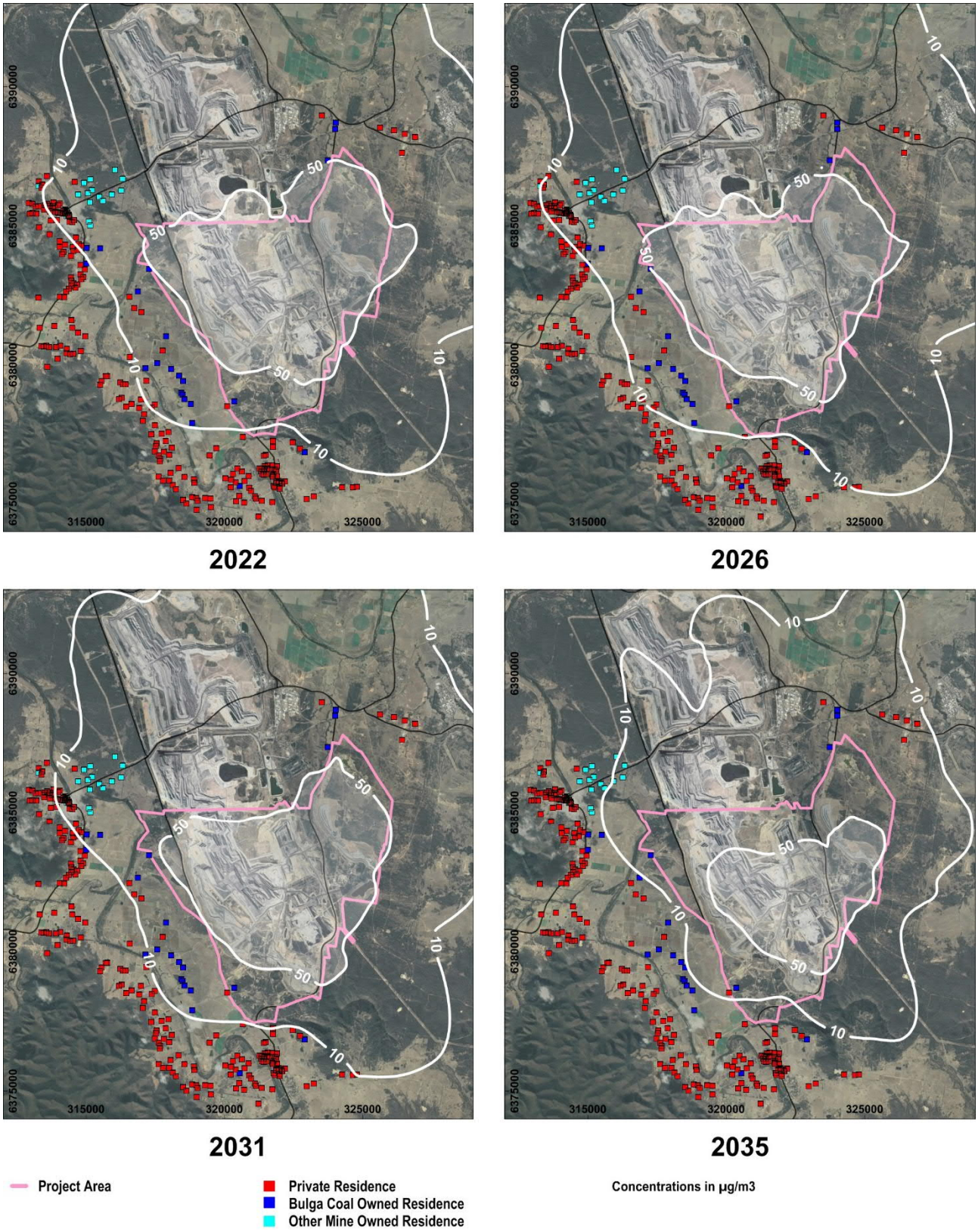

Figure 18 Predicted maximum 24-hour average PM_{10} concentrations due to the BCC (as modified)

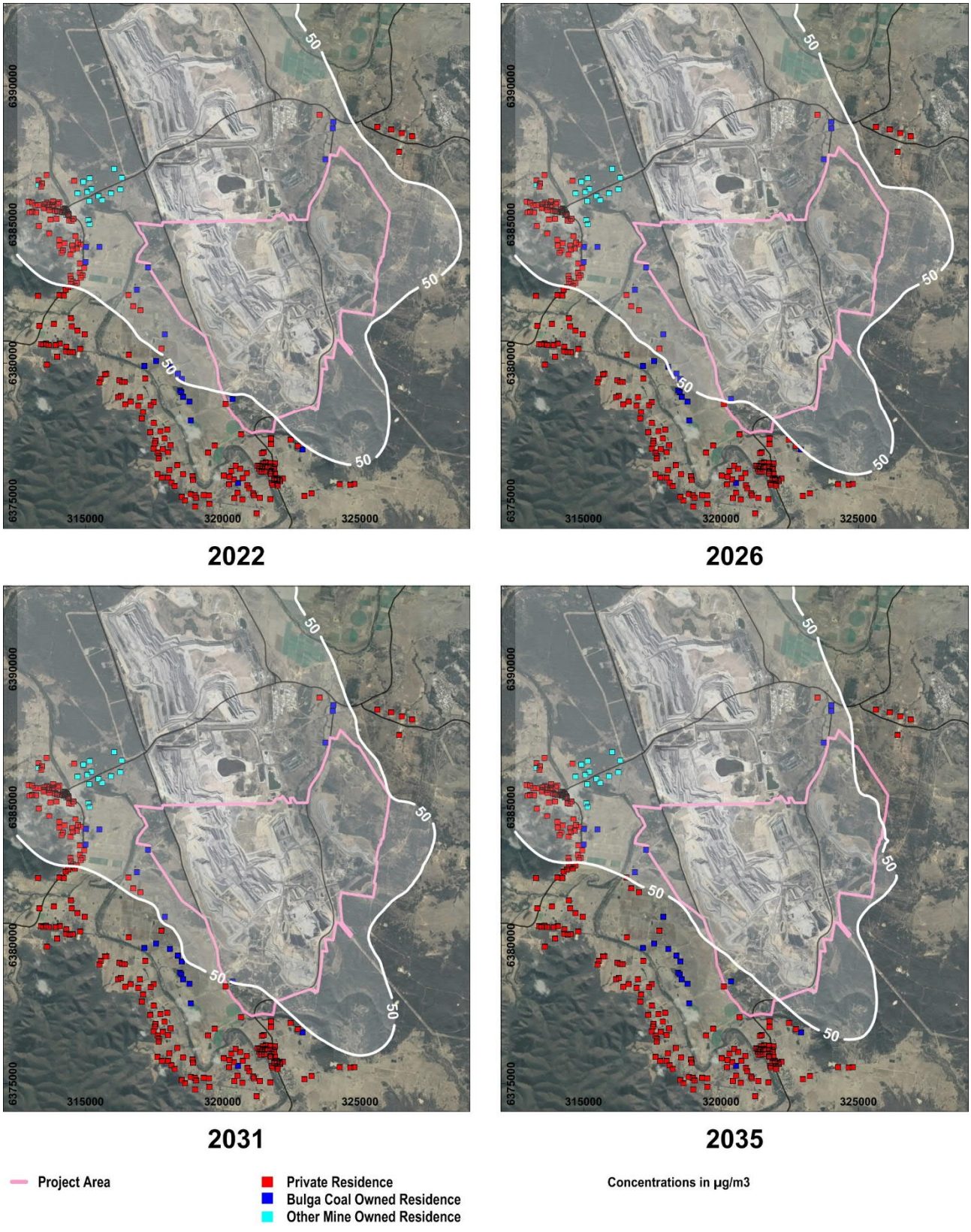

Figure 19 Predicted maximum 24-hour average PM_{10} concentrations due all sources (cumulative)

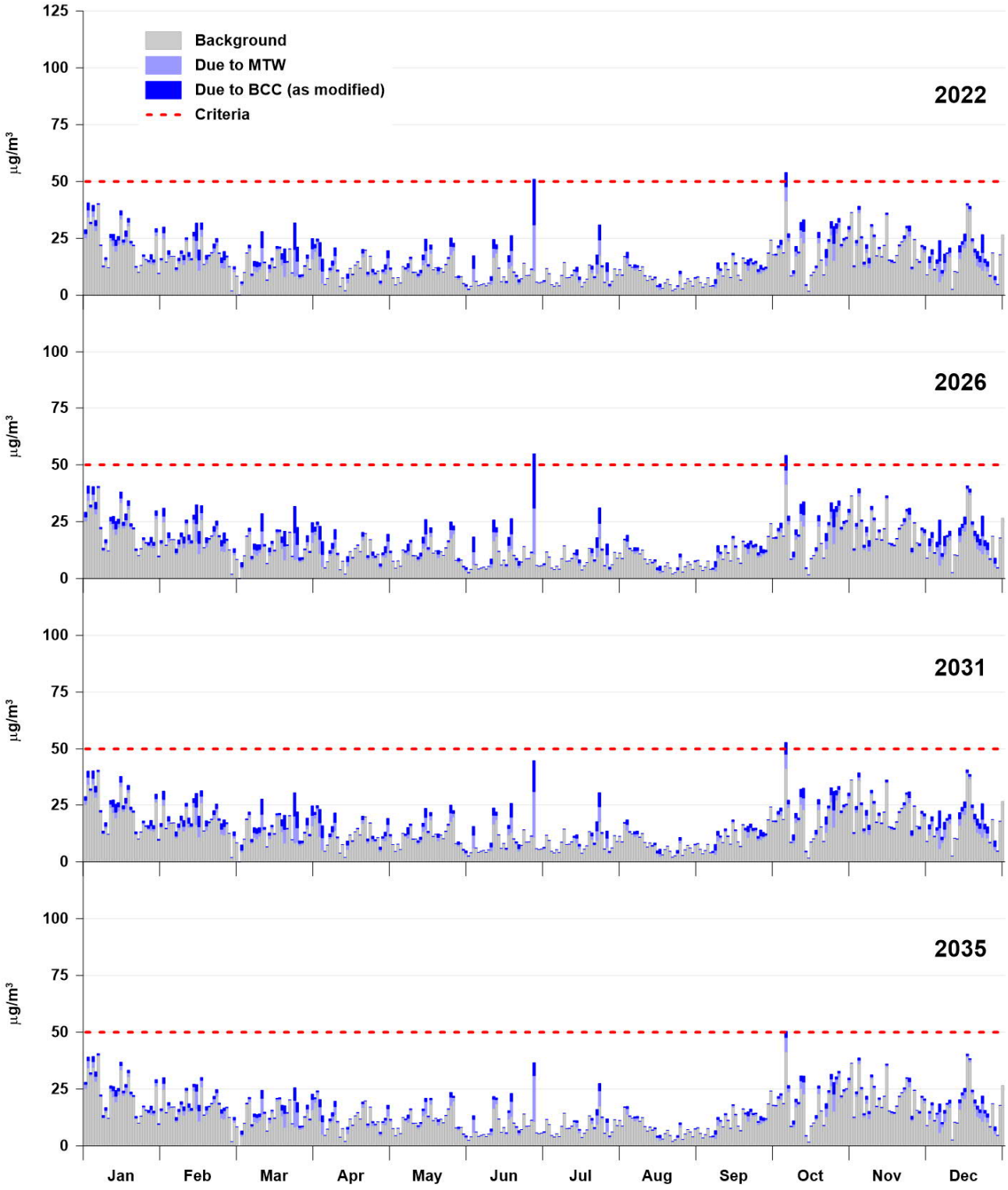

Figure 20 Predicted 24-hour average PM_{10} concentrations at property 195

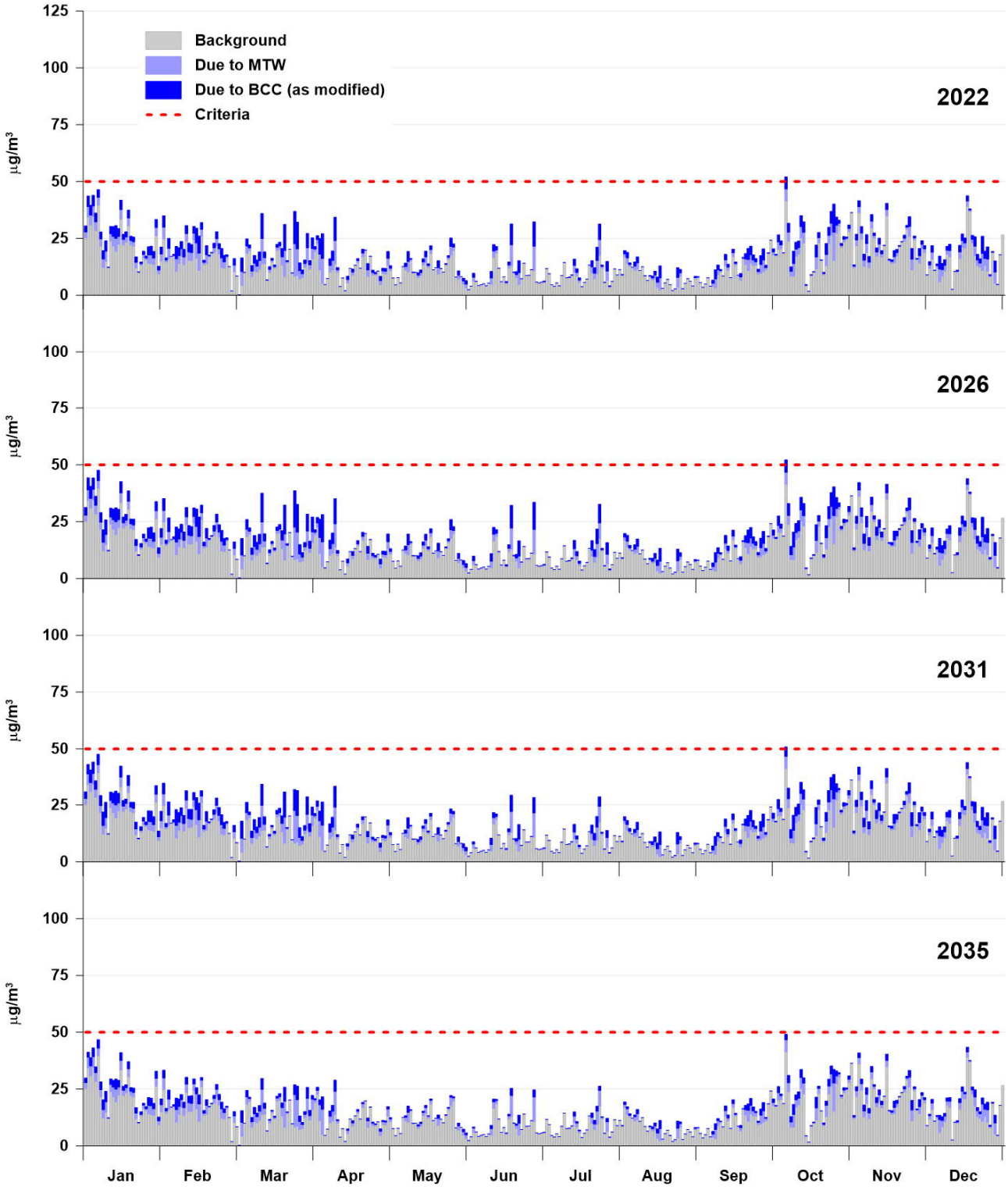

Figure 21 Predicted 24-hour average PM_{10} concentrations at property 217s

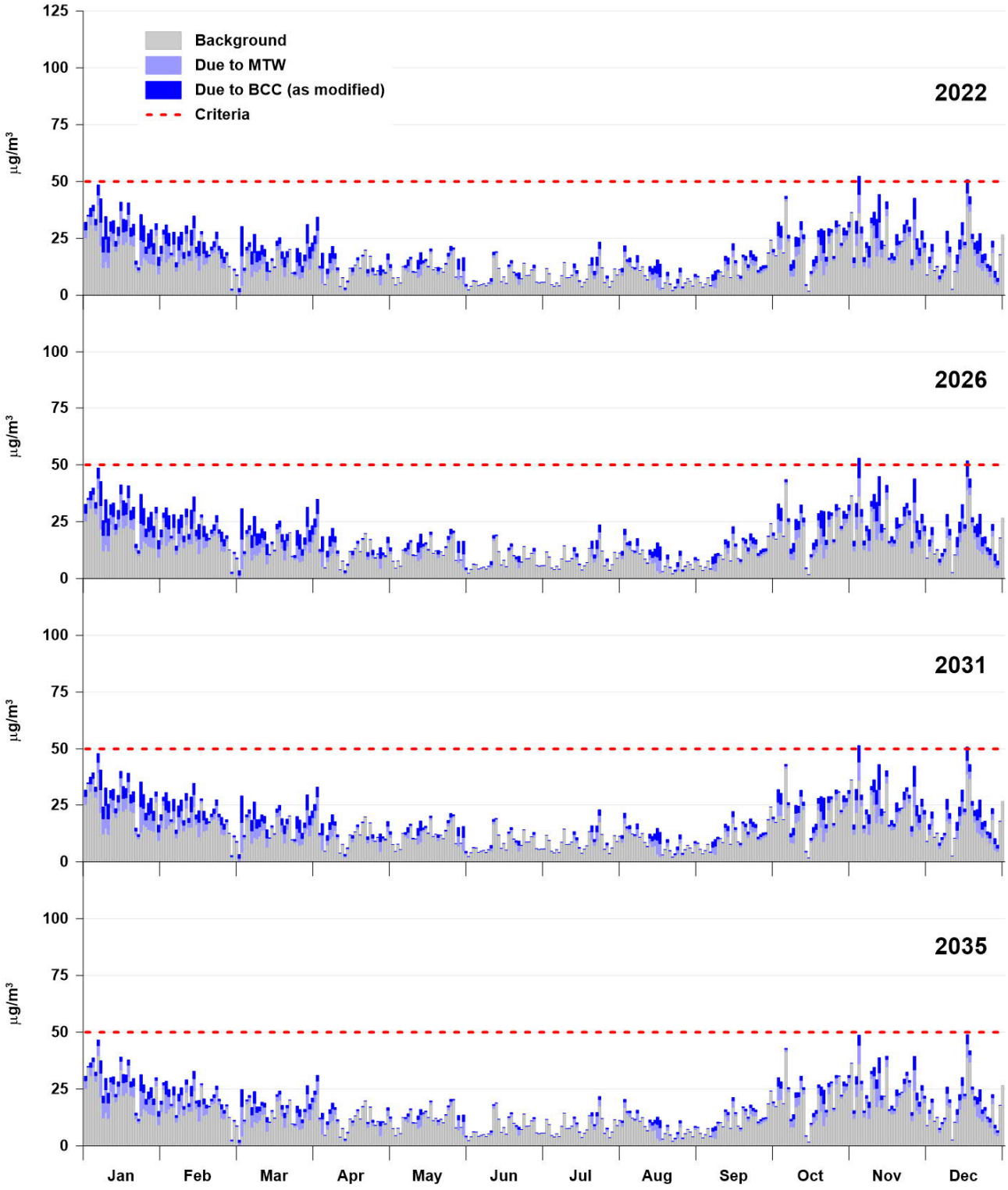

Figure 22 Predicted 24-hour average PM_{10} concentrations at property 311

Figure 23 shows the measured and predicted annual average PM_{10} concentrations for 2014. These results show that the model predictions range from 18 per cent lower to 33 per cent higher than measured results. In absolute numbers, the range is from 3 µg/m^3 lower to 6 µg/m^3 higher. These differences have been regarded as demonstrating good model performance, as the differences consume only a small fraction of the criterion against which they are assessed, namely 25 µg/m^3. Similar performance may therefore be expected for the predictions of future conditions.

Figure 24 shows the predicted annual average PM_{10} concentrations due to the BCC (as modified) and **Figure 25** shows the predicted cumulative concentrations. The EPA air quality assessment criterion for annual average PM_{10} is 25 µg/m^3, now applicable to the assessment of the Proposed Modification. From **Figure 25** it can be seen that there is one property (1A to the north of BCC) where annual average PM_{10} concentrations are predicted to exceed the 25 µg/m^3 criterion, with a prediction of 27 µg/m^3 in both 2022 and 2026. The contribution of the BCC to annual average PM_{10} concentrations at property 1A is predicted to be up to, and in the order of, 7 µg/m^3 (in 2022). Compliance is predicted at all other private sensitive receptors.

Figure 26 shows the predicted relative contributions of background and mining operations to annual average PM_{10} concentrations at property 1A. As can be seen from **Figure 26** the cumulative PM_{10} levels are predicted to exceed the 25 µg/m^3 EPA criterion in 2022, 2026 and 2031 with approximately equal contributions from the BCC (as modified) and from Mt Thorley Warkworth. The results indicate that property 1A would be entitled to voluntary mitigation and acquisition rights under the VLAMP.

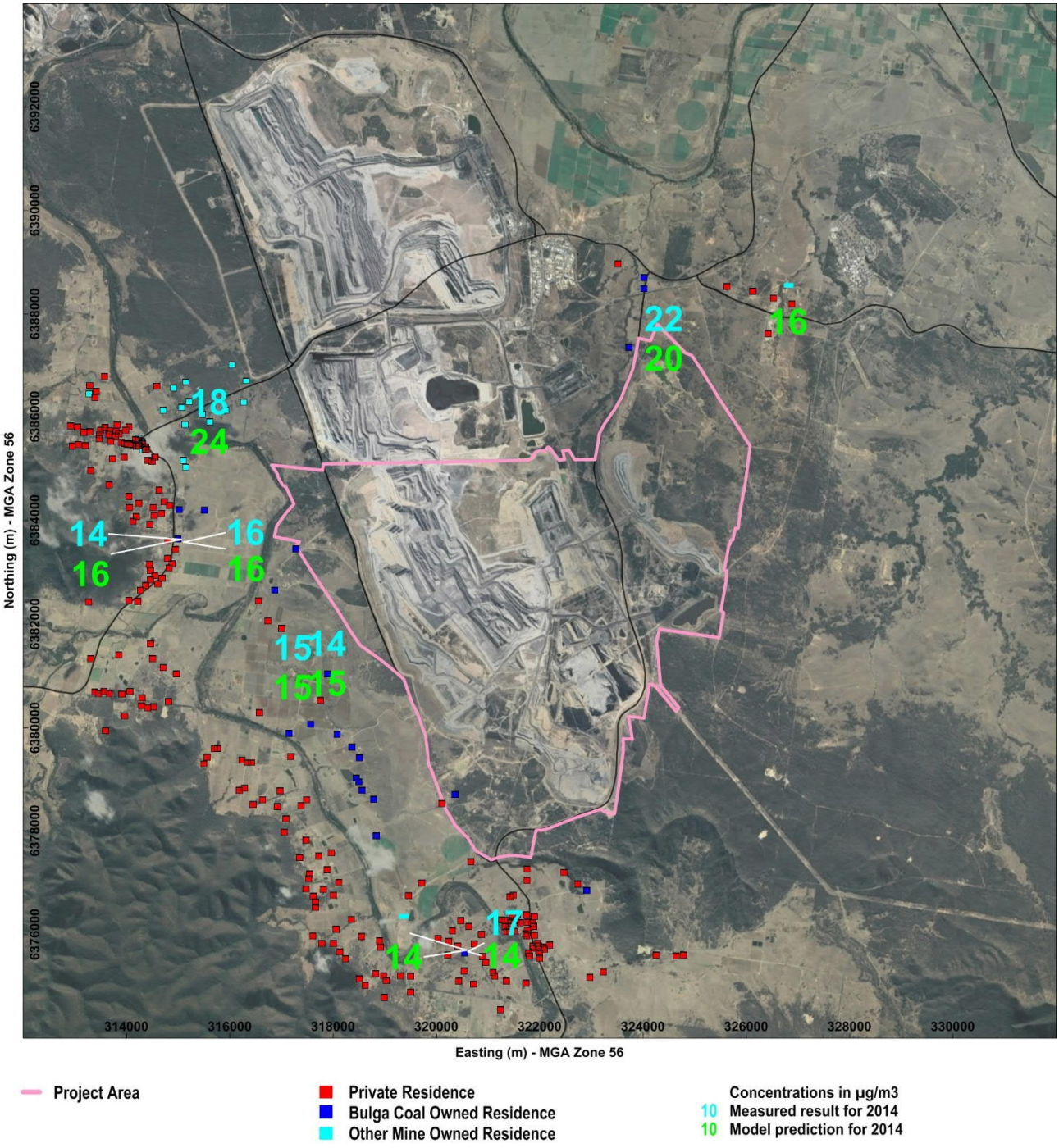

Figure 23 Predicted annual average PM_{10} concentrations due to all sources (cumulative) in 2014

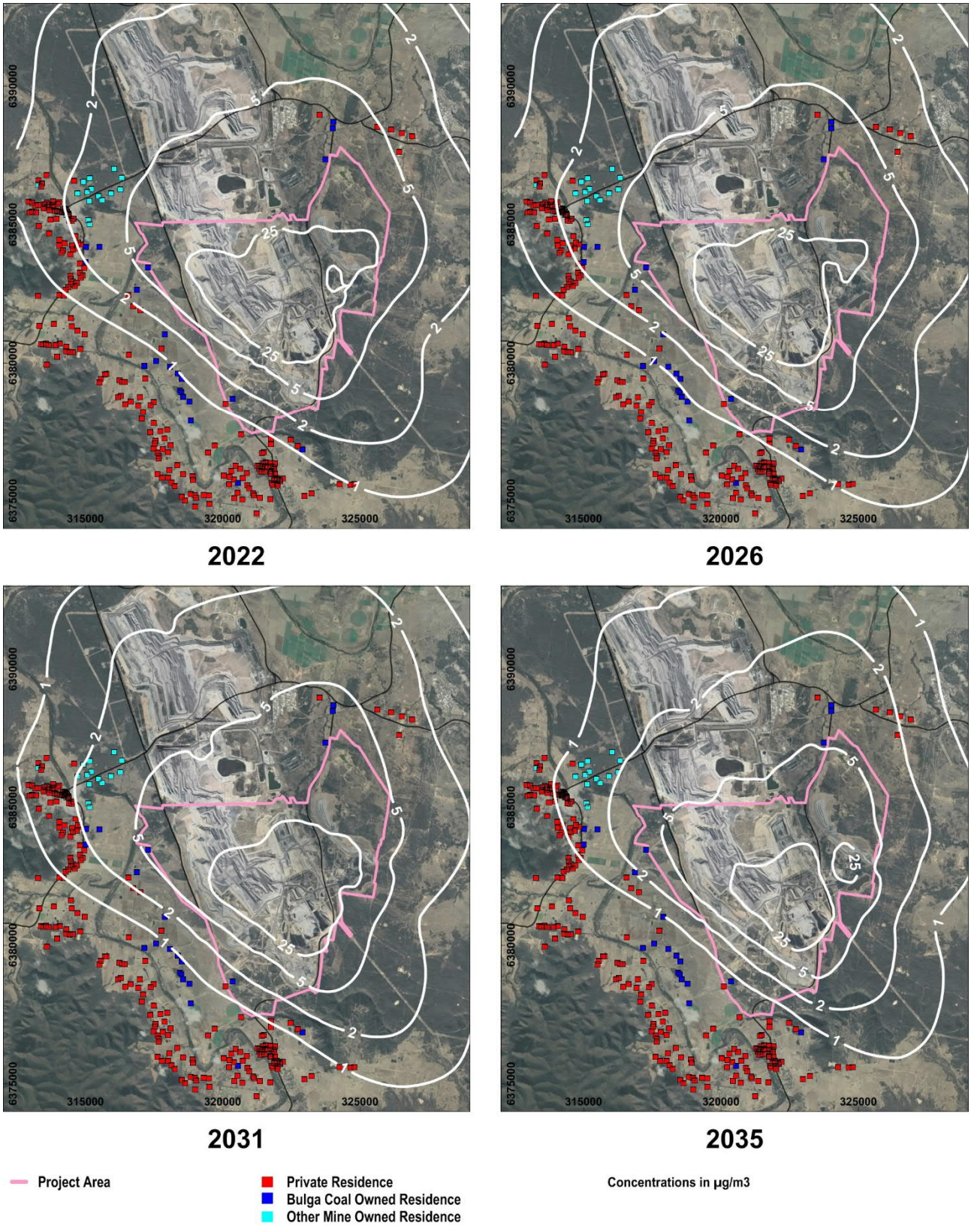

Figure 24 Predicted annual average PM_{10} concentrations due to the BCC (as modified)

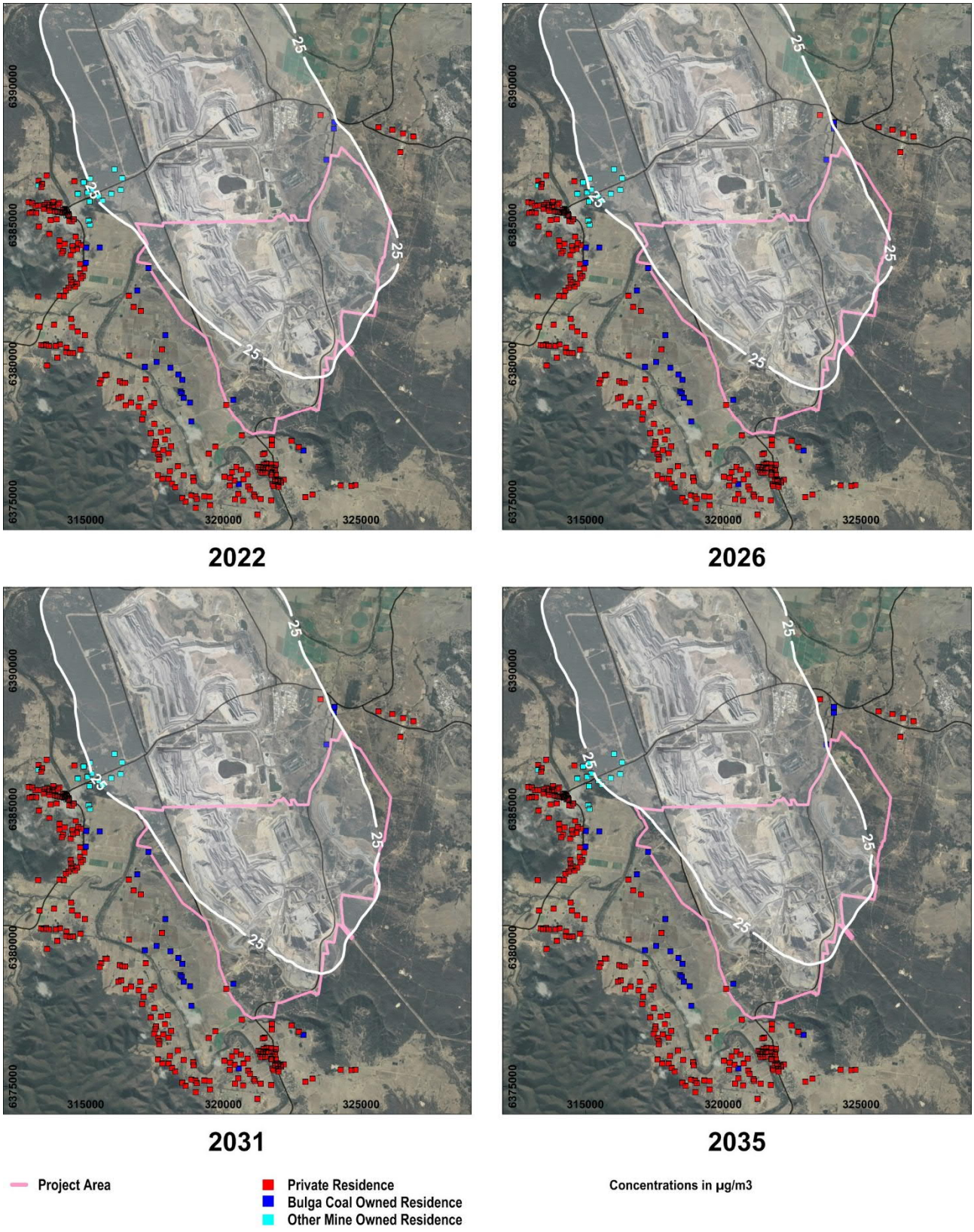

Figure 25 Predicted annual average PM_{10} concentrations due to all sources (cumulative)

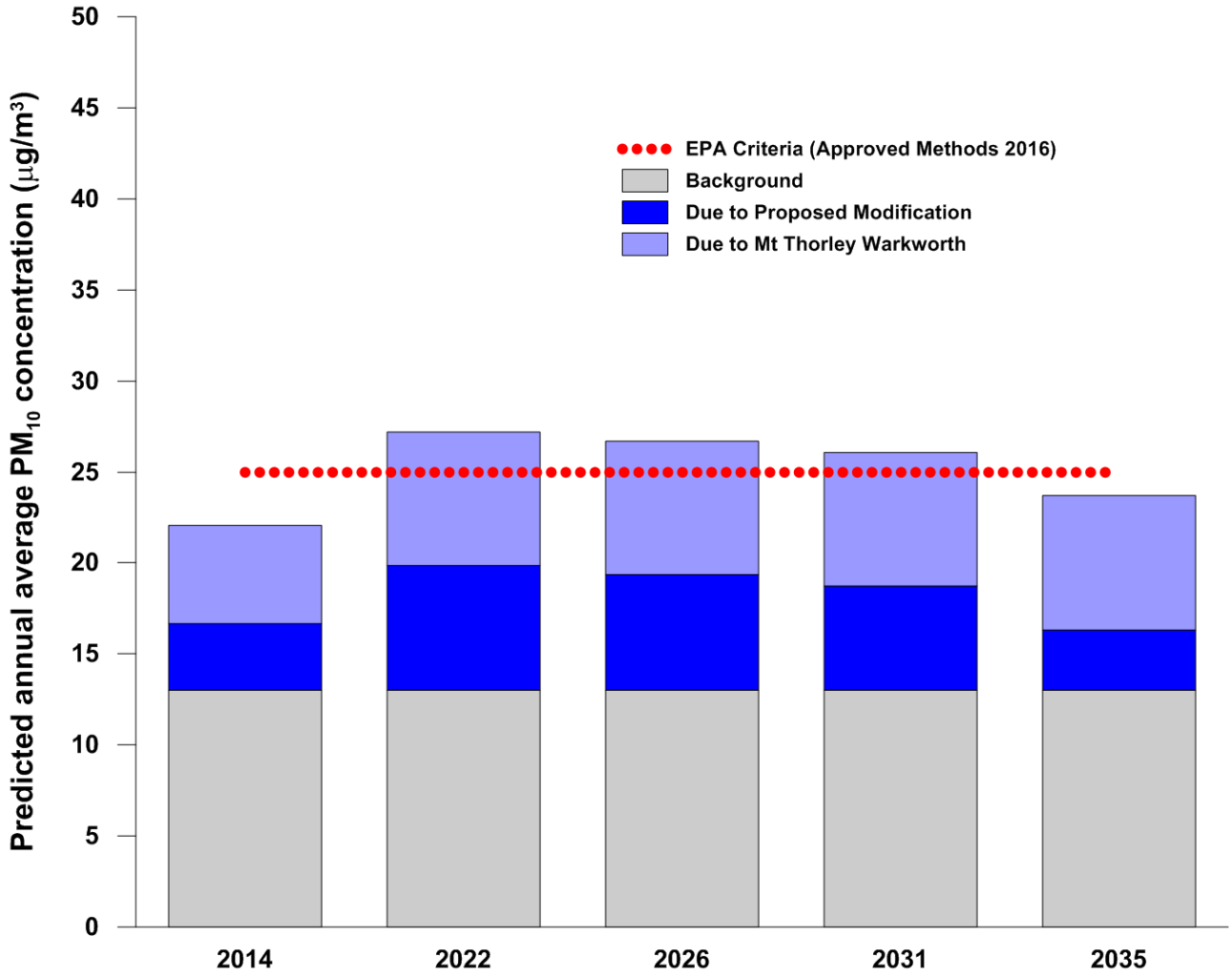

Figure 26 Predicted annual average PM_{10} concentrations at property 1A

8.2 Particulate Matter (as $PM_{2.5}$)

The results for $PM_{2.5}$ are shown in **Figure 27** to **Figure 30**, including the BCC (as modified) only and cumulative scenarios, for maximum 24-hour and annual averages. **Appendix D** provides all $PM_{2.5}$ model results for each receptor in tabular form.

The contribution of the BCC (as modified) to maximum 24-hour average $PM_{2.5}$ concentrations is predicted to be in the order of up to 5 µg/m^3 at the nearest private sensitive receptors (see **Figure 27**).

Figure 28 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to all modelled sources and with the derived background dataset that includes maximum concentrations up to 18 µg/m^3. These results indicate that maximum 24-hour average $PM_{2.5}$ concentrations at all private sensitive locations will not exceed the 25 µg/m^3 criterion at any stage of the BCC (as modified). The monitoring data review (**Section 5.2**) did however reveal that there have been typically one or two days each year when the measured 24-hour average $PM_{2.5}$ concentrations exceeded 25 µg/m^3. These extraneous events are unlikely to be predicted by dispersion modelling but it is useful to note that the BCC (as modified) is unlikely to be the main cause of an exceedance given that its maximum predicted contribution to levels at the nearest private sensitive receptors is less than 20 percent of the criterion. That is, in the order of up to 5 µg/m^3.

The model results from **Figure 29** and **Figure 30** show that there are no private sensitive locations which are predicted to experience exceedances of the annual average $PM_{2.5}$ criterion (8 µg/m^3) at any stage of the BCC (as modified). On the basis of this modelling there are no additional impacts to private land and sensitive receivers associated with the BCC (as modified), relative to the existing approved operations.

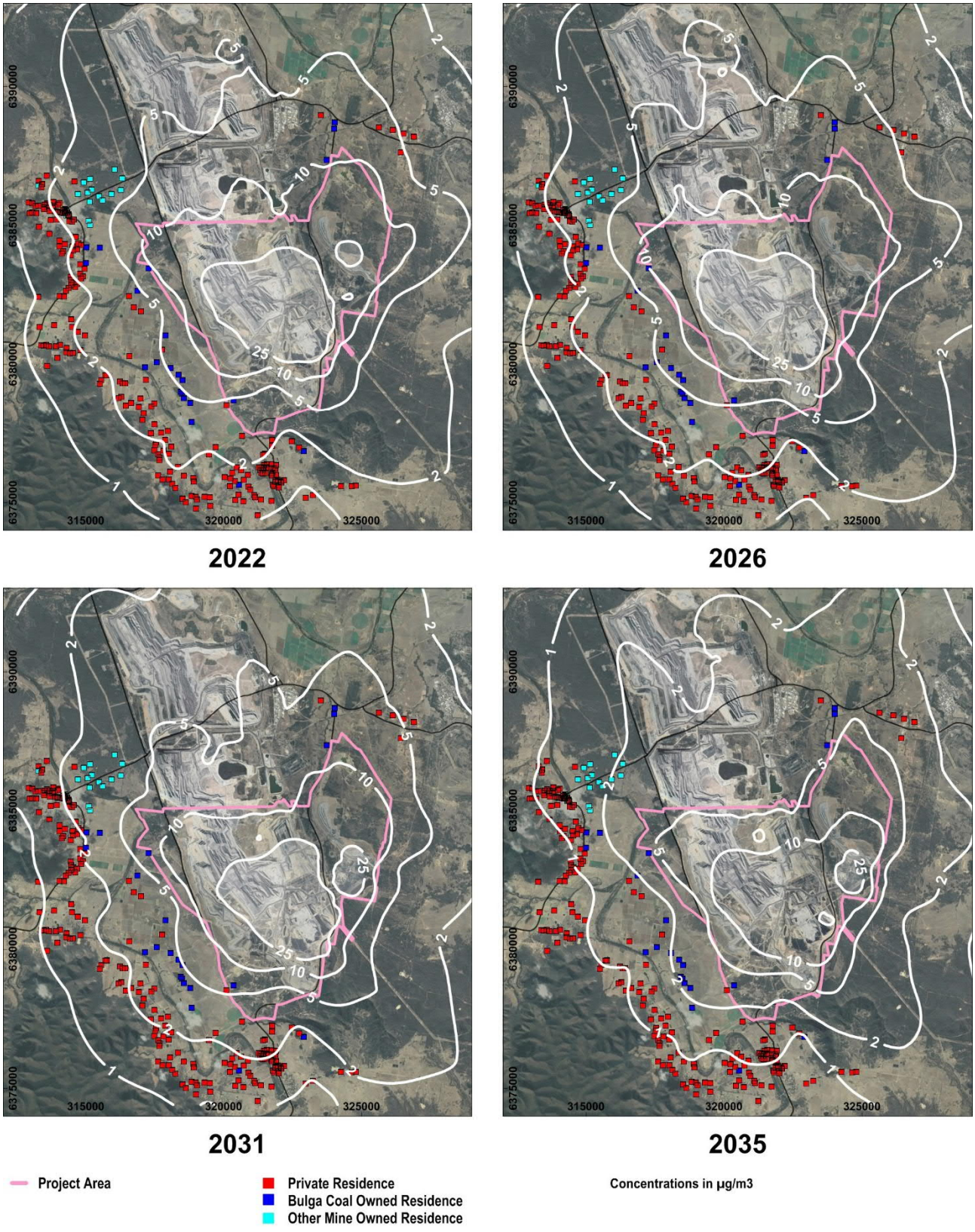

Figure 27 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to the BCC (as modified)

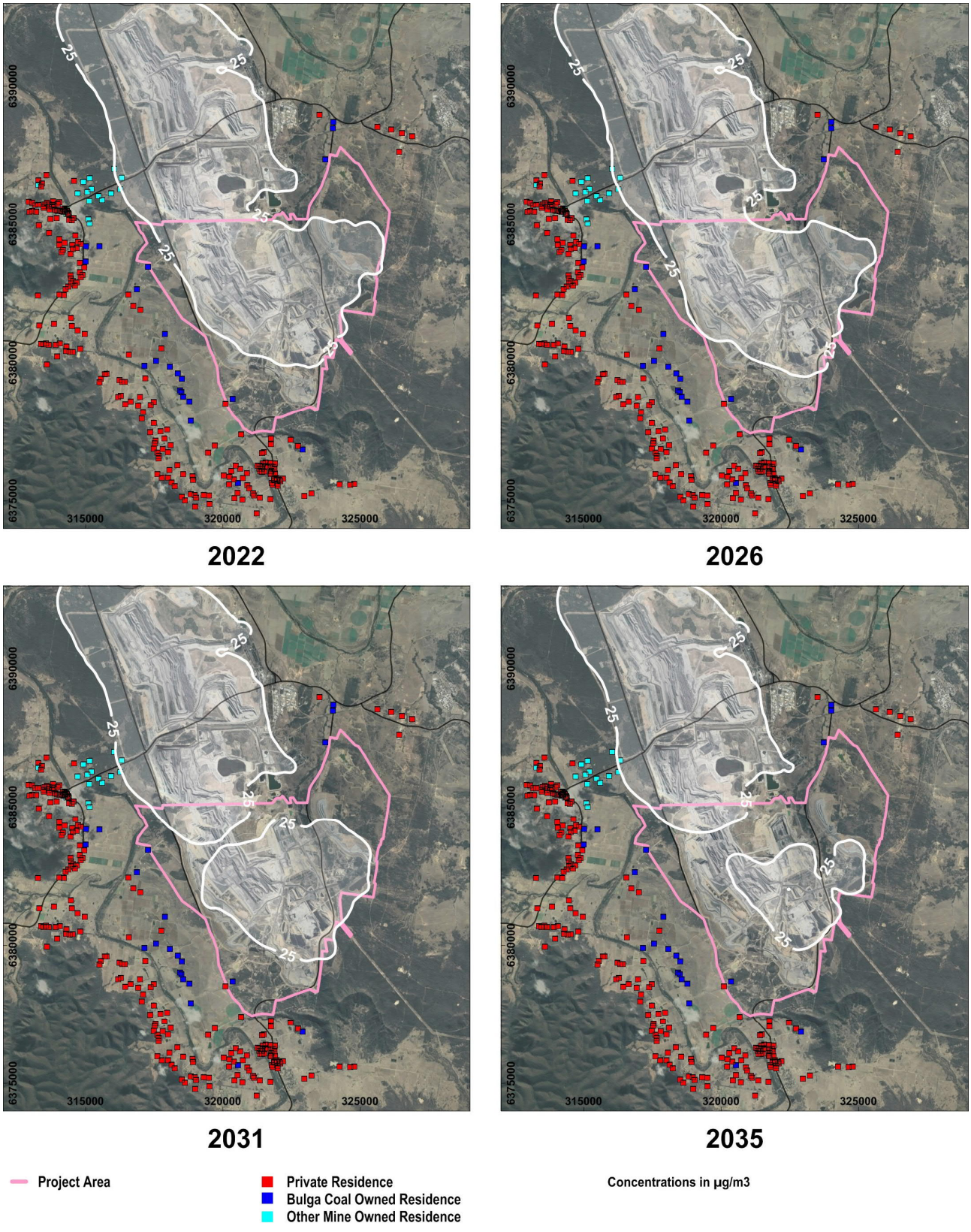

Figure 28 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to all sources (cumulative)

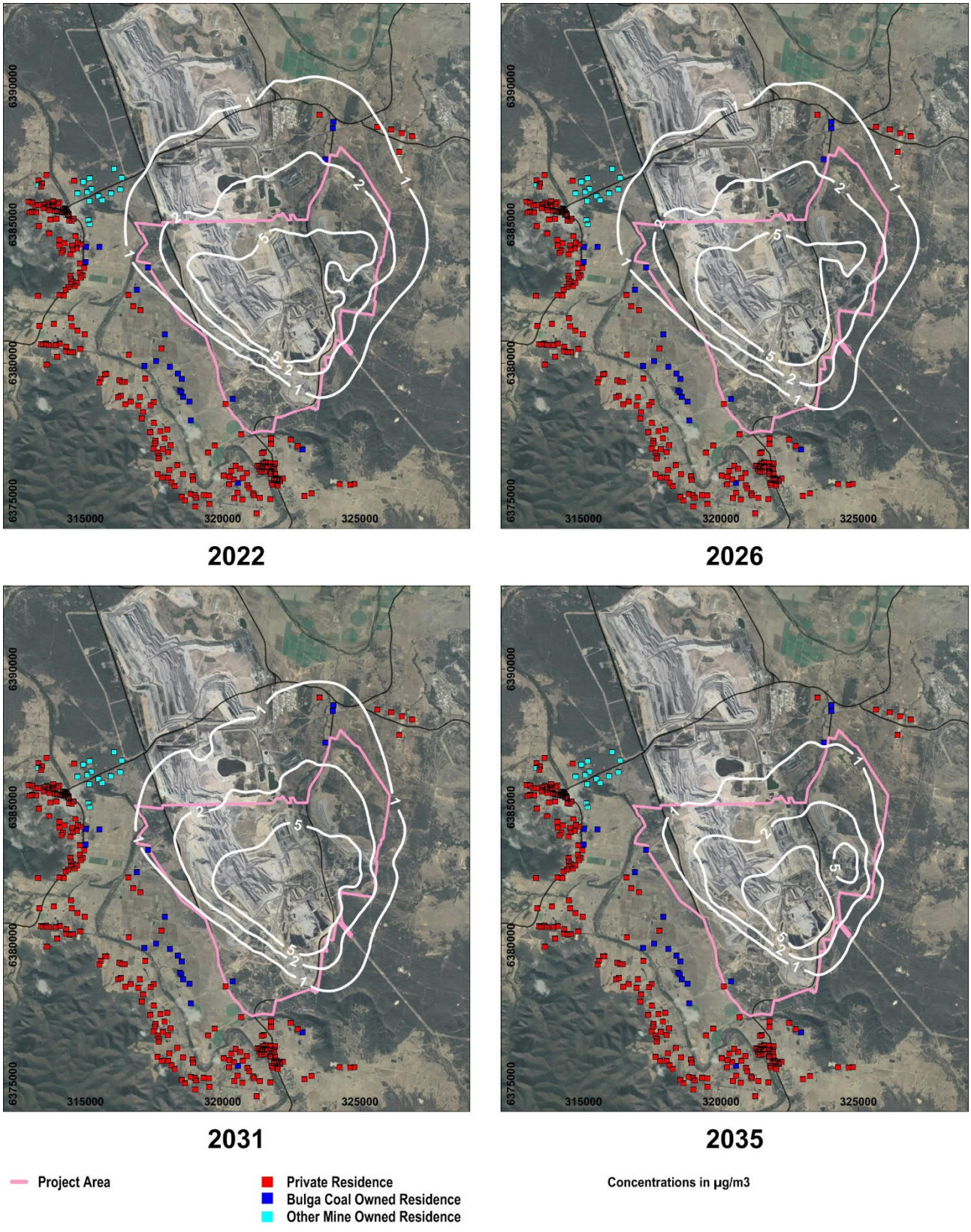

Figure 29 Predicted annual average $PM_{2.5}$ concentrations due to the BCC (as modified)

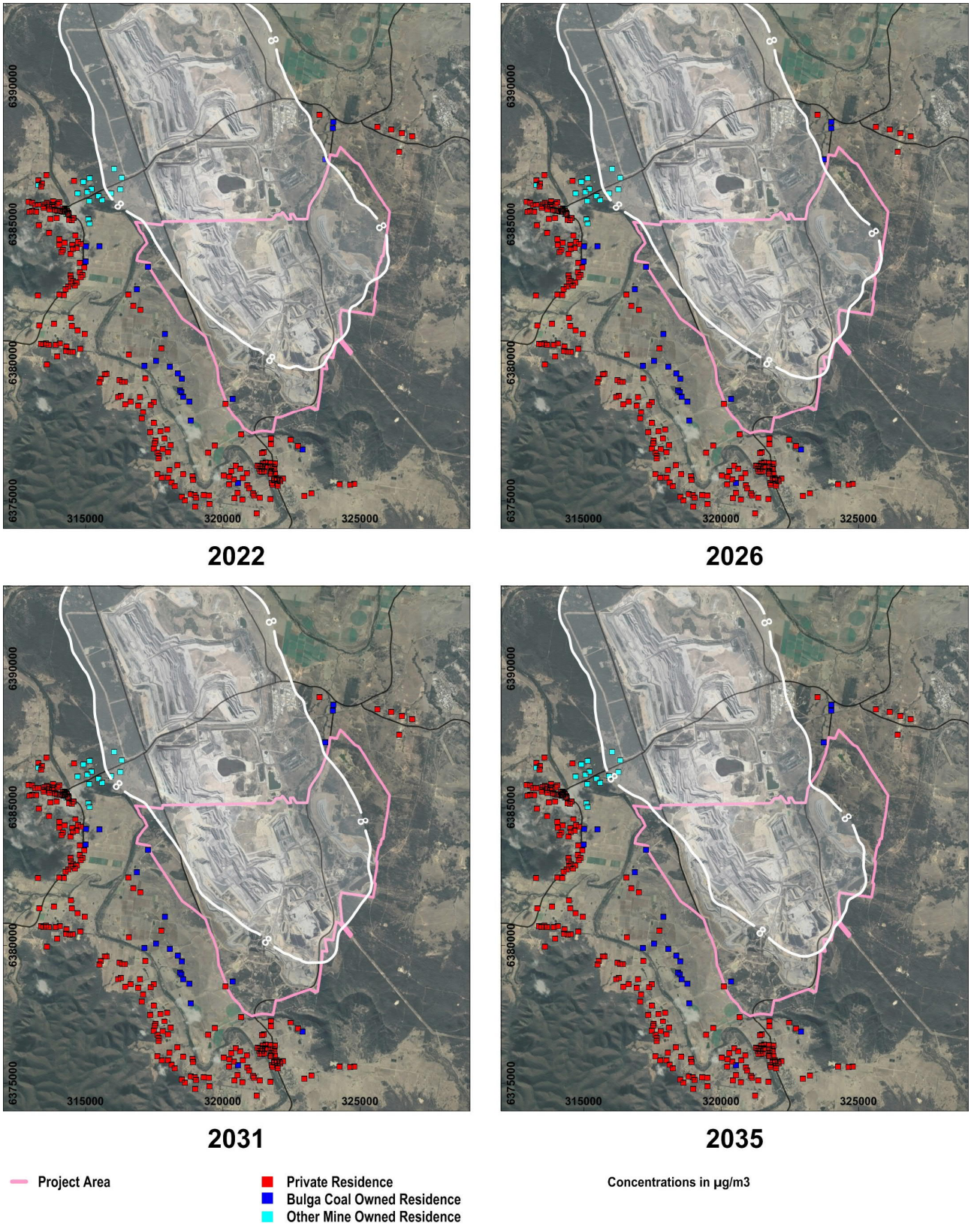

Figure 30 Predicted annual average $PM_{2.5}$ concentrations due to all sources (cumulative)

8.3 Particulate Matter (as TSP)

Figure 31 shows the annual average TSP concentrations for existing conditions (2014). This figure shows that the model predictions for this statistic are between 5 and 17 per cent higher than the measured results, depending on the location. Some over-prediction may therefore be inferred when assessing the results for the Project. **Figure 32** and **Figure 33** show the predicted annual average TSP concentrations in future years for the Project only and cumulative scenarios respectively. There are no private sensitive locations which are predicted to experience exceedances of the annual average TSP criterion (90 µg/m^3) at any stage of the BCC (as modified).

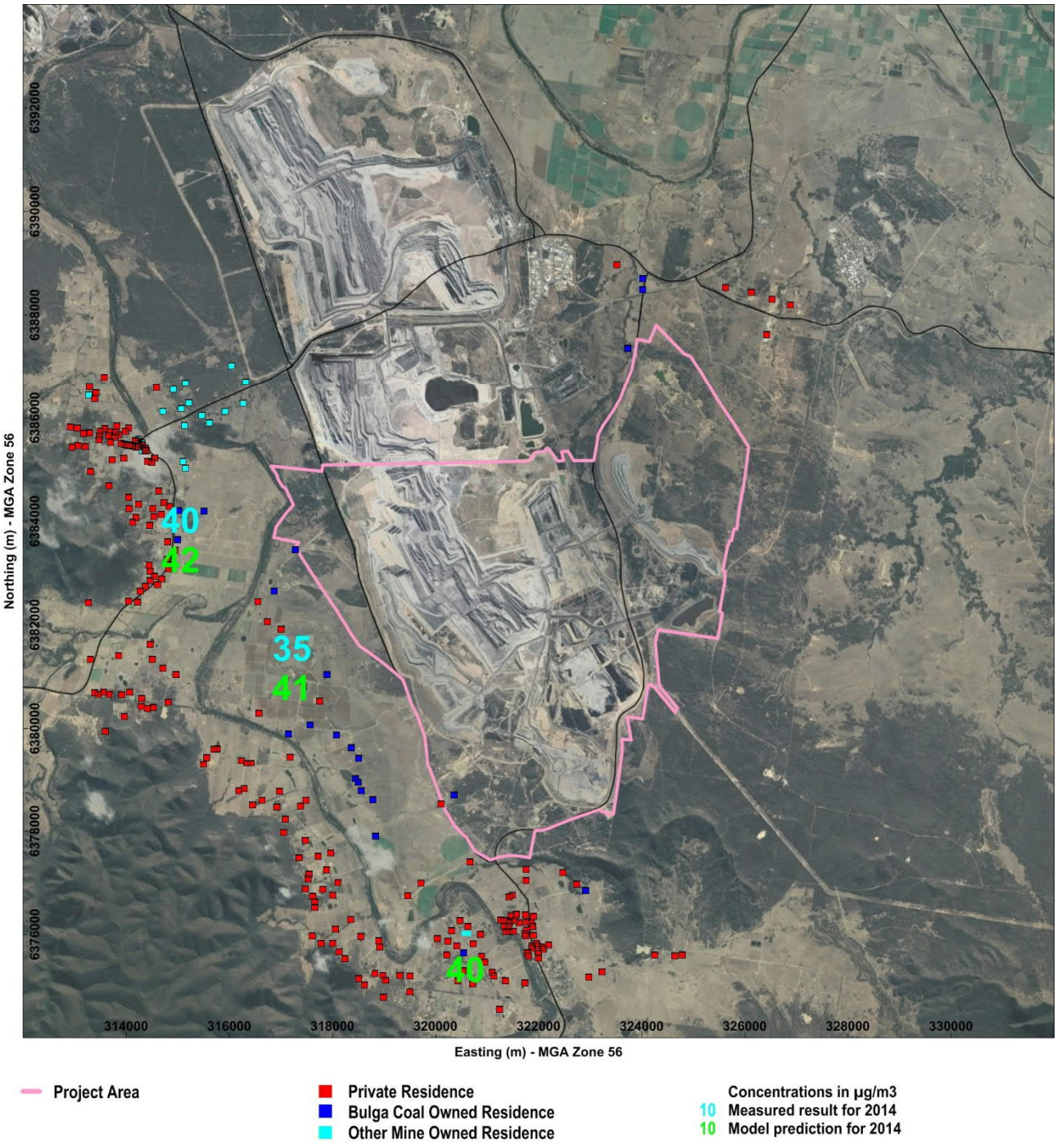

Figure 31 Predicted annual average TSP concentrations due to all sources (cumulative) in 2014

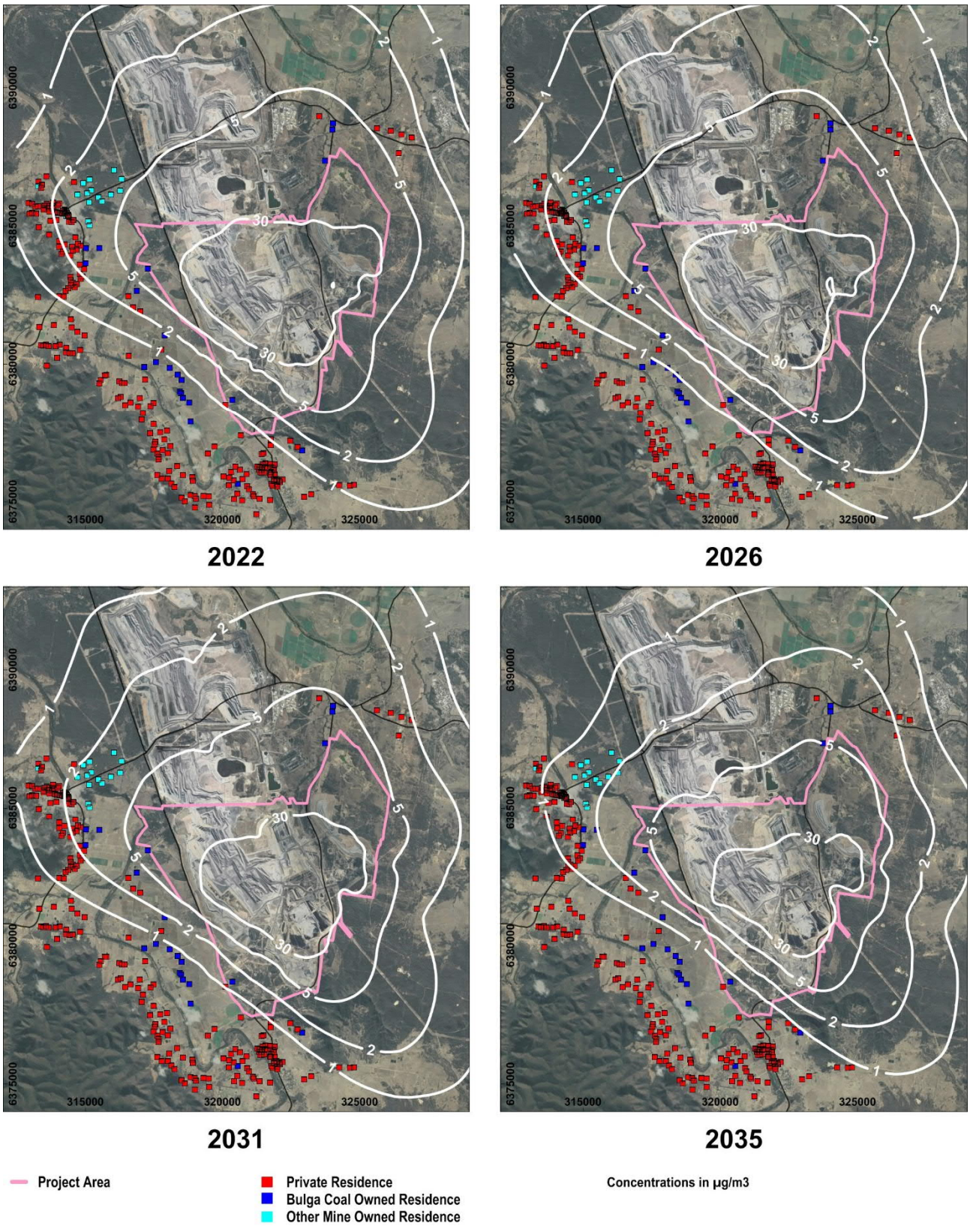

Figure 32 Predicted annual average TSP concentrations due to the BCC (as modified)

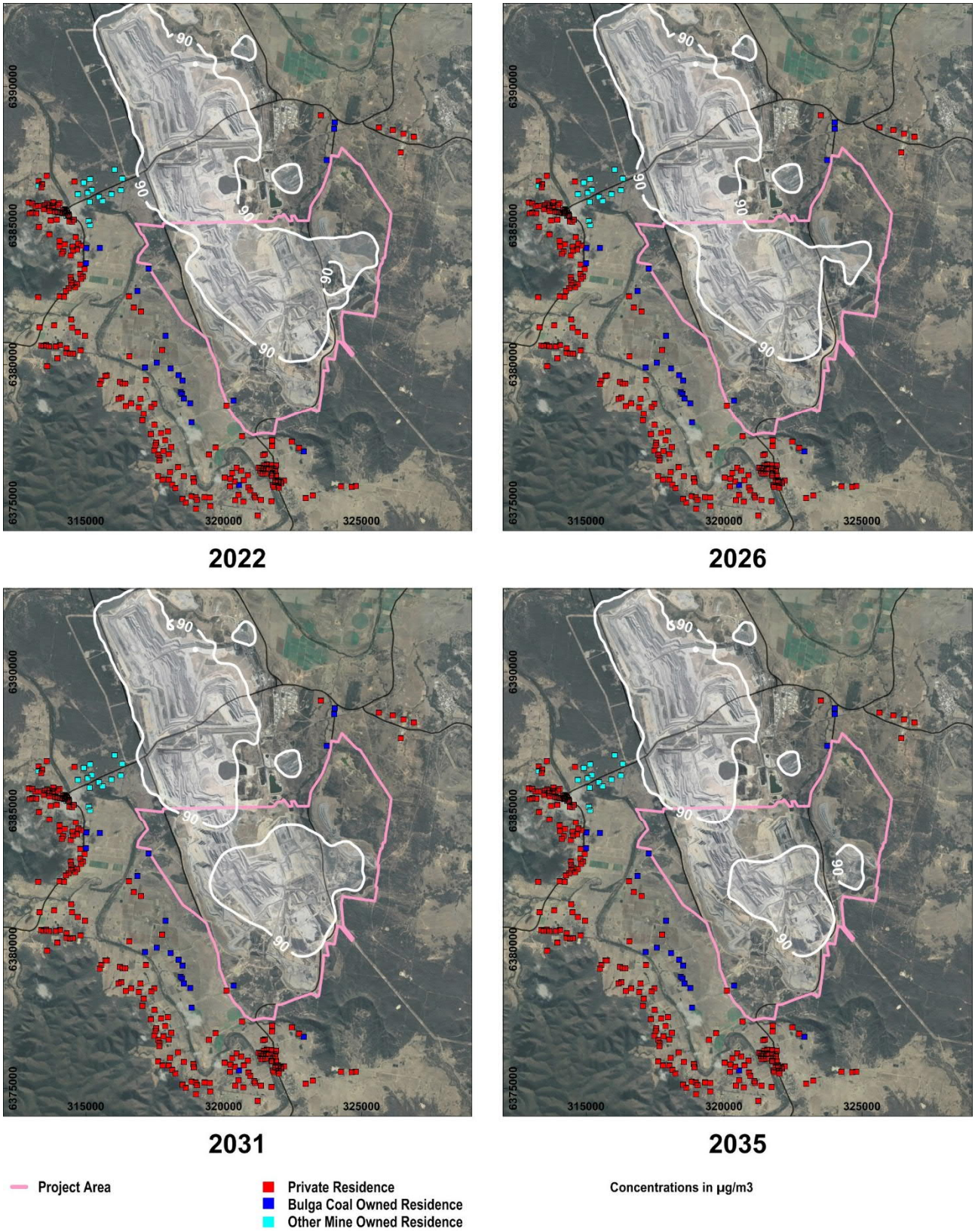

Figure 33 Predicted annual average TSP concentrations due to all sources (cumulative)

8.4 Deposited Dust

Figure 34 shows the annual average dust deposition levels for existing conditions (2014). The model predictions are higher than the measured results at all locations. This suggests that model predictions for the Project are conservative.

Figure 35 and **Figure 36** show the predicted annual average dust deposition levels in future years for the BCC (as modified) only and cumulative scenarios respectively. There are no private sensitive locations which are predicted to experience exceedances of the annual average dust deposition criteria at any stage of the BCC (as modified).

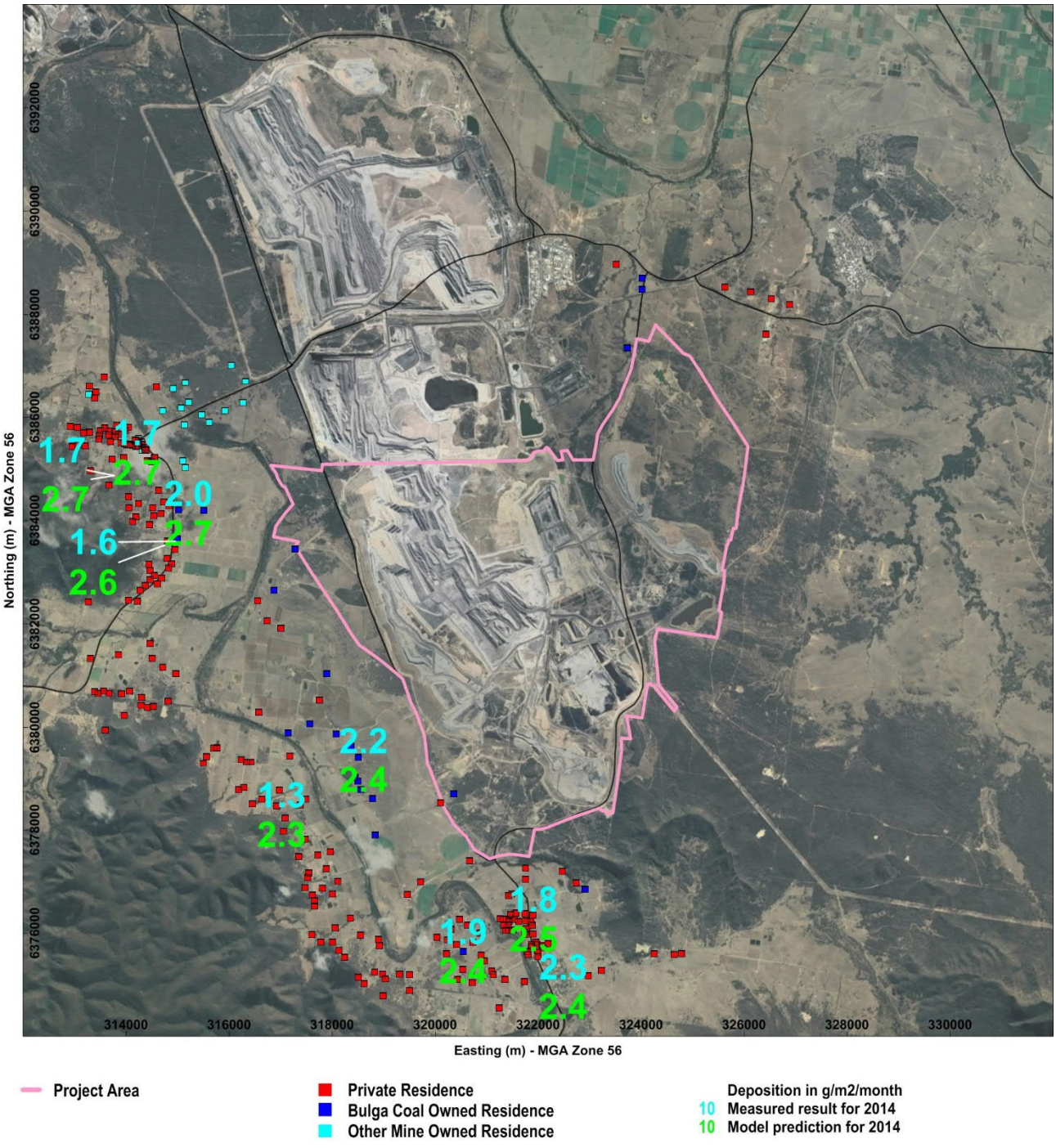

Figure 34 Predicted annual average deposited dust levels due to all sources (cumulative) in 2014

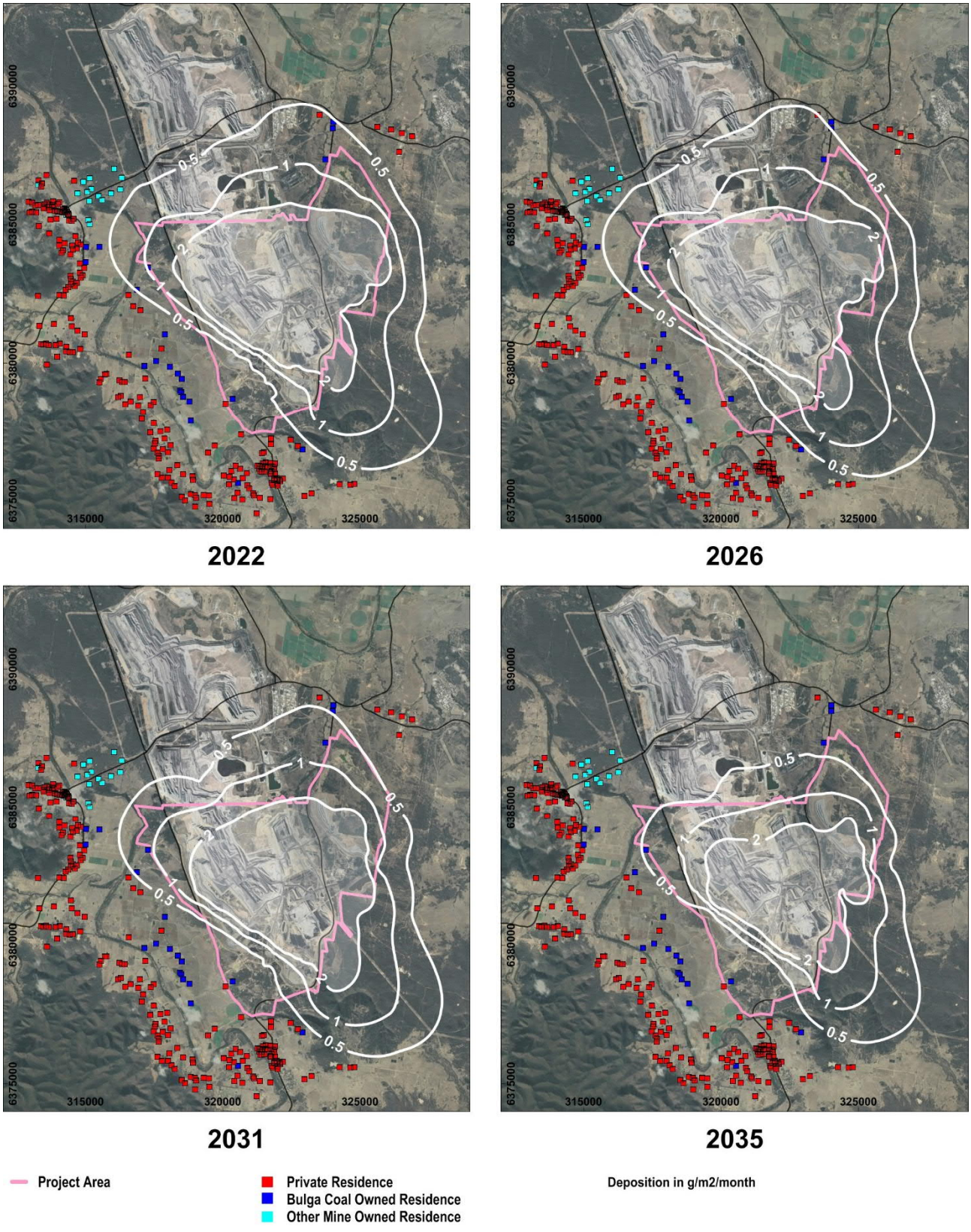

Figure 35 Predicted annual average deposited dust levels due to the BCC (as modified)

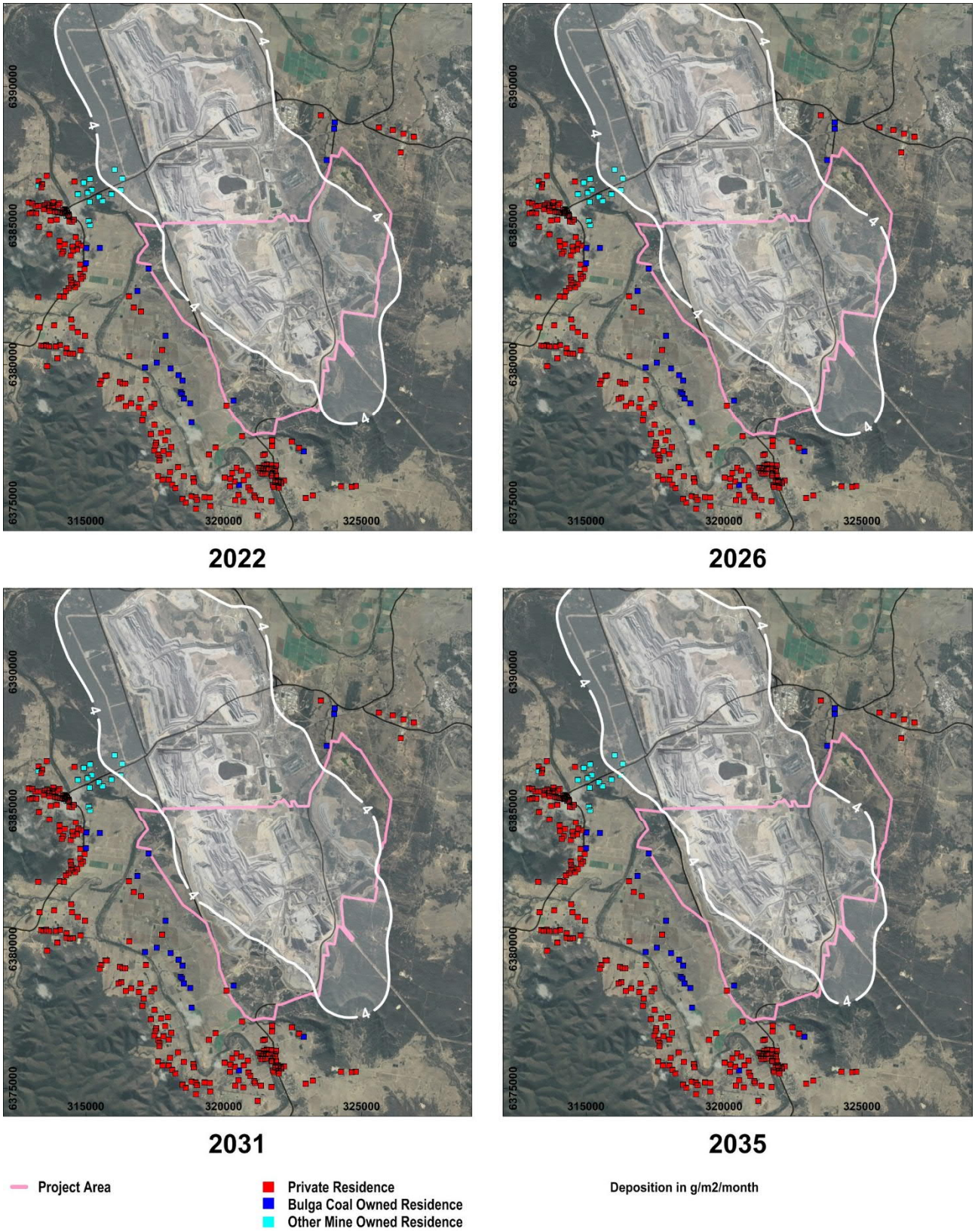

Figure 36 Predicted annual average deposited dust levels due to all sources (cumulative)

8.5 Post-Blast Fume (NO_2)

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are included in the dispersion modelling results presented in **Sections 8.1** to **8.4**. Post-blast fume can be produced in non-ideal explosive conditions of the ammonium nitrate/fuel oil (ANFO) and is visible as an orange / brown plume.

Post-blast fumes comprise of oxides of nitrogen (NO_x) including nitric oxide (NO) and nitrogen dioxide (NO_2). In general, at the point of emission, NO will comprise the greatest proportion of the total NO_x emission. Typically, this is 90% by volume of the NO_x. The remaining 10% will comprise mostly NO_2. It is the NO_2 which has been linked to adverse health effects.

Glencore has developed blasting procedures to provide for effective fume management. A site-specific blast management plan is implemented during operations, including key fume management actions, such as defining the potential risk zone based upon weather patterns and obtaining permission to fire, based on an assessment of current weather conditions. In addition to general fume management practices Glencore continues to work closely with its explosive suppliers to minimise the potential for post-blast fume.

No changes are proposed to the number of blasts per day, permissible blasting hours, blasting practices or blast management procedures as part of the Proposed Modification. Therefore, the extent of potential blast fume impact will be within the extent of potential blast fume impact under the Approved Development and will continue to be managed in accordance with existing approved management plans and processes.

8.6 Diesel Exhaust Emissions

Emissions from diesel exhausts associated with off-road vehicles and equipment at mine sites are often deemed a lower air quality impact risk than dust emissions from the material handling activities. This is because of the relatively few emission sources involved, for example when compared to a busy motorway, and the large distances between the sources and sensitive receptors. Nevertheless, a review of the potential impacts has been carried out.

The most significant emissions from diesel exhausts are products of combustion including carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM_{10} and including $PM_{2.5}$). It is the NO_x, or more specifically NO_2, and PM_{10} (including $PM_{2.5}$) which have been reviewed in this section.

8.6.1 Particulate Matter (as PM_{10} and $PM_{2.5}$)

The emission factors, presented in **Section 6** and **Appendix B**, represent the contribution from both wheel generated particulates and the exhaust particulates. These emission factors, including with control factors, are based on measured emissions which include diesel particulates in the form of both PM_{10} and $PM_{2.5}$. The emission factors are also likely to include more diesel exhaust particulate than from a modern truck as the factors were developed on the basis of emissions from trucks measured in the 1980's (that is, older trucks). Todoroski Air Sciences has also reported (TAS 2016) that several studies, reported to the EPA, confirmed that a control factor of 85% can be maintained, representing all components of the truck haulage emission.

Based on the information collated above, the potential impacts of diesel exhaust emissions (as PM_{10} and $PM_{2.5}$) are represented in the preceding results, in **Sections 8.1** to **8.4**.

Table 20 provides the explicit estimates of PM_{10} and $PM_{2.5}$ emissions due only to diesel plant and equipment exhausts. Emission factors for "Industrial off-road vehicles and equipment" from the EPA's 2008 Air Emissions Inventory (EPA 2012) were used for the calculations. These factors relate to diesel exhaust and evaporative emissions.

Table 20 Estimate of PM_{10} and $PM_{2.5}$ emissions from diesel engines

Total fuel used (litres) (based on maximum annual fuel usage between 2015 and 2017) (L/y)	Emission factors (kg/kL)		Emissions (kg/y)	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
68,061,340	2.84	2.75	193,294	187,495

BCM has considered the practicalities of exhaust after-treatment technologies for in service non-road diesel engines. Consideration has been given to the emission reductions, capital costs, maintenance costs and operational costs. The proposed mitigation measures to manage diesel combustion emissions aim to address the equipment maintenance and engine replacement strategies from the *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions"* (EPA 2014).

The emission control measures proposed by BCM include:

- Servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance.
- Targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle.
- Defining failure modes, effects and criticality which helps to minimise potential equipment failure.
- Constructing timelines for downtimes.

8.6.2 Nitrogen Dioxide (NO_2)

Emissions from machinery exhausts include of oxides of nitrogen (NO_x) which comprise of nitric oxide (NO) and nitrogen dioxide (NO_2). In general, at the point of emission, NO will comprise the greatest proportion of the total NO_x emission. Typically this is 90% by volume of the NO_x. The remaining 10% will comprise mostly NO_2. It is the NO_2 which has been linked to adverse health effects.

Ultimately however, much of the NO emitted into the atmosphere is oxidised to NO_2. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours. The rate of conversion is important because from the point of emission to the point of maximum ground-level concentration there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low then the level of oxidation is unimportant. However, if the oxidation is rapid and the dispersion is slow then high concentrations of NO_2 can occur.

In NO_x monitoring data near significant emission sources (for example, power stations and motorways) the percentage of NO_2 in the NO_x is (as a rule) inversely proportional to the total NO_x concentration, and when NO_x concentrations are high, the percentage of NO_2 in the NO_x is typically of the order of 20%. This is demonstrated by **Figure 37** which shows that, for high NO_x concentrations, the NO_2 to NO_x ratio reduces to less than 20%.

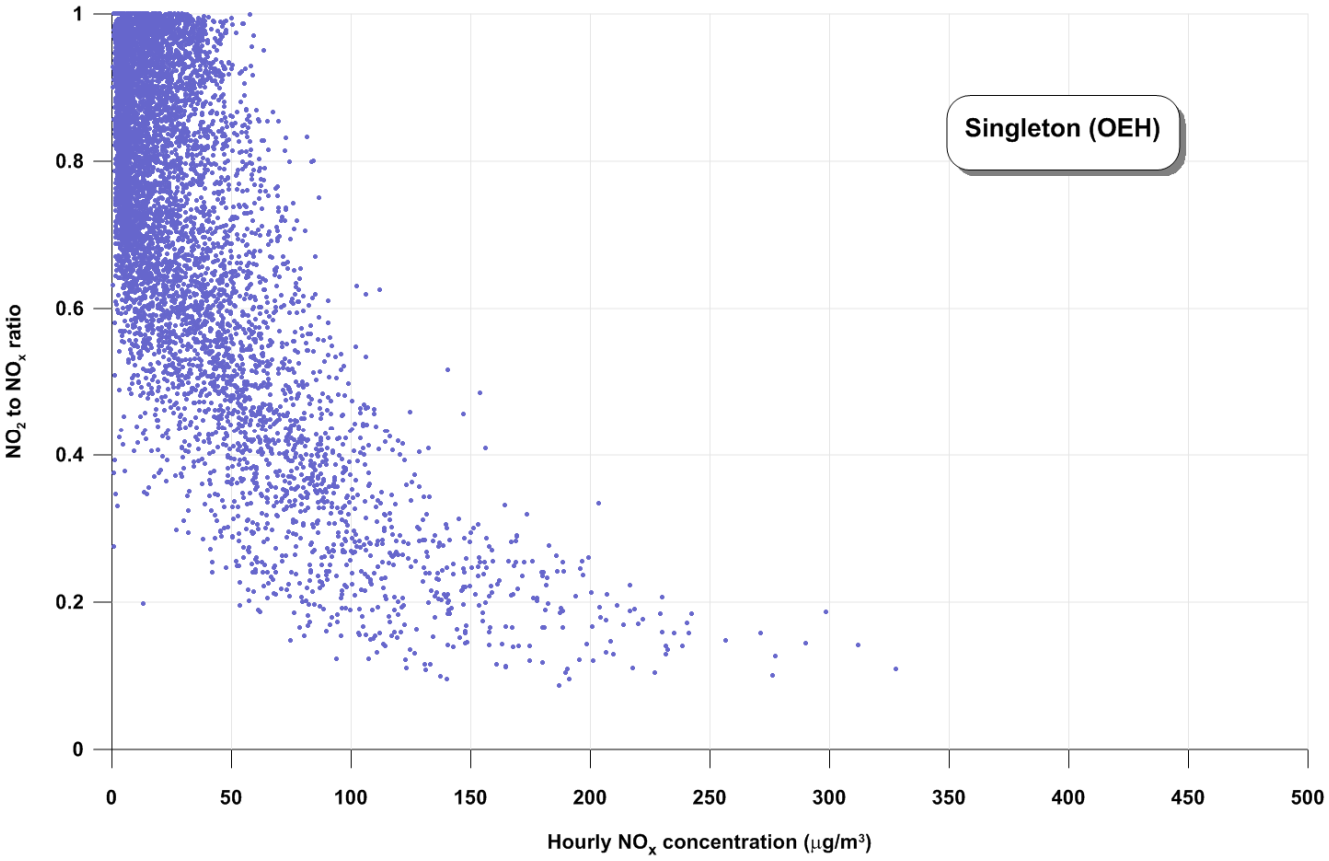

Figure 37 Measured NO_2 to NO_x ratios from hourly average data collected at Singleton by the OEH in 2014

Emissions of NO_x from diesel exhausts have been estimated using fuel consumption data, reported by BCM as part of their AEMR greenhouse gas emission estimates, and an emission factor from the EPA's Air Emissions Inventory for 2008 (EPA 2012). **Table 21** shows the calculations.

Table 21 Estimated NO_X emissions from diesel exhausts

Item	Value
Total fuel used (litres) (based on maximum annual fuel usage between 2015 and 2017)	68,061,340
Diesel exhaust emission factor (kg/kL)	40.77
Diesel exhaust emissions – all equipment (kg/y)	2,774,861

The NO_x emission estimate from **Table 21** has been modelled using the same source locations as 2031 to provide an indication of the off-site NO_2 concentrations due to diesel exhaust emissions. The predicted maximum 1-hour average NO_2 concentrations are shown in **Figure 38**, which assumes that 20% of the NO_x is NO_2 at the locations of maximum ground-level concentrations.

At the nearest sensitive receptors, the predicted maximum 1-hour average NO_2 concentrations are in the order of 50 to 100 µg/m^3. With the addition of maximum background levels (74 µg/m^3 from **Table 11**) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion. The 172 µg/m^3 contour represents the EPA criterion assuming a background level of 74 µg/m^3.

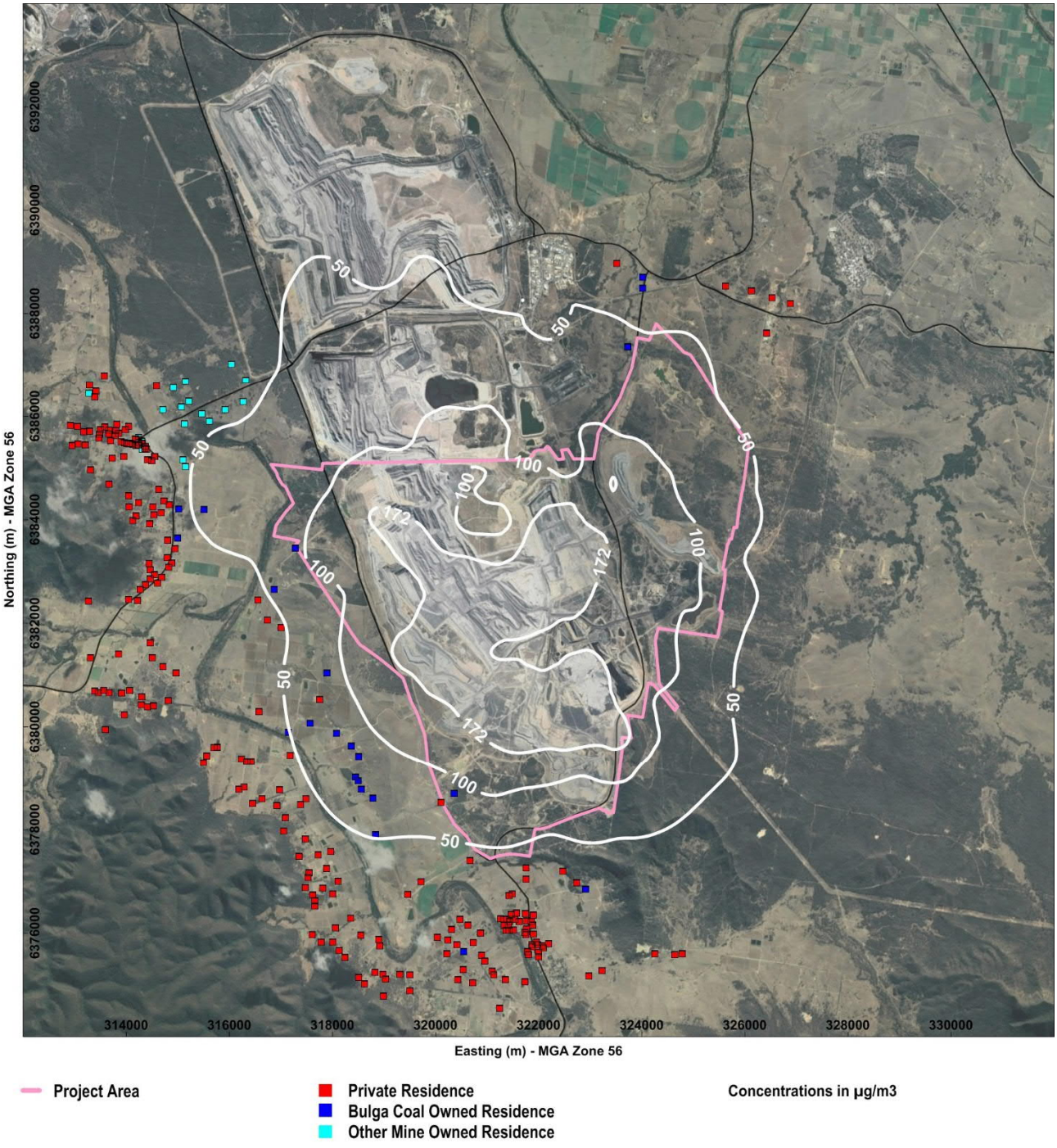

Figure 38 Predicted maximum 1-hour average NO_2 concentrations due to diesel exhausts

Figure 39 shows the predicted annual average NO_2 concentrations, which assumes that 50% of the NO_x is NO_2 (a conservative estimate for annual averages based on the Singleton data). At nearest sensitive receptors the predicted average NO_2 concentrations are in the order of 5 µg/m^3 or less. With the addition of conservative background levels (16 µg/m^3 from **Table 11**) the results show compliance with the EPA's 62 µg/m^3 criterion.

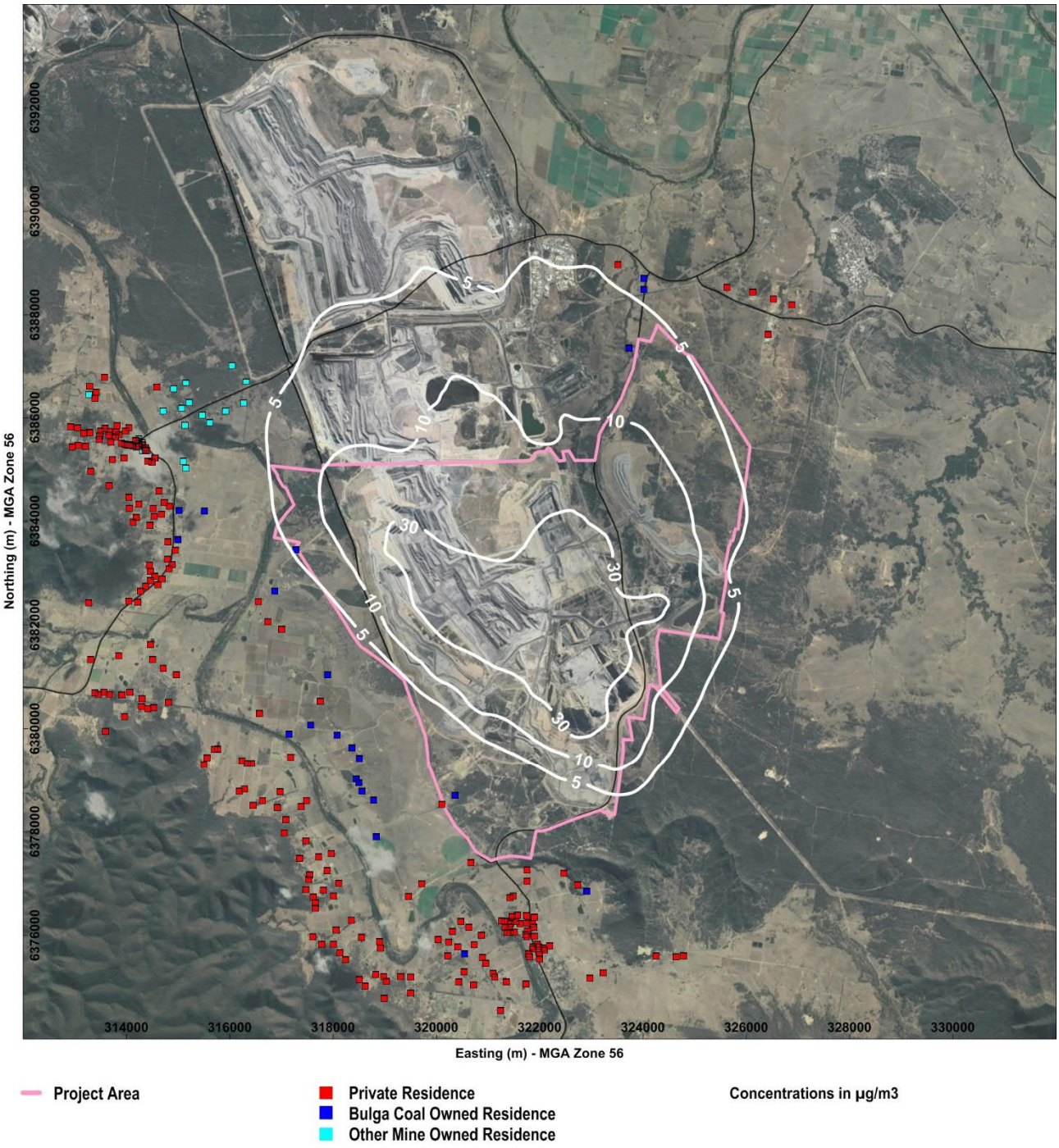

Figure 39 Predicted annual average NO_2 concentrations due to diesel exhausts

8.7 Construction

Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of weather conditions for the period in which work will be taking place in each location on the site.

Air quality impacts during construction would largely result from dust generated during earthworks and other engineering activities associated with the site construction works. Specifically, these works will include the construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure, and construction of new water management facilities to manage site surface water catchments. The total amount of dust generated would depend on the quantities of material handled, silt and moisture content of the soil, the types of operations being carried out, exposed areas, frequency of water spraying and speed of machinery. The detailed approach to construction will depend on decisions that will be made by the contractor(s) and changes to the construction methods and sequences that are expected to take place during the construction phase.

Material handling quantities in the construction phase are expected to be much lower than the material handling quantities in the operations phase. Consequently, the air quality impacts during construction will be lower than during operations. However, as for the operations phase, it is important that exposed areas be stabilised as quickly as possible and that appropriate dust suppression methods be used to keep dust impacts to a minimum. Dust management will require the use of water carts, the defining of trafficked areas, the imposition of site vehicle speed limits and constraints on work under extreme unfavourable weather conditions, such as dry wind conditions. Monitoring would also continue to be carried out during the construction phase to assess compliance with EPA criteria.

9. Management and Monitoring

Table 22 summarises the standard emission management measures, currently implemented as part of the existing Air Quality Management Plan, that will continue to be adopted as part of the Proposed Modification.

Table 22 Emission management measures

Activity	Emission management measures	Assumed emission control (%) (NPI 2012, Donnelly et el 2011)	Measures identified from Donnelly et al (2011)	Consistent with best practice
Stripping topsoil by dozer	Watering of haul routes Restricting vehicle speeds	50	Control measures for this activity are not specifically identified but can be inferred from the bulldozers information below.	Y
Drilling overburden	Water injection and application of water to drill cuttings upon removal Dust curtains Ceasing operations when visible dust is generated	70	*"Best practice control measures include air extraction to a bag filter. No mines were found to use this practice."*	N (bag filters are not best practice in NSW)
Blasting overburden	Pre-blast checks including review of meteorological conditions	0	*"Best practice control measures include delaying shot to avoid unfavourable weather conditions and minimising the area blasted"*	Y
Hauling overburden and coal on unsealed roads	Watering of haul routes Gravel compaction and maintenance of haul routes Restricting vehicle speeds Clearly marked haul routes Fleet optimisation to reduce vehicle kilometres travelled Prompt clean-up of any material spillage	85	*"Control measures include watering, grading, well-defined haul routes, speed limits to 40 km/h and/or the use of suppressants."*	Y
Loading and unloading of overburden	Minimisation of fall distances during unloading and loading Planning of dump locations based on weather conditions Ceasing operations during adverse dust conditions	0	*"Current practices adopted to control emissions from loading and dumping overburden were found to be water application, minimisation of drop heights and suspension or modification of activities during adverse weather conditions. Best practice control measures were identified as minimising drop heights and / or the application of water".*	Y
Unloading coal to ROM hopper	Water sprays and partial enclosure	70	*"Best practice control measures for minimising emissions from the ROM hopper is enclosure with air extraction to a fabric filter or other control device. No mines in the GMR adopt this approach."*	N (additional control devices are not best practice in NSW)
Coal processing	Enclosure	70	Control measures for this process are not specifically identified.	-

Activity	Emission management measures	Assumed emission control (%) (NPI 2012, Donnelly et el 2011)	Measures identified from Donnelly et al (2011)	Consistent with best practice
Dozers or loaders on ROM and product coal stockpiles	Watering of travel routes Minimisation during dusty conditions Reduced travel speed during dusty conditions	50	*"Best practice control measures include minimising the travel speed and distance travelled by bulldozers and the application of water to keep travel routes moist"*	Y
Conveyors to stockpiles	Covered / enclosure Belt cleaning as required	70	*"The use of wind shielding on conveyor sides, water sprays at conveyor transfers, enclosure of transfer points, and, soft-loading chutes."*	Y (except for water sprays and soft-loading chutes)
Wind erosion from partially rehabilitated dumps	Partial rehabilitation / stabilisation	30	*"Control measures include watering exposed areas, minimising areas of disturbance, progressive rehabilitation and use of suppressants"*	Y
Wind erosion from ROM and product coal stockpiles	Water sprays Minimisation of FEL drop heights when loading	50	*"Control measures include watering exposed areas, minimising areas of disturbance, progressive rehabilitation and use of suppressants"*	Y
Grading roads	Watering of haul routes Restricting vehicle speeds Clearly marked routes	50	Control measures for this activity are not specifically identified. This activity forms part of the control measures for haul roads.	-
Machinery exhausts and plant and equipment	Servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance. Targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle. Defining failure modes, effects and criticality. Constructing timelines for downtimes.	0	Control measures for this activity are not specifically identified.	-

In addition to the measures listed above BCM implements both proactive and reactive dust control strategies. Reactive air quality management include the modification or suspension of activities in response to the following triggers:

- Visual conditions, such as visible dust from trucks above wheel height as observed by operators and via the in-pit camera system;
- Meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors; or
- Ambient air quality conditions (that is, elevated short-term PM_{10} concentrations).

Specific “triggers” are defined in the BCM Air Quality Management Plan. These triggers are linked to specific actions for managing dust at both private and mine owned residences.

Proactive air quality management involves the discussion and planning of activities in advance of potentially adverse conditions. Specifically, the pro-active air quality management approach includes:

- Plant operator training and awareness of potentially adverse conditions.
- Implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation.
- Discussion of the dust forecast at daily pre-shift meetings.
- Modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts.

The dust management measures as outlined have been compared to the measures outlined in the “NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining” (Donnelly et al, 2011). This comparison identified that the majority of proposed measures are consistent with best practice dust mitigation measures.

The meteorological and air quality monitoring network currently operated by BCM (refer to **Section 5**) is suitably setup to measure the key air quality parameters, compliance with air quality criteria, and to allow for the contribution of mining activities to be determined. This monitoring network will continue to be operated as part of the Proposed Modification.

10. Conclusions

This report has provided an assessment of the potential air quality impacts of the Bulga Coal Complex Modification 3. In summary the assessment involved identifying the key air quality issues, characterising the existing air quality and meteorological environment, quantifying emissions to air and using an air dispersion model to predict the impact of the BCC (as modified) emissions on local air quality.

The potential air quality issues were identified as:

- Dust (that is, particulate matter in the form of TSP, PM_{10} or $PM_{2.5}$) from the general mining activities;
- Fume (that is, NO_x emissions) from blasting; and
- Emissions of substances from machinery exhausts, that is, diesel emissions.

A detailed review of the existing environment was carried out. The following conclusions were made in relation to the existing air quality and meteorological conditions:

- Wind patterns in the vicinity of BCC Mine are similar to other parts of the Hunter Valley, with the prevailing winds being from either the northwest or southeast. Winds from the south are also common for this area.
- There are seasonal variations in particulate matter concentrations, with PM_{10} levels higher in spring and $PM_{2.5}$ levels higher in winter.
- In terms of PM_{10}, and aside from the OEH's Mt Thorley monitoring location, air quality conditions can be regarded as good, with annual average concentrations well below the revised assessment criterion of 25 µg/m^3. Most monitoring sites in the vicinity of BCC have experienced at least one day above the EPA's 50 µg/m^3 criterion in the past five years. This is not uncommon for most locations in NSW, including in rural and urban areas.
- In terms of $PM_{2.5}$, annual averages have been below the recently introduced assessment criterion (8 µg/m^3) at both BCM monitoring locations. Results from Singleton were above 8 µg/m^3 in one of the past five years. A study by the OEH (2013) found that wood smoke from domestic heating was one of the main factors that influenced $PM_{2.5}$ concentrations in the Singleton area, especially in winter.
- TSP, dust deposition and NO_2 levels are below their relevant EPA criteria.

The computer-based dispersion model known as CALPUFF was used to predict the potential air quality impacts of the BCC (as modified), including cumulative impacts. The dispersion modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts. The performance of the model was reviewed by comparing predictions to measured results for a representative year. It was found that, with the adopted approach for modelling and assessment, the model predictions for average concentrations were typically within 20 per cent of measured results. This result is well within the factor-of-two accuracy that has been recognised for these types of models (US EPA, 2005).

It was noted that there is a relatively low potential for material change in the magnitude of air quality impacts from the Proposed Modification, given that it is only increasing the total area of proposed disturbance by 0.5%. In addition, there is no proposed increase to the maximum annual production rate, and equipment types and utilization remain very similar to that assessed for the Approved Development. Nevertheless, the modelling for the assessment has been based on the most up-to-date information on existing conditions, mining operations, and model setup.

The following conclusions have been made:

- Estimated annual emissions to air for BCC (as modified) are expected to be lower than those estimated for the Bulga Optimisation Project.
- Maximum 24-hour average PM_{10} concentrations may continue to exceed the EPA's 50 µg/m^3 criterion at various locations in the vicinity of the BCC (including private properties), due to contributions from the BCC (as modified), Mt Thorley Warkworth mine and background (other) sources of particulate matter. Specifically, the model predictions indicated that there may be up to two days each year when the BCC (as modified) would contribute to an exceedance of 50 µg/m^3 at the nearest locations to the west of the BCC.

These predictions did not highlight any significant change in air quality as they were within the range of historical measured conditions. It is concluded that 24-hour average PM_{10} concentrations will continue to be variable from day-to-day, due to existing conditions and sources, and that operations will need to be managed in a way which minimises the contribution to off-site PM_{10} levels, as is done under the existing approved operation.

- There is one property (1A to the north of BCC) where annual average PM_{10} concentrations are predicted to exceed the EPA's 25 µg/m^3 criterion in one or more future years. Compliance with the EPA's annual average PM_{10} criterion is predicted at all other private sensitive receptors. The results indicate that property 1A would be entitled to voluntary mitigation and acquisition rights under the VLAMP, based on cumulative PM_{10} levels that are predicted to exceed the 25 µg/m^3 VLAMP criterion in 2022, 2026 and 2031 with approximately equal contributions from the Proposed Modification and from Mt Thorley Warkworth.
- As for PM_{10}, concentrations of $PM_{2.5}$ will continue to be variable from day-to-day. There are typically a few days each year when $PM_{2.5}$ concentrations exceed the recently introduced assessment criterion of 25 µg/m^3. This trend is expected to continue with or without the Proposed Modification.
- There are no private sensitive locations which are predicted to experience exceedances of the $PM_{2.5}$, TSP or dust deposition criteria at any stage of the Proposed Modification.
- There would be no change to the extent of potential impact of post-blast fume due to the Proposed Modification.
- Emissions from diesel exhausts associated with off-road vehicles and equipment are not expected to result in any adverse air quality impacts, based on model predictions which show compliance with air quality criteria.

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Appendix A. Wind-roses for all meteorological stations

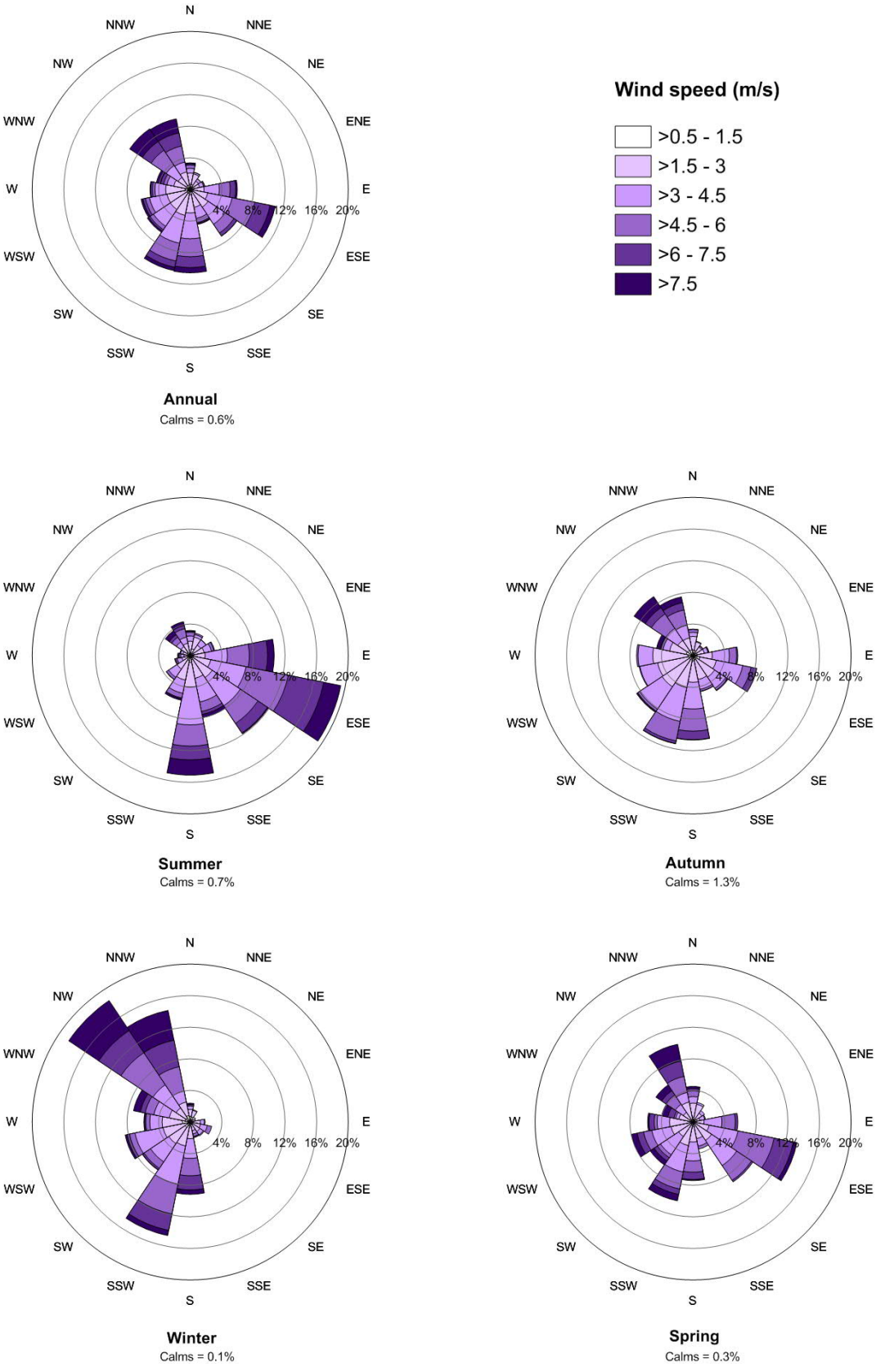

Figure A1 Annual and seasonal wind-roses for Bulga Complex 2014

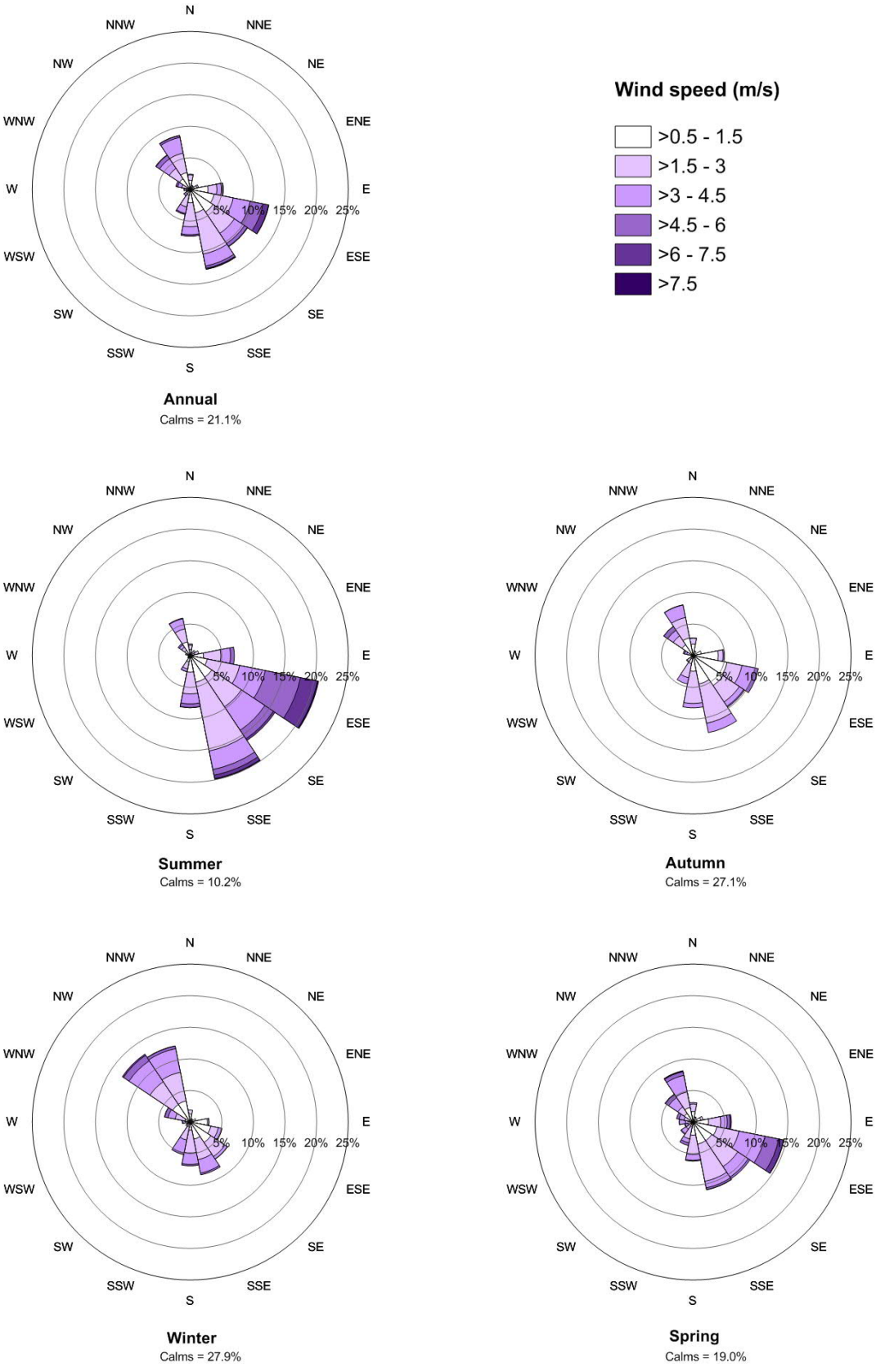

Figure A2 Annual and seasonal wind-roses for OEH Bulga 2014

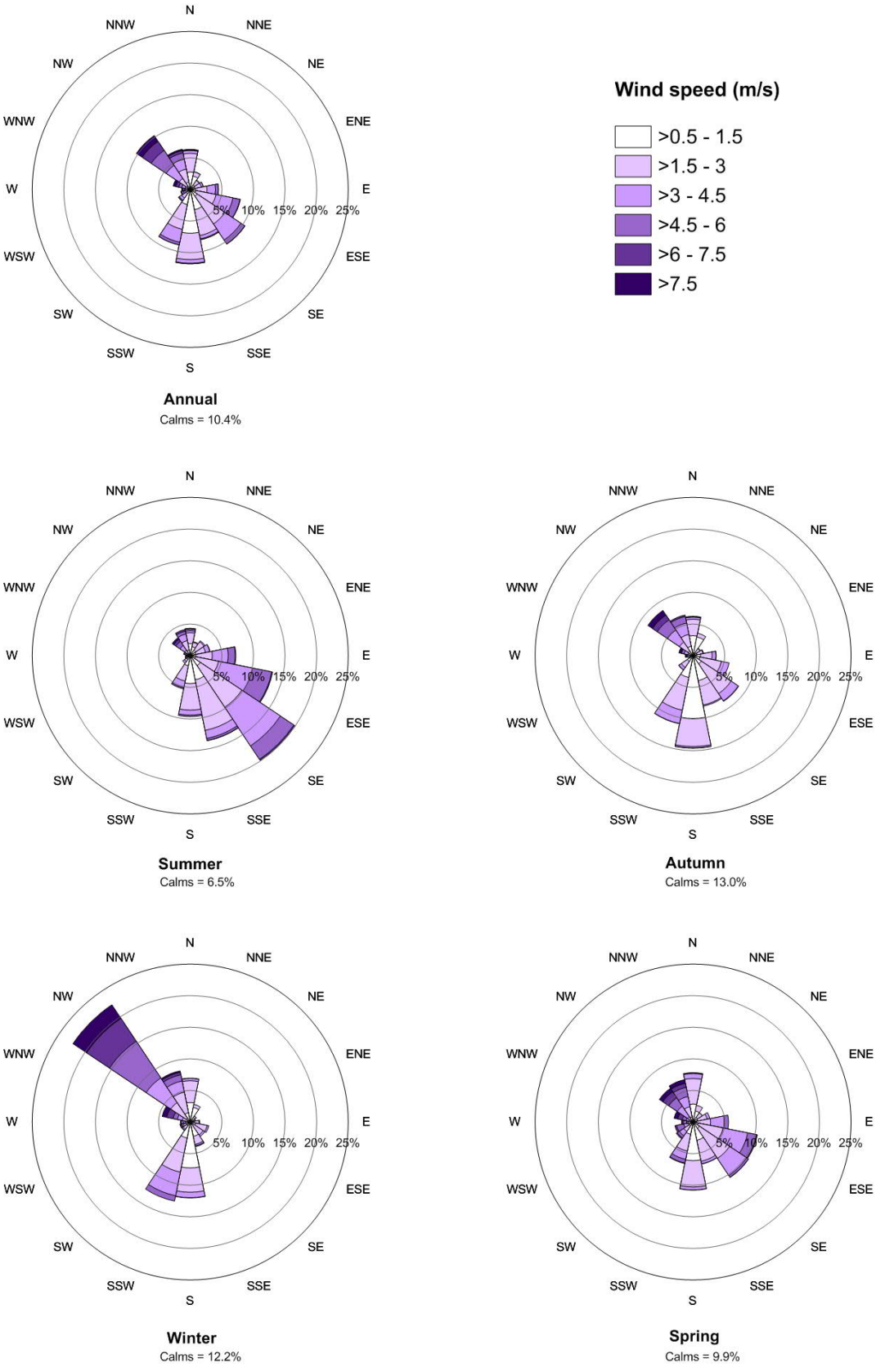

Figure A3 Annual and seasonal wind-roses for OEH Mt Thorley 2014

Appendix B. Emissions Calculations

Bulga Coal Complex (as modified) 2014

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables							
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (dozers)	65870	16036	3294	0	3936	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Drilling overburden (Main Pit)	2455	1290	123	70	13871	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (South Pit)	3715	1952	186	70	20988	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (Main Pit)	23684	12273	1184	0	35	blasts/y	677.1	kg/blast	350.8	kg/blast	33.854	kg/blast	21158	-	-	-	-	-	-	-	-
Blasting overburden (South Pit)	23684	12273	1184	0	35	blasts/y	677.1	kg/blast	350.8	kg/blast	33.854	kg/blast	21158	-	-	-	-	-	-	-	-
Dragline working on overburden	229104	50311	11455	0	7210690	bcm/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	2	7	-	-	-	-	-
Excavators loading overburden to trucks (Main Pit)	143986	68101	7199	0	53218715	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Excavators loading overburden to trucks (South Pit)	143986	68101	7199	0	53218715	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Hauling overburden from Main Pit to Main Dump	944054	278976	47203	85	53218715	t/y	0.11826	kg/t	0.03495	kg/t	0.006	kg/t	-	-	-	-	4	230	6.8	-	-
Hauling overburden from South Pit to Main Dump	749690	221540	37484	85	53218715	t/y	0.09391	kg/t	0.02775	kg/t	0.005	kg/t	-	-	-	-	4	230	5.4	-	-
Hauling overburden from Main/South Pit to EEA	0	0	0	85	0	t/y	0.03478	kg/t	0.01028	kg/t	0.002	kg/t	-	-	-	-	4	230	2	-	-
Unloading overburden to Main Dump	287971	136203	14399	0	106437430	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Unloading overburden to EEA	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Dozers shaping overburden (Main dump)	380184	92554	19009	0	22717	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (EEA)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	
Dozers working on overburden for rehabilitation	142569	34708	7128	0	8519	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on coal (Main Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers working on coal (South Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Loading ROM coal to trucks (Main pit)	326712	43101	16336	0	4836356	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Loading ROM coal to trucks (South pit)	326712	43101	16336	0	4836356	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Hauling ROM coal from Main pit to hopper / ROM pad	232145	68601	11607	85	4836356	t/y	0.32000	kg/t	0.09456	kg/t	0.016	kg/t	-	-	-	-	4	165	13.2	-	-
Hauling ROM coal from South pit to hopper / ROM pad	204006	60286	10200	85	4836356	t/y	0.28121	kg/t	0.0831	kg/t	0.014	kg/t	-	-	-	-	4	165	11.6	-	-
Unloading ROM coal to hopper ROM pad (from all pits)	14509	6094	725	85	9672712	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	10000	4200	500	0	1000000	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	1686	798	84	70	9672712	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyor unloading to hopper / ROM pad (underground)	605	286	30	87.5	8322136	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Dozers on ROM stockpile (underground)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on ROM stockpile (open cut)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on product coal stockpiles	65901	19104	3295	50	11359	h/y	11.6	kg/h	3.4	kg/h	0.580	kg/h	-	-	9	-	-	-	-	5.1	-
Handling coal at CHPP	6772	3203	339	0	11652543	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyer transfer to product stockpiles	1152	545	58	70	11652543	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Conveyor unloading to product stockpiles	480	227	24	87.5	11652543	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Loading product coal from stockpiles to trains	3839	1816	192	0	11652543	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Wind erosion from active pits	456667	228334	34250	0	521	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	365292	182646	27397	0	417	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from inactive or partially rehabed dumps	99952	49976	7496	30	163	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	4380	2190	329	50	10	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	3942	1971	296	50	9	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	79691	28175	3985	0	129480	km	0.61547	kg/VKT	0.2176	kg/VKT	0.031	kg/VKT	-	-	-	-	-	-	-	-	8
	5694167	1840071	307964																		

Notes: based on data from BCM (2015)

Bulga Coal Complex (as modified) 2022

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (dozers)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Drilling overburden (Main Pit)	13745	7222	687	70	77654	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (South Pit)	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (Main Pit)	131525	68154	6576	0	168	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Blasting overburden (South Pit)	0	0	0	0	0	blasts/y	0.0	kg/blast	0.0	kg/blast	0.000	kg/blast	0	-	-	-	-	-	-	-	-
Dragline working on overburden	0	0	0	0	0	bcm/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	2	7	-	-	-	-	-
Excavators loading overburden to trucks (Main Pit)	365318	172785	18266	0	135025425	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Excavators loading overburden to trucks (South Pit)	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Hauling overburden from Main Pit to Main Dump	2592488	766102	129624	85	108020340	t/y	0.16000	kg/t	0.04728	kg/t	0.008	kg/t	-	-	-	-	4	230	9.2	-	-
Hauling overburden from South Pit to Main Dump	0	0	0	85	0	t/y	0.18783	kg/t	0.0555	kg/t	0.009	kg/t	-	-	-	-	4	230	10.8	-	-
Hauling overburden from Main/South Pit to EEA	760839	224834	38042	85	27005085	t/y	0.18783	kg/t	0.0555	kg/t	0.009	kg/t	-	-	-	-	4	230	10.8	-	-
Unloading overburden to Main Dump	219191	103671	10960	0	81015255	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Unloading overburden to EEA	73064	34557	3653	0	27005085	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Dozers shaping overburden (Main dump)	773272	188250	38664	0	46206	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (EEA)	193318	47062	9666	0	11551	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	
Dozers working on overburden for rehabilitation	142569	34708	7128	0	8519	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on coal (Main Pit)	232515	67403	11626	0	11359	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers working on coal (South Pit)	0	0	0	0	0	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Loading ROM coal to trucks (Main pit)	706648	93224	35332	0	10460607	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Loading ROM coal to trucks (South pit)	0	0	0	0	0	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Hauling ROM coal from Main pit to hopper / ROM pad	319524	94422	15976	85	10460607	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Hauling ROM coal from South pit to hopper / ROM pad	0	0	0	85	0	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Unloading ROM coal to hopper ROM pad (from all pits)	15691	6590	785	85	10460607	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	10461	4393	523	0	1046061	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	1824	863	91	70	10460607	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyor unloading to hopper / ROM pad (underground)	0	0	0	87.5	0	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Dozers on ROM stockpile (underground)	0	0	0	50	0	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on ROM stockpile (open cut)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on product coal stockpiles	65901	19104	3295	50	11359	h/y	11.6	kg/h	3.4	kg/h	0.580	kg/h	-	-	9	-	-	-	-	5.1	-
Handling coal at CHPP	6079	2875	304	0	10460607	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyer transfer to product stockpiles	1034	489	52	70	10460607	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Conveyor unloading to product stockpiles	431	204	22	87.5	10460607	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Loading product coal from stockpiles to trains	3446	1630	172	0	10460607	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Wind erosion from active pits	496692	248346	37252	0	567	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	762996	381498	57225	0	871	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from inactive or partially rehabed dumps	224431	112216	16832	30	366	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	4380	2190	329	50	10	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	3942	1971	296	50	9	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	79691	28175	3985	0	129480	km	0.61547	kg/VKT	0.2176	kg/VKT	0.031	kg/VKT	-	-	-	-	-	-	-	-	8
	7231922	2423334	398907																		

Notes: production data supplied by BCM

Bulga Coal Complex (as modified) 2026

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (dozers)	184758	44979	9238	0	11040	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Drilling overburden (Main Pit)	10872	5712	544	70	61424	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (South Pit)	2718	1428	136	70	15356	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (Main Pit)	104034	53909	5202	0	133	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Blasting overburden (South Pit)	26009	13477	1300	0	33	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Dragline working on overburden	0	0	0	0	0	bcm/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	2	7	-	-	-	-	-
Excavators loading overburden to trucks (Main Pit)	288962	136671	14448	0	106803422	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Excavators loading overburden to trucks (South Pit)	72240	34168	3612	0	26700855	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Hauling overburden from Main Pit to Main Dump	2306954	681724	115348	85	96123079	t/y	0.16000	kg/t	0.04728	kg/t	0.008	kg/t	-	-	-	-	4	230	9.2	-	-
Hauling overburden from South Pit to Main Dump	702116	207481	35106	85	24030770	t/y	0.19478	kg/t	0.05756	kg/t	0.010	kg/t	-	-	-	-	4	230	11.2	-	-
Hauling overburden from Main/South Pit to EEA	403996	119384	20200	85	13350428	t/y	0.20174	kg/t	0.05962	kg/t	0.010	kg/t	-	-	-	-	4	230	11.6	-	-
Unloading overburden to Main Dump	325082	153755	16254	0	120153849	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Unloading overburden to EEA	36120	17084	1806	0	13350428	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Dozers shaping overburden (Main dump)	869931	211781	43497	0	51982	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (EEA)	96659	23531	4833	0	5776	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	
Dozers working on overburden for rehabilitation	142569	34708	7128	0	8519	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on coal (Main Pit)	186012	53922	9301	0	9087	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers working on coal (South Pit)	46503	13481	2325	0	2272	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Loading ROM coal to trucks (Main pit)	543737	71732	27187	0	8049004	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Loading ROM coal to trucks (South pit)	135934	17933	6797	0	2012251	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Hauling ROM coal from Main pit to hopper / ROM pad	245860	72654	12293	85	8049004	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Hauling ROM coal from South pit to hopper / ROM pad	61465	18163	3073	85	2012251	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Unloading ROM coal to hopper ROM pad (from all pits)	15092	6339	755	85	10061255	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	10061	4226	503	0	1006126	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	1754	830	88	70	10061255	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyor unloading to hopper / ROM pad (underground)	436	206	22	87.5	6000000	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Dozers on ROM stockpile (underground)	0	0	0	50	0	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on ROM stockpile (open cut)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on product coal stockpiles	65901	19104	3295	50	11359	h/y	11.6	kg/h	3.4	kg/h	0.580	kg/h	-	-	9	-	-	-	-	5.1	-
Handling coal at CHPP	9334	4415	467	0	16061255	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyer transfer to product stockpiles	1587	751	79	70	16061255	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Conveyor unloading to product stockpiles	661	313	33	87.5	16061255	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Loading product coal from stockpiles to trains	5291	2502	265	0	16061255	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Wind erosion from active pits	522972	261486	39223	0	597	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	720948	360474	54071	0	823	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from inactive or partially rehabed dumps	212780	106390	15959	30	347	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	4380	2190	329	50	10	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	3942	1971	296	50	9	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	79691	28175	3985	0	129480	km	0.61547	kg/VKT	0.2176	kg/VKT	0.031	kg/VKT	-	-	-	-	-	-	-	-	8
	7968717	2643899	435061																		

Notes: production data supplied by BCM

Bulga Coal Complex (as modified) 2031

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (dozers)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Drilling overburden (Main Pit)	6142	3227	307	70	34703	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (South Pit)	6142	3227	307	70	34703	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (Main Pit)	58777	30457	2939	0	75	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Blasting overburden (South Pit)	58777	30457	2939	0	75	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Dragline working on overburden	0	0	0	0	0	bcm/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	2	7	-	-	-	-	-
Excavators loading overburden to trucks (Main Pit)	163255	77215	8163	0	60340898	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Excavators loading overburden to trucks (South Pit)	163255	77215	8163	0	60340898	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Hauling overburden from Main Pit to Main Dump	1385217	409343	69261	85	60340898	t/y	0.15304	kg/t	0.04523	kg/t	0.008	kg/t	-	-	-	-	4	230	8.8	-	-
Hauling overburden from South Pit to Main Dump	1605593	474466	80280	85	60340898	t/y	0.17739	kg/t	0.05242	kg/t	0.009	kg/t	-	-	-	-	4	230	10.2	-	-
Hauling overburden from Main/South Pit to EEA	0	0	0	85	0	t/y	0.03478	kg/t	0.01028	kg/t	0.002	kg/t	-	-	-	-	4	230	2	-	-
Unloading overburden to Main Dump	326510	154431	16326	0	120681795	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Unloading overburden to EEA	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Dozers shaping overburden (Main dump)	380184	92554	19009	0	22717	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (EEA)	586406	142758	29320	0	35040	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	
Dozers working on overburden for rehabilitation	142569	34708	7128	0	8519	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on coal (Main Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers working on coal (South Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Loading ROM coal to trucks (Main pit)	410237	54120	20512	0	6072794	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Loading ROM coal to trucks (South pit)	410237	54120	20512	0	6072794	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Hauling ROM coal from Main pit to hopper / ROM pad	185496	54816	9275	85	6072794	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Hauling ROM coal from South pit to hopper / ROM pad	185496	54816	9275	85	6072794	t/y	0.20364	kg/t	0.06018	kg/t	0.010	kg/t	-	-	-	-	4	165	8.4	-	-
Unloading ROM coal to hopper ROM pad (from all pits)	18218	7652	911	85	12145587	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	12146	5101	607	0	1214559	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	2118	1002	106	70	12145587	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyor unloading to hopper / ROM pad (underground)	436	206	22	87.5	6000000	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Dozers on ROM stockpile (underground)	0	0	0	50	0	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on ROM stockpile (open cut)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on product coal stockpiles	65901	19104	3295	50	11359	h/y	11.6	kg/h	3.4	kg/h	0.580	kg/h	-	-	9	-	-	-	-	5.1	-
Handling coal at CHPP	10545	4988	527	0	18145587	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyer transfer to product stockpiles	1793	848	90	70	18145587	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Conveyor unloading to product stockpiles	747	353	37	87.5	18145587	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Loading product coal from stockpiles to trains	5978	2827	299	0	18145587	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Wind erosion from active pits	475668	237834	35675	0	543	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	652620	326310	48947	0	745	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from inactive or partially rehabed dumps	199903	99952	14993	30	326	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	4380	2190	329	50	10	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	3942	1971	296	50	9	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	79691	28175	3985	0	129480	km	0.61547	kg/VKT	0.2176	kg/VKT	0.031	kg/VKT	-	-	-	-	-	-	-	-	8
	7312618	2427938	399044																		

Notes: production data supplied by BCM

Bulga Coal Complex (as modified) 2035

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables							
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (dozers)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Drilling overburden (Main Pit)	4550	2391	227	70	25706	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (South Pit)	4550	2391	227	70	25706	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (Main Pit)	43538	22561	2177	0	56	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Blasting overburden (South Pit)	43538	22561	2177	0	56	blasts/y	784.1	kg/blast	406.3	kg/blast	39.206	kg/blast	23333	-	-	-	-	-	-	-	-
Dragline working on overburden	0	0	0	0	0	bcm/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	2	7	-	-	-	-	-
Excavators loading overburden to trucks (Main Pit)	120929	57196	6046	0	44696737	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Excavators loading overburden to trucks (South Pit)	120929	57196	6046	0	44696737	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Hauling overburden from Main Pit to Main Dump	478061	141271	23903	85	44696737	t/y	0.07130	kg/t	0.02107	kg/t	0.004	kg/t	-	-	-	-	4	230	4.1	-	-
Hauling overburden from South Pit to Main Dump	478061	141271	23903	85	44696737	t/y	0.07130	kg/t	0.02107	kg/t	0.004	kg/t	-	-	-	-	4	230	4.1	-	-
Hauling overburden from Main/South Pit to EEA	0	0	0	85	0	t/y	0.03478	kg/t	0.01028	kg/t	0.002	kg/t	-	-	-	-	4	230	2	-	-
Unloading overburden to Main Dump	241858	114392	12093	0	89393474	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Unloading overburden to EEA	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.000	kg/t	-	2.29	2	-	-	-	-	-	-
Dozers shaping overburden (Main dump)	380184	92554	19009	0	22717	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (EEA)	586406	142758	29320	0	35040	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	
Dozers working on overburden for rehabilitation	142569	34708	7128	0	8519	h/y	16.7	kg/h	4.07415	kg/h	0.837	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on coal (Main Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers working on coal (South Pit)	116258	33701	5813	0	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Loading ROM coal to trucks (Main pit)	328716	43366	16436	0	4866019	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Loading ROM coal to trucks (South pit)	328716	43366	16436	0	4866019	t/y	0.06755	kg/t	0.00891	kg/t	0.003	kg/t	-	-	6	-	-	-	-	-	-
Hauling ROM coal from Main pit to hopper / ROM pad	58392	17255	2920	85	4866019	t/y	0.08000	kg/t	0.02364	kg/t	0.004	kg/t	-	-	-	-	4	165	3.3	-	-
Hauling ROM coal from South pit to hopper / ROM pad	58392	17255	2920	85	4866019	t/y	0.08000	kg/t	0.02364	kg/t	0.004	kg/t	-	-	-	-	4	165	3.3	-	-
Unloading ROM coal to hopper ROM pad (from all pits)	14598	6131	730	85	9732039	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	9732	4087	487	0	973204	t/y	0.01	kg/t	0.0042	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	1697	803	85	70	9732039	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyor unloading to hopper / ROM pad (underground)	0	0	0	87.5	0	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Dozers on ROM stockpile (underground)	0	0	0	50	0	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on ROM stockpile (open cut)	58129	16851	2906	50	5679	h/y	20.5	kg/h	5.9	kg/h	1.024	kg/h	-	-	6	-	-	-	-	5.1	-
Dozers on product coal stockpiles	65901	19104	3295	50	11359	h/y	11.6	kg/h	3.4	kg/h	0.580	kg/h	-	-	9	-	-	-	-	5.1	-
Handling coal at CHPP	5656	2675	283	0	9732039	t/y	0.00058	kg/t	0.00027	kg/t	0.000	kg/t	-	2.29	6	-	-	-	-	-	-
Conveyer transfer to product stockpiles	962	455	48	70	9732039	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Conveyor unloading to product stockpiles	401	190	20	87.5	9732039	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Loading product coal from stockpiles to trains	3206	1516	160	0	9732039	t/y	0.00033	kg/t	0.00016	kg/t	0.000	kg/t	-	2.29	9	-	-	-	-	-	-
Wind erosion from active pits	318864	159432	23915	0	364	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	657000	328500	49275	0	750	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from inactive or partially rehabed dumps	164338	82169	12325	30	268	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	4380	2190	329	50	10	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	3942	1971	296	50	9	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	79691	28175	3985	0	129480	km	0.61547	kg/VKT	0.2176	kg/VKT	0.031	kg/VKT	-	-	-	-	-	-	-	-	8
	4453993	1531384	251413																		

Notes: production data supplied by BCM

Mt Thorley Warkworth 2014

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil by scraper	1450	365	73	50	100000	t/y	0.029	kg/t	0.0073	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Drilling overburden (All Pits)	31294	16273	939	70	176800	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (-)	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (All Pits)	137518	71509	4126	0	221	blasts/y	622.3	kg/blast	323.6	kg/blast	18.7	kg/blast	20000	-	-	-	-	-	-	-	-
Blasting overburden (-)	0	0	0	0	0	blasts/y	622.3	kg/blast	323.6	kg/blast	18.7	kg/blast	20000	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks (All Pits)	548911	259620	39314	0	202899330	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Excavators loading overburden to trucks (-)	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Hauling overburden from All Pits to dump	3936247	1163194	118087	85	202899330	t/y	0.12933	kg/t	0.03822	kg/t	0.004	kg/t	-	-	-	-	4	240	8	-	-
Hauling overburden from - to dump	0	0	0	85	0	t/y	0.00000	kg/t	0	kg/t	0.000	kg/t	-	-	-	-	4	240	0.0	-	-
Unloading overburden to dump (from All Pits)	548911	259620	39314	0	202899330	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Unloading overburden to dump (from -)	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Dozers shaping overburden (all dumps)	879609	214137	92359	0	52560	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (-)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on overburden for rehabilitation	219902	53534	23090	0	13140	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Drilling coal (All Pits)	15647	8136	469	70	88400	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Drilling coal (-)	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting coal (All Pits)	48620	25282	1459	0	221	blasts/y	220.0	kg/blast	114.4	kg/blast	6.6	kg/blast	10000	-	-	-	-	-	-	-	-
Blasting coal (-)	0	0	0	0	0	blasts/y	220.0	kg/blast	114.4	kg/blast	6.6	kg/blast	10000	-	-	-	-	-	-	-	-
Dozers working on coal (All Pits)	788784	251444	17353	0	39420	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Dozers working on coal (-)	0	0	0	0	0	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Loading ROM coal to trucks (All Pits)	846294	121710	16080	0	17693000	t/y	0.04783	kg/t	0.00688	kg/t	0.001	kg/t	-	-	8	-	-	-	-	-	-
Loading ROM coal to trucks (-)	0	0	0	0	0	t/y	0.04783	kg/t	0.00688	kg/t	0.001	kg/t	-	-	8	-	-	-	-	-	-
Hauling ROM coal from All Pits to hopper / ROM pad	650357	192186	19511	85	17693000	t/y	0.24505	kg/t	0.07242	kg/t	0.007	kg/t	-	-	-	-	4	190	12	-	-
Hauling ROM coal from - to hopper / ROM pad	0	0	0	85	0	t/y	0.00000	kg/t	0	kg/t	0.000	kg/t	-	-	-	-	4	190	0	-	-
Unloading ROM coal to ROM pad	53079	22293	1009	70	17693000	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	17693	7431	336	0	17693000	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP, inc UG	2062	975	148	70	17693000	t/y	0.00039	kg/t	0.00018	kg/t	0.0000	kg/t	-	2.28	8	-	-	-	-	-	-
Handling coal at CHPP, inc UG	10309	4876	148	70	17693000	t/y	0.00194	kg/t	0.00092	kg/t	0.0000	kg/t	-	2.28	8	-	-	-	-	-	-
Dozers on ROM coal stockpiles	131464	41907	2892	50	13140	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Dozers on product coal stockpiles	56212	16198	1237	50	13140	h/y	8.6	kg/h	2.5	kg/h	0.188	kg/h	-	-	11	-	-	-	-	5	-
Conveyer to product stockpiles	890	421	64	70	11930000	t/y	0.00025	kg/t	0.00012	kg/t	0.0000	kg/t	-	2.28	11	-	-	-	-	-	-
Loading product coal to trains	4772	2028	239	0	11930000	t/y	0.00040	kg/t	0.00017	kg/t	0.0000	kg/t	-	-	-	-	-	-	-	-	-
Wind erosion from active pits	671016	335508	50326	0	766	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	989004	494502	74175	0	1129	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from partially rehabilitated dumps	0	0	0	30	0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	8760	4380	657	50	20	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpile	2190	1095	164	50	5	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	18464	6528	202	50	60000	km	0.61547	kg/VKT	0.2176	kg/VKT	0.007	kg/VKT	-	-	-	-	-	-	-	-	8
Dragline working on overburden	311435	68390	15572	0	9801900	bcm/y	0.03	kg/bcm	0.01	kg/bcm	0.002	kg/bcm	-	-	2	7	-	-	-	-	-
	10930896	3643545	519340																		

Data from Rio Tinto (2015)

Mt Thorley Warkworth 2022-2035

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil by scraper	1450	365	73	50	100000	t/y	0.029	kg/t	0.0073	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Drilling overburden (All Pits)	31294	16273	939	70	176800	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Drilling overburden (-)	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden (All Pits)	137518	71509	4126	0	221	blasts/y	622.3	kg/blast	323.6	kg/blast	18.7	kg/blast	20000	-	-	-	-	-	-	-	-
Blasting overburden (-)	0	0	0	0	0	blasts/y	622.3	kg/blast	323.6	kg/blast	18.7	kg/blast	20000	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks (All Pits)	868678	410861	62216	0	321097679	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Excavators loading overburden to trucks (-)	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Hauling overburden from All Pits to dump	6229295	1840808	186879	85	321097679	t/y	0.12933	kg/t	0.03822	kg/t	0.004	kg/t	-	-	-	-	4	240	8	-	-
Hauling overburden from - to dump	0	0	0	85	0	t/y	0.00000	kg/t	0	kg/t	0.000	kg/t	-	-	-	-	4	240	0.0	-	-
Unloading overburden to dump (from All Pits)	868678	410861	62216	0	321097679	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Unloading overburden to dump (from -)	0	0	0	0	0	t/y	0.00271	kg/t	0.00128	kg/t	0.0002	kg/t	-	2.28	2	-	-	-	-	-	-
Dozers shaping overburden (all dumps)	879609	214137	92359	0	52560	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Dozers shaping overburden (-)	0	0	0	0	0	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on overburden for rehabilitation	219902	53534	23090	0	13140	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Drilling coal (All Pits)	15647	8136	469	70	88400	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Drilling coal (-)	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting coal (All Pits)	48620	25282	1459	0	221	blasts/y	220.0	kg/blast	114.4	kg/blast	6.6	kg/blast	10000	-	-	-	-	-	-	-	-
Blasting coal (-)	0	0	0	0	0	blasts/y	220.0	kg/blast	114.4	kg/blast	6.6	kg/blast	10000	-	-	-	-	-	-	-	-
Dozers working on coal (All Pits)	788784	251444	17353	0	39420	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Dozers working on coal (-)	0	0	0	0	0	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Loading ROM coal to trucks (All Pits)	1339301	192613	25447	0	28000000	t/y	0.04783	kg/t	0.00688	kg/t	0.001	kg/t	-	-	8	-	-	-	-	-	-
Loading ROM coal to trucks (-)	0	0	0	0	0	t/y	0.04783	kg/t	0.00688	kg/t	0.001	kg/t	-	-	8	-	-	-	-	-	-
Hauling ROM coal from All Pits to hopper / ROM pad	1029221	304143	30877	85	28000000	t/y	0.24505	kg/t	0.07242	kg/t	0.007	kg/t	-	-	-	-	4	190	12	-	-
Hauling ROM coal from - to hopper / ROM pad	0	0	0	85	0	t/y	0.00000	kg/t	0	kg/t	0.000	kg/t	-	-	-	-	4	190	0	-	-
Unloading ROM coal to ROM pad	84000	35280	1596	70	28000000	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	28000	11760	532	0	2800000	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP, inc UG	3263	1543	234	70	28000000	t/y	0.00039	kg/t	0.00018	kg/t	0.0000	kg/t	-	2.28	8	-	-	-	-	-	-
Handling coal at CHPP, inc UG	16315	7717	234	70	28000000	t/y	0.00194	kg/t	0.00092	kg/t	0.0000	kg/t	-	2.28	8	-	-	-	-	-	-
Dozers on ROM coal stockpiles	131464	41907	2892	50	13140	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Dozers on product coal stockpiles	56212	16198	1237	50	13140	h/y	8.6	kg/h	2.5	kg/h	0.188	kg/h	-	-	11	-	-	-	-	5	-
Conveyer to product stockpiles	2089	988	150	70	28000000	t/y	0.00025	kg/t	0.00012	kg/t	0.0000	kg/t	-	2.28	11	-	-	-	-	-	-
Loading product coal to trains	11200	4760	560	0	28000000	t/y	0.00040	kg/t	0.00017	kg/t	0.0000	kg/t	-	-	-	-	-	-	-	-	-
Wind erosion from active pits	671016	335508	50326	0	766	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	989004	494502	74175	0	1129	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from partially rehabilitated dumps	0	0	0	30	0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	8760	4380	657	50	20	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpile	2190	1095	164	50	5	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	18464	6528	202	50	60000	km	0.61547	kg/VKT	0.2176	kg/VKT	0.007	kg/VKT	-	-	-	-	-	-	-	-	8
Dragline working on overburden	492860	108230	24643	0	15511965	bcm/y	0.03	kg/bcm	0.01	kg/bcm	0.002	kg/bcm	-	-	2	7	-	-	-	-	-
	14972834	4870365	665103																		

Maximum approved production for MTW

Bulga Coal Complex (as modified) 2014

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--------------------------------      09-Oct-2018 10:09
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2014\Bulga\emiss
.vol
 Meteorological file    : NA
 Number of dust sources : 72
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (dozers)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65870 kg/y TSP  16036 kg/y PM10  3294 kg/y PM2.5
 FROM SOURCES  : 4
4 5 6 7
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2455 kg/y TSP  1290 kg/y PM10  123 kg/y PM2.5
 FROM SOURCES  : 13
1 2 3 4 5 6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3715 kg/y TSP  1952 kg/y PM10  186 kg/y PM2.5
 FROM SOURCES  : 8
14 15 16 17 18 19 20 21
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 23684 kg/y TSP  12273 kg/y PM10  1184 kg/y PM2.5
 FROM SOURCES  : 13
1 2 3 4 5 6 7 8 9 10 11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 23684 kg/y TSP  12273 kg/y PM10  1184 kg/y PM2.5
 FROM SOURCES  : 8
14 15 16 17 18 19 20 21
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 229104 kg/y TSP  50311 kg/y PM10  11455 kg/y PM2.5
 FROM SOURCES  : 12
8 9 10 11 12 13 14 22 23 24 25 26
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (Main Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 143986 kg/y TSP  68101 kg/y PM10  7199 kg/y PM2.5
 FROM SOURCES  : 13
1 2 3 4 5 6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (South
Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 143986 kg/y TSP  68101 kg/y PM10  7199 kg/y PM2.5
 FROM SOURCES  : 8
14 15 16 17 18 19 20 21
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 944054 kg/y TSP  278976 kg/y PM10  47203 kg/y
PM2.5
 FROM SOURCES  : 20
1 2 3 4 5 6 7 8 9 10 11 12 13 23 29 30 42 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from South Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 749690 kg/y TSP  221540 kg/y PM10  37484 kg/y
PM2.5
 FROM SOURCES  : 15
14 15 16 17 18 19 20 21 33 34 35 36 37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main/South Pit to EEA
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to Main Dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 287971 kg/y TSP  136203 kg/y PM10  14399 kg/y
PM2.5
 FROM SOURCES  : 22
27 28 29 30 31 33 34 35 36 37 38 39 41 42 43 44 45 46 47 48 61 62
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to EEA
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (Main dump)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 380184 kg/y TSP  92554 kg/y PM10  19009 kg/y PM2.5
 FROM SOURCES  : 22
27 28 29 30 31 33 34 35 36 37 38 39 41 42 43 44 45 46 47 48 61 62
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (EEA)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 142569 kg/y TSP  34708 kg/y PM10  7128 kg/y PM2.5
 FROM SOURCES  : 6
43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 13
1 2 3 4 5 6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 8
14 15 16 17 18 19 20 21
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (Main pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 326712 kg/y TSP  43101 kg/y PM10  16336 kg/y PM2.5
 FROM SOURCES  : 13
1 2 3 4 5 6 7 8 9 10 11 12 13
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (South pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 326712 kg/y TSP  43101 kg/y PM10  16336 kg/y PM2.5
 FROM SOURCES  : 8
14 15 16 17 18 19 20 21
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from Main pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 232145 kg/y TSP  68601 kg/y PM10  11607 kg/y PM2.5
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 22 32 40 63 64 65 66 67 68 69 70 71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from South pit to hopper / ROM
pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 204006 kg/y TSP  60286 kg/y PM10  10200 kg/y PM2.5
 FROM SOURCES  : 20
14 15 16 17 18 19 20 21 22 32 40 63 64 65 66 67 68 69 70 71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to hopper ROM pad (from all
pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 14509 kg/y TSP  6094 kg/y PM10  725 kg/y PM2.5
 FROM SOURCES  : 1
71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 10000 kg/y TSP  4200 kg/y PM10  500 kg/y PM2.5
 FROM SOURCES  : 1
71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1686 kg/y TSP  798 kg/y PM10  84 kg/y PM2.5
 FROM SOURCES  : 2
71 72
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to hopper / ROM pad
(underground)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 605 kg/y TSP  286 kg/y PM10  30 kg/y PM2.5
 FROM SOURCES  : 1
```

72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (underground)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP 16851 kg/y PM10 2906 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (open cut)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP 16851 kg/y PM10 2906 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65901 kg/y TSP 19104 kg/y PM10 3295 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6772 kg/y TSP 3203 kg/y PM10 339 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer transfer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1152 kg/y TSP 545 kg/y PM10 58 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 480 kg/y TSP 227 kg/y PM10 24 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal from stockpiles to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 3839 kg/y TSP 1816 kg/y PM10 192 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 456667 kg/y TSP 228334 kg/y PM10 34250 kg/y
PM2.5
 FROM SOURCES : 26
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 365292 kg/y TSP 182646 kg/y PM10 27397 kg/y
PM2.5
 FROM SOURCES : 25
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
61 62 63
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from inactive or partially rehabed
dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 99952 kg/y TSP 49976 kg/y PM10 7496 kg/y PM2.5
 FROM SOURCES : 12
49 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4380 kg/y TSP 2190 kg/y PM10 329 kg/y PM2.5
 FROM SOURCES : 1
71
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3942 kg/y TSP 1971 kg/y PM10 296 kg/y PM2.5
 FROM SOURCES : 1
72
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79691 kg/y TSP 28175 kg/y PM10 3985 kg/y PM2.5
 FROM SOURCES : 59
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
48 61 62 63 64 65 66 67 68 69 70 71
 HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Bulga Coal Complex (as modified) 2022

```
--------------------------------      09-Oct-2018 10:11
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2022\Bulga\emiss
.vol
 Meteorological file    : NA
 Number of dust sources : 82
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (dozers)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 2
3 4
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 13745 kg/y TSP  7222 kg/y PM10  687 kg/y PM2.5
 FROM SOURCES  : 10
9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 6
3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 131525 kg/y TSP  68154 kg/y PM10  6576 kg/y PM2.5
 FROM SOURCES  : 10
9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 6
3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 7
14 15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (Main Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 365318 kg/y TSP  172785 kg/y PM10  18266 kg/y
PM2.5
 FROM SOURCES  : 10
9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (South
Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 6
3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2592488 kg/y TSP  766102 kg/y PM10  129624 kg/y
PM2.5
 FROM SOURCES  : 28
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 39 40 41 42
43 44 45 48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from South Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 17
3 4 5 6 7 8 11 16 39 40 41 42 43 44 45 48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main/South Pit to EEA
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 760839 kg/y TSP  224834 kg/y PM10  38042 kg/y
PM2.5
 FROM SOURCES  : 27
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 72 73 74 75 76 77 78
79 80 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to Main Dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 219191 kg/y TSP  103671 kg/y PM10  10960 kg/y
PM2.5
 FROM SOURCES  : 13
39 40 41 42 43 44 45 46 47 48 49 50 51
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to EEA
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 73064 kg/y TSP  34557 kg/y PM10  3653 kg/y PM2.5
 FROM SOURCES  : 9
74 75 76 77 78 79 80 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (Main dump)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 773272 kg/y TSP  188250 kg/y PM10  38664 kg/y
PM2.5
 FROM SOURCES  : 13
39 40 41 42 43 44 45 46 47 48 49 50 51
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (EEA)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 193318 kg/y TSP  47062 kg/y PM10  9666 kg/y PM2.5
 FROM SOURCES  : 9
74 75 76 77 78 79 80 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 142569 kg/y TSP  34708 kg/y PM10  7128 kg/y PM2.5
 FROM SOURCES  : 10
52 53 54 55 56 57 58 59 60 61
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 232515 kg/y TSP  67403 kg/y PM10  11626 kg/y PM2.5
 FROM SOURCES  : 10
9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 6
3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (Main pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 706648 kg/y TSP  93224 kg/y PM10  35332 kg/y PM2.5
 FROM SOURCES  : 10
9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (South pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 6
3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from Main pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 319524 kg/y TSP  94422 kg/y PM10  15976 kg/y PM2.5
 FROM SOURCES  : 14
1 9 10 11 12 13 14 15 16 17 18 69 70 71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from South pit to hopper / ROM
pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 12
3 4 5 6 7 8 11 12 13 69 70 71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to hopper ROM pad (from all
pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 15691 kg/y TSP  6590 kg/y PM10  785 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 10461 kg/y TSP  4393 kg/y PM10  523 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1824 kg/y TSP  863 kg/y PM10  91 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Conveyor unloading to hopper / ROM pad
(underground)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (underground)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (open cut)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP  16851 kg/y PM10  2906 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65901 kg/y TSP  19104 kg/y PM10  3295 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6079 kg/y TSP  2875 kg/y PM10  304 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer transfer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1034 kg/y TSP  489 kg/y PM10  52 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 431 kg/y TSP  204 kg/y PM10  22 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal from stockpiles to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 3446 kg/y TSP  1630 kg/y PM10  172 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 496692 kg/y TSP  248346 kg/y PM10  37252 kg/y
PM2.5
 FROM SOURCES  : 25
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 762996 kg/y TSP  381498 kg/y PM10  57225 kg/y
PM2.5
 FROM SOURCES  : 32
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
61 74 75 76 77 78 79 80 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from inactive or partially rehabed
dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 224431 kg/y TSP  112216 kg/y PM10  16832 kg/y
PM2.5
 FROM SOURCES  : 19
28 29 30 31 32 33 34 35 36 37 38 61 62 63 64 65 66 67 68
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4380 kg/y TSP  2190 kg/y PM10  329 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3942 kg/y TSP  1971 kg/y PM10  296 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79691 kg/y TSP  28175 kg/y PM10  3985 kg/y PM2.5
 FROM SOURCES  : 62
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
61 69 70 71 72 73 74 75 76 77 78 79 80 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 28 29 30
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Bulga Coal Complex (as modified) 2026

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--------------------------------      09-Oct-2018 10:17
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2026\Bulga\emiss
.vol
 Meteorological file    : NA
 Number of dust sources : 91
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (dozers)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 184758 kg/y TSP  44979 kg/y PM10  9238 kg/y PM2.5
 FROM SOURCES  : 9
3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10872 kg/y TSP  5712 kg/y PM10  544 kg/y PM2.5
 FROM SOURCES  : 9
10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2718 kg/y TSP  1428 kg/y PM10  136 kg/y PM2.5
 FROM SOURCES  : 7
3 4 5 6 7 8 9
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 104034 kg/y TSP  53909 kg/y PM10  5202 kg/y PM2.5
 FROM SOURCES  : 9
10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 26009 kg/y TSP  13477 kg/y PM10  1300 kg/y PM2.5
 FROM SOURCES  : 7
3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 15
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (Main Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 288962 kg/y TSP  136671 kg/y PM10  14448 kg/y
PM2.5
 FROM SOURCES  : 9
10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (South
Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 72240 kg/y TSP  34168 kg/y PM10  3612 kg/y PM2.5
 FROM SOURCES  : 7
3 4 5 6 7 8 9
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2306954 kg/y TSP  681724 kg/y PM10  115348 kg/y
PM2.5
 FROM SOURCES  : 39
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
32 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from South Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 702116 kg/y TSP  207481 kg/y PM10  35106 kg/y
PM2.5
 FROM SOURCES  : 26
3 4 5 6 7 8 9 12 15 23 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main/South Pit to EEA
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 403996 kg/y TSP  119384 kg/y PM10  20200 kg/y
PM2.5
 FROM SOURCES  : 21
10 11 12 13 14 15 16 17 18 63 64 65 66 67 68 69 70 71 72 73 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to Main Dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 325082 kg/y TSP  153755 kg/y PM10  16254 kg/y
PM2.5
 FROM SOURCES  : 16
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to EEA
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 36120 kg/y TSP  17084 kg/y PM10  1806 kg/y PM2.5
 FROM SOURCES  : 16
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (Main dump)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 869931 kg/y TSP  211781 kg/y PM10  43497 kg/y
PM2.5
 FROM SOURCES  : 16
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (EEA)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 96659 kg/y TSP  23531 kg/y PM10  4833 kg/y PM2.5
 FROM SOURCES  : 10
65 66 67 68 69 70 71 72 73 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 142569 kg/y TSP  34708 kg/y PM10  7128 kg/y PM2.5
 FROM SOURCES  : 10
54 55 56 57 58 59 60 61 81 82
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 186012 kg/y TSP  53922 kg/y PM10  9301 kg/y PM2.5
 FROM SOURCES  : 9
10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 46503 kg/y TSP  13481 kg/y PM10  2325 kg/y PM2.5
 FROM SOURCES  : 7
3 4 5 6 7 8 9
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (Main pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 543737 kg/y TSP  71732 kg/y PM10  27187 kg/y PM2.5
 FROM SOURCES  : 9
10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (South pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 135934 kg/y TSP  17933 kg/y PM10  6797 kg/y PM2.5
 FROM SOURCES  : 7
3 4 5 6 7 8 9
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from Main pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 245860 kg/y TSP  72654 kg/y PM10  12293 kg/y PM2.5
 FROM SOURCES  : 13
1 10 11 12 13 14 15 16 17 18 19 90 91
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from South pit to hopper / ROM
pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 61465 kg/y TSP  18163 kg/y PM10  3073 kg/y PM2.5
 FROM SOURCES  : 15
3 4 5 6 7 8 9 12 15 16 17 18 19 90 91
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to hopper ROM pad (from all
pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 15092 kg/y TSP  6339 kg/y PM10  755 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 10061 kg/y TSP  4226 kg/y PM10  503 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1754 kg/y TSP  830 kg/y PM10  88 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Conveyor unloading to hopper / ROM pad
(underground)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 436 kg/y TSP  206 kg/y PM10  22 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (underground)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (open cut)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP  16851 kg/y PM10  2906 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65901 kg/y TSP  19104 kg/y PM10  3295 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9334 kg/y TSP  4415 kg/y PM10  467 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer transfer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1587 kg/y TSP  751 kg/y PM10  79 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 661 kg/y TSP  313 kg/y PM10  33 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal from stockpiles to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 5291 kg/y TSP  2502 kg/y PM10  265 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 522972 kg/y TSP  261486 kg/y PM10  39223 kg/y
PM2.5
 FROM SOURCES  : 30
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 720948 kg/y TSP  360474 kg/y PM10  54071 kg/y
PM2.5
 FROM SOURCES  : 35
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
60 61 62 65 66 67 68 69 70 71 72 73 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from inactive or partially rehabed
dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 212780 kg/y TSP  106390 kg/y PM10  15959 kg/y
PM2.5
 FROM SOURCES  : 20
33 34 35 36 37 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4380 kg/y TSP  2190 kg/y PM10  329 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3942 kg/y TSP  1971 kg/y PM10  296 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79691 kg/y TSP  28175 kg/y PM10  3985 kg/y PM2.5
 FROM SOURCES  : 69
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 90 91
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 33 34 35
36 37
```

Bulga Coal Complex (as modified) 2031

```
--------------------------------      09-Oct-2018 10:19
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2031\Bulga\emiss
.vol
 Meteorological file    : NA
 Number of dust sources : 80
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (dozers)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 4
3 4 5 6
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6142 kg/y TSP  3227 kg/y PM10  307 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6142 kg/y TSP  3227 kg/y PM10  307 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58777 kg/y TSP  30457 kg/y PM10  2939 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58777 kg/y TSP  30457 kg/y PM10  2939 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 10
18 19 20 21 22 23 24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (Main Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 163255 kg/y TSP  77215 kg/y PM10  8163 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (South
Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 163255 kg/y TSP  77215 kg/y PM10  8163 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1385217 kg/y TSP  409343 kg/y PM10  69261 kg/y
PM2.5
 FROM SOURCES  : 44
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from South Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1605593 kg/y TSP  474466 kg/y PM10  80280 kg/y
PM2.5
 FROM SOURCES  : 44
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main/South Pit to EEA
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to Main Dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 326510 kg/y TSP  154431 kg/y PM10  16326 kg/y
PM2.5
 FROM SOURCES  : 19
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to EEA
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (Main dump)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 380184 kg/y TSP  92554 kg/y PM10  19009 kg/y PM2.5
 FROM SOURCES  : 19
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (EEA)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 586406 kg/y TSP  142758 kg/y PM10  29320 kg/y
PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 142569 kg/y TSP  34708 kg/y PM10  7128 kg/y PM2.5
 FROM SOURCES  : 15
44 45 46 66 67 68 69 70 71 72 73 74 75 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (Main pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 410237 kg/y TSP  54120 kg/y PM10  20512 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (South pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 410237 kg/y TSP  54120 kg/y PM10  20512 kg/y PM2.5
 FROM SOURCES  : 20
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from Main pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 185496 kg/y TSP  54816 kg/y PM10  9275 kg/y PM2.5
 FROM SOURCES  : 24
1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 78 79 80
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from South pit to hopper / ROM
pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 185496 kg/y TSP  54816 kg/y PM10  9275 kg/y PM2.5
 FROM SOURCES  : 23
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 78 79 80
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to hopper ROM pad (from all
pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 18218 kg/y TSP  7652 kg/y PM10  911 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 12146 kg/y TSP  5101 kg/y PM10  607 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2118 kg/y TSP  1002 kg/y PM10  106 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to hopper / ROM pad
(underground)
```

```
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 436 kg/y TSP  206 kg/y PM10  22 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (underground)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (open cut)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP  16851 kg/y PM10  2906 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65901 kg/y TSP  19104 kg/y PM10  3295 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10545 kg/y TSP  4988 kg/y PM10  527 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer transfer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1793 kg/y TSP  848 kg/y PM10  90 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 747 kg/y TSP  353 kg/y PM10  37 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal from stockpiles to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 5978 kg/y TSP  2827 kg/y PM10  299 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 475668 kg/y TSP  237834 kg/y PM10  35675 kg/y
PM2.5
 FROM SOURCES  : 25
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 652620 kg/y TSP  326310 kg/y PM10  48947 kg/y
PM2.5
 FROM SOURCES  : 31
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
69 70 71 72 73 74 75 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from inactive or partially rehabed
dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 199903 kg/y TSP  99952 kg/y PM10  14993 kg/y PM2.5
 FROM SOURCES  : 19
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4380 kg/y TSP  2190 kg/y PM10  329 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3942 kg/y TSP  1971 kg/y PM10  296 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79691 kg/y TSP  28175 kg/y PM10  3985 kg/y PM2.5
 FROM SOURCES  : 59
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
69 70 71 72 73 74 75 76 77 78 79 80
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
```

Bulga Coal Complex (as modified) 2035

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--------------------------------      09-Oct-2018 10:11
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2035\Bulga\emiss
.vol
 Meteorological file    : NA
 Number of dust sources : 75
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (dozers)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4550 kg/y TSP  2391 kg/y PM10  227 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4550 kg/y TSP  2391 kg/y PM10  227 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 43538 kg/y TSP  22561 kg/y PM10  2177 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 43538 kg/y TSP  22561 kg/y PM10  2177 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 10
22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (Main Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 120929 kg/y TSP  57196 kg/y PM10  6046 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (South
Pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 120929 kg/y TSP  57196 kg/y PM10  6046 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 478061 kg/y TSP  141271 kg/y PM10  23903 kg/y
PM2.5
 FROM SOURCES  : 42
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from South Pit to Main Dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 478061 kg/y TSP  141271 kg/y PM10  23903 kg/y
PM2.5
 FROM SOURCES  : 42
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from Main/South Pit to EEA
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to Main Dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 241858 kg/y TSP  114392 kg/y PM10  12093 kg/y
PM2.5
 FROM SOURCES  : 24
5 6 7 8 9 10 11 12 13 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to EEA
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (Main dump)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 380184 kg/y TSP  92554 kg/y PM10  19009 kg/y PM2.5
 FROM SOURCES  : 24
5 6 7 8 9 10 11 12 13 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (EEA)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 586406 kg/y TSP  142758 kg/y PM10  29320 kg/y
PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 142569 kg/y TSP  34708 kg/y PM10  7128 kg/y PM2.5
 FROM SOURCES  : 13
48 49 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (Main Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (South Pit)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 116258 kg/y TSP  33701 kg/y PM10  5813 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (Main pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 328716 kg/y TSP  43366 kg/y PM10  16436 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (South pit)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 328716 kg/y TSP  43366 kg/y PM10  16436 kg/y PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from Main pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58392 kg/y TSP  17255 kg/y PM10  2920 kg/y PM2.5
 FROM SOURCES  : 23
1 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 72 73 74 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from South pit to hopper / ROM
pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58392 kg/y TSP  17255 kg/y PM10  2920 kg/y PM2.5
 FROM SOURCES  : 22
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 72 73 74 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to hopper ROM pad (from all
pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 14598 kg/y TSP  6131 kg/y PM10  730 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9732 kg/y TSP  4087 kg/y PM10  487 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1697 kg/y TSP  803 kg/y PM10  85 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to hopper / ROM pad
(underground)
```

```
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (underground)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM stockpile (open cut)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58129 kg/y TSP  16851 kg/y PM10  2906 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 65901 kg/y TSP  19104 kg/y PM10  3295 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5656 kg/y TSP  2675 kg/y PM10  283 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer transfer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 962 kg/y TSP  455 kg/y PM10  48 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyor unloading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 401 kg/y TSP  190 kg/y PM10  20 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal from stockpiles to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 3206 kg/y TSP  1516 kg/y PM10  160 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 318864 kg/y TSP  159432 kg/y PM10  23915 kg/y
PM2.5
 FROM SOURCES  : 18
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 657000 kg/y TSP  328500 kg/y PM10  49275 kg/y
PM2.5
 FROM SOURCES  : 35
4 5 6 7 8 9 10 11 12 13 32 33 34 35 36 37 38 39 40 41 42 43 44 45
46 47 48 49 50 51 52 53 54 55 56
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from inactive or partially rehabed
dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 164338 kg/y TSP  82169 kg/y PM10  12325 kg/y PM2.5
 FROM SOURCES  : 16
3 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 4380 kg/y TSP  2190 kg/y PM10  329 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3942 kg/y TSP  1971 kg/y PM10  296 kg/y PM2.5
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79691 kg/y TSP  28175 kg/y PM10  3985 kg/y PM2.5
 FROM SOURCES  : 57
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 72 73 74 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
3 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
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Mt Thorley Warkworth 2014

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--------------------------------      17-Sep-2018 11:21
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2014\MTW\emiss.v
ol
 Meteorological file    : NA
 Number of dust sources : 77
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil by scraper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1450 kg/y TSP  365 kg/y PM10  73 kg/y PM2.5
 FROM SOURCES  : 11
1 2 3 4 5 6 7 8 42 43 44
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 31294 kg/y TSP  16273 kg/y PM10  939 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 137518 kg/y TSP  71509 kg/y PM10  4126 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks (All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 548911 kg/y TSP  259620 kg/y PM10  39314 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (-)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from All Pits to dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3936247 kg/y TSP  1163194 kg/y PM10  118087 kg/y
PM2.5
 FROM SOURCES  : 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 22 23 24 25 26 34 35 39 42
43 44 45 46 47 48 50 51 52 53 54 55 56 58 59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from - to dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dump (from All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 548911 kg/y TSP  259620 kg/y PM10  39314 kg/y
PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dump (from -)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (all dumps)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 879609 kg/y TSP  214137 kg/y PM10  92359 kg/y
PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 219902 kg/y TSP  53534 kg/y PM10  23090 kg/y PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Drilling coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 15647 kg/y TSP  8136 kg/y PM10  469 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 48620 kg/y TSP  25282 kg/y PM10  1459 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dozers working on coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 788784 kg/y TSP  251444 kg/y PM10  17353 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 846294 kg/y TSP  121710 kg/y PM10  16080 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (-)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from All Pits to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 650357 kg/y TSP  192186 kg/y PM10  19511 kg/y
PM2.5
 FROM SOURCES  : 41
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 20 21 29 42 43 44 45 46 47
48 50 56 57 62 63 64 65 66 67 68 70 71 72 73 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from - to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to ROM pad
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 53079 kg/y TSP  22293 kg/y PM10  1009 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 17693 kg/y TSP  7431 kg/y PM10  336 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP, inc UG
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2062 kg/y TSP  975 kg/y PM10  148 kg/y PM2.5
 FROM SOURCES  : 4
68 69 74 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP, inc UG
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10309 kg/y TSP  4876 kg/y PM10  148 kg/y PM2.5
 FROM SOURCES  : 2
69 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 131464 kg/y TSP  41907 kg/y PM10  2892 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 56212 kg/y TSP  16198 kg/y PM10  1237 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 890 kg/y TSP  421 kg/y PM10  64 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 4772 kg/y TSP  2028 kg/y PM10  239 kg/y PM2.5
 FROM SOURCES  : 1
69
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 671016 kg/y TSP  335508 kg/y PM10  50326 kg/y
PM2.5
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48 49 50
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 989004 kg/y TSP  494502 kg/y PM10  74175 kg/y
PM2.5
 FROM SOURCES  : 35
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from partially rehabilitated dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 8760 kg/y TSP  4380 kg/y PM10  657 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpile
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 2190 kg/y TSP  1095 kg/y PM10  164 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18464 kg/y TSP  6528 kg/y PM10  202 kg/y PM2.5
 FROM SOURCES  : 77
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
70 71 72 73 74 75 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 311435 kg/y TSP  68390 kg/y PM10  15572 kg/y PM2.5
 FROM SOURCES  : 17
3 4 5 6 7 10 11 12 13 14 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
```

Mt Thorley Warkworth 2022-2035

```
--------------------------------      18-Sep-2018 16:13
  DUST EMISSION CALCULATIONS XL1
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 Output emissions file  :
C:\Users\slakmaker\Projects\IA127300_Bulga\calpuff\2022\MTW\emiss.v
ol
 Meteorological file    : NA
 Number of dust sources : 77
 Number of activities   : 39

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil by scraper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1450 kg/y TSP  365 kg/y PM10  73 kg/y PM2.5
 FROM SOURCES  : 11
1 2 3 4 5 6 7 8 42 43 44
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 31294 kg/y TSP  16273 kg/y PM10  939 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 137518 kg/y TSP  71509 kg/y PM10  4126 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks (All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 868678 kg/y TSP  410861 kg/y PM10  62216 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading overburden to trucks (-)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from All Pits to dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6229295 kg/y TSP  1840808 kg/y PM10  186879 kg/y
PM2.5
 FROM SOURCES  : 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 22 23 24 25 26 34 35 39 42
43 44 45 46 47 48 50 51 52 53 54 55 56 58 59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from - to dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dump (from All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 868678 kg/y TSP  410861 kg/y PM10  62216 kg/y
PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dump (from -)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (all dumps)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 879609 kg/y TSP  214137 kg/y PM10  92359 kg/y
PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 219902 kg/y TSP  53534 kg/y PM10  23090 kg/y PM2.5
 FROM SOURCES  : 36
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Drilling coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 15647 kg/y TSP  8136 kg/y PM10  469 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 48620 kg/y TSP  25282 kg/y PM10  1459 kg/y PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dozers working on coal (All Pits)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 788784 kg/y TSP  251444 kg/y PM10  17353 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal (-)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (All Pits)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1339301 kg/y TSP  192613 kg/y PM10  25447 kg/y
PM2.5
 FROM SOURCES  : 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks (-)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from All Pits to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1029221 kg/y TSP  304143 kg/y PM10  30877 kg/y
PM2.5
 FROM SOURCES  : 41
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 20 21 29 42 43 44 45 46 47
48 50 56 57 62 63 64 65 66 67 68 70 71 72 73 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from - to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal to ROM pad
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 84000 kg/y TSP  35280 kg/y PM10  1596 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : ROM coal rehandle to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 28000 kg/y TSP  11760 kg/y PM10  532 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transferring ROM coal by conveyor to CHPP, inc UG
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 3263 kg/y TSP  1543 kg/y PM10  234 kg/y PM2.5
 FROM SOURCES  : 4
68 69 74 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP, inc UG
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16315 kg/y TSP  7717 kg/y PM10  234 kg/y PM2.5
 FROM SOURCES  : 2
69 75
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on ROM coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 131464 kg/y TSP  41907 kg/y PM10  2892 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers on product coal stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 56212 kg/y TSP  16198 kg/y PM10  1237 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Conveyer to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2089 kg/y TSP  988 kg/y PM10  150 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 11200 kg/y TSP  4760 kg/y PM10  560 kg/y PM2.5
 FROM SOURCES  : 1
69
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 671016 kg/y TSP  335508 kg/y PM10  50326 kg/y
PM2.5
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48 49 50
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 989004 kg/y TSP  494502 kg/y PM10  74175 kg/y
PM2.5
 FROM SOURCES  : 35
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from partially rehabilitated dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 8760 kg/y TSP  4380 kg/y PM10  657 kg/y PM2.5
 FROM SOURCES  : 2
68 74
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product coal stockpile
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 2190 kg/y TSP  1095 kg/y PM10  164 kg/y PM2.5
 FROM SOURCES  : 3
69 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18464 kg/y TSP  6528 kg/y PM10  202 kg/y PM2.5
 FROM SOURCES  : 77
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
70 71 72 73 74 75 76 77
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dragline working on overburden
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 492860 kg/y TSP  108230 kg/y PM10  24643 kg/y
PM2.5
 FROM SOURCES  : 17
3 4 5 6 7 10 11 12 13 14 42 43 44 45 46 47 48
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 42 43 44 45 46 47 48
```

Appendix C. Model Receptors

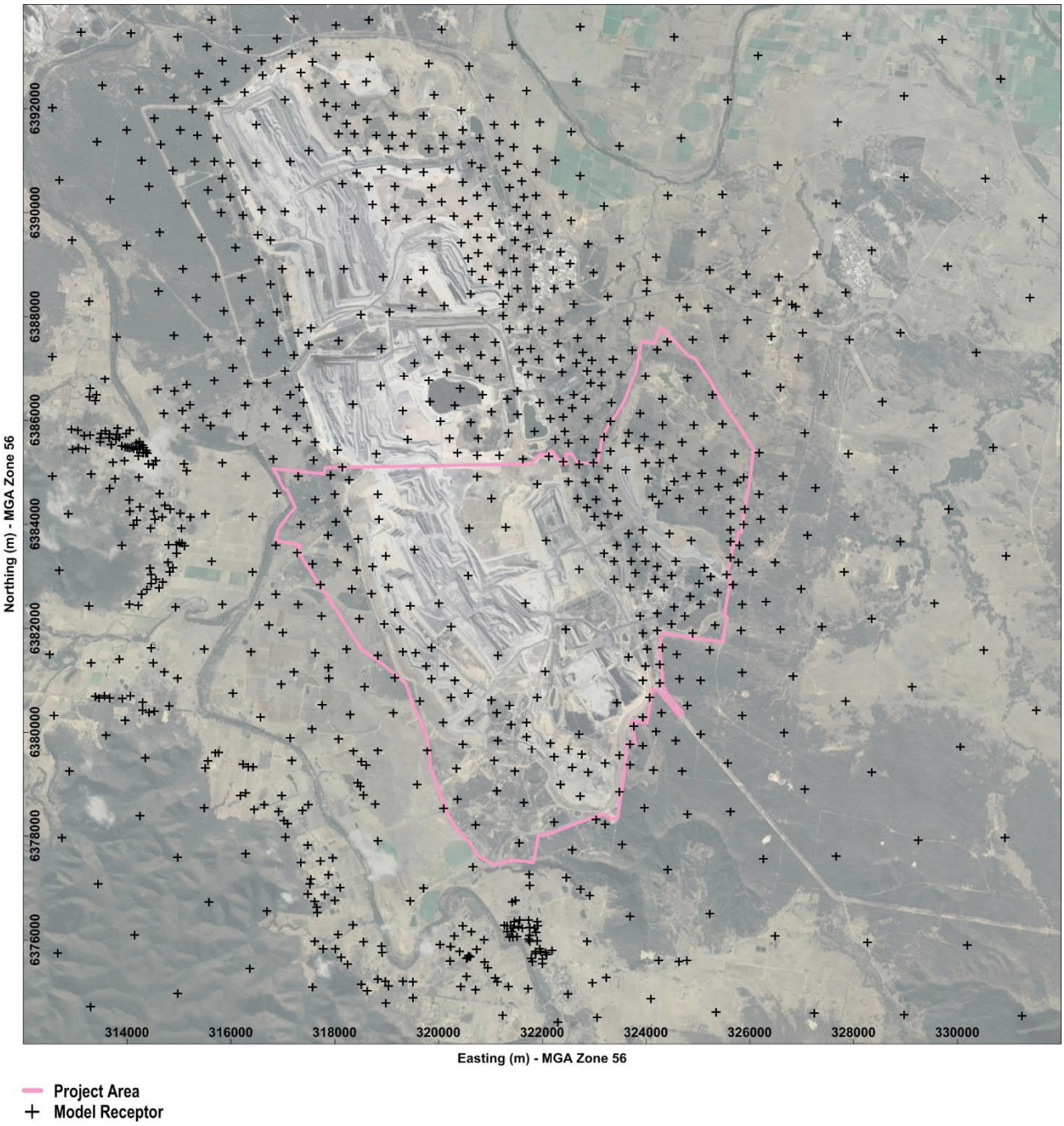


Figure C1 Location of model receptors

Appendix D. Tabulated Model Results

Model predictions at properties and monitors

ID	Type	Project in isolation				Cumulative					Criteria
		2022	2026	2031	2035	2014	2022	2026	2031	2035	
Maximum 24-hour average PM10 (ug/m3)											
3	Private	32	26	26	18	46	48	48	47	47	50
8	Private	24	21	25	17	45	48	47	46	46	50
21	Private	9	10	10	6	45	47	48	48	46	50
33	Private	8	9	9	5	48	48	49	48	47	50
37	Private	8	9	10	5	45	45	45	46	44	50
38	Private	8	9	9	5	44	45	45	46	44	50
41	Private	6	7	7	4	42	44	44	45	43	50
46	Private	6	7	7	4	42	44	44	44	43	50
55	Private	6	7	7	4	42	44	45	45	43	50
56	Private	7	7	7	4	42	44	44	45	43	50
57	Private	7	7	7	4	42	44	44	45	43	50
58	Private	6	7	7	3	42	44	44	45	43	50
60	Private	6	7	6	3	42	44	44	44	43	50
61	Private	6	7	7	4	42	44	44	45	43	50
62	Private	6	7	7	4	42	44	44	44	43	50
63	Private	6	7	6	3	42	44	44	44	43	50
71	Private	6	7	7	4	42	44	45	45	43	50
76	Private	6	7	6	3	42	44	44	45	43	50
78	Private	6	6	6	3	42	44	44	44	43	50
80	Private	5	6	6	3	42	43	43	44	43	50
82	Private	4	5	5	2	42	43	43	43	43	50
83	Private	4	5	4	2	42	43	43	44	43	50
84	Private	4	5	4	2	42	43	44	44	43	50
85	Private	4	5	4	2	42	43	44	44	43	50
86	Private	4	5	4	2	42	44	44	44	43	50
87	Private	4	5	4	2	42	44	44	44	43	50
90	Private	3	4	3	2	42	43	44	43	43	50
91	Private	3	4	4	2	42	44	44	44	43	50
93	Private	4	5	5	2	43	44	44	44	43	50
94	Private	5	6	6	3	43	44	45	45	43	50
95	Private	5	6	6	3	43	44	45	45	43	50
97	Private	9	10	10	5	43	46	46	46	44	50
98	Private	3	3	3	2	42	43	44	44	43	50
100	Private	4	4	4	2	43	44	44	44	43	50
101	Private	4	5	4	2	43	44	44	44	43	50
102	Private	4	5	5	2	43	44	44	44	43	50
103	Private	5	5	5	3	43	44	45	44	43	50
107	Private	3	3	3	2	43	43	44	43	43	50
108	Private	3	3	3	2	43	43	44	43	43	50
109	Private	2	3	3	2	42	43	43	43	43	50
114	Private	3	2	2	1	42	43	43	43	42	50
115	Private	3	3	3	2	43	43	43	43	43	50
116	Private	3	3	3	2	43	43	44	43	43	50
117	Private	4	4	4	2	43	44	44	44	43	50
118	Private	4	4	4	2	43	44	44	44	43	50
119	Private	4	4	4	2	43	44	44	44	43	50
122	Private	3	3	3	2	43	43	43	43	43	50
123	Private	3	3	4	2	43	44	44	43	43	50
124	Private	3	4	4	2	43	44	44	44	43	50
125	Private	4	4	4	2	43	44	44	44	43	50
130	Private	5	5	5	3	43	44	44	44	43	50
131	Private	5	5	5	3	43	44	44	44	43	50
132	Private	6	6	6	3	43	44	44	44	43	50
137	Private	6	6	6	3	43	44	45	44	43	50
138	Private	6	6	6	3	44	45	45	45	44	50
140	Private	6	6	6	3	44	44	45	44	43	50
144	Private	8	8	8	4	44	45	46	46	44	50
145	Private	8	8	8	4	44	45	46	45	44	50
147	BCM	11	12	12	6	44	46	47	46	45	50
149	Private	16	19	21	12	45	49	50	49	46	50
154	BCM	17	16	15	8	45	48	49	48	46	50
160	BCM	22	23	19	9	47	51	51	49	47	50
164	Private	9	9	8	4	44	46	46	46	45	50
165	Private	8	8	7	4	44	46	46	46	45	50
170	Private	8	9	7	3	45	47	47	46	45	50
171	Private	10	10	8	4	45	47	47	47	45	50
175	Private	7	8	6	3	45	47	46	46	45	50
179	Private	12	13	9	4	46	48	48	47	46	50
183	Private	8	9	6	3	46	47	47	47	45	50
184	Private	8	9	6	3	46	47	47	47	45	50
185	Private	8	8	6	3	46	47	47	47	45	50

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
190	Private	4	5	4	3	45	46	47	46	45	50
191	Private	4	4	4	3	45	46	46	46	45	50
192	Private	4	4	4	3	45	46	46	46	45	50
193	Private	3	4	3	2	45	46	46	45	45	50
194	Private	3	3	3	2	44	45	45	45	44	50
195	Private	20	24	14	6	49	51	51	49	47	50
197	Private	9	11	8	4	47	49	49	48	46	50
198	Private	6	7	6	4	47	47	47	47	46	50
199	Private	5	5	5	3	46	47	47	46	45	50
200	Private	6	6	5	3	47	47	47	47	46	50
202	Private	4	4	4	3	46	46	46	46	45	50
203	Private	4	4	4	2	46	46	46	46	45	50
204	Private	4	4	4	2	45	46	46	45	45	50
206	Private	3	3	4	2	45	46	46	45	45	50
207	Private	3	3	3	2	45	46	46	45	45	50
208	Private	3	3	3	2	45	45	45	45	44	50
209	Private	3	3	3	2	45	45	45	45	44	50
211	Private	6	5	5	3	47	47	47	47	46	50
212	Private	6	6	5	3	47	47	47	47	46	50
213	Private	5	5	4	3	46	46	46	46	45	50
214	Private	4	4	4	2	46	46	46	46	45	50
220	Private	5	5	5	3	48	49	50	49	48	50
221	Private	5	5	4	3	48	49	49	48	48	50
222	Private	6	6	5	3	49	50	50	50	49	50
223	Private	5	6	5	3	49	50	50	49	49	50
225	Private	4	4	4	2	47	48	48	47	47	50
226	Private	6	7	6	4	50	51	51	50	49	50
227	Private	6	6	5	3	49	50	51	50	49	50
228	Private	6	7	5	4	50	51	51	50	50	50
229	Private	6	7	6	4	50	51	52	51	50	50
230	Private	7	8	7	5	51	52	52	52	51	50
231	Private	6	7	6	4	50	52	52	52	51	50
232	Private	8	9	8	6	52	54	54	54	53	50
233	Private	7	8	7	5	51	53	53	52	52	50
234	Private	8	9	8	6	53	55	56	55	54	50
235	Private	8	9	8	6	54	58	58	57	57	50
236	Private	7	8	7	5	53	57	57	57	56	50
237	Private	9	10	10	7	56	60	60	59	58	50
238	Private	7	8	8	5	54	58	58	57	57	50
239	Private	11	12	11	7	57	61	61	61	60	50
240	Private	9	10	10	6	56	60	60	59	59	50
241	Private	8	9	9	6	55	59	59	59	58	50
242	Private	7	8	8	5	54	58	58	58	57	50
243	Private	8	9	8	6	55	59	59	59	58	50
244	Private	8	8	8	5	53	57	57	57	56	50
247	Private	7	8	7	5	52	56	56	55	55	50
250	Private	5	5	4	3	48	49	49	48	48	50
254	Private	10	11	10	6	54	58	58	58	58	50
256	Private	9	10	9	6	53	57	57	57	56	50
261	Private	13	13	12	7	57	61	62	61	61	50
262	Private	12	13	11	7	57	61	61	61	60	50
263	Private	12	13	11	7	56	61	61	60	60	50
264	Private	12	13	11	7	57	61	61	61	60	50
265	Private	12	13	11	7	56	60	60	60	59	50
266	Private	12	13	11	7	56	60	60	60	59	50
267	Yancoal	12	13	11	7	56	60	60	60	59	50
272	Private	12	13	11	7	56	60	60	60	59	50
273	Private	12	13	11	7	56	60	60	60	59	50
274	Yancoal	12	13	11	7	55	60	60	59	59	50
275	Private	12	13	11	7	55	59	59	59	59	50
276	Private	12	13	11	7	55	59	59	59	59	50
279	Private	12	13	11	7	55	60	60	59	59	50
280	Private	12	12	11	7	55	59	59	59	59	50
281	Private	12	12	11	7	55	59	59	59	59	50
283	Private	11	12	11	7	55	59	59	59	58	50
285	Private	11	12	10	7	54	58	58	58	58	50
286	Private	11	12	10	7	54	58	58	58	58	50
287	Private	11	12	10	6	54	58	58	58	57	50
288	Private	12	12	11	7	55	59	59	59	58	50
289	Private	11	12	10	6	54	58	58	57	57	50
290	Private	11	12	10	6	54	58	58	58	57	50
291	Private	11	11	10	6	54	58	58	58	57	50
292	Private	11	12	10	6	54	58	58	58	57	50
293	Private	11	12	10	6	54	58	58	57	57	50
295	Private	10	11	10	6	53	57	57	57	57	50

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
296	Private	10	11	10	6	53	57	57	57	57	50
297	Private	10	11	10	6	54	57	58	57	57	50
298	Private	10	11	9	6	53	57	57	57	56	50
300	Private	10	10	9	6	53	56	56	56	56	50
301	Private	10	10	9	6	53	56	56	56	56	50
302	Private	9	10	9	6	52	56	56	55	55	50
303	Private	9	9	8	5	52	55	55	55	55	50
304	Private	8	9	8	5	51	55	55	55	54	50
305	Private	8	9	8	5	51	54	54	54	54	50
306	Private	12	12	10	7	54	58	58	58	58	50
307	Yancoal	15	16	14	9	61	66	66	66	66	50
308	Yancoal	13	15	13	8	58	63	63	63	62	50
309	Private	10	10	9	5	52	56	56	56	56	50
311	Private	13	13	12	8	58	63	63	63	63	50
314	Yancoal	10	10	8	5	52	56	56	55	55	50
317	Private	9	10	9	6	53	57	57	57	56	50
323	Private	26	22	24	16	45	47	47	46	46	50
324	Private	21	18	20	14	45	47	46	46	45	50
325	Private	20	17	18	12	44	46	46	45	45	50
326	Private	10	11	9	6	53	57	57	56	56	50
327	Private	7	8	6	4	50	52	52	51	50	50
105A	Private	6	7	7	4	44	45	46	45	44	50
105C	Private	6	7	7	4	44	45	46	45	44	50
113A	Private	3	3	3	2	43	43	44	43	43	50
113B	Private	3	3	3	2	43	43	44	43	43	50
121A	Private	5	5	5	3	43	44	44	44	43	50
121B	Private	4	4	4	2	43	44	44	44	43	50
126A	Private	4	4	4	2	43	44	44	44	43	50
126B	Private	4	4	4	2	43	44	44	44	43	50
142A	Private	7	7	7	4	44	45	45	45	44	50
142B	Private	7	7	7	3	44	45	45	45	44	50
142C	Private	6	6	6	3	44	45	45	45	44	50
143A	Private	8	8	7	4	44	45	45	45	44	50
143B	Private	7	7	7	4	44	45	45	45	44	50
169A	Private	9	9	8	4	45	47	47	46	45	50
169e	Private	10	10	9	4	45	47	47	47	45	50
177B	Private	6	6	5	2	45	47	47	46	45	50
188A	Private	6	7	5	3	46	47	47	47	45	50
188B	Private	6	7	5	3	46	47	47	47	45	50
188C	Private	6	7	5	3	46	47	47	47	45	50
1A	Private	39	39	33	16	51	55	55	54	54	50
217m	Private	13	14	11	6	51	52	52	51	49	50
217n	Private	13	14	12	7	52	53	53	52	50	50
217s	Private	14	16	11	6	51	52	52	51	49	50
316A	Private	9	10	8	5	52	55	55	55	55	50
316B	Private	10	10	9	5	52	56	56	56	56	50
318A	Yancoal	15	16	13	8	60	66	66	65	65	50
318B	Yancoal	15	16	13	9	61	66	66	66	65	50
319A	Private	7	8	8	4	43	45	45	45	44	50
AB	BCM	12	14	9	4	47	48	49	48	46	50
AD	BCM	22	27	14	7	50	52	52	51	48	50
AF	BCM	7	8	8	5	47	49	50	48	47	50
AH	BCM	50	47	45	22	54	58	57	57	56	50
AI	BCM	22	22	19	9	47	51	51	50	47	50
AJ	BCM	39	37	36	19	49	52	52	52	52	50
AK	BCM	42	39	39	21	50	53	53	52	52	50
B	Private	8	9	8	5	52	56	56	55	55	50
C	Private	8	9	8	5	51	55	55	55	54	50
D	Private	7	8	7	5	51	54	54	54	54	50
E	BCM	9	10	9	6	53	56	56	55	54	50
G	Private	5	6	5	3	43	44	45	44	43	50
H	Private	5	5	5	3	43	43	43	43	42	50
I	Private	9	10	9	6	55	59	59	59	58	50
J	Private	11	12	11	7	57	61	62	61	60	50
K	BCM	11	13	12	8	58	62	62	61	60	50
M	BCM	44	50	38	20	69	66	68	64	59	50
N	BCM	17	19	15	9	54	55	56	54	52	50
O	BCM	14	16	14	9	60	63	63	62	61	50
P	Private	11	12	11	7	57	62	62	61	61	50
Q	BCM	18	22	25	14	45	50	51	50	47	50
Z	BCM	21	23	17	7	48	50	50	49	47	50
139	Private	6	6	6	3	44	44	45	44	43	50
277	Yancoal	12	13	11	7	55	59	59	59	59	50
284	Yancoal	11	12	10	7	55	59	59	58	58	50
A	Private	3	3	3	2	42	43	43	43	42	50

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
AG	BCM	4	5	4	2	43	44	44	44	43	50
R	Yancoal	14	14	12	8	60	65	65	65	65	50
X	Yancoal	17	18	15	10	90	102	102	99	97	50
294	Private	11	11	10	6	54	58	58	57	57	50
328	Private	6	7	7	3	42	44	44	45	43	50
329	Private	6	6	6	3	42	44	44	44	43	50
330	Private	6	7	6	3	42	44	44	45	43	50
331	Private	5	6	6	3	42	44	44	44	43	50
332	Private	5	6	6	3	42	43	44	44	43	50
333	Private	6	7	7	4	42	44	44	44	43	50
334	Private	5	6	6	3	42	43	44	44	43	50
335	Private	5	6	6	3	42	43	44	44	43	50
336	Private	5	6	6	3	42	43	43	44	43	50
337	Private	5	6	6	3	42	43	43	44	43	50
338	Private	5	6	6	4	42	43	43	44	43	50
339	Private	5	6	6	3	42	43	44	44	43	50
340	Private	5	6	6	3	42	43	44	44	43	50
341	Private	5	6	6	3	42	43	44	44	43	50
342	Private	6	7	7	4	42	44	44	44	43	50
343	Private	4	5	5	3	43	44	44	44	43	50
88	Private	5	5	6	3	43	44	44	44	43	50
344	Private	7	9	8	5	47	49	49	48	47	50
156B	BCM	18	17	16	8	46	48	49	48	46	50
156w	BCM	18	17	16	8	46	49	49	48	46	50
177A	Private	6	6	5	2	45	47	47	46	45	50
176	Private	7	8	6	3	45	46	46	46	45	50
174	Private	8	8	7	3	45	46	46	46	45	50
162	Private	11	11	9	5	45	47	47	47	45	50
AA	BCM	17	20	13	5	47	49	49	49	47	50
153	BCM	17	16	16	8	45	47	49	48	46	50
105B	Private	5	6	6	3	43	45	45	45	44	50
319B	Private	7	8	8	4	43	45	45	45	44	50
72	Private	6	7	6	3	42	44	45	45	43	50
73	Private	6	7	6	3	42	44	44	45	43	50
74	Private	6	7	6	3	42	44	44	45	43	50
345	Private	6	7	6	3	42	44	44	44	43	50
23	Private	8	9	8	6	45	47	48	47	45	50
20	Private	9	11	10	7	45	47	49	48	46	50
S	Yancoal	16	17	15	9	61	67	67	67	66	50
T	Yancoal	17	17	15	9	65	73	73	72	72	50
U	Yancoal	18	18	15	10	66	74	74	73	72	50
V	Yancoal	19	19	16	10	75	84	84	83	82	50
W	Yancoal	21	22	19	12	97	115	116	114	112	50
Y	Yancoal	20	21	18	11	105	128	128	124	121	50
346	Yancoal	15	16	13	8	62	68	68	68	67	50
347	Yancoal	14	14	12	7	61	68	68	67	67	50
MCF	MCF	104	86	85	55	56	116	100	91	64	50
D10	BAM PM2.5	10	11	11	7	55	59	59	58	57	50
D2	BAM PM2.5	4	5	4	2	43	44	44	44	43	50
A3	Dust dep	9	9	9	6	53	57	57	57	57	50
D9	Dust dep	12	12	11	7	55	60	60	59	59	50
D10	Dust dep	9	9	9	6	53	55	56	55	54	50
Sharrock 1	Dust dep	9	9	8	4	44	46	47	46	45	50
D6	Dust dep	3	4	4	2	42	43	43	43	42	50
Hedley	Dust dep	39	33	38	24	48	51	51	50	50	50
C5	Dust dep	6	7	7	4	42	44	44	44	43	50
N5	Dust dep	12	13	12	8	58	62	62	61	60	50
F3	Dust dep	22	23	20	10	47	50	51	50	47	50
Redibar	Dust dep	4	5	4	2	43	44	44	44	43	50
EPA 9	EWU PM10	76	65	45	20	207	114	115	115	114	50
EPA 10	EWU PM10	25	32	27	21	58	65	71	68	63	50
Dawtrey	HVAS PM10	14	16	11	6	49	51	51	49	47	50
D10	HVAS PM10	10	10	10	6	53	56	56	55	54	50
Hill Street	HVAS PM10	4	5	5	2	43	44	44	44	43	50
Dawtrey	HVAS TSP	14	16	11	6	49	51	51	49	47	50
D10	HVAS TSP	10	10	10	6	53	56	56	55	54	50
Hill Street	HVAS TSP	4	5	5	2	43	44	44	44	43	50
Mt Thorley	OEH	47	40	45	26	50	55	52	53	52	50
MCF	TEOM PM10	104	86	85	55	56	116	100	91	64	50
D1	TEOM PM10	4	5	5	2	43	44	44	44	43	50
D3	TEOM PM10	10	10	10	6	53	55	56	55	54	50
D5	TEOM PM10	22	26	15	8	51	53	53	51	48	50
D11	TEOM PM10	19	17	18	12	44	46	46	45	45	50
Days above PM10 criterion (days)											
3	Private	0	0	0	0	0	0	0	0	0	-

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
8	Private	0	0	0	0	0	0	0	0	0	-
21	Private	0	0	0	0	0	0	0	0	0	-
33	Private	0	0	0	0	0	0	0	0	0	-
37	Private	0	0	0	0	0	0	0	0	0	-
38	Private	0	0	0	0	0	0	0	0	0	-
41	Private	0	0	0	0	0	0	0	0	0	-
46	Private	0	0	0	0	0	0	0	0	0	-
55	Private	0	0	0	0	0	0	0	0	0	-
56	Private	0	0	0	0	0	0	0	0	0	-
57	Private	0	0	0	0	0	0	0	0	0	-
58	Private	0	0	0	0	0	0	0	0	0	-
60	Private	0	0	0	0	0	0	0	0	0	-
61	Private	0	0	0	0	0	0	0	0	0	-
62	Private	0	0	0	0	0	0	0	0	0	-
63	Private	0	0	0	0	0	0	0	0	0	-
71	Private	0	0	0	0	0	0	0	0	0	-
76	Private	0	0	0	0	0	0	0	0	0	-
78	Private	0	0	0	0	0	0	0	0	0	-
80	Private	0	0	0	0	0	0	0	0	0	-
82	Private	0	0	0	0	0	0	0	0	0	-
83	Private	0	0	0	0	0	0	0	0	0	-
84	Private	0	0	0	0	0	0	0	0	0	-
85	Private	0	0	0	0	0	0	0	0	0	-
86	Private	0	0	0	0	0	0	0	0	0	-
87	Private	0	0	0	0	0	0	0	0	0	-
90	Private	0	0	0	0	0	0	0	0	0	-
91	Private	0	0	0	0	0	0	0	0	0	-
93	Private	0	0	0	0	0	0	0	0	0	-
94	Private	0	0	0	0	0	0	0	0	0	-
95	Private	0	0	0	0	0	0	0	0	0	-
97	Private	0	0	0	0	0	0	0	0	0	-
98	Private	0	0	0	0	0	0	0	0	0	-
100	Private	0	0	0	0	0	0	0	0	0	-
101	Private	0	0	0	0	0	0	0	0	0	-
102	Private	0	0	0	0	0	0	0	0	0	-
103	Private	0	0	0	0	0	0	0	0	0	-
107	Private	0	0	0	0	0	0	0	0	0	-
108	Private	0	0	0	0	0	0	0	0	0	-
109	Private	0	0	0	0	0	0	0	0	0	-
114	Private	0	0	0	0	0	0	0	0	0	-
115	Private	0	0	0	0	0	0	0	0	0	-
116	Private	0	0	0	0	0	0	0	0	0	-
117	Private	0	0	0	0	0	0	0	0	0	-
118	Private	0	0	0	0	0	0	0	0	0	-
119	Private	0	0	0	0	0	0	0	0	0	-
122	Private	0	0	0	0	0	0	0	0	0	-
123	Private	0	0	0	0	0	0	0	0	0	-
124	Private	0	0	0	0	0	0	0	0	0	-
125	Private	0	0	0	0	0	0	0	0	0	-
130	Private	0	0	0	0	0	0	0	0	0	-
131	Private	0	0	0	0	0	0	0	0	0	-
132	Private	0	0	0	0	0	0	0	0	0	-
137	Private	0	0	0	0	0	0	0	0	0	-
138	Private	0	0	0	0	0	0	0	0	0	-
140	Private	0	0	0	0	0	0	0	0	0	-
144	Private	0	0	0	0	0	0	0	0	0	-
145	Private	0	0	0	0	0	0	0	0	0	-
147	BCM	0	0	0	0	0	0	0	0	0	-
149	Private	0	0	0	0	0	0	0	0	0	-
154	BCM	0	0	0	0	0	0	0	0	0	-
160	BCM	0	0	0	0	0	1	1	0	0	-
164	Private	0	0	0	0	0	0	0	0	0	-
165	Private	0	0	0	0	0	0	0	0	0	-
170	Private	0	0	0	0	0	0	0	0	0	-
171	Private	0	0	0	0	0	0	0	0	0	-
175	Private	0	0	0	0	0	0	0	0	0	-
179	Private	0	0	0	0	0	0	0	0	0	-
183	Private	0	0	0	0	0	0	0	0	0	-
184	Private	0	0	0	0	0	0	0	0	0	-
185	Private	0	0	0	0	0	0	0	0	0	-
190	Private	0	0	0	0	0	0	0	0	0	-
191	Private	0	0	0	0	0	0	0	0	0	-
192	Private	0	0	0	0	0	0	0	0	0	-
193	Private	0	0	0	0	0	0	0	0	0	-
194	Private	0	0	0	0	0	0	0	0	0	-

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
195	Private	0	0	0	0	0	1	1	0	0	-
197	Private	0	0	0	0	0	0	0	0	0	-
198	Private	0	0	0	0	0	0	0	0	0	-
199	Private	0	0	0	0	0	0	0	0	0	-
200	Private	0	0	0	0	0	0	0	0	0	-
202	Private	0	0	0	0	0	0	0	0	0	-
203	Private	0	0	0	0	0	0	0	0	0	-
204	Private	0	0	0	0	0	0	0	0	0	-
206	Private	0	0	0	0	0	0	0	0	0	-
207	Private	0	0	0	0	0	0	0	0	0	-
208	Private	0	0	0	0	0	0	0	0	0	-
209	Private	0	0	0	0	0	0	0	0	0	-
211	Private	0	0	0	0	0	0	0	0	0	-
212	Private	0	0	0	0	0	0	0	0	0	-
213	Private	0	0	0	0	0	0	0	0	0	-
214	Private	0	0	0	0	0	0	0	0	0	-
220	Private	0	0	0	0	0	0	0	0	0	-
221	Private	0	0	0	0	0	0	0	0	0	-
222	Private	0	0	0	0	0	1	1	0	0	-
223	Private	0	0	0	0	0	0	0	0	0	-
225	Private	0	0	0	0	0	0	0	0	0	-
226	Private	0	0	0	0	0	1	1	1	0	-
227	Private	0	0	0	0	0	1	1	1	0	-
228	Private	0	0	0	0	0	1	1	1	0	-
229	Private	0	0	0	0	0	1	1	1	1	-
230	Private	0	0	0	0	1	1	1	1	1	-
231	Private	0	0	0	0	1	1	1	1	1	-
232	Private	0	0	0	0	1	1	1	1	1	-
233	Private	0	0	0	0	1	1	1	1	1	-
234	Private	0	0	0	0	1	1	1	1	1	-
235	Private	0	0	0	0	1	1	1	1	1	-
236	Private	0	0	0	0	1	1	1	1	1	-
237	Private	0	0	0	0	1	1	1	1	1	-
238	Private	0	0	0	0	1	1	1	1	1	-
239	Private	0	0	0	0	1	1	1	1	1	-
240	Private	0	0	0	0	1	1	1	1	1	-
241	Private	0	0	0	0	1	1	1	1	1	-
242	Private	0	0	0	0	1	1	1	1	1	-
243	Private	0	0	0	0	1	1	1	1	1	-
244	Private	0	0	0	0	1	1	1	1	1	-
247	Private	0	0	0	0	1	1	1	1	1	-
250	Private	0	0	0	0	0	0	0	0	0	-
254	Private	0	0	0	0	1	1	1	1	1	-
256	Private	0	0	0	0	1	1	1	1	1	-
261	Private	0	0	0	0	1	1	1	1	1	-
262	Private	0	0	0	0	1	1	1	1	1	-
263	Private	0	0	0	0	1	1	1	1	1	-
264	Private	0	0	0	0	1	1	1	1	1	-
265	Private	0	0	0	0	1	1	1	1	1	-
266	Private	0	0	0	0	1	1	1	1	1	-
267	Yancoal	0	0	0	0	1	1	1	1	1	-
272	Private	0	0	0	0	1	1	1	1	1	-
273	Private	0	0	0	0	1	1	1	1	1	-
274	Yancoal	0	0	0	0	1	1	1	1	1	-
275	Private	0	0	0	0	1	1	1	1	1	-
276	Private	0	0	0	0	1	1	1	1	1	-
279	Private	0	0	0	0	1	1	1	1	1	-
280	Private	0	0	0	0	1	1	1	1	1	-
281	Private	0	0	0	0	1	1	1	1	1	-
283	Private	0	0	0	0	1	1	1	1	1	-
285	Private	0	0	0	0	1	1	1	1	1	-
286	Private	0	0	0	0	1	1	1	1	1	-
287	Private	0	0	0	0	1	1	1	1	1	-
288	Private	0	0	0	0	1	1	1	1	1	-
289	Private	0	0	0	0	1	1	1	1	1	-
290	Private	0	0	0	0	1	1	1	1	1	-
291	Private	0	0	0	0	1	1	1	1	1	-
292	Private	0	0	0	0	1	1	1	1	1	-
293	Private	0	0	0	0	1	1	1	1	1	-
295	Private	0	0	0	0	1	1	1	1	1	-
296	Private	0	0	0	0	1	1	1	1	1	-
297	Private	0	0	0	0	1	1	1	1	1	-
298	Private	0	0	0	0	1	1	1	1	1	-
300	Private	0	0	0	0	1	1	1	1	1	-
301	Private	0	0	0	0	1	1	1	1	1	-

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
302	Private	0	0	0	0	1	1	1	1	1	-
303	Private	0	0	0	0	1	1	1	1	1	-
304	Private	0	0	0	0	1	1	1	1	1	-
305	Private	0	0	0	0	1	1	1	1	1	-
306	Private	0	0	0	0	1	1	1	1	1	-
307	Yancoal	0	0	0	0	4	10	11	9	4	-
308	Yancoal	0	0	0	0	2	3	4	2	1	-
309	Private	0	0	0	0	1	1	1	1	1	-
311	Private	0	0	0	0	2	5	5	3	2	-
314	Yancoal	0	0	0	0	1	1	1	1	1	-
317	Private	0	0	0	0	1	1	1	1	1	-
323	Private	0	0	0	0	0	0	0	0	0	-
324	Private	0	0	0	0	0	0	0	0	0	-
325	Private	0	0	0	0	0	0	0	0	0	-
326	Private	0	0	0	0	1	1	1	1	1	-
327	Private	0	0	0	0	1	1	1	1	1	-
105A	Private	0	0	0	0	0	0	0	0	0	-
105C	Private	0	0	0	0	0	0	0	0	0	-
113A	Private	0	0	0	0	0	0	0	0	0	-
113B	Private	0	0	0	0	0	0	0	0	0	-
121A	Private	0	0	0	0	0	0	0	0	0	-
121B	Private	0	0	0	0	0	0	0	0	0	-
126A	Private	0	0	0	0	0	0	0	0	0	-
126B	Private	0	0	0	0	0	0	0	0	0	-
142A	Private	0	0	0	0	0	0	0	0	0	-
142B	Private	0	0	0	0	0	0	0	0	0	-
142C	Private	0	0	0	0	0	0	0	0	0	-
143A	Private	0	0	0	0	0	0	0	0	0	-
143B	Private	0	0	0	0	0	0	0	0	0	-
169A	Private	0	0	0	0	0	0	0	0	0	-
169e	Private	0	0	0	0	0	0	0	0	0	-
177B	Private	0	0	0	0	0	0	0	0	0	-
188A	Private	0	0	0	0	0	0	0	0	0	-
188B	Private	0	0	0	0	0	0	0	0	0	-
188C	Private	0	0	0	0	0	0	0	0	0	-
1A	Private	0	0	0	0	1	3	3	2	1	-
217m	Private	0	0	0	0	1	1	1	1	0	-
217n	Private	0	0	0	0	1	1	1	1	1	-
217s	Private	0	0	0	0	1	1	1	1	0	-
316A	Private	0	0	0	0	1	1	1	1	1	-
316B	Private	0	0	0	0	1	1	1	1	1	-
318A	Yancoal	0	0	0	0	1	1	2	1	1	-
318B	Yancoal	0	0	0	0	1	1	1	1	1	-
319A	Private	0	0	0	0	0	0	0	0	0	-
AB	BCM	0	0	0	0	0	0	0	0	0	-
AD	BCM	0	0	0	0	1	1	1	1	0	-
AF	BCM	0	0	0	0	0	0	0	0	0	-
AH	BCM	0	0	0	0	1	13	10	8	5	-
AI	BCM	0	0	0	0	0	1	1	0	0	-
AJ	BCM	0	0	0	0	0	2	2	2	1	-
AK	BCM	0	0	0	0	0	2	2	2	1	-
B	Private	0	0	0	0	1	1	1	1	1	-
C	Private	0	0	0	0	1	1	1	1	1	-
D	Private	0	0	0	0	1	1	1	1	1	-
E	BCM	0	0	0	0	1	1	1	1	1	-
G	Private	0	0	0	0	0	0	0	0	0	-
H	Private	0	0	0	0	0	0	0	0	0	-
I	Private	0	0	0	0	1	1	1	1	1	-
J	Private	0	0	0	0	1	1	1	1	1	-
K	BCM	0	0	0	0	1	1	1	1	1	-
M	BCM	0	1	0	0	7	7	7	4	2	-
N	BCM	0	0	0	0	1	1	1	1	1	-
O	BCM	0	0	0	0	1	1	1	1	1	-
P	Private	0	0	0	0	1	1	1	1	1	-
Q	BCM	0	0	0	0	0	0	1	1	0	-
Z	BCM	0	0	0	0	0	0	1	0	0	-
139	Private	0	0	0	0	0	0	0	0	0	-
277	Yancoal	0	0	0	0	1	1	1	1	1	-
284	Yancoal	0	0	0	0	1	1	1	1	1	-
A	Private	0	0	0	0	0	0	0	0	0	-
AG	BCM	0	0	0	0	0	0	0	0	0	-
R	Yancoal	0	0	0	0	4	9	9	8	4	-
X	Yancoal	0	0	0	0	71	127	130	121	111	-
294	Private	0	0	0	0	1	1	1	1	1	-
328	Private	0	0	0	0	0	0	0	0	0	-

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
329	Private	0	0	0	0	0	0	0	0	0	-
330	Private	0	0	0	0	0	0	0	0	0	-
331	Private	0	0	0	0	0	0	0	0	0	-
332	Private	0	0	0	0	0	0	0	0	0	-
333	Private	0	0	0	0	0	0	0	0	0	-
334	Private	0	0	0	0	0	0	0	0	0	-
335	Private	0	0	0	0	0	0	0	0	0	-
336	Private	0	0	0	0	0	0	0	0	0	-
337	Private	0	0	0	0	0	0	0	0	0	-
338	Private	0	0	0	0	0	0	0	0	0	-
339	Private	0	0	0	0	0	0	0	0	0	-
340	Private	0	0	0	0	0	0	0	0	0	-
341	Private	0	0	0	0	0	0	0	0	0	-
342	Private	0	0	0	0	0	0	0	0	0	-
343	Private	0	0	0	0	0	0	0	0	0	-
88	Private	0	0	0	0	0	0	0	0	0	-
344	Private	0	0	0	0	0	0	0	0	0	-
156B	BCM	0	0	0	0	0	0	0	0	0	-
156w	BCM	0	0	0	0	0	0	0	0	0	-
177A	Private	0	0	0	0	0	0	0	0	0	-
176	Private	0	0	0	0	0	0	0	0	0	-
174	Private	0	0	0	0	0	0	0	0	0	-
162	Private	0	0	0	0	0	0	0	0	0	-
AA	BCM	0	0	0	0	0	0	0	0	0	-
153	BCM	0	0	0	0	0	0	0	0	0	-
105B	Private	0	0	0	0	0	0	0	0	0	-
319B	Private	0	0	0	0	0	0	0	0	0	-
72	Private	0	0	0	0	0	0	0	0	0	-
73	Private	0	0	0	0	0	0	0	0	0	-
74	Private	0	0	0	0	0	0	0	0	0	-
345	Private	0	0	0	0	0	0	0	0	0	-
23	Private	0	0	0	0	0	0	0	0	0	-
20	Private	0	0	0	0	0	0	0	0	0	-
S	Yancoal	0	0	0	0	3	7	8	7	5	-
T	Yancoal	0	0	0	0	11	21	21	18	15	-
U	Yancoal	0	0	0	0	11	20	21	16	15	-
V	Yancoal	0	0	0	0	34	58	59	56	54	-
W	Yancoal	0	0	0	0	105	150	150	145	132	-
Y	Yancoal	0	0	0	0	140	192	194	188	180	-
346	Yancoal	0	0	0	0	7	13	14	11	10	-
347	Yancoal	0	0	0	0	5	13	12	11	9	-
MCF	MCF	33	13	6	1	3	143	80	59	15	-
D10	BAM PM2.5	0	0	0	0	1	1	1	1	1	-
D2	BAM PM2.5	0	0	0	0	0	0	0	0	0	-
A3	Dust dep	0	0	0	0	1	1	1	1	1	-
D9	Dust dep	0	0	0	0	1	1	1	1	1	-
D10	Dust dep	0	0	0	0	1	1	1	1	1	-
Sharrock 1	Dust dep	0	0	0	0	0	0	0	0	0	-
D6	Dust dep	0	0	0	0	0	0	0	0	0	-
Hedley	Dust dep	0	0	0	0	0	1	1	1	0	-
C5	Dust dep	0	0	0	0	0	0	0	0	0	-
N5	Dust dep	0	0	0	0	1	1	1	1	1	-
F3	Dust dep	0	0	0	0	0	1	1	0	0	-
Redibar	Dust dep	0	0	0	0	0	0	0	0	0	-
EPA 9	EWU PM10	26	5	0	0	271	254	187	149	127	-
EPA 10	EWU PM10	0	0	0	0	2	3	4	3	2	-
Dawtrey	HVAS PM10	0	0	0	0	0	1	1	0	0	-
D10	HVAS PM10	0	0	0	0	1	1	1	1	1	-
Hill Street	HVAS PM10	0	0	0	0	0	0	0	0	0	-
Dawtrey	HVAS TSP	0	0	0	0	0	1	1	0	0	-
D10	HVAS TSP	0	0	0	0	1	1	1	1	1	-
Hill Street	HVAS TSP	0	0	0	0	0	0	0	0	0	-
Mt Thorley	OEH	0	0	0	0	1	6	3	3	1	-
MCF	TEOM PM10	33	13	6	1	3	143	80	59	15	-
D1	TEOM PM10	0	0	0	0	0	0	0	0	0	-
D3	TEOM PM10	0	0	0	0	1	1	1	1	1	-
D5	TEOM PM10	0	0	0	0	1	1	1	1	0	-
D11	TEOM PM10	0	0	0	0	0	0	0	0	0	-
-											
Annual average PM10 (ug/m3)											
3	Private	5.3	4.4	4.1	2.7	17	22	21	20	19	25
8	Private	4.4	3.6	3.3	2.1	17	20	19	19	18	25
21	Private	1.0	1.2	1.1	0.7	15	15	15	15	15	25
33	Private	1.2	1.4	1.2	0.7	15	15	16	15	15	25
37	Private	1.0	1.2	1.0	0.6	15	15	15	15	15	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
38	Private	0.9	1.0	0.9	0.5	14	15	15	15	15	25
41	Private	0.7	0.8	0.7	0.4	14	15	15	15	14	25
46	Private	0.6	0.7	0.6	0.4	14	14	15	14	14	25
55	Private	0.6	0.7	0.6	0.4	14	14	15	14	14	25
56	Private	0.6	0.7	0.7	0.4	14	14	15	14	14	25
57	Private	0.7	0.8	0.7	0.4	14	14	15	15	14	25
58	Private	0.6	0.7	0.6	0.4	14	14	14	14	14	25
60	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
61	Private	0.6	0.7	0.7	0.4	14	14	15	14	14	25
62	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
63	Private	0.6	0.6	0.6	0.3	14	14	14	14	14	25
71	Private	0.6	0.6	0.6	0.3	14	14	14	14	14	25
76	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
78	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
80	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
82	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
83	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
84	Private	0.3	0.4	0.4	0.2	14	14	14	14	14	25
85	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
86	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
87	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
90	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
91	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
93	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
94	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
95	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
97	Private	0.8	0.9	0.8	0.5	14	15	15	15	14	25
98	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
100	Private	0.3	0.4	0.4	0.2	14	14	14	14	14	25
101	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
102	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
103	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
107	Private	0.3	0.3	0.3	0.1	14	14	14	14	14	25
108	Private	0.3	0.3	0.3	0.1	14	14	14	14	14	25
109	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
114	Private	0.2	0.2	0.2	0.1	13	14	14	14	14	25
115	Private	0.2	0.2	0.2	0.1	13	14	14	14	14	25
116	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
117	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
118	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
119	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
122	Private	0.2	0.2	0.2	0.1	14	14	14	14	14	25
123	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
124	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
125	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
130	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
131	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
132	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
137	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
138	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
140	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
144	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
145	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
147	BCM	0.6	0.7	0.6	0.3	14	14	14	14	14	25
149	Private	1.2	1.4	1.2	0.7	15	15	16	15	15	25
154	BCM	0.8	0.9	0.8	0.4	14	15	15	15	14	25
160	BCM	1.0	1.1	1.0	0.5	14	15	15	15	15	25
164	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
165	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
170	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
171	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
175	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
179	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
183	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
184	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
185	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
190	Private	0.4	0.5	0.5	0.3	14	14	14	14	14	25
191	Private	0.4	0.5	0.4	0.3	14	14	14	14	14	25
192	Private	0.4	0.5	0.4	0.3	14	14	14	14	14	25
193	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
194	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
195	Private	1.1	1.3	1.2	0.7	15	15	16	15	15	25
197	Private	0.7	0.8	0.7	0.4	14	15	15	15	14	25
198	Private	0.6	0.8	0.7	0.4	14	14	15	15	14	25
199	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
200	Private	0.6	0.7	0.7	0.4	14	14	15	14	14	25
202	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
203	Private	0.4	0.5	0.5	0.3	14	14	14	14	14	25
204	Private	0.4	0.5	0.4	0.3	14	14	14	14	14	25
206	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
207	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
208	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
209	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
211	Private	0.6	0.8	0.7	0.4	14	14	15	15	14	25
212	Private	0.7	0.8	0.8	0.5	14	15	15	15	14	25
213	Private	0.6	0.6	0.6	0.4	14	14	14	14	14	25
214	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
220	Private	1.1	1.2	1.1	0.7	15	15	15	15	15	25
221	Private	0.9	1.1	1.0	0.6	14	15	15	15	15	25
222	Private	1.2	1.4	1.3	0.8	15	16	16	16	15	25
223	Private	1.1	1.3	1.2	0.7	15	15	16	15	15	25
225	Private	0.7	0.8	0.7	0.5	14	15	15	15	14	25
226	Private	1.3	1.5	1.4	0.9	15	16	16	16	15	25
227	Private	1.2	1.4	1.3	0.8	15	16	16	16	15	25
228	Private	1.3	1.5	1.3	0.8	15	16	16	16	15	25
229	Private	1.3	1.5	1.3	0.8	15	16	16	16	15	25
230	Private	1.6	1.8	1.6	1.0	15	16	16	16	16	25
231	Private	1.4	1.5	1.4	0.9	15	16	16	16	15	25
232	Private	1.8	2.0	1.8	1.1	16	17	17	17	16	25
233	Private	1.6	1.8	1.6	1.0	16	16	16	16	16	25
234	Private	1.8	2.0	1.7	1.1	16	17	17	17	16	25
235	Private	1.7	1.9	1.6	1.0	16	17	17	17	16	25
236	Private	1.5	1.7	1.4	0.9	16	17	17	17	16	25
237	Private	1.9	2.1	1.8	1.1	17	17	18	17	17	25
238	Private	1.6	1.7	1.5	0.9	16	17	17	17	16	25
239	Private	2.1	2.3	1.9	1.2	17	18	18	18	17	25
240	Private	1.9	2.0	1.7	1.1	16	17	18	17	17	25
241	Private	1.7	1.9	1.6	1.0	16	17	17	17	16	25
242	Private	1.6	1.7	1.5	0.9	16	17	17	17	16	25
243	Private	1.6	1.8	1.5	0.9	16	17	17	17	16	25
244	Private	1.4	1.6	1.3	0.8	16	17	17	17	16	25
247	Private	1.3	1.4	1.2	0.8	16	17	17	17	16	25
250	Private	1.0	1.1	1.0	0.6	15	15	15	15	15	25
254	Private	1.8	1.9	1.6	1.0	17	18	18	18	17	25
256	Private	1.6	1.7	1.5	0.9	17	17	18	17	17	25
261	Private	2.2	2.3	1.9	1.2	18	19	19	18	18	25
262	Private	2.2	2.3	1.9	1.2	18	19	19	18	18	25
263	Private	2.0	2.2	1.8	1.1	17	18	19	18	18	25
264	Private	2.1	2.3	1.9	1.2	18	18	19	18	18	25
265	Private	2.1	2.2	1.8	1.1	18	19	19	18	18	25
266	Private	2.0	2.2	1.8	1.1	18	19	19	18	18	25
267	Yancoal	2.0	2.2	1.8	1.1	18	19	19	18	18	25
272	Private	2.1	2.2	1.8	1.1	18	19	19	19	18	25
273	Private	2.0	2.2	1.8	1.1	18	19	19	19	18	25
274	Yancoal	2.0	2.2	1.8	1.1	18	19	19	19	18	25
275	Private	2.0	2.1	1.8	1.1	18	19	19	18	18	25
276	Private	2.0	2.1	1.8	1.1	18	19	19	18	18	25
279	Private	2.0	2.1	1.8	1.1	18	19	19	18	18	25
280	Private	2.0	2.1	1.8	1.1	18	19	19	18	18	25
281	Private	1.9	2.1	1.7	1.1	18	18	19	18	18	25
283	Private	1.9	2.0	1.7	1.1	17	18	18	18	17	25
285	Private	1.9	2.0	1.7	1.0	17	18	18	18	17	25
286	Private	1.8	2.0	1.6	1.0	17	18	18	18	17	25
287	Private	1.8	1.9	1.6	1.0	17	18	18	18	17	25
288	Private	2.0	2.1	1.7	1.1	18	19	19	18	18	25
289	Private	1.8	1.9	1.6	1.0	17	18	18	18	17	25
290	Private	1.8	1.9	1.6	1.0	17	18	18	18	17	25
291	Private	1.7	1.9	1.6	1.0	17	18	18	18	17	25
292	Private	1.9	2.0	1.6	1.0	18	19	19	18	18	25
293	Private	1.8	1.9	1.6	1.0	17	18	19	18	18	25
295	Private	1.7	1.8	1.5	0.9	17	18	18	18	17	25
296	Private	1.7	1.8	1.5	0.9	17	18	18	18	17	25
297	Private	1.7	1.8	1.5	0.9	17	18	18	18	17	25
298	Private	1.6	1.7	1.4	0.9	17	18	18	18	17	25
300	Private	1.6	1.7	1.4	0.9	17	18	18	17	17	25
301	Private	1.5	1.6	1.4	0.9	17	18	18	17	17	25
302	Private	1.4	1.5	1.3	0.8	17	17	17	17	17	25
303	Private	1.4	1.5	1.2	0.8	16	17	17	17	17	25
304	Private	1.3	1.4	1.2	0.7	16	17	17	17	17	25
305	Private	1.3	1.3	1.1	0.7	16	17	17	17	16	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
306	Private	1.9	2.0	1.7	1.0	18	19	19	18	18	25
307	Yancoal	2.6	2.8	2.2	1.4	22	24	24	24	23	25
308	Yancoal	2.3	2.5	2.0	1.2	20	22	22	21	21	25
309	Private	1.5	1.6	1.4	0.8	17	18	18	18	17	25
311	Private	2.1	2.3	1.8	1.1	20	22	22	22	21	25
314	Yancoal	1.5	1.6	1.3	0.8	17	18	18	18	17	25
317	Private	1.6	1.7	1.4	0.9	18	19	19	19	18	25
323	Private	4.4	3.7	3.4	2.2	17	20	19	19	18	25
324	Private	3.7	3.1	2.9	1.9	16	19	19	18	17	25
325	Private	3.2	2.7	2.5	1.6	16	18	18	18	17	25
326	Private	1.6	1.7	1.4	0.9	17	18	18	18	17	25
327	Private	1.5	1.7	1.5	1.0	15	16	16	16	15	25
105A	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
105C	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
113A	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
113B	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
121A	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
121B	Private	0.3	0.3	0.3	0.1	14	14	14	14	14	25
126A	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
126B	Private	0.2	0.3	0.2	0.1	14	14	14	14	14	25
142A	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
142B	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
142C	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
143A	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
143B	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
169A	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
169e	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
177B	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
188A	Private	0.4	0.5	0.5	0.3	14	14	14	14	14	25
188B	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
188C	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
1A	Private	6.8	6.3	5.7	3.3	22	27	27	26	24	25
217m	Private	1.9	2.2	2.0	1.2	15	16	17	17	16	25
217n	Private	2.2	2.6	2.3	1.4	16	17	17	17	16	25
217s	Private	1.9	2.3	2.0	1.3	16	17	17	17	16	25
316A	Private	1.5	1.6	1.3	0.8	17	18	18	18	17	25
316B	Private	1.5	1.6	1.4	0.8	17	18	18	18	18	25
318A	Yancoal	2.7	2.9	2.4	1.5	19	20	20	20	19	25
318B	Yancoal	2.7	3.0	2.4	1.5	19	20	20	19	18	25
319A	Private	0.7	0.8	0.7	0.4	14	15	15	15	14	25
AB	BCM	0.7	0.8	0.7	0.4	14	15	15	15	14	25
AD	BCM	1.6	1.9	1.7	1.0	15	16	16	16	15	25
AF	BCM	1.1	1.3	1.2	0.7	15	15	15	15	15	25
AH	BCM	9.5	8.5	8.1	4.7	23	30	29	28	25	25
AI	BCM	1.0	1.1	1.0	0.5	14	15	15	15	15	25
AJ	BCM	6.8	6.1	5.8	3.4	20	25	25	24	22	25
AK	BCM	7.2	6.5	6.1	3.6	20	26	25	25	22	25
B	Private	1.4	1.5	1.2	0.8	16	17	17	17	17	25
C	Private	1.3	1.4	1.2	0.7	16	17	17	17	16	25
D	Private	1.2	1.3	1.1	0.7	16	17	17	17	16	25
E	BCM	2.0	2.2	1.9	1.2	16	17	17	17	16	25
G	Private	0.6	0.7	0.6	0.4	14	14	14	14	14	25
H	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
I	Private	1.8	2.0	1.7	1.1	16	17	17	17	16	25
J	Private	2.1	2.3	2.0	1.2	17	18	18	18	17	25
K	BCM	2.3	2.5	2.1	1.3	17	18	18	18	17	25
M	BCM	6.3	7.2	5.6	3.3	22	22	23	22	19	25
N	BCM	2.9	3.4	2.9	1.8	17	18	18	18	17	25
O	BCM	2.9	3.2	2.6	1.6	18	19	19	19	18	25
P	Private	2.1	2.2	1.9	1.2	17	18	18	18	17	25
Q	BCM	1.4	1.7	1.5	0.8	15	16	16	16	15	25
Z	BCM	0.9	1.1	1.0	0.5	14	15	15	15	15	25
139	Private	0.3	0.4	0.3	0.2	14	14	14	14	14	25
277	Yancoal	2.0	2.1	1.8	1.1	18	19	19	19	18	25
284	Yancoal	1.9	2.0	1.7	1.0	17	18	18	18	17	25
A	Private	0.3	0.3	0.3	0.2	14	14	14	14	14	25
AG	BCM	0.4	0.4	0.4	0.2	14	14	14	14	14	25
R	Yancoal	2.3	2.5	2.0	1.2	22	24	24	23	23	25
X	Yancoal	3.3	3.4	2.7	1.6	34	40	41	40	39	25
294	Private	1.7	1.9	1.5	1.0	17	18	18	18	17	25
328	Private	0.6	0.7	0.6	0.4	14	14	14	14	14	25
329	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
330	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
331	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
332	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
333	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
334	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
335	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
336	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
337	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
338	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
339	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
340	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
341	Private	0.5	0.6	0.6	0.3	14	14	14	14	14	25
342	Private	0.6	0.7	0.7	0.4	14	14	15	14	14	25
343	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
88	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
344	Private	1.1	1.3	1.2	0.7	15	15	16	15	15	25
156B	BCM	0.8	0.9	0.8	0.4	14	15	15	15	14	25
156w	BCM	0.8	0.9	0.8	0.4	14	15	15	15	14	25
177A	Private	0.4	0.5	0.4	0.2	14	14	14	14	14	25
176	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
174	Private	0.4	0.4	0.4	0.2	14	14	14	14	14	25
162	Private	0.5	0.6	0.5	0.3	14	14	14	14	14	25
AA	BCM	0.9	1.0	0.9	0.5	14	15	15	15	14	25
153	BCM	0.8	0.9	0.8	0.4	14	15	15	15	14	25
105B	Private	0.5	0.5	0.5	0.3	14	14	14	14	14	25
319B	Private	0.7	0.8	0.8	0.4	14	15	15	15	14	25
72	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
73	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
74	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
345	Private	0.6	0.7	0.6	0.3	14	14	14	14	14	25
23	Private	0.9	1.1	1.0	0.6	14	15	15	15	15	25
20	Private	1.0	1.2	1.1	0.7	15	15	15	15	15	25
S	Yancoal	2.8	3.0	2.4	1.4	21	23	23	23	22	25
T	Yancoal	3.1	3.3	2.6	1.6	24	27	27	26	25	25
U	Yancoal	3.2	3.5	2.7	1.7	24	26	27	26	25	25
V	Yancoal	3.6	3.8	3.0	1.8	29	33	33	32	31	25
W	Yancoal	4.1	4.3	3.3	2.0	38	44	45	44	42	25
Y	Yancoal	3.9	4.1	3.2	1.9	42	50	50	49	48	25
346	Yancoal	2.7	2.9	2.3	1.4	23	25	26	25	24	25
347	Yancoal	2.5	2.6	2.1	1.2	23	26	26	25	24	25
MCF	MCF	27.2	20.6	16.8	11.2	26	46	39	36	30	25
D10	BAM PM2.5	2.2	2.4	2.0	1.3	17	18	18	17	17	25
D2	BAM PM2.5	0.4	0.4	0.4	0.2	14	14	14	14	14	25
A3	Dust dep	1.5	1.7	1.4	0.9	16	17	17	17	16	25
D9	Dust dep	1.9	2.1	1.7	1.1	17	18	18	18	17	25
D10	Dust dep	1.9	2.1	1.8	1.2	16	17	17	17	16	25
Sharrock 1	Dust dep	0.4	0.5	0.4	0.2	14	14	14	14	14	25
D6	Dust dep	0.4	0.5	0.4	0.3	14	14	14	14	14	25
Hedley	Dust dep	7.2	6.0	5.8	3.7	19	25	23	23	21	25
C5	Dust dep	0.7	0.8	0.7	0.4	14	14	15	15	14	25
N5	Dust dep	2.5	2.7	2.3	1.4	17	18	19	18	17	25
F3	Dust dep	1.0	1.1	1.0	0.5	14	15	15	15	15	25
Redibar	Dust dep	0.4	0.4	0.4	0.2	14	14	14	14	14	25
EPA 9	EWU PM10	25.0	18.0	12.1	6.6	82	61	54	48	43	25
EPA 10	EWU PM10	3.3	4.2	3.9	2.6	17	18	19	19	17	25
Dawtrey	HVAS PM10	1.3	1.5	1.4	0.8	15	16	16	16	15	25
D10	HVAS PM10	2.0	2.3	1.9	1.2	16	17	17	17	16	25
Hill Street	HVAS PM10	0.4	0.4	0.4	0.2	14	14	14	14	14	25
Dawtrey	HVAS TSP	1.3	1.5	1.4	0.8	15	16	16	16	15	25
D10	HVAS TSP	2.0	2.3	1.9	1.2	16	17	17	17	16	25
Hill Street	HVAS TSP	0.4	0.4	0.4	0.2	14	14	14	14	14	25
Mt Thorley	OEH	8.8	7.5	7.3	4.5	20	27	26	26	23	25
MCF	TEOM PM10	27.2	20.6	16.8	11.2	26	46	39	36	30	25
D1	TEOM PM10	0.4	0.4	0.4	0.2	14	14	14	14	14	25
D3	TEOM PM10	2.0	2.3	2.0	1.2	16	17	17	17	16	25
D5	TEOM PM10	1.8	2.2	1.9	1.1	15	16	17	17	16	25
D11	TEOM PM10	3.3	2.8	2.5	1.7	16	18	18	18	17	25
-											
Maximum 24-hour average PM2.5 (ug/m3)											
3	Private	7	6	6	4	18	18	18	18	18	25
8	Private	5	5	6	4	18	18	18	18	18	25
21	Private	2	2	2	1	18	18	18	18	18	25
33	Private	2	2	2	1	18	18	18	18	18	25
37	Private	2	3	3	2	18	18	18	18	18	25
38	Private	2	2	3	1	18	18	18	18	18	25
41	Private	2	2	2	1	18	18	18	18	18	25
46	Private	2	2	2	1	18	18	18	18	18	25
55	Private	2	2	2	1	18	18	18	18	18	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
56	Private	2	2	2	1	18	18	18	18	18	25
57	Private	2	2	2	1	18	18	18	18	18	25
58	Private	2	2	2	1	18	18	18	18	18	25
60	Private	2	2	2	1	18	18	18	18	18	25
61	Private	2	2	2	1	18	18	18	18	18	25
62	Private	2	2	2	1	18	18	18	18	18	25
63	Private	2	2	2	1	18	18	18	18	18	25
71	Private	2	2	2	1	18	18	18	18	18	25
76	Private	2	2	2	1	18	18	18	18	18	25
78	Private	2	2	2	1	18	18	18	18	18	25
80	Private	1	1	2	1	18	18	18	18	18	25
82	Private	1	1	1	1	18	18	18	18	18	25
83	Private	1	1	1	1	18	18	18	18	18	25
84	Private	1	1	1	1	18	18	18	18	18	25
85	Private	1	2	1	1	18	18	18	18	18	25
86	Private	1	2	2	1	18	18	18	18	18	25
87	Private	2	2	2	1	18	18	18	18	18	25
90	Private	1	1	1	1	18	18	18	18	18	25
91	Private	1	2	1	1	18	18	18	18	18	25
93	Private	2	2	2	1	18	18	18	18	18	25
94	Private	2	2	2	1	18	18	18	18	18	25
95	Private	2	2	2	1	18	18	18	18	18	25
97	Private	3	3	3	1	18	18	18	18	18	25
98	Private	1	1	1	1	18	18	18	18	18	25
100	Private	2	2	2	1	18	18	18	18	18	25
101	Private	2	2	2	1	18	18	18	18	18	25
102	Private	2	2	2	1	18	18	18	18	18	25
103	Private	2	2	2	1	18	18	18	18	18	25
107	Private	1	1	1	1	18	18	18	18	18	25
108	Private	1	1	1	1	18	18	18	18	18	25
109	Private	1	1	1	1	18	18	18	18	18	25
114	Private	1	1	1	1	18	18	18	18	18	25
115	Private	1	1	1	1	18	18	18	18	18	25
116	Private	1	1	1	1	18	18	18	18	18	25
117	Private	2	2	2	1	18	18	18	18	18	25
118	Private	2	2	2	1	18	18	18	18	18	25
119	Private	2	2	2	1	18	18	18	18	18	25
122	Private	1	1	1	1	18	18	18	18	18	25
123	Private	2	2	1	1	18	18	18	18	18	25
124	Private	2	2	1	1	18	18	18	18	18	25
125	Private	2	2	2	1	18	18	18	18	18	25
130	Private	2	2	2	1	18	18	18	18	18	25
131	Private	2	2	2	1	18	18	18	18	18	25
132	Private	2	2	2	1	18	18	18	18	18	25
137	Private	2	2	2	1	18	18	18	18	18	25
138	Private	2	2	2	1	18	18	18	18	18	25
140	Private	2	2	2	1	18	18	18	18	18	25
144	Private	2	2	2	1	18	18	18	18	18	25
145	Private	2	2	2	1	18	18	18	18	18	25
147	BCM	3	3	3	2	18	18	18	18	18	25
149	Private	4	5	5	3	18	18	18	18	18	25
154	BCM	5	4	4	2	18	18	18	18	18	25
160	BCM	6	6	5	2	18	18	18	18	18	25
164	Private	3	3	2	1	18	18	18	18	18	25
165	Private	2	2	2	1	18	18	18	18	18	25
170	Private	2	3	2	1	18	18	18	18	18	25
171	Private	3	3	2	1	18	18	18	18	18	25
175	Private	2	2	2	1	18	18	18	18	18	25
179	Private	3	3	3	1	18	18	18	18	18	25
183	Private	2	2	2	1	18	18	18	18	18	25
184	Private	2	3	2	1	18	18	18	18	18	25
185	Private	2	2	2	1	18	18	18	18	18	25
190	Private	2	2	2	1	18	18	18	18	18	25
191	Private	2	2	1	1	18	18	18	18	18	25
192	Private	2	2	1	1	18	18	18	18	18	25
193	Private	1	2	1	1	18	18	18	18	18	25
194	Private	1	1	1	1	18	18	18	18	18	25
195	Private	5	6	4	2	18	18	18	18	18	25
197	Private	3	3	2	1	18	18	18	18	18	25
198	Private	2	2	2	1	18	18	18	18	18	25
199	Private	2	2	2	1	18	18	18	18	18	25
200	Private	2	2	2	1	18	18	18	18	18	25
202	Private	2	2	1	1	18	18	18	18	18	25
203	Private	2	2	1	1	18	18	18	18	18	25
204	Private	2	2	1	1	18	18	18	18	18	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
206	Private	1	1	1	1	18	18	18	18	18	25
207	Private	1	1	1	1	18	18	18	18	18	25
208	Private	1	1	1	1	18	18	18	18	18	25
209	Private	1	1	1	1	18	18	18	18	18	25
211	Private	2	2	1	1	18	18	18	18	18	25
212	Private	2	2	1	1	18	18	18	18	18	25
213	Private	2	2	1	1	18	18	18	18	18	25
214	Private	1	1	1	1	18	18	18	18	18	25
220	Private	2	2	1	1	18	18	18	18	18	25
221	Private	1	1	1	1	18	18	18	18	18	25
222	Private	2	2	2	1	18	18	18	18	18	25
223	Private	2	2	2	1	18	18	18	18	18	25
225	Private	1	1	1	1	18	18	18	18	18	25
226	Private	2	2	2	1	18	18	18	18	18	25
227	Private	2	2	2	1	18	18	18	18	18	25
228	Private	2	2	2	1	18	18	18	18	18	25
229	Private	2	2	2	1	18	18	18	18	18	25
230	Private	2	2	2	1	18	18	18	18	18	25
231	Private	2	2	2	1	18	18	18	18	18	25
232	Private	2	3	2	1	18	18	18	18	18	25
233	Private	2	2	2	1	18	18	18	18	18	25
234	Private	2	2	2	1	18	18	18	18	18	25
235	Private	2	2	2	1	18	18	18	18	18	25
236	Private	2	2	1	1	18	18	18	18	18	25
237	Private	2	2	2	1	18	18	18	18	18	25
238	Private	2	2	1	1	18	18	18	18	18	25
239	Private	2	2	2	1	18	18	18	18	18	25
240	Private	2	2	2	1	18	18	18	18	18	25
241	Private	2	2	2	1	18	18	18	18	18	25
242	Private	2	2	1	1	18	18	18	18	18	25
243	Private	2	2	2	1	18	18	18	18	18	25
244	Private	2	2	1	1	18	18	18	18	18	25
247	Private	1	2	1	1	18	18	18	18	18	25
250	Private	1	1	1	1	18	18	18	18	18	25
254	Private	2	2	2	1	18	18	18	18	18	25
256	Private	2	2	2	1	18	18	18	18	18	25
261	Private	2	2	2	1	19	19	19	19	18	25
262	Private	2	2	2	1	19	19	19	19	18	25
263	Private	2	2	2	1	18	18	19	18	18	25
264	Private	2	2	2	1	18	19	19	19	18	25
265	Private	2	2	2	1	19	19	19	19	18	25
266	Private	2	2	2	1	18	19	19	19	18	25
267	Yancoal	2	2	2	1	18	19	19	19	18	25
272	Private	2	2	2	1	19	19	19	19	18	25
273	Private	2	2	2	1	19	19	19	19	18	25
274	Yancoal	2	2	2	1	19	19	19	19	18	25
275	Private	2	2	2	1	18	19	19	19	18	25
276	Private	2	2	2	1	19	19	19	19	18	25
279	Private	2	2	2	1	18	19	19	19	18	25
280	Private	2	2	2	1	18	19	19	19	18	25
281	Private	2	2	2	1	18	19	19	19	18	25
283	Private	2	2	2	1	18	19	19	19	18	25
285	Private	2	2	2	1	18	18	19	18	18	25
286	Private	2	2	2	1	18	18	19	18	18	25
287	Private	2	2	2	1	18	18	19	18	18	25
288	Private	2	2	2	1	18	19	19	19	18	25
289	Private	2	2	2	1	18	18	19	18	18	25
290	Private	2	2	2	1	18	18	19	18	18	25
291	Private	2	2	2	1	18	18	19	18	18	25
292	Private	2	2	2	1	18	19	19	19	18	25
293	Private	2	2	2	1	18	19	19	19	18	25
295	Private	2	2	2	1	18	18	18	18	18	25
296	Private	2	2	2	1	18	18	18	18	18	25
297	Private	2	2	2	1	18	18	19	18	18	25
298	Private	2	2	2	1	18	18	18	18	18	25
300	Private	2	2	2	1	18	18	18	18	18	25
301	Private	2	2	2	1	18	18	18	18	18	25
302	Private	2	2	2	1	18	18	18	18	18	25
303	Private	2	2	2	1	18	18	18	18	18	25
304	Private	2	2	2	1	18	18	18	18	18	25
305	Private	2	2	1	1	18	18	18	18	18	25
306	Private	2	2	2	1	19	19	19	19	18	25
307	Yancoal	3	3	3	2	20	20	20	20	19	25
308	Yancoal	3	3	2	2	19	19	20	19	19	25
309	Private	2	2	2	1	18	19	19	19	18	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
311	Private	3	3	2	1	19	20	20	20	19	25
314	Yancoal	2	2	2	1	18	19	19	19	18	25
317	Private	2	2	2	1	19	19	19	19	19	25
323	Private	6	5	5	4	18	18	18	18	18	25
324	Private	4	4	5	3	18	18	18	18	18	25
325	Private	4	3	4	3	18	18	18	18	18	25
326	Private	2	2	2	1	18	18	18	18	18	25
327	Private	2	2	2	1	18	18	18	18	18	25
105A	Private	2	2	2	1	18	18	18	18	18	25
105C	Private	2	2	2	1	18	18	18	18	18	25
113A	Private	1	1	1	1	18	18	18	18	18	25
113B	Private	1	1	1	1	18	18	18	18	18	25
121A	Private	2	2	2	1	18	18	18	18	18	25
121B	Private	2	2	2	1	18	18	18	18	18	25
126A	Private	2	2	1	1	18	18	18	18	18	25
126B	Private	2	2	1	1	18	18	18	18	18	25
142A	Private	2	2	2	1	18	18	18	18	18	25
142B	Private	2	2	2	1	18	18	18	18	18	25
142C	Private	2	2	2	1	18	18	18	18	18	25
143A	Private	2	2	2	1	18	18	18	18	18	25
143B	Private	2	2	2	1	18	18	18	18	18	25
169A	Private	3	3	2	1	18	18	18	18	18	25
169e	Private	3	3	3	1	18	18	18	18	18	25
177B	Private	2	2	2	1	18	18	18	18	18	25
188A	Private	2	2	2	1	18	18	18	18	18	25
188B	Private	2	2	2	1	18	18	18	18	18	25
188C	Private	2	2	2	1	18	18	18	18	18	25
1A	Private	8	8	6	3	18	19	18	18	18	25
217m	Private	3	3	3	2	18	18	18	18	18	25
217n	Private	4	4	3	2	18	18	18	18	18	25
217s	Private	3	4	3	2	18	18	18	18	18	25
316A	Private	2	2	2	1	18	19	19	19	18	25
316B	Private	2	2	2	1	19	19	19	19	18	25
318A	Yancoal	3	3	3	2	19	19	19	19	19	25
318B	Yancoal	3	3	2	2	19	19	19	19	19	25
319A	Private	2	2	3	1	18	18	18	18	18	25
AB	BCM	3	4	3	1	18	18	18	18	18	25
AD	BCM	6	7	4	2	18	18	18	18	18	25
AF	BCM	2	2	2	1	18	18	18	18	18	25
AH	BCM	10	9	8	4	18	19	19	19	19	25
AI	BCM	6	6	5	3	18	18	18	18	18	25
AJ	BCM	8	7	7	4	18	18	18	18	18	25
AK	BCM	8	8	8	4	18	18	18	18	18	25
B	Private	2	2	2	1	18	18	18	18	18	25
C	Private	2	2	1	1	18	18	18	18	18	25
D	Private	1	2	1	1	18	18	18	18	18	25
E	BCM	3	3	2	1	18	18	18	18	18	25
G	Private	1	1	1	1	18	18	18	18	18	25
H	Private	1	1	1	1	18	18	18	18	18	25
I	Private	2	2	2	1	18	18	18	18	18	25
J	Private	2	2	2	1	18	18	18	18	18	25
K	BCM	2	2	2	1	18	18	18	18	18	25
M	BCM	9	10	8	4	20	20	20	20	19	25
N	BCM	5	5	4	2	18	19	19	19	18	25
O	BCM	3	3	3	2	18	19	19	19	18	25
P	Private	2	2	2	1	18	18	18	18	18	25
Q	BCM	5	6	6	3	18	18	18	18	18	25
Z	BCM	5	6	4	2	18	18	18	18	18	25
139	Private	2	2	2	1	18	18	18	18	18	25
277	Yancoal	2	2	2	1	19	19	19	19	18	25
284	Yancoal	2	2	2	1	18	18	19	19	18	25
A	Private	1	1	1	1	18	18	18	18	18	25
AG	BCM	2	2	2	1	18	18	18	18	18	25
R	Yancoal	3	3	2	2	20	20	20	20	20	25
X	Yancoal	3	3	3	2	24	25	25	25	24	25
294	Private	2	2	2	1	18	18	19	18	18	25
328	Private	2	2	2	1	18	18	18	18	18	25
329	Private	2	2	2	1	18	18	18	18	18	25
330	Private	2	2	2	1	18	18	18	18	18	25
331	Private	1	2	2	1	18	18	18	18	18	25
332	Private	1	2	2	1	18	18	18	18	18	25
333	Private	1	2	2	1	18	18	18	18	18	25
334	Private	1	2	2	1	18	18	18	18	18	25
335	Private	1	1	2	1	18	18	18	18	18	25
336	Private	1	1	2	1	18	18	18	18	18	25

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
337	Private	1	1	2	1	18	18	18	18	18	25
338	Private	1	1	2	1	18	18	18	18	18	25
339	Private	1	2	2	1	18	18	18	18	18	25
340	Private	1	2	2	1	18	18	18	18	18	25
341	Private	1	2	2	1	18	18	18	18	18	25
342	Private	2	2	2	1	18	18	18	18	18	25
343	Private	2	2	2	1	18	18	18	18	18	25
88	Private	2	2	2	1	18	18	18	18	18	25
344	Private	2	2	2	1	18	18	18	18	18	25
156B	BCM	5	5	4	2	18	18	18	18	18	25
156w	BCM	5	5	4	2	18	18	18	18	18	25
177A	Private	2	2	2	1	18	18	18	18	18	25
176	Private	2	2	2	1	18	18	18	18	18	25
174	Private	2	2	2	1	18	18	18	18	18	25
162	Private	3	3	3	1	18	18	18	18	18	25
AA	BCM	4	5	3	2	18	18	18	18	18	25
153	BCM	5	4	4	2	18	18	18	18	18	25
105B	Private	2	2	2	1	18	18	18	18	18	25
319B	Private	2	2	3	1	18	18	18	18	18	25
72	Private	2	2	2	1	18	18	18	18	18	25
73	Private	2	2	2	1	18	18	18	18	18	25
74	Private	2	2	2	1	18	18	18	18	18	25
345	Private	2	2	2	1	18	18	18	18	18	25
23	Private	2	2	2	1	18	18	18	18	18	25
20	Private	2	2	2	1	18	18	18	18	18	25
S	Yancoal	3	3	3	2	19	20	20	20	19	25
T	Yancoal	4	4	3	2	20	20	20	20	20	25
U	Yancoal	4	4	3	2	20	20	20	20	20	25
V	Yancoal	4	4	3	2	21	21	21	21	21	25
W	Yancoal	4	4	4	2	23	25	25	24	24	25
Y	Yancoal	4	4	3	2	26	28	28	27	26	25
346	Yancoal	3	3	3	2	20	20	20	20	20	25
347	Yancoal	3	3	3	2	20	20	21	20	20	25
MCF	MCF	22	18	17	11	19	29	26	23	19	25
D10	BAM PM2.5	3	3	2	1	18	18	18	18	18	25
D2	BAM PM2.5	2	2	2	1	18	18	18	18	18	25
A3	Dust dep	2	2	2	1	18	18	18	18	18	25
D9	Dust dep	2	2	2	1	18	18	19	18	18	25
D10	Dust dep	2	3	2	1	18	18	18	18	18	25
Sharrock 1	Dust dep	3	3	2	1	18	18	18	18	18	25
D6	Dust dep	1	1	1	1	18	18	18	18	18	25
Hedley	Dust dep	8	7	8	5	18	18	18	18	18	25
C5	Dust dep	2	2	2	1	18	18	18	18	18	25
N5	Dust dep	3	3	2	2	18	18	18	18	18	25
F3	Dust dep	6	6	5	3	18	18	18	18	18	25
Redibar	Dust dep	2	2	2	1	18	18	18	18	18	25
EPA 9	EWU PM10	16	13	9	5	48	28	27	27	27	25
EPA 10	EWU PM10	5	6	5	4	18	18	18	18	18	25
Dawtrey	HVAS PM10	4	4	3	1	18	18	18	18	18	25
D10	HVAS PM10	3	3	2	1	18	18	18	18	18	25
Hill Street	HVAS PM10	2	2	2	1	18	18	18	18	18	25
Dawtrey	HVAS TSP	4	4	3	1	18	18	18	18	18	25
D10	HVAS TSP	3	3	2	1	18	18	18	18	18	25
Hill Street	HVAS TSP	2	2	2	1	18	18	18	18	18	25
Mt Thorley	OEH	9	8	9	5	18	19	18	18	18	25
MCF	TEOM PM10	22	18	17	11	19	29	26	23	19	25
D1	TEOM PM10	2	2	2	1	18	18	18	18	18	25
D3	TEOM PM10	3	3	2	1	18	18	18	18	18	25
D5	TEOM PM10	6	6	3	2	18	18	18	18	18	25
D11	TEOM PM10	4	3	4	3	18	18	18	18	18	25
-											
Annual average PM2.5 (ug/m3)											
3	Private	1.1	0.9	0.8	0.6	5.8	6.6	6.4	6.3	6.1	8
8	Private	0.9	0.7	0.7	0.5	5.6	6.2	6.1	6.0	5.8	8
21	Private	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
33	Private	0.2	0.3	0.3	0.2	5.3	5.4	5.4	5.4	5.3	8
37	Private	0.2	0.3	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
38	Private	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
41	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
46	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
55	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
56	Private	0.1	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
57	Private	0.1	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
58	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
60	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
61	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
62	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
63	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
71	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
76	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
78	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
80	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
82	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.0	8
83	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
84	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
85	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.0	8
86	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
87	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
90	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
91	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
93	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
94	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
95	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
97	Private	0.2	0.2	0.2	0.1	5.2	5.2	5.3	5.2	5.2	8
98	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
100	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.0	8
101	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
102	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
103	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
107	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.1	5.0	5.0	8
108	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.1	5.0	5.0	8
109	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
114	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
115	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
116	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
117	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
118	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
119	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
122	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
123	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
124	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.1	5.0	5.0	8
125	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.1	5.0	5.0	8
130	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
131	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
132	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
137	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
138	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
140	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
144	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
145	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
147	BCM	0.2	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
149	Private	0.3	0.3	0.3	0.2	5.3	5.4	5.4	5.4	5.3	8
154	BCM	0.2	0.2	0.2	0.1	5.2	5.2	5.3	5.2	5.2	8
160	BCM	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.2	8
164	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
165	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
170	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
171	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
175	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
179	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
183	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
184	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
185	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
190	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
191	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
192	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
193	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
194	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.1	8
195	Private	0.3	0.3	0.3	0.2	5.3	5.4	5.4	5.4	5.3	8
197	Private	0.2	0.2	0.2	0.1	5.2	5.2	5.3	5.3	5.2	8
198	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.3	5.2	5.2	8
199	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
200	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.3	5.2	5.2	8
202	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
203	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
204	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
206	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
207	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
208	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
209	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
211	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.3	5.2	5.2	8
212	Private	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
213	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
214	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
220	Private	0.3	0.3	0.3	0.2	5.3	5.4	5.4	5.4	5.3	8
221	Private	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.3	8
222	Private	0.3	0.3	0.3	0.2	5.3	5.4	5.5	5.4	5.3	8
223	Private	0.3	0.3	0.3	0.2	5.3	5.4	5.5	5.4	5.3	8
225	Private	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
226	Private	0.3	0.3	0.3	0.2	5.4	5.5	5.5	5.5	5.4	8
227	Private	0.3	0.3	0.3	0.2	5.3	5.5	5.5	5.5	5.3	8
228	Private	0.3	0.3	0.3	0.2	5.4	5.5	5.5	5.5	5.4	8
229	Private	0.3	0.3	0.3	0.2	5.4	5.5	5.5	5.5	5.4	8
230	Private	0.4	0.4	0.4	0.2	5.4	5.6	5.6	5.6	5.4	8
231	Private	0.3	0.3	0.3	0.2	5.4	5.5	5.6	5.5	5.4	8
232	Private	0.4	0.5	0.4	0.2	5.5	5.7	5.7	5.7	5.5	8
233	Private	0.4	0.4	0.4	0.2	5.5	5.6	5.6	5.6	5.4	8
234	Private	0.4	0.4	0.4	0.2	5.5	5.7	5.7	5.7	5.5	8
235	Private	0.4	0.4	0.4	0.2	5.6	5.7	5.8	5.7	5.6	8
236	Private	0.3	0.4	0.3	0.2	5.5	5.7	5.7	5.6	5.5	8
237	Private	0.4	0.5	0.4	0.2	5.6	5.8	5.8	5.8	5.6	8
238	Private	0.4	0.4	0.3	0.2	5.5	5.7	5.7	5.7	5.5	8
239	Private	0.4	0.5	0.4	0.3	5.7	5.9	5.9	5.8	5.7	8
240	Private	0.4	0.4	0.4	0.2	5.6	5.8	5.8	5.8	5.6	8
241	Private	0.4	0.4	0.3	0.2	5.6	5.8	5.8	5.7	5.6	8
242	Private	0.3	0.4	0.3	0.2	5.6	5.7	5.7	5.7	5.6	8
243	Private	0.4	0.4	0.3	0.2	5.6	5.8	5.8	5.7	5.6	8
244	Private	0.3	0.3	0.3	0.2	5.5	5.7	5.7	5.7	5.5	8
247	Private	0.3	0.3	0.3	0.2	5.5	5.7	5.7	5.6	5.5	8
250	Private	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.4	5.3	8
254	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
256	Private	0.4	0.4	0.3	0.2	5.6	5.8	5.8	5.7	5.6	8
261	Private	0.5	0.5	0.4	0.3	5.9	6.0	6.1	6.0	5.8	8
262	Private	0.5	0.5	0.4	0.3	5.9	6.0	6.1	6.0	5.8	8
263	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
264	Private	0.5	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
265	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	6.0	5.8	8
266	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
267	Yancoal	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
272	Private	0.4	0.5	0.4	0.2	5.9	6.0	6.1	6.0	5.8	8
273	Private	0.4	0.5	0.4	0.2	5.9	6.0	6.1	6.0	5.8	8
274	Yancoal	0.4	0.5	0.4	0.2	5.9	6.0	6.1	6.0	5.8	8
275	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
276	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	6.0	5.8	8
279	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
280	Private	0.4	0.5	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
281	Private	0.4	0.4	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
283	Private	0.4	0.4	0.4	0.2	5.8	5.9	6.0	5.9	5.8	8
285	Private	0.4	0.4	0.4	0.2	5.8	5.9	5.9	5.9	5.7	8
286	Private	0.4	0.4	0.4	0.2	5.8	5.9	5.9	5.9	5.7	8
287	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.9	5.7	8
288	Private	0.4	0.4	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
289	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
290	Private	0.4	0.4	0.3	0.2	5.8	5.9	5.9	5.9	5.8	8
291	Private	0.4	0.4	0.3	0.2	5.8	5.9	6.0	5.9	5.8	8
292	Private	0.4	0.4	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
293	Private	0.4	0.4	0.3	0.2	5.8	6.0	6.0	5.9	5.8	8
295	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
296	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
297	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.9	5.7	8
298	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
300	Private	0.3	0.4	0.3	0.2	5.7	5.8	5.8	5.8	5.7	8
301	Private	0.3	0.4	0.3	0.2	5.7	5.8	5.8	5.8	5.7	8
302	Private	0.3	0.3	0.3	0.2	5.6	5.8	5.8	5.7	5.6	8
303	Private	0.3	0.3	0.3	0.2	5.6	5.7	5.8	5.7	5.6	8
304	Private	0.3	0.3	0.3	0.2	5.6	5.7	5.7	5.7	5.6	8
305	Private	0.3	0.3	0.2	0.2	5.5	5.7	5.7	5.7	5.6	8
306	Private	0.4	0.4	0.4	0.2	5.8	6.0	6.0	6.0	5.8	8
307	Yancoal	0.6	0.6	0.5	0.3	6.6	6.9	6.9	6.8	6.6	8
308	Yancoal	0.5	0.5	0.4	0.3	6.3	6.5	6.5	6.4	6.3	8
309	Private	0.3	0.3	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
311	Private	0.5	0.5	0.4	0.2	6.3	6.6	6.6	6.5	6.4	8
314	Yancoal	0.3	0.3	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
317	Private	0.3	0.4	0.3	0.2	5.8	6.0	6.0	6.0	5.9	8
323	Private	0.9	0.8	0.7	0.5	5.6	6.3	6.2	6.1	5.9	8

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
324	Private	0.8	0.6	0.6	0.4	5.6	6.1	6.0	5.9	5.7	8
325	Private	0.7	0.6	0.5	0.3	5.5	5.9	5.9	5.8	5.6	8
326	Private	0.3	0.4	0.3	0.2	5.7	5.8	5.9	5.8	5.7	8
327	Private	0.3	0.4	0.3	0.2	5.4	5.5	5.6	5.5	5.4	8
105A	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
105C	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
113A	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
113B	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
121A	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
121B	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
126A	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
126B	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.0	5.0	5.0	8
142A	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
142B	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.0	8
142C	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
143A	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
143B	Private	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
169A	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
169e	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
177B	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
188A	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
188B	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
188C	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
1A	Private	1.4	1.3	1.1	0.7	6.6	7.5	7.4	7.3	6.8	8
217m	Private	0.4	0.5	0.4	0.3	5.4	5.6	5.7	5.6	5.5	8
217n	Private	0.5	0.6	0.5	0.3	5.5	5.7	5.8	5.7	5.5	8
217s	Private	0.4	0.5	0.4	0.3	5.5	5.7	5.7	5.7	5.5	8
316A	Private	0.3	0.3	0.3	0.2	5.7	5.9	5.9	5.8	5.7	8
316B	Private	0.3	0.4	0.3	0.2	5.7	5.9	5.9	5.9	5.8	8
318A	Yancoal	0.6	0.6	0.5	0.3	6.1	6.3	6.3	6.2	6.0	8
318B	Yancoal	0.6	0.6	0.5	0.3	6.0	6.2	6.3	6.1	5.9	8
319A	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
AB	BCM	0.2	0.2	0.2	0.1	5.2	5.2	5.3	5.2	5.2	8
AD	BCM	0.4	0.4	0.4	0.2	5.4	5.5	5.6	5.6	5.4	8
AF	BCM	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.2	8
AH	BCM	1.9	1.7	1.6	1.0	6.7	8.0	7.8	7.7	7.1	8
AI	BCM	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.2	8
AJ	BCM	1.4	1.2	1.2	0.7	6.3	7.2	7.1	7.0	6.6	8
AK	BCM	1.4	1.3	1.2	0.8	6.3	7.3	7.2	7.1	6.6	8
B	Private	0.3	0.3	0.3	0.2	5.6	5.7	5.7	5.7	5.6	8
C	Private	0.3	0.3	0.3	0.2	5.5	5.7	5.7	5.7	5.6	8
D	Private	0.3	0.3	0.2	0.2	5.5	5.7	5.7	5.6	5.5	8
E	BCM	0.4	0.5	0.4	0.3	5.6	5.7	5.8	5.7	5.6	8
G	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
H	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
I	Private	0.4	0.4	0.4	0.2	5.6	5.8	5.8	5.7	5.6	8
J	Private	0.5	0.5	0.4	0.3	5.7	5.9	5.9	5.8	5.7	8
K	BCM	0.5	0.5	0.5	0.3	5.8	5.9	6.0	5.9	5.7	8
M	BCM	1.3	1.4	1.1	0.7	6.7	6.8	6.9	6.6	6.2	8
N	BCM	0.6	0.7	0.6	0.4	5.7	5.9	6.0	5.9	5.7	8
O	BCM	0.6	0.7	0.6	0.3	5.9	6.1	6.1	6.0	5.8	8
P	Private	0.4	0.5	0.4	0.3	5.7	5.9	5.9	5.9	5.7	8
Q	BCM	0.3	0.4	0.3	0.2	5.3	5.4	5.5	5.5	5.3	8
Z	BCM	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.2	8
139	Private	0.1	0.1	0.1	0.0	5.0	5.1	5.1	5.1	5.0	8
277	Yancoal	0.4	0.5	0.4	0.2	5.9	6.0	6.0	6.0	5.8	8
284	Yancoal	0.4	0.4	0.4	0.2	5.8	5.9	6.0	5.9	5.8	8
A	Private	0.1	0.1	0.1	0.0	5.0	5.0	5.1	5.0	5.0	8
AG	BCM	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
R	Yancoal	0.5	0.5	0.4	0.3	6.5	6.8	6.9	6.8	6.6	8
X	Yancoal	0.7	0.7	0.6	0.3	8.5	9.4	9.4	9.3	9.1	8
294	Private	0.4	0.4	0.3	0.2	5.7	5.9	5.9	5.9	5.7	8
328	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
329	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
330	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
331	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
332	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
333	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
334	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
335	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
336	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
337	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.1	5.1	8
338	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
339	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
340	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
341	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.2	5.2	5.1	8
342	Private	0.1	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
343	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
88	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
344	Private	0.2	0.3	0.2	0.1	5.3	5.3	5.4	5.4	5.3	8
156B	BCM	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
156w	BCM	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
177A	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
176	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
174	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
162	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
AA	BCM	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
153	BCM	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
105B	Private	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
319B	Private	0.2	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
72	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
73	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
74	Private	0.1	0.2	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
345	Private	0.1	0.1	0.1	0.1	5.1	5.2	5.2	5.2	5.1	8
23	Private	0.2	0.2	0.2	0.1	5.2	5.3	5.3	5.3	5.2	8
20	Private	0.2	0.3	0.2	0.2	5.2	5.3	5.3	5.3	5.2	8
S	Yancoal	0.6	0.6	0.5	0.3	6.5	6.7	6.8	6.7	6.5	8
T	Yancoal	0.6	0.7	0.5	0.3	7.0	7.3	7.4	7.2	7.0	8
U	Yancoal	0.7	0.7	0.6	0.3	7.0	7.3	7.3	7.2	6.9	8
V	Yancoal	0.7	0.8	0.6	0.4	7.7	8.2	8.3	8.1	7.9	8
W	Yancoal	0.8	0.9	0.7	0.4	9.1	10.0	10.0	9.8	9.5	8
Y	Yancoal	0.8	0.8	0.7	0.4	9.7	10.8	10.8	10.6	10.4	8
346	Yancoal	0.6	0.6	0.5	0.3	6.8	7.1	7.1	7.0	6.8	8
347	Yancoal	0.5	0.5	0.4	0.3	6.7	7.1	7.2	7.0	6.9	8
MCF	MCF	5.1	3.9	3.3	2.3	7.3	11.1	9.9	9.3	8.2	8
D10	BAM PM2.5	0.5	0.5	0.4	0.3	5.7	5.8	5.9	5.8	5.6	8
D2	BAM PM2.5	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
A3	Dust dep	0.3	0.4	0.3	0.2	5.6	5.7	5.8	5.7	5.6	8
D9	Dust dep	0.4	0.4	0.4	0.2	5.8	6.0	6.0	5.9	5.8	8
D10	Dust dep	0.4	0.5	0.4	0.2	5.6	5.7	5.8	5.7	5.5	8
Sharrock 1	Dust dep	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
D6	Dust dep	0.1	0.1	0.1	0.1	5.1	5.1	5.1	5.1	5.1	8
Hedley	Dust dep	1.4	1.2	1.2	0.8	6.1	7.1	6.9	6.9	6.5	8
C5	Dust dep	0.1	0.2	0.2	0.1	5.1	5.2	5.2	5.2	5.1	8
N5	Dust dep	0.5	0.6	0.5	0.3	5.8	6.0	6.0	5.9	5.7	8
F3	Dust dep	0.2	0.3	0.2	0.1	5.2	5.3	5.4	5.3	5.2	8
Redibar	Dust dep	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
EPA 9	EWU PM10	4.6	3.4	2.3	1.3	17.4	13.5	12.3	11.2	10.2	8
EPA 10	EWU PM10	0.7	0.8	0.8	0.5	5.6	5.9	6.1	6.0	5.7	8
Dawtrey	HVAS PM10	0.3	0.3	0.3	0.2	5.3	5.5	5.5	5.5	5.3	8
D10	HVAS PM10	0.4	0.5	0.4	0.3	5.6	5.7	5.8	5.7	5.6	8
Hill Street	HVAS PM10	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
Dawtrey	HVAS TSP	0.3	0.3	0.3	0.2	5.3	5.5	5.5	5.5	5.3	8
D10	HVAS TSP	0.4	0.5	0.4	0.3	5.6	5.7	5.8	5.7	5.6	8
Hill Street	HVAS TSP	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
Mt Thorley	OEH	1.8	1.5	1.5	0.9	6.3	7.6	7.3	7.3	6.8	8
MCF	TEOM PM10	5.1	3.9	3.3	2.3	7.3	11.1	9.9	9.3	8.2	8
D1	TEOM PM10	0.1	0.1	0.1	0.1	5.0	5.1	5.1	5.1	5.1	8
D3	TEOM PM10	0.5	0.5	0.4	0.3	5.6	5.7	5.8	5.7	5.6	8
D5	TEOM PM10	0.4	0.5	0.4	0.2	5.4	5.6	5.7	5.6	5.5	8
D11	TEOM PM10	0.7	0.6	0.5	0.4	5.5	6.0	5.9	5.8	5.7	8
-											
Annual average TSP (ug/m3)											
3	Private	4.5	3.7	3.6	2.5	43	46	45	45	44	90
8	Private	3.8	3.1	2.9	2.1	42	45	44	44	43	90
21	Private	1.2	1.4	1.3	0.8	41	42	42	42	41	90
33	Private	1.3	1.6	1.3	0.9	42	42	42	42	42	90
37	Private	1.0	1.2	1.0	0.6	41	42	42	42	41	90
38	Private	0.9	1.1	0.9	0.6	41	42	42	41	41	90
41	Private	0.7	0.8	0.7	0.4	41	41	41	41	41	90
46	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
55	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
56	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
57	Private	0.7	0.8	0.6	0.4	41	41	41	41	41	90
58	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
60	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
61	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
62	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
63	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
71	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
76	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
78	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
80	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
82	Private	0.4	0.4	0.4	0.2	41	41	41	41	40	90
83	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
84	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
85	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
86	Private	0.4	0.4	0.3	0.2	40	41	41	41	40	90
87	Private	0.4	0.4	0.3	0.2	40	41	41	41	40	90
90	Private	0.3	0.3	0.3	0.2	40	40	41	40	40	90
91	Private	0.3	0.3	0.3	0.2	40	41	41	40	40	90
93	Private	0.4	0.4	0.3	0.2	40	41	41	41	40	90
94	Private	0.4	0.5	0.4	0.3	41	41	41	41	41	90
95	Private	0.4	0.5	0.4	0.3	41	41	41	41	41	90
97	Private	0.7	0.8	0.7	0.4	41	41	41	41	41	90
98	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
100	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
101	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
102	Private	0.4	0.4	0.3	0.2	40	41	41	41	40	90
103	Private	0.4	0.4	0.4	0.2	41	41	41	41	40	90
107	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
108	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
109	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
114	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
115	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
116	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
117	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
118	Private	0.3	0.3	0.2	0.1	40	40	40	40	40	90
119	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
122	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
123	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
124	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
125	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
130	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
131	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
132	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
137	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
138	Private	0.3	0.3	0.3	0.2	40	40	41	40	40	90
140	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
144	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
145	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
147	BCM	0.5	0.6	0.5	0.3	41	41	41	41	41	90
149	Private	1.1	1.2	1.0	0.6	41	42	42	42	41	90
154	BCM	0.6	0.7	0.6	0.4	41	41	41	41	41	90
160	BCM	0.8	1.0	0.9	0.5	41	41	41	41	41	90
164	Private	0.3	0.4	0.3	0.2	40	41	41	41	40	90
165	Private	0.3	0.3	0.3	0.2	40	40	41	40	40	90
170	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
171	Private	0.4	0.4	0.4	0.3	40	41	41	41	40	90
175	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
179	Private	0.5	0.6	0.6	0.4	41	41	41	41	41	90
183	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
184	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
185	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
190	Private	0.4	0.5	0.5	0.3	40	41	41	41	40	90
191	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
192	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
193	Private	0.3	0.4	0.4	0.2	40	40	41	40	40	90
194	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
195	Private	1.1	1.3	1.2	0.8	41	41	42	42	41	90
197	Private	0.7	0.8	0.7	0.5	41	41	41	41	41	90
198	Private	0.6	0.8	0.7	0.5	41	41	41	41	41	90
199	Private	0.5	0.6	0.5	0.3	40	41	41	41	40	90
200	Private	0.6	0.8	0.7	0.5	41	41	41	41	41	90
202	Private	0.4	0.5	0.5	0.3	40	41	41	41	40	90
203	Private	0.4	0.5	0.5	0.3	40	41	41	41	40	90
204	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
206	Private	0.4	0.4	0.4	0.3	40	40	41	41	40	90
207	Private	0.4	0.4	0.4	0.3	40	40	41	41	40	90
208	Private	0.4	0.4	0.4	0.3	40	40	41	40	40	90
209	Private	0.4	0.4	0.4	0.2	40	40	41	40	40	90
211	Private	0.7	0.8	0.7	0.5	41	41	41	41	41	90
212	Private	0.8	0.9	0.8	0.6	41	41	41	41	41	90
213	Private	0.6	0.7	0.6	0.4	40	41	41	41	41	90
214	Private	0.5	0.5	0.5	0.3	40	41	41	41	40	90

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
220	Private	1.2	1.4	1.3	0.8	41	41	42	42	41	90
221	Private	1.0	1.2	1.1	0.7	41	41	41	41	41	90
222	Private	1.5	1.7	1.5	1.0	41	42	42	42	41	90
223	Private	1.3	1.5	1.4	0.9	41	42	42	42	41	90
225	Private	0.8	0.9	0.8	0.6	41	41	41	41	41	90
226	Private	1.6	1.8	1.6	1.1	41	42	42	42	41	90
227	Private	1.4	1.6	1.5	1.0	41	42	42	42	41	90
228	Private	1.5	1.7	1.6	1.0	41	42	42	42	41	90
229	Private	1.6	1.8	1.6	1.0	41	42	42	42	41	90
230	Private	1.9	2.2	1.9	1.2	42	42	43	42	42	90
231	Private	1.6	1.8	1.6	1.1	41	42	42	42	41	90
232	Private	2.2	2.5	2.1	1.4	42	43	43	43	42	90
233	Private	2.0	2.2	1.9	1.2	42	42	43	42	42	90
234	Private	2.2	2.5	2.1	1.3	42	43	43	43	42	90
235	Private	2.1	2.3	1.9	1.2	42	43	43	42	42	90
236	Private	1.8	2.0	1.7	1.1	42	42	42	42	42	90
237	Private	2.4	2.6	2.2	1.4	42	43	43	43	42	90
238	Private	1.9	2.1	1.8	1.1	42	42	43	42	42	90
239	Private	2.5	2.7	2.3	1.4	43	43	43	43	42	90
240	Private	2.3	2.5	2.1	1.3	42	43	43	43	42	90
241	Private	2.1	2.2	1.9	1.2	42	43	43	42	42	90
242	Private	1.9	2.0	1.7	1.1	42	42	43	42	42	90
243	Private	1.9	2.1	1.8	1.1	42	43	43	42	42	90
244	Private	1.7	1.9	1.6	1.0	42	42	42	42	42	90
247	Private	1.6	1.7	1.4	0.9	42	42	42	42	41	90
250	Private	1.1	1.2	1.2	0.8	41	41	41	41	41	90
254	Private	2.1	2.2	1.8	1.1	43	43	43	43	42	90
256	Private	1.9	2.0	1.7	1.1	42	43	43	42	42	90
261	Private	2.6	2.7	2.2	1.4	43	44	44	43	43	90
262	Private	2.5	2.7	2.2	1.4	43	44	44	43	43	90
263	Private	2.4	2.6	2.1	1.3	43	43	44	43	42	90
264	Private	2.5	2.7	2.2	1.4	43	44	44	43	42	90
265	Private	2.4	2.6	2.1	1.3	43	44	44	43	43	90
266	Private	2.4	2.6	2.1	1.3	43	44	44	43	42	90
267	Yancoal	2.4	2.5	2.1	1.3	43	44	44	43	42	90
272	Private	2.4	2.6	2.1	1.3	43	44	44	43	43	90
273	Private	2.4	2.5	2.1	1.3	43	44	44	43	43	90
274	Yancoal	2.4	2.5	2.0	1.3	43	44	44	43	43	90
275	Private	2.3	2.5	2.0	1.3	43	44	44	43	43	90
276	Private	2.3	2.5	2.0	1.3	43	44	44	43	43	90
279	Private	2.3	2.5	2.0	1.3	43	44	44	43	42	90
280	Private	2.3	2.4	2.0	1.3	43	43	44	43	42	90
281	Private	2.3	2.4	2.0	1.2	43	43	44	43	42	90
283	Private	2.2	2.4	1.9	1.2	43	43	44	43	42	90
285	Private	2.2	2.3	1.9	1.2	43	43	43	43	42	90
286	Private	2.1	2.3	1.9	1.2	43	43	43	43	42	90
287	Private	2.1	2.2	1.8	1.2	43	43	43	43	42	90
288	Private	2.3	2.4	2.0	1.2	43	44	44	43	43	90
289	Private	2.1	2.2	1.8	1.1	43	43	43	43	42	90
290	Private	2.0	2.2	1.8	1.1	43	43	43	43	42	90
291	Private	2.0	2.1	1.7	1.1	43	43	43	43	42	90
292	Private	2.1	2.3	1.8	1.2	43	43	44	43	43	90
293	Private	2.0	2.1	1.7	1.1	43	43	44	43	42	90
295	Private	1.9	2.0	1.7	1.1	43	43	43	43	42	90
296	Private	1.9	2.0	1.7	1.1	43	43	43	43	42	90
297	Private	1.9	2.0	1.7	1.1	43	43	43	43	42	90
298	Private	1.9	2.0	1.6	1.0	43	43	43	43	42	90
300	Private	1.8	1.9	1.6	1.0	42	43	43	43	42	90
301	Private	1.8	1.9	1.6	1.0	42	43	43	43	42	90
302	Private	1.7	1.8	1.5	0.9	42	43	43	42	42	90
303	Private	1.6	1.7	1.4	0.9	42	42	43	42	42	90
304	Private	1.5	1.6	1.3	0.8	42	42	43	42	42	90
305	Private	1.4	1.5	1.2	0.8	42	42	42	42	42	90
306	Private	2.2	2.3	1.9	1.2	43	44	44	43	43	90
307	Yancoal	2.9	3.0	2.4	1.5	46	47	47	46	45	90
308	Yancoal	2.6	2.7	2.2	1.4	45	45	46	45	44	90
309	Private	1.7	1.8	1.5	0.9	43	43	43	43	43	90
311	Private	2.3	2.4	1.9	1.2	45	46	46	45	45	90
314	Yancoal	1.6	1.7	1.4	0.9	43	43	43	43	42	90
317	Private	1.7	1.8	1.5	0.9	43	44	44	44	43	90
323	Private	3.7	3.1	2.9	2.1	42	45	44	44	43	90
324	Private	3.0	2.6	2.4	1.8	42	44	43	43	43	90
325	Private	2.5	2.1	2.0	1.4	42	43	43	43	42	90
326	Private	1.8	1.9	1.6	1.0	43	43	43	43	42	90
327	Private	1.8	2.0	1.8	1.2	42	42	42	42	42	90

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
105A	Private	0.5	0.5	0.4	0.3	41	41	41	41	41	90
105C	Private	0.5	0.5	0.4	0.3	41	41	41	41	41	90
113A	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
113B	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
121A	Private	0.3	0.3	0.2	0.1	40	40	40	40	40	90
121B	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
126A	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
126B	Private	0.2	0.2	0.2	0.1	40	40	40	40	40	90
142A	Private	0.3	0.3	0.3	0.2	40	40	41	40	40	90
142B	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
142C	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
143A	Private	0.3	0.4	0.3	0.2	40	41	41	40	40	90
143B	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
169A	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
169e	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
177B	Private	0.4	0.4	0.4	0.2	40	40	41	41	40	90
188A	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
188B	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
188C	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
1A	Private	6.6	6.2	5.6	3.2	46	51	50	50	47	90
217m	Private	2.2	2.6	2.4	1.6	42	43	43	43	42	90
217n	Private	2.6	3.1	2.8	1.8	42	43	44	43	42	90
217s	Private	2.2	2.7	2.4	1.6	42	43	43	43	42	90
316A	Private	1.6	1.7	1.4	0.9	43	43	43	43	43	90
316B	Private	1.7	1.8	1.5	0.9	43	43	44	43	43	90
318A	Yancoal	3.2	3.4	2.7	1.7	44	45	45	44	43	90
318B	Yancoal	3.2	3.5	2.8	1.7	44	44	45	44	43	90
319A	Private	0.7	0.8	0.7	0.4	41	41	41	41	41	90
AB	BCM	0.6	0.8	0.7	0.4	41	41	41	41	41	90
AD	BCM	1.7	2.1	1.9	1.2	41	42	43	42	42	90
AF	BCM	1.3	1.5	1.3	0.9	42	42	42	42	42	90
AH	BCM	10.0	9.0	8.6	4.9	48	54	53	53	49	90
AI	BCM	0.8	0.9	0.8	0.5	41	41	41	41	41	90
AJ	BCM	6.4	5.8	5.6	3.3	45	49	48	48	46	90
AK	BCM	6.9	6.2	6.0	3.6	45	50	49	49	46	90
B	Private	1.6	1.7	1.4	0.9	42	42	42	42	42	90
C	Private	1.5	1.6	1.3	0.8	42	42	42	42	42	90
D	Private	1.4	1.5	1.3	0.8	42	42	42	42	41	90
E	BCM	2.5	2.7	2.3	1.5	42	43	43	43	42	90
G	Private	0.7	0.8	0.6	0.4	41	41	41	41	41	90
H	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
I	Private	2.2	2.4	2.0	1.3	42	43	43	43	42	90
J	Private	2.6	2.8	2.3	1.5	43	43	44	43	42	90
K	BCM	2.8	3.1	2.5	1.6	43	43	44	43	42	90
M	BCM	8.5	9.6	7.2	4.3	48	50	51	48	45	90
N	BCM	3.6	4.2	3.7	2.4	43	44	45	44	43	90
O	BCM	3.6	3.9	3.1	2.0	44	44	45	44	43	90
P	Private	2.5	2.7	2.2	1.4	43	43	43	43	42	90
Q	BCM	1.3	1.6	1.3	0.8	42	42	42	42	42	90
Z	BCM	0.8	1.0	0.9	0.6	41	41	41	41	41	90
139	Private	0.3	0.3	0.3	0.2	40	40	40	40	40	90
277	Yancoal	2.3	2.5	2.0	1.3	43	44	44	43	43	90
284	Yancoal	2.2	2.3	1.9	1.2	43	43	43	43	42	90
A	Private	0.2	0.3	0.2	0.1	40	40	40	40	40	90
AG	BCM	0.3	0.4	0.3	0.2	40	41	41	41	40	90
R	Yancoal	2.5	2.6	2.1	1.3	46	46	47	46	45	90
X	Yancoal	3.3	3.4	2.6	1.6	53	56	56	55	54	90
294	Private	2.0	2.1	1.7	1.1	43	43	43	43	42	90
328	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
329	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
330	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
331	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
332	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
333	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
334	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
335	Private	0.6	0.7	0.6	0.3	41	41	41	41	41	90
336	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
337	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
338	Private	0.6	0.7	0.6	0.4	41	41	41	41	41	90
339	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
340	Private	0.5	0.6	0.5	0.3	41	41	41	41	41	90
341	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
342	Private	0.7	0.8	0.6	0.4	41	41	41	41	41	90
343	Private	0.4	0.4	0.4	0.2	41	41	41	41	41	90
88	Private	0.4	0.5	0.4	0.3	41	41	41	41	41	90

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
344	Private	1.3	1.5	1.3	0.9	42	42	42	42	42	90
156B	BCM	0.7	0.8	0.7	0.4	41	41	41	41	41	90
156w	BCM	0.7	0.8	0.7	0.4	41	41	41	41	41	90
177A	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
176	Private	0.3	0.4	0.3	0.2	40	40	41	40	40	90
174	Private	0.3	0.4	0.3	0.2	40	40	41	40	40	90
162	Private	0.4	0.5	0.4	0.3	40	41	41	41	40	90
AA	BCM	0.8	0.9	0.9	0.5	41	41	41	41	41	90
153	BCM	0.7	0.8	0.7	0.4	41	41	41	41	41	90
105B	Private	0.4	0.4	0.4	0.2	40	41	41	41	40	90
319B	Private	0.7	0.8	0.7	0.4	41	41	41	41	41	90
72	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
73	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
74	Private	0.6	0.6	0.5	0.3	41	41	41	41	41	90
345	Private	0.6	0.7	0.6	0.3	41	41	41	41	41	90
23	Private	1.1	1.3	1.1	0.7	41	42	42	42	41	90
20	Private	1.2	1.5	1.3	0.9	42	42	42	42	42	90
S	Yancoal	3.1	3.3	2.6	1.6	46	46	46	45	44	90
T	Yancoal	3.4	3.5	2.8	1.7	47	48	48	47	46	90
U	Yancoal	3.6	3.8	3.0	1.8	47	48	48	47	46	90
V	Yancoal	3.9	4.0	3.1	1.9	50	51	51	50	49	90
W	Yancoal	4.4	4.5	3.4	2.1	55	58	58	57	55	90
Y	Yancoal	4.1	4.2	3.2	1.9	58	62	62	61	60	90
346	Yancoal	2.9	3.1	2.4	1.5	46	47	47	47	46	90
347	Yancoal	2.6	2.7	2.1	1.3	46	47	48	47	46	90
MCF	MCF	41.3	28.9	22.5	15.6	53	85	73	66	59	90
D10	BAM PM2.5	2.7	2.9	2.5	1.6	43	43	44	43	42	90
D2	BAM PM2.5	0.4	0.4	0.3	0.2	40	41	41	41	40	90
A3	Dust dep	1.8	2.0	1.6	1.1	42	43	43	42	42	90
D9	Dust dep	2.3	2.4	2.0	1.3	43	43	44	43	42	90
D10	Dust dep	2.4	2.6	2.2	1.4	42	43	43	43	42	90
Sharrock 1	Dust dep	0.3	0.4	0.3	0.2	40	41	41	41	40	90
D6	Dust dep	0.4	0.5	0.4	0.3	41	41	41	41	41	90
Hedley	Dust dep	6.4	5.4	5.4	3.5	44	48	47	47	45	90
C5	Dust dep	0.7	0.8	0.7	0.4	41	41	41	41	41	90
N5	Dust dep	3.0	3.3	2.7	1.7	43	44	44	43	42	90
F3	Dust dep	0.8	1.0	0.8	0.5	41	41	41	41	41	90
Redibar	Dust dep	0.3	0.4	0.3	0.2	40	41	41	41	40	90
EPA 9	EWU PM10	47.2	28.4	17.5	9.8	182	111	93	82	74	90
EPA 10	EWU PM10	4.6	5.8	5.1	3.7	45	46	47	47	45	90
Dawtrey	HVAS PM10	1.4	1.7	1.5	1.0	41	42	42	42	41	90
D10	HVAS PM10	2.5	2.8	2.3	1.5	42	43	43	43	42	90
Hill Street	HVAS PM10	0.4	0.4	0.3	0.2	40	41	41	41	40	90
Dawtrey	HVAS TSP	1.4	1.7	1.5	1.0	41	42	42	42	41	90
D10	HVAS TSP	2.5	2.8	2.3	1.5	42	43	43	43	42	90
Hill Street	HVAS TSP	0.4	0.4	0.3	0.2	40	41	41	41	40	90
Mt Thorley	OEH	8.5	7.2	7.2	4.5	45	51	50	50	47	90
MCF	TEOM PM10	41.3	28.9	22.5	15.6	53	85	73	66	59	90
D1	TEOM PM10	0.4	0.4	0.3	0.2	40	41	41	41	40	90
D3	TEOM PM10	2.5	2.8	2.4	1.5	42	43	43	43	42	90
D5	TEOM PM10	2.0	2.5	2.2	1.4	42	43	43	43	42	90
D11	TEOM PM10	2.6	2.2	2.1	1.5	42	43	43	43	42	90
-											
Annual average dust deposition (g/m2/month)											
3	Private	0.4	0.3	0.3	0.2	2.5	2.8	2.7	2.7	2.7	4
8	Private	0.3	0.3	0.2	0.2	2.5	2.7	2.7	2.7	2.6	4
21	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.8	2.7	4
33	Private	0.3	0.4	0.3	0.2	2.8	2.8	2.9	2.8	2.7	4
37	Private	0.2	0.2	0.2	0.1	2.6	2.6	2.7	2.6	2.6	4
38	Private	0.2	0.2	0.2	0.1	2.6	2.6	2.6	2.6	2.5	4
41	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
46	Private	0.1	0.1	0.1	0.1	2.4	2.5	2.5	2.5	2.4	4
55	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
56	Private	0.1	0.1	0.1	0.1	2.4	2.5	2.5	2.5	2.4	4
57	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.4	4
58	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
60	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
61	Private	0.1	0.1	0.1	0.1	2.4	2.5	2.5	2.5	2.4	4
62	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
63	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
71	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
76	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
78	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
80	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
82	Private	0.0	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
83	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
84	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
85	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
86	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
87	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
90	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.3	4
91	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
93	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
94	Private	0.1	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
95	Private	0.1	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
97	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.4	4
98	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
100	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
101	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
102	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
103	Private	0.0	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
107	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.4	2.3	2.3	4
108	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
109	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
114	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
115	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
116	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
117	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.3	2.3	4
118	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
119	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.4	2.3	2.3	4
122	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
123	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
124	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
125	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
130	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.4	2.3	2.3	4
131	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.4	2.3	2.3	4
132	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
137	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
138	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
140	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
144	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
145	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
147	BCM	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
149	Private	0.1	0.2	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
154	BCM	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
160	BCM	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.5	2.4	4
164	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
165	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
170	Private	0.0	0.1	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
171	Private	0.0	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
175	Private	0.0	0.1	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
179	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
183	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
184	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
185	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
190	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
191	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
192	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
193	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
194	Private	0.0	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.3	4
195	Private	0.1	0.2	0.2	0.1	2.4	2.5	2.5	2.5	2.5	4
197	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
198	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
199	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
200	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
202	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
203	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
204	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
206	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
207	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
208	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
209	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
211	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
212	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.5	2.4	4
213	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
214	Private	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
220	Private	0.2	0.2	0.2	0.1	2.5	2.5	2.6	2.5	2.5	4
221	Private	0.2	0.2	0.2	0.1	2.4	2.5	2.5	2.5	2.5	4
222	Private	0.2	0.3	0.2	0.2	2.5	2.6	2.6	2.6	2.5	4
223	Private	0.2	0.2	0.2	0.2	2.5	2.6	2.6	2.6	2.5	4

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
225	Private	0.2	0.2	0.2	0.1	2.4	2.5	2.5	2.5	2.4	4
226	Private	0.2	0.3	0.2	0.2	2.5	2.6	2.6	2.6	2.5	4
227	Private	0.2	0.3	0.2	0.2	2.5	2.6	2.6	2.6	2.5	4
228	Private	0.2	0.3	0.2	0.2	2.5	2.6	2.6	2.6	2.5	4
229	Private	0.3	0.3	0.3	0.2	2.5	2.6	2.6	2.6	2.5	4
230	Private	0.3	0.3	0.3	0.2	2.5	2.6	2.6	2.6	2.5	4
231	Private	0.3	0.3	0.3	0.2	2.5	2.6	2.6	2.6	2.5	4
232	Private	0.3	0.3	0.3	0.2	2.6	2.7	2.7	2.6	2.5	4
233	Private	0.3	0.3	0.3	0.2	2.6	2.6	2.7	2.6	2.5	4
234	Private	0.3	0.3	0.3	0.2	2.6	2.7	2.7	2.7	2.5	4
235	Private	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
236	Private	0.4	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
237	Private	0.4	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
238	Private	0.4	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
239	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
240	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
241	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
242	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
243	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
244	Private	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
247	Private	0.3	0.3	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
250	Private	0.2	0.2	0.2	0.1	2.4	2.5	2.5	2.5	2.5	4
254	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
256	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
261	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
262	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
263	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
264	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
265	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
266	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
267	Yancoal	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
272	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
273	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
274	Yancoal	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
275	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
276	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
279	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
280	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
281	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
283	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
285	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
286	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
287	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
288	Private	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
289	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
290	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
291	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
292	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
293	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
295	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
296	Private	0.3	0.3	0.2	0.2	2.7	2.7	2.8	2.7	2.6	4
297	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
298	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.6	4
300	Private	0.3	0.3	0.2	0.2	2.7	2.7	2.7	2.7	2.6	4
301	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
302	Private	0.3	0.3	0.2	0.2	2.7	2.7	2.7	2.7	2.6	4
303	Private	0.3	0.3	0.2	0.2	2.7	2.7	2.7	2.7	2.6	4
304	Private	0.3	0.3	0.2	0.1	2.7	2.7	2.7	2.7	2.6	4
305	Private	0.3	0.3	0.2	0.1	2.7	2.7	2.7	2.7	2.6	4
306	Private	0.3	0.3	0.2	0.2	2.7	2.8	2.8	2.7	2.7	4
307	Yancoal	0.4	0.4	0.3	0.2	3.1	3.2	3.2	3.2	3.0	4
308	Yancoal	0.3	0.3	0.3	0.2	3.0	3.0	3.0	3.0	2.9	4
309	Private	0.2	0.2	0.2	0.1	2.7	2.8	2.8	2.7	2.7	4
311	Private	0.3	0.3	0.2	0.2	3.0	3.2	3.2	3.1	3.0	4
314	Yancoal	0.2	0.2	0.2	0.1	2.7	2.8	2.8	2.7	2.7	4
317	Private	0.2	0.2	0.2	0.1	2.8	2.8	2.8	2.8	2.7	4
323	Private	0.3	0.2	0.2	0.2	2.5	2.7	2.7	2.7	2.6	4
324	Private	0.2	0.2	0.2	0.1	2.5	2.7	2.6	2.6	2.6	4
325	Private	0.2	0.2	0.2	0.1	2.5	2.6	2.6	2.6	2.5	4
326	Private	0.3	0.3	0.2	0.2	2.7	2.7	2.8	2.7	2.6	4
327	Private	0.3	0.3	0.3	0.2	2.5	2.6	2.6	2.6	2.5	4
105A	Private	0.1	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
105C	Private	0.1	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
113A	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
113B	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
121A	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
121B	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.4	2.3	2.3	4
126A	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
126B	Private	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	4
142A	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
142B	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
142C	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
143A	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
143B	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
169A	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
169e	Private	0.0	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
177B	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
188A	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
188B	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4
188C	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
1A	Private	0.5	0.5	0.5	0.3	2.9	3.3	3.2	3.2	3.0	4
217m	Private	0.3	0.4	0.4	0.2	2.5	2.7	2.7	2.7	2.6	4
217n	Private	0.4	0.4	0.4	0.3	2.6	2.7	2.8	2.8	2.6	4
217s	Private	0.3	0.4	0.4	0.3	2.5	2.7	2.7	2.7	2.6	4
316A	Private	0.2	0.2	0.2	0.1	2.7	2.8	2.8	2.7	2.7	4
316B	Private	0.2	0.2	0.2	0.1	2.7	2.8	2.8	2.7	2.7	4
318A	Yancoal	0.4	0.4	0.3	0.2	2.8	2.8	2.8	2.8	2.7	4
318B	Yancoal	0.4	0.4	0.3	0.2	2.8	2.8	2.8	2.8	2.6	4
319A	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
AB	BCM	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	2.4	4
AD	BCM	0.2	0.3	0.3	0.2	2.5	2.6	2.6	2.6	2.5	4
AF	BCM	0.3	0.4	0.3	0.2	2.8	2.8	2.9	2.8	2.7	4
AH	BCM	0.8	0.7	0.7	0.4	3.0	3.6	3.5	3.5	3.2	4
AI	BCM	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.4	2.4	4
AJ	BCM	0.5	0.5	0.5	0.3	2.8	3.1	3.1	3.1	2.9	4
AK	BCM	0.5	0.5	0.5	0.3	2.8	3.2	3.1	3.1	2.9	4
B	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
C	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
D	Private	0.3	0.3	0.2	0.2	2.6	2.7	2.7	2.6	2.6	4
E	BCM	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
G	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
H	Private	0.1	0.1	0.1	0.1	2.4	2.5	2.5	2.5	2.4	4
I	Private	0.4	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
J	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
K	BCM	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
M	BCM	1.0	1.2	0.9	0.5	3.3	3.4	3.6	3.3	2.9	4
N	BCM	0.5	0.6	0.5	0.4	2.7	2.9	3.0	2.9	2.7	4
O	BCM	0.4	0.5	0.4	0.2	2.7	2.8	2.8	2.7	2.6	4
P	Private	0.4	0.4	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
Q	BCM	0.2	0.2	0.2	0.1	2.6	2.6	2.6	2.6	2.5	4
Z	BCM	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.5	2.4	4
139	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
277	Yancoal	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
284	Yancoal	0.3	0.3	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
A	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
AG	BCM	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
R	Yancoal	0.3	0.3	0.3	0.2	3.2	3.4	3.4	3.3	3.2	4
X	Yancoal	0.5	0.5	0.4	0.2	4.5	5.0	5.0	4.9	4.8	4
294	Private	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
328	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
329	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
330	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
331	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
332	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
333	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
334	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.4	2.4	4
335	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.5	2.4	4
336	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.4	2.4	4
337	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
338	Private	0.1	0.1	0.1	0.1	2.4	2.5	2.5	2.5	2.4	4
339	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
340	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
341	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.4	2.4	4
342	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.4	4
343	Private	0.0	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
88	Private	0.1	0.1	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
344	Private	0.3	0.4	0.3	0.2	2.8	2.8	2.9	2.8	2.7	4
156B	BCM	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
156w	BCM	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
177A	Private	0.1	0.1	0.1	0.0	2.3	2.4	2.4	2.4	2.4	4

		Project in isolation				Cumulative					
ID	Type	2022	2026	2031	2035	2014	2022	2026	2031	2035	Criteria
176	Private	0.0	0.1	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
174	Private	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.3	4
162	Private	0.0	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
AA	BCM	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.4	2.4	4
153	BCM	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
105B	Private	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
319B	Private	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
72	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
73	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
74	Private	0.1	0.1	0.1	0.0	2.4	2.4	2.5	2.4	2.4	4
345	Private	0.1	0.1	0.1	0.0	2.4	2.5	2.5	2.4	2.4	4
23	Private	0.3	0.3	0.3	0.2	2.6	2.7	2.8	2.7	2.6	4
20	Private	0.3	0.4	0.3	0.2	2.7	2.8	2.8	2.8	2.7	4
S	Yancoal	0.4	0.4	0.3	0.2	3.0	3.0	3.1	3.0	2.9	4
T	Yancoal	0.4	0.4	0.3	0.2	3.2	3.3	3.3	3.2	3.1	4
U	Yancoal	0.4	0.4	0.3	0.2	3.1	3.2	3.2	3.1	3.0	4
V	Yancoal	0.4	0.4	0.3	0.2	3.4	3.6	3.6	3.5	3.4	4
W	Yancoal	0.4	0.4	0.3	0.2	3.9	4.2	4.2	4.1	4.0	4
Y	Yancoal	0.5	0.5	0.4	0.2	4.6	5.2	5.2	5.1	4.9	4
346	Yancoal	0.4	0.4	0.3	0.2	3.3	3.4	3.4	3.3	3.2	4
347	Yancoal	0.4	0.4	0.3	0.2	3.4	3.6	3.6	3.5	3.4	4
MCF	MCF	5.1	3.4	2.5	1.8	3.9	8.2	6.4	5.5	4.8	4
D10	BAM PM2.5	0.4	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
D2	BAM PM2.5	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
A3	Dust dep	0.3	0.4	0.3	0.2	2.7	2.7	2.7	2.7	2.6	4
D9	Dust dep	0.3	0.3	0.3	0.2	2.7	2.7	2.8	2.7	2.6	4
D10	Dust dep	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.5	4
Sharrock 1	Dust dep	0.0	0.0	0.0	0.0	2.3	2.4	2.4	2.4	2.4	4
D6	Dust dep	0.1	0.1	0.1	0.0	2.4	2.4	2.4	2.4	2.4	4
Hedley	Dust dep	0.5	0.4	0.4	0.3	2.7	3.0	3.0	3.0	2.8	4
C5	Dust dep	0.1	0.1	0.1	0.1	2.5	2.5	2.5	2.5	2.5	4
N5	Dust dep	0.4	0.4	0.3	0.2	2.7	2.8	2.8	2.7	2.6	4
F3	Dust dep	0.1	0.1	0.1	0.1	2.4	2.4	2.5	2.4	2.4	4
Redibar	Dust dep	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
EPA 9	EWU PM10	4.8	2.7	1.7	0.9	14.1	9.7	7.6	6.6	5.9	4
EPA 10	EWU PM10	1.0	1.3	1.1	0.8	3.4	3.7	3.9	3.8	3.5	4
Dawtrey	HVAS PM10	0.2	0.2	0.2	0.2	2.4	2.5	2.6	2.6	2.5	4
D10	HVAS PM10	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
Hill Street	HVAS PM10	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
Dawtrey	HVAS TSP	0.2	0.2	0.2	0.2	2.4	2.5	2.6	2.6	2.5	4
D10	HVAS TSP	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
Hill Street	HVAS TSP	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
Mt Thorley	OEH	0.7	0.6	0.6	0.4	2.8	3.3	3.2	3.2	3.0	4
MCF	TEOM PM10	5.1	3.4	2.5	1.8	3.9	8.2	6.4	5.5	4.8	4
D1	TEOM PM10	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	4
D3	TEOM PM10	0.3	0.4	0.3	0.2	2.6	2.7	2.7	2.7	2.6	4
D5	TEOM PM10	0.3	0.3	0.3	0.2	2.5	2.6	2.7	2.7	2.6	4
D11	TEOM PM10	0.2	0.2	0.2	0.1	2.5	2.6	2.6	2.6	2.5	4
-											

Appendix E. Additional Model Performance Evaluations

This section provides information on the performance of the model for predicting measured PM_{10} concentrations. The performance evaluation has been carried out by predicting PM_{10} concentrations for the 2014 calendar year (based on mining and activities rates in 2014) and comparing these results to measurement data.

Figure E1 shows quantile-quantile plots of measured and predicted 24-hour average PM_{10} concentrations at D1, D3 and D5. These plots show the measured data and predictions paired by highest to lowest, and not matched in time. Dispersion models often encounter difficulties when trying to reproduce monitoring results for a single point, especially for the extreme statistics such as the maximum 24-hour average. The most significant factor is the limitation of using computers to model large, complex systems (this would be the case even if all the physics were perfectly correct). The quantile-quantile plots **Figure E1** do however show that the model predictions are well within a factor of two for all percentiles.

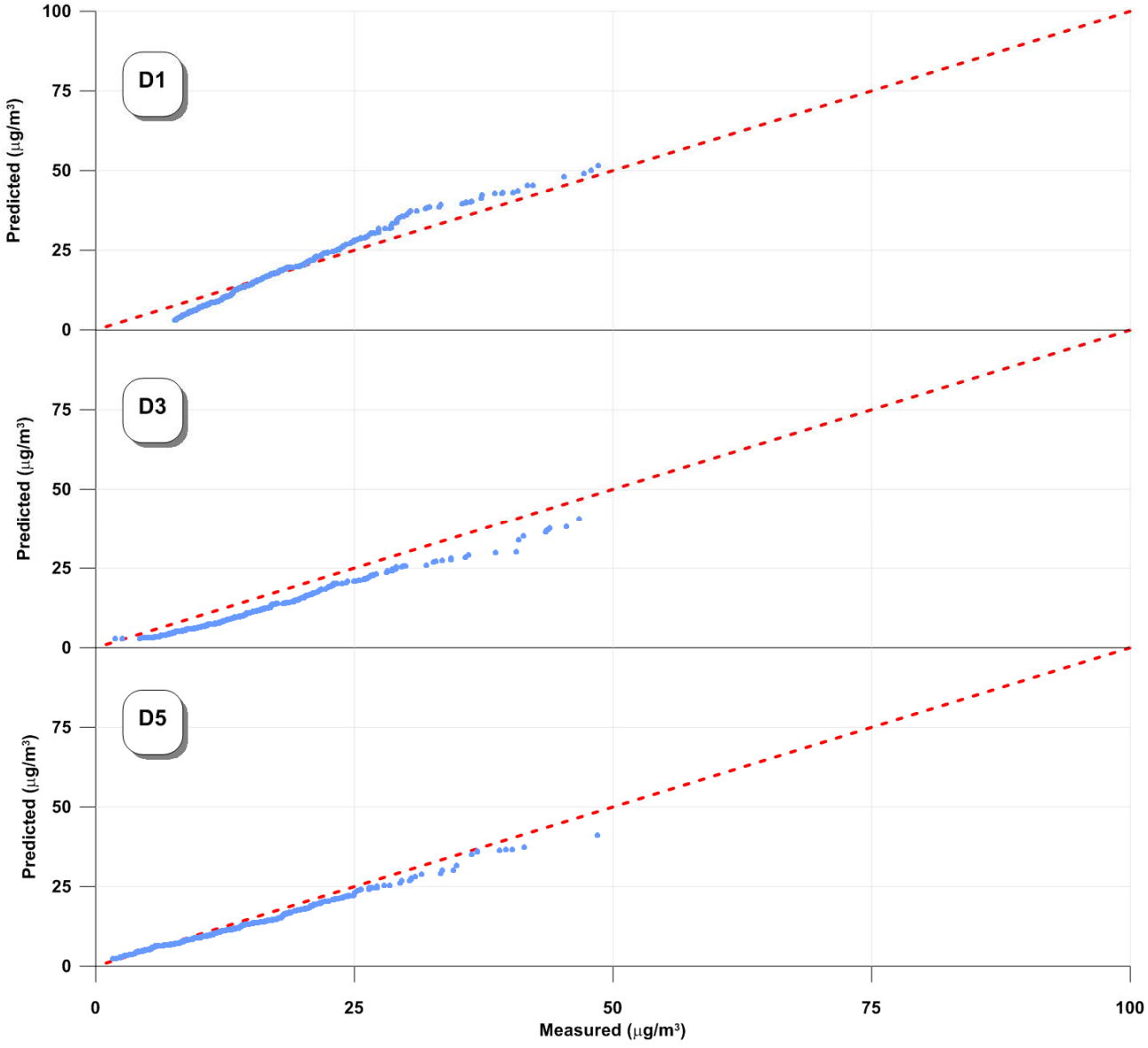
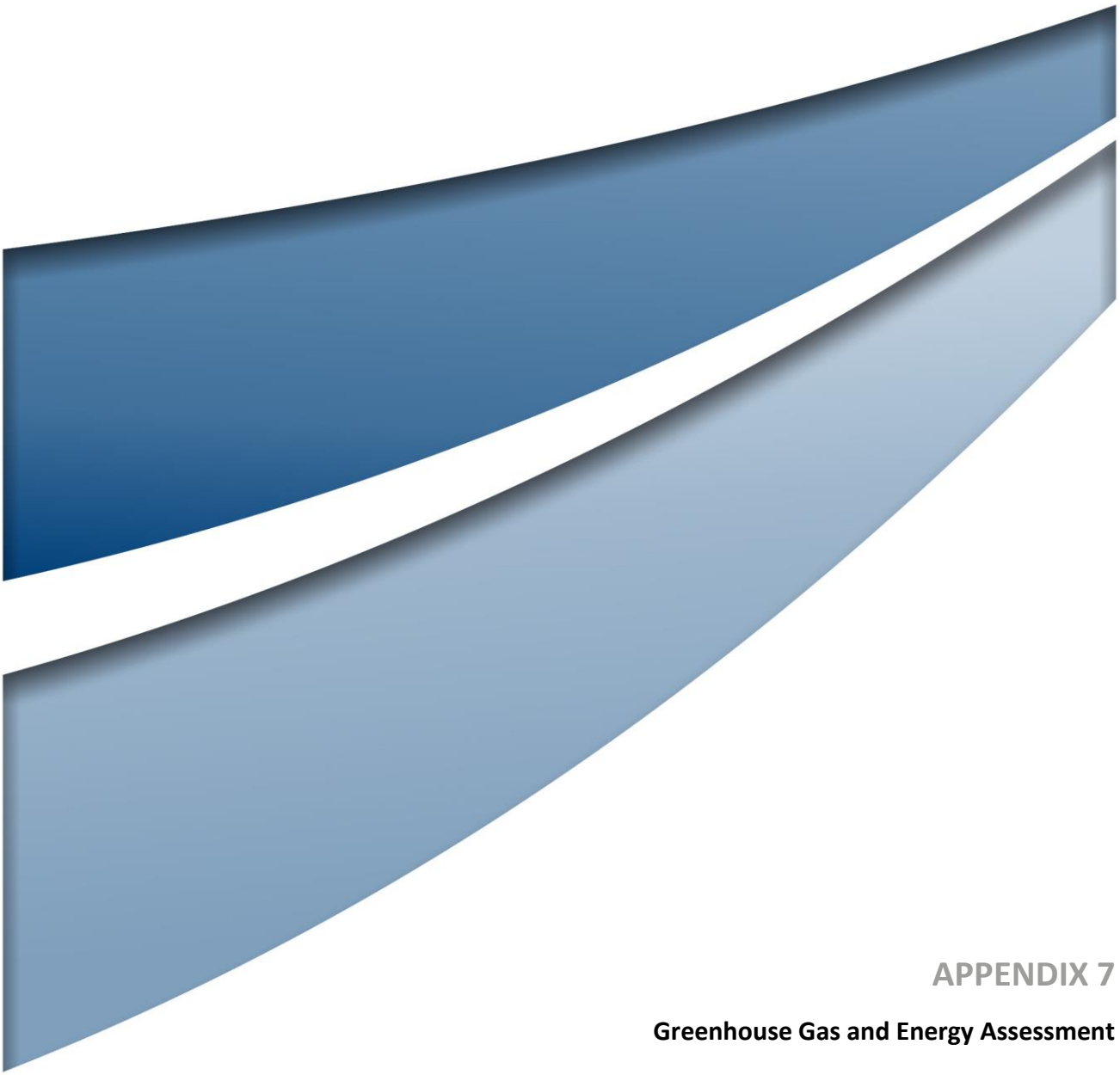


Figure E1 Quantile-quantile plots of measured and predicted 24-hour average PM_{10} concentrations



APPENDIX 7

Greenhouse Gas and Energy Assessment

umwelt
Environmental & Social Consultants

GLENCORE

GREENHOUSE GAS AND ENERGY ASSESSMENT

Bulga Optimisation Project Modification 3

FINAL

June 2019

GLENCORE

GREENHOUSE GAS AND ENERGY ASSESSMENT

Bulga Optimisation Project Modification 3

FINAL

Prepared by
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Report No.	4100/R06
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Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
FINAL	Malcolm Sedgwick	13 June 2019	Malcolm Sedgwick	13 June 2019

Executive Summary

The Bulga Optimisation Project Modification 3 (the Proposed Modification) will seek approval to extract 63 million tonnes of additional coal resources within the Bulga Coal Complex. The Proposed Modification will also seek to extend mining operations to 2039, which will allow the additional 63 million tonne of ROM coal to be extracted during the progression of ongoing mining, over a 21 year period (i.e. between 2019 and 2039). Approval for the Proposed Modification will be sought under Section 4.55(2) of the Environmental Planning & Assessment (EP&A) Act, which requires Bulga Coal Management Pty Ltd (BCM) to prepare a Statement of Environmental Effects (SEE) to support the Proposed Modification.

This report has been prepared to support the preparation of the SEE, and it includes greenhouse gas emission projections, an evaluation of the climate change impacts and mitigation options. The scope of the greenhouse gas and energy assessment (GHGEA) includes:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification (i.e. the additional 63 million tonnes)
- estimating energy use directly associated with the Proposed Modification
- qualifying how the Proposed Modification's greenhouse gas emissions may impact the environment
- estimating the impact of the Proposed Modification's emissions on national and international greenhouse gas emission targets
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

The GHGEA found that the Proposed Modification can be associated with the following greenhouse gas emissions.

	Emissions from Proposed Modification	
	(t CO_2-e)	(%)
Scope 1	4,262,000	3.73
Scope 2	389,000	0.34
Scope 3	109,717,000	95.93
TOTAL	**114,368,000**	**100**

The Proposed Modification is forecast to produce approximately 203,000 t CO_2-e Scope 1 emissions per annum (averaged over 21 years), which is comparable to other Hunter Valley open cut coal mining operations of similar size. The majority of Scope 1 emissions are generated by fugitive emissions and diesel combustion. BCM has a direct influence over Scope 1 emissions and these emissions will be subject to management and mitigation plans.

The Proposed Modification is forecast to consume approximately 82,000 GJ of electricity per annum (averaged over 21 years), which will generate approximately 19,000 t CO_2-e of Scope 2 emissions. BCM can influence reductions in Scope 2 emissions by driving electricity reduction and efficiency initiatives.

Approximately 5,225,000 t CO_2-e of Scope 3 emissions per annum are estimated to be associated with the Proposed Modification. The majority of Scope 3 emissions associated with the Proposed Modification will be generated by third parties who transport and consume coal products. BCM has no operational control over Scope 3 emissions, as these emissions are generated by the activities of other organisations.

The Proposed Modification's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 96 per cent of the Proposed Modification's greenhouse gas emissions will occur either upstream or downstream of the Proposed Modification and outside the direct operational control of BCM. Approximately 4 per cent of the greenhouse gases associated with the Proposed Modification are related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions) (refer to **Figure 1**).

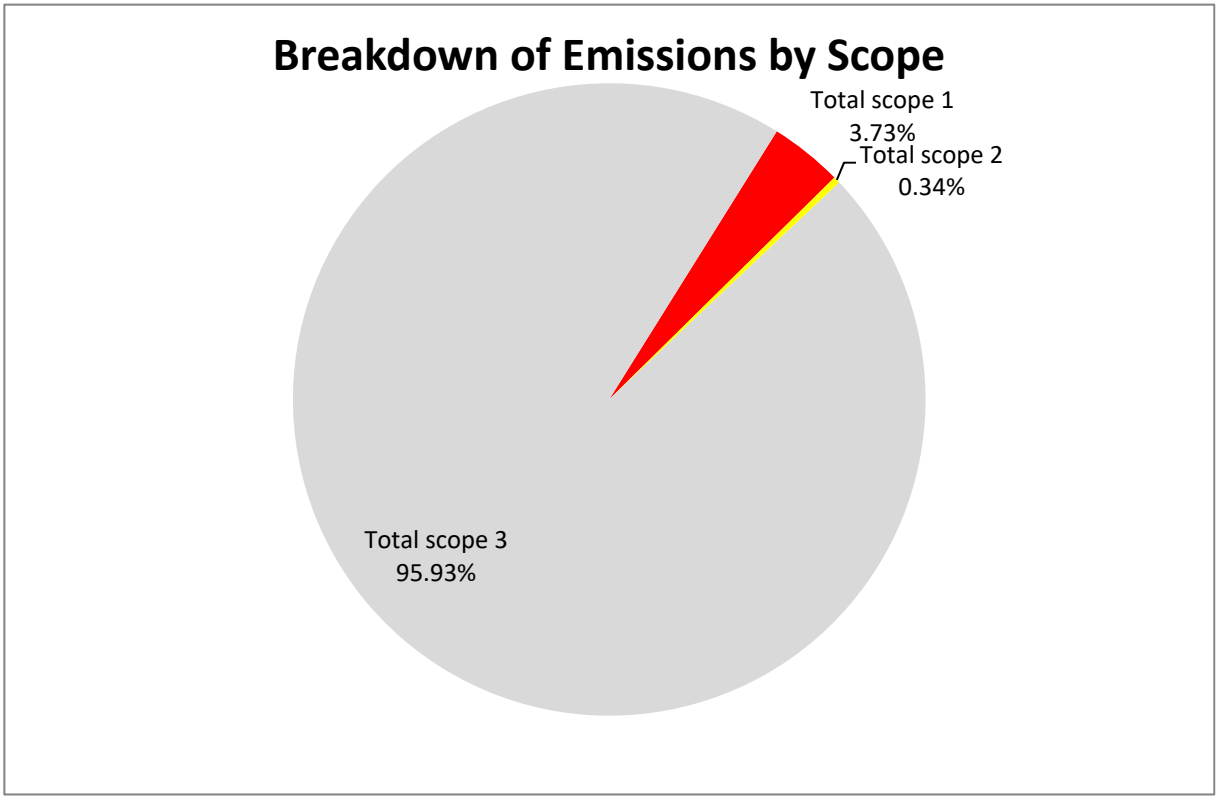

Figure 1 – Breakdown of Emissions by Scope

The GHGEA found that the Proposed Modification is unlikely to impact national greenhouse gas policy objectives due to the relatively small contribution the Proposed Modification will make to national emissions on an annual basis.

The Proposed Modification will mitigate greenhouse gas emissions through ongoing energy efficiency initiatives and optimising productivity.

The Proposed Modification will contribute to global emissions, however, the extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions which includes all major emission sources and sinks.

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Appendix A	Calculation of greenhouse gas emissions associated with the Proposed Modification

1.0 Introduction

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located in the Hunter Valley, NSW (refer to **Figure 1.1**). The BCC consists of two existing coal mining operations that share coal washing and rail loading infrastructure. Bulga Open Cut is currently operating however Bulga Underground is not operating currently.

Bulga Coal Management Pty Ltd (BCM) was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD 4960 was subsequently been modified twice it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

The Bulga Optimisation Project Modification 3 (Proposed Modification) will facilitate a relatively small extension of the open cut operations approved under the existing consent (SSD 4960) into a former open cut mining area occupied by the current Tailings Storage Facilities. The extension of the pit will enable the recovery of additional coal resources below and adjacent to parts of the currently approved Bulga open cut operation. **Table 1.1** includes the key features of the Proposed Modification that will impact greenhouse gas emissions.

Table 1.1 Key features of the Proposed Modification that will impact greenhouse gas emissions

Key Feature	Proposed Operations
Mining methods	No change
Mine Life	Mine life increased by 4 years, allowing ROM coal to be recovered over a 21 year period
Total resource recovered	ROM Coal recovered increased by 63 million tonne
Annual production	No change
CHPP production	No change



FIGURE 1.1

Locality Plan

2.0 Assessment Framework

2.1 Objectives

Approval for the Proposed Modification will be sought under Section 4.55(2) of the Environmental Planning & Assessment (EP&A) Act, which requires Bulga Coal Management Pty Ltd (BCM) to prepare a Statement of Environmental Effects (SEE) to support the Proposed Modification.

This report has been prepared to support the preparation of the SEE, and it includes greenhouse gas emission projections, an evaluation of the climate change impacts and mitigation options.

2.2 Scope

The scope of the GHGEA includes:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification
- estimating energy use directly associated with the Proposed Modification
- qualifying how the Proposed Modification's greenhouse gas emissions may impact the environment
- estimating the impact of the Proposed Modification's emissions on national and international greenhouse gas emission targets
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency.

2.3 Definitions

Table 2.1 contains concepts and a glossary of terms relevant to this GHGEA.

Table 2.1 Glossary of Terms[1]

Concept	Definition
Greenhouse gases	The greenhouse gases covered by the Kyoto Protocol and referred to in this GHGEA include: • Carbon dioxide • Methane • Nitrous oxide • Hydrofluorocarbons • Perfluorocarbons • Sulphur hexafluoride.
Scope 1 emissions	Direct emissions occur from sources that are owned or controlled by the Proposed Modification (in this case, the proponent, BCM) (e.g. fuel use, fugitive emissions). Scope 1 emissions are emissions over which the Proposed Modification has a high level of control.
Scope 2 emissions	Emissions from the generation of purchased electricity consumed by the Proposed Modification.
Scope 3 emissions	Indirect emissions that are a consequence of the activities of the Proposed Modification, but occur at sources owned or controlled by other entities (e.g. outsourced services). Scope 3 emissions can include emissions generated upstream of the Proposed Modification by providers of energy, materials and transport. Scope 3 emissions can also include emissions generated downstream of the Proposed Modification by transport providers and product use.

2.4 Impact Assessment Methodology

The GHGEA framework is based on the methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2018. The assessment framework also incorporates the principles of The Greenhouse Gas Protocol 2004.

The Greenhouse Gas Protocol (The GHG Protocol) provides an internationally accepted approach to greenhouse gas accounting. The Protocol provides guidance on setting reporting boundaries, defining emission sources and dealing with issues such as data quality and materiality.

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2018 (DEE 2018a). Fugitive emissions from the open cut operation were calculated based on the modelled gas reservoir of the Proposed Modification, which was calculated by BCM, using the Method 2 approach described in the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

Scope 3 emissions associated with product transport were calculated based on emission factors contained in the National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2018 (DEE 2018a).

All methodologies and calculations have been made assuming that all operations will continue as described in **Section 1.1**.

[1] The GHG Protocol 2004

2.5 Data Sources

The calculations in this report are based on activity data developed by BCM during the mine planning process.

Table 2.2 contains the source of activity data.

Table 2.2 Source of Activity Data Used for the Assessment

Activity data	Source
On-site fuel consumption	BCM - forecast diesel consumption
Electricity consumption	BCM - forecast electricity consumption
Fugitive emissions	BCM - forecast fugitive emissions
Product consumption	BCM - forecast mine production
Product transport	Umwelt - haulage distances

A detailed description of activity data and calculations are provided in **Appendix A**.

2.6 Assessment Boundary

The GHGEA boundary was developed to include all significant scope 1, 2 and 3 emissions. **Figure 2.1** demonstrates how the assessment boundary interacts with the potential emission sources under BCM's operational control and other emission sources associated with the Proposed Modification.

2.7 Data Exclusions

The GHG Protocol requires inventory data and methodologies to be relevant, consistent, complete, transparent and accurate. The relevance principle states that the greenhouse gas inventory should appropriately reflect greenhouse gas emissions and serve the decision-making needs of users – both internal and external [to the Proposed Modification] (GHG Protocol 2004).

An open cut coal mine has a number of potential emission sources, however, the dominant emission sources, often targeted by mitigation measures and stakeholders can be summarised as:

- diesel use
- fugitive emissions
- electricity use
- product transport
- product use
- materials transport.

The completeness principle states that all relevant emission sources within the chosen inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled (GHG Protocol 2004).

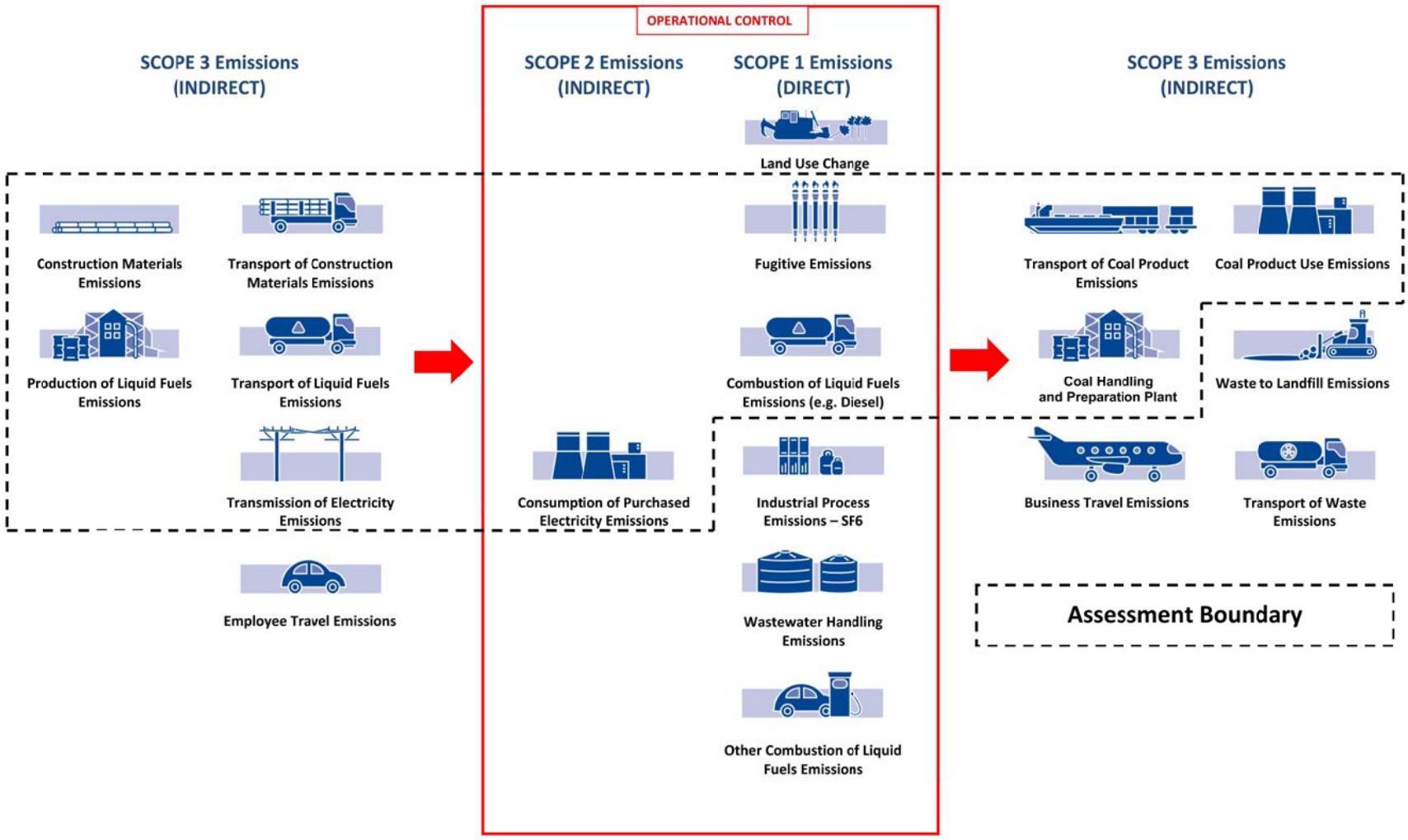

FIGURE 2.1

Greenhouse Gas Assessment Boundary

The emission sources listed in **Table 2.3** have been excluded from the GHGEA as activity data is not readily available, and modelling activity data is unlikely to generate sufficient emissions to materially change impacts or influence the decision making outcomes of stakeholders.

Table 2.3 Emission Source

Emissions source	Scope	Description
Combustion of fuel for energy	Scope 1	• Small quantities of fuels such as petrol and LPG.
Industrial processes	Scope 1	• Sulphur hexafluoride (high voltage switch gear). • Hydrofluorocarbon (commercial and industrial refrigeration).
Waste water handling (industrial)	Scope 1	• Methane emissions from waste water management.
Solid waste	Scope 3	• Solid waste to landfill.
Business travel	Scope 3	• Employees travelling for business purposes.
Employee travel	Scope 3	• Employees travelling between their place of residence and the Bulga site.

Greenhouse gas emissions resulting from land use, land use change and forestry (LULUCF) were also excluded from the greenhouse gas assessment. While it is acknowledged that emissions resulting from LULUCF may be an important emission source for decision makers, the assessment made an assumption that all emissions generated during the land clearing process would be sequestered via rehabilitation plantings.

3.0 Impact Assessment Results

Greenhouse gas and energy use estimates have only been calculated for the additional 63 million tonne as per the Proposed Modification. Greenhouse gas and energy use estimates have also only been calculated for the operational stage of the Proposed Modification. Construction activities are a relatively minor part of the Proposed Modification (civil works are included in operational energy use forecasts), and the decommissioning impacts were considered as part of the Approved Project.

The following information was used to estimate the greenhouse gas emissions from the operational stage of the Proposed Modification:

- recover an additional 63,000,000 ROM tonnes over 21 years
- extend the life of the Bulga Open Cut Coal mine to approximately 31 December 2039
- no to change the extraction rate, mining methods, processing, transport or major infrastructure
- electricity use averages 0.0184 GJ/ROM T
- electricity use required to relocate 31 GL of tailings will average approximately 91,000 GJ per annum over 6 years
- product coal will be approximately 22% Coking quality and 78% Thermal quality
- 100% of all product coal will be exported
- product coal will yield approximately 66% of ROM coal
- fugitive emissions will average 0.048 t CO_2-e / ROM tonne
- rail transport will be approximately 92 Km
- ship transport will be approximately 9500 Km.

The Proposed Modification's greenhouse gas emissions are summarised in **Table 3.1**. Greenhouse gas emission forecasts are based on the Proposed Modification recovering approximately 63,000,000 ROM tonnes and extending the Approved Project by four years.

The Proposed Modification is forecast to generate approximately 4,263,000 t CO_2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. If the Scope 1 emissions associated with the Proposed Modification are averaged across the extended life of mine (21 years), the Proposed Modification may generate annual average Scope 1 emissions of approximately 203,000 t CO_2-e per annum. Annual average Scope 1 emission estimates should not be used to benchmark annual performance, as annual emissions will vary significantly due to normal variations in annual activity.

The Proposed Modification is forecast to be associated with approximately 389,000 t CO_2-e of Scope 2 emissions from consuming electricity. The Proposed Modification is expected to increase annual Scope 2 emissions from the Approved Project, by an average of approximately 19,000 t CO_2-e per annum.

The Proposed Modification is forecast to be associated with approximately 109,717,000 t CO_2-e of Scope 3 emissions. Scope 3 emissions will be generated by third parties who transport and consume coal products. The Proposed Modification is expected to increase annual Scope 3 emissions from the Approved Project, by an average of approximately 5,225,000 t CO_2-e per annum.

Figure 3.1 demonstrates that the Proposed Modification's greenhouse gas inventory is dominated by Scope 3 emissions. Approximately 96 per cent of the Proposed Modification's greenhouse gas emissions occur downstream of the Proposed Modification. Approximately 4 per cent of the greenhouse gases associated with the Proposed Modification are related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions).

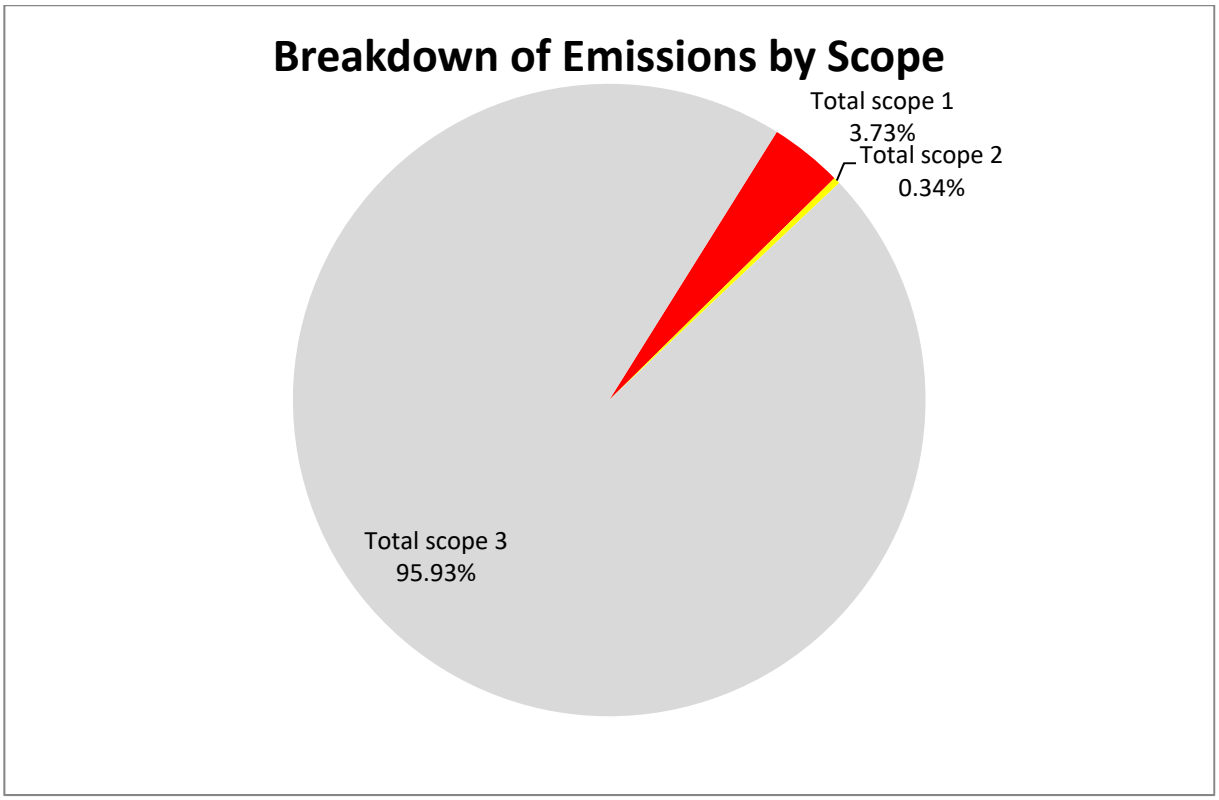

Figure 3.1 Breakdown of Emissions by Scope

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Proposed Modification. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

3.1.1 Operational Energy Use

The Proposed Modification is forecast to require approximately 19,441,000 GJ of energy from diesel and grid electricity. If forecast energy use associated with the Proposed Modification is averaged across the extended life of mine (21 years), the Proposed Modification may require an average of approximately 926,000 GJ per annum.

The industry average energy use for open cut coal mines in Australia ranges between 430 and 660 Megajoules (MJ)/Product tonne (AGSO 2000). The Proposed Modification is forecast to operate with an average energy use intensity of approximately 466 MJ/Product Tonne. The forecast energy use intensity of the Proposed Modification is within the normal operating range for Australian open cut coal mines.

Table 3.1 GHG Emission Summary for the Proposed Modification

(Refer to Appendix A for further detail)

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Proposed Modification	Scope 1 (Direct)	Diesel use	1,238,248	4,262,248
		Fugitive emissions	3,024,000	
	Scope 2 (Indirect)	Electricity	388,647	388,647
	Scope 3 (Indirect)	Product use	104,584,912	109,716,962
		Associated with energy extraction and distribution	111,577	
		Product transport	5,012,874	
		Materials transport	7,599	
Total GHG Emissions for the Proposed Modification				**114,367,857**

4.0 Impact Assessment Summary

The GHG emissions generated by the Proposed Modification have the potential to impact the physical environment and the GHG reduction objectives of national and international governing bodies. The following assessment makes the distinction between environment impacts and impacts on policy objectives.

4.1 Impact on the Environment

The Proposed Modification's greenhouse gas emissions will have a dispersive impact as they are highly mobile and are generated up and down the supply chain. The accumulation of greenhouse gases or carbon in 'carbon sinks' is the primary impact of greenhouse gas emissions. Anthropogenic greenhouse gas emissions have accumulated in three major carbon sinks - the ocean (30%), terrestrial plants (30%) and the atmosphere (40%) (BOM and CSIRO, 2014).

The accumulation of greenhouse gases in the atmosphere is an important driver of global warming, sea level rise and climate change (IPCC 2013). Sea level rise and climate change may have many ramifications for the natural and built environment. The accumulation of greenhouse gases in the ocean is an important driver of ocean acidification (IPCC 2013).

The Proposed Modification's direct emissions are forecast to be approximately 203,000 t CO_2 –e per annum.

To put the Proposed Modification's emissions into perspective, under current policy settings, global greenhouse gas emissions are forecast to reach 56,200,000,000 t CO_2-e per annum by 2025 (UNEP 2016). During operation, the Proposed Modification will contribute approximately 0.0004 per cent to global emissions per annum (based on its projected Scope 1 emissions). The relative environmental impact of the Proposed Modification is likely to be relative to its proportion of global GHG emissions.

The Scope 2 and 3 emissions associated with the Proposed Modification should not be considered, as global projections only represent Scope 1 emissions (i.e. the sum of all individual emission sources).

4.2 Impact on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) define climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007).

Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation (IPCC 2007).

Climate change models forecast many different climate change impacts, which are influenced by future greenhouse gas emission scenarios. Climate change forecasts also vary significantly from region to region.

A qualitative assessment of climate change requires a regional reference and future emission trajectory assumptions. The Proposed Modification, in isolation, is unlikely to influence global emission trajectories. Future emission trajectories will largely be influenced by global scale issues such as; technology, population growth and greenhouse gas mitigation policy. NSW climate change projections have been modelled by the NSW and ACT Regional Climate Modelling (NARCliM) project. NARCliM has

modelled climate change projections for 2030 and 2070, using the IPCC high emissions A2 emission trajectory scenario. The A2 scenario assumes (IPCC 2000):

- Relatively slow demographic transition and relatively slow convergence in regional fertility patterns.
- Relatively slow convergence in inter-regional GDP per capita differences.
- Relatively slow end-use and supply-side energy efficiency improvements (compared to other storylines).
- Delayed development of renewable energy.
- No barriers to the use of nuclear energy.

The Proposed Modification is consistent with the A2 emissions trajectory scenario, therefore the climate change projections developed by NARCliM seem a reasonable basis for a qualitative climate change impact assessment. NARCliM makes the following climate change projections for NSW (Adapt NSW 2016):

- maximum temperatures are projected to increase
- minimum temperatures are projected to increase
- the number of hot days will increase
- the number of cold nights will decrease
- rainfall is projected to decrease in spring and winter
- rainfall is projected to increase in summer and autumn
- average fire weather is projected to increase in summer and spring
- number of days with severe fire danger is projected to increase in summer and spring.

The extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

4.3 Impact on Policy Objectives

The United Nations Framework Convention on Climate Change (UNFCCC) is the leading international forum for setting climate change targets and objectives. The UNFCCC has been responsible for developing internationally accepted greenhouse gas emission reporting methodologies, and has led the development of:

- the Kyoto Protocol
- the Paris Agreement
- specific directives and guidance to improve the implementation of the UNFCCC.

The Kyoto Protocol became international policy in 2005, and it committed the European Union (EU) plus 37 other member states to manage greenhouse gas emissions between 2008 and 2012. A second round of the

Kyoto Protocol (the Doha Amendment) committed the EU plus 191 other member states to manage greenhouse gas emissions between 2013 and 2020. Australia was a signatory to both rounds of the Kyoto Protocol and Australia will meet its obligations under the Kyoto Protocol in 2020 (DoEE 2018b).

In 2015 the UNFCCC successfully negotiated an international climate change agreement between 195 countries (the Paris Agreement). The Paris Agreement aims to:

- hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels
- increase the ability [of nations] to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production
- make finance flows consistent with a pathway towards low GHG emissions and climate-resilient development.

The Paris Agreement seeks to meet its objectives by developing programs and mechanisms that:

- require participating Parties to prepare and communicate GHG mitigation contributions. Parties are expected to set mitigation targets for 2020, and then develop new targets every five years. Each successive target is expected to represent a larger mitigation effort than the previous target
- promote climate change resilience and adaptation
- provide mitigation and adaptation funding to developing countries
- foster mitigation and adaptation technology transfer between Parties
- require participating Parties to report progress towards their mitigation contributions on an annual basis.

Australia signed the Paris Agreement on 22 April 2016, and Australia's obligations under the Paris Agreement will drive national greenhouse gas policy between 2020 and 2030. Under the Paris Agreement, Australia is obliged to:

- prepare, communicate and maintain a Nationally Determined Contribution (NDC). An NDC outlines the size and type of mitigation contribution each member state will make to the international effort
- pursue domestic mitigation measures, with the aim of achieving the objectives of its NDC
- communicate an NDC every 5 years
- quantify its NDC in accordance with IPCC methodologies, which promote transparency and avoid double counting.

4.3.1 Australian Targets

Australia's commitment to the Paris Agreement includes reducing GHG emissions by 26 - 28 %, on 2005 levels, by 2030 (Commonwealth of Australia, 2015). To meet the requirements of the Paris Agreement, Australia will also have to develop interim targets for 2020 and 2025. Australia's NDC is summarised in **Table 4.1**.

Table 4.1 Summary of Australia's NDC

Emissions reduction target	Economy-wide target to reduce greenhouse gas emissions by 26 to 28 per cent below 2005 levels by 2030
Coverage	Economy-wide
Scope	Energy Industrial processes and product use Agriculture Land-use, land-use change and forestry Waste
Gases	CO2, CH4, N2O, HFCs, PFCs, SF6, NF3

Australia's NDC prescribes an unconditional economy-wide target to reduce GHG emissions, and states that future policies will target emissions generated from:

- energy use
- industrial processes
- agriculture, land-use, land-use change and forestry
- waste.

Australia's NDC does not contain sector or state based targets, nor does it make any reference to the mining sector.

Australia's current national greenhouse gas mitigation policy framework caps facility level emissions via the Safeguard Mechanism, and funds mitigation projects through the Emissions Reduction Fund. The Department of the Environment and Energy forecasts that the current national greenhouse gas policy will not be enough to achieve the level of mitigation contribution prescribed in Australia's NDC (DoEE 2018b). **Table 4.2** is based on data produced by the Department of the Environment and Energy in December 2018 (DoEE 2018b). The table includes 2005 baseline emissions and a current forecast of 2030 emissions (using current policy settings).

Table 4.2 Forecast impact of current mitigation efforts (DEE 2018b)

Sector	2005 GHG emissions (t CO2-e pa)	Current 2030 forecast (t CO2-e pa)
Electricity	197,000,000	163,000,000
Direct combustion	82,000,000	107,000,000
Transport	82,000,000	111,000,000
Fugitives	39,000,000	62,000,000
Industrial processes	32,000,000	33,000,000
Agriculture	76,000,000	78,000,000
Waste	14,000,000	9,000,000
LULUCF	82,000,000	-1,000,000
Total	605,000,000	563,000,000
% of 2005	100	93%

Table 4.2 demonstrates that current policy settings are expected to reduce emissions from the electricity generation and waste sectors, and achieve an overall 7% reduction from 2005 emissions by 2030. If Australia is to achieve its 28% mitigation commitment under the Paris Agreement, annual national emissions must reach 447,700,000 t CO_2-e by 2030. Reducing the current 2030 forecast of 563,000,000 t CO_2-e to 447,700,000 t CO_2-e will require Australia to set a more aggressive mitigation trajectory between 2020 and 2030. To achieve the 28% 2030 Paris Agreement target, the DoEE estimates that the Australian economy must set a mitigation trajectory which will save approximately 762,000,000 t CO_2-e between 2021 and 2030.

The greenhouse gas emissions modelling completed by the DoEE anticipates growth in the Australian economy, and the DoEE forecasts an increase in emissions generated from direct consumption, transport and fugitive emissions (presumably from additional projects like the Proposed Modification). It is difficult to determine whether the Proposed Modification's emissions are included in the 2030 projections (i.e. the DoEE has assumed a certain number of new coal projects will be developed) or whether the Proposed Modification's emissions will inflate 2030 projections.

If as a worst case, it is assumed that the none of the Proposed Modification's Scope 1 emissions have been included in DoEE's forecast (and all other assumptions hold true), then the Proposed Modification's cumulative Scope 1 emissions (4,263,000 t CO_2-e) will increase the required national mitigation effort by approximately 0.56%.

The Proposed Modification may increase the national effort required to reach Australia's 2030 GHG mitigation target, however, the Modification in isolation is unlikely to affect Australia achieving its national mitigation targets in any material way. Small fluctuations in the performance of the electricity generation and transport sectors offer a far greater potential to influence the achievement of national targets than single facilities.

The Proposed Modification's Scope 2 and 3 emissions will be generated by Australian facilities and / or in international jurisdictions with environmental approval to generate GHG emissions.

4.3.2 NSW Policy

The NSW Government has developed its NSW Climate Change Policy Framework, which aims to deliver net-zero emissions by 2050, and a State that is more resilient and responsive to climate change (OEH 2016).

Under the NSW Climate Change Policy Framework, NSW has committed to both follow the Paris Agreement and to work to complement national action. The key policy directions under the NSW Climate Change Policy Framework are summarised in the **Table 4.3**.

Table 4.3 A summary of the NSW Climate Change Policy Framework

Policy Direction	Rationale/Goals
Creating an investment environment that manages the emissions reduction transition	Energy will be transformed and investment/job opportunities will be created in emerging industries of advanced energy, transport and carbon farming and environmental services
Boost energy productivity and put downward pressure on energy bills	Boosting energy and resource productivity will help reduce prices and the cost of transitions to net-zero emissions
Grow new industries and capitalise on competitive advantages	Capitalising on the competitive advantage and growth of industries in professional services, advanced energy technology, property management and financial services
Reduce risks and damage to public and private assets arising from climate change	Embed climate change considerations into asset and risk management as well as support the private sector by providing information and supportive regulatory frameworks for adaptation
Reduce climate change impacts on health and wellbeing	Recognise the increased demand for health and emergency services due to climate change and identify ways to better support more vulnerable communities to health impacts
Manage impacts on natural resources and communities	Coordinate efforts to increase resilience of primary industries and rural communities as climate change impacts water availability, water quality, habitats, weeds and air pollution

The policy framework is being delivered through:

- the Climate Change Fund
- developing an economic appraisal methodology to value greenhouse gas emissions mitigation
- embedding climate change mitigation and adaptation across government operations
- building on NSW's expansion of renewable energy
- developing action plans and strategies.

The Proposed Modification is unlikely to affect the objectives of the NSW Climate Change Policy Framework in a material way.

5.0 Evaluation of Greenhouse Gas Mitigation

The GHGEA is required to assess reasonable and feasible measures to minimise the Modification's greenhouse gas emissions.

The term reasonable incorporates notions of costs and benefits, whereas the term feasible focuses on the more fundamental practicalities of the mitigation measures, such as engineering considerations and what is practical to build or operate (Hunter Environment Lobby Inc v Minister for Planning 2011).

5.1 Energy Efficiency

BCM will mitigate Scope 1 and 2 emissions through energy efficiency initiatives. The energy efficiency of mining operations is driven by energy use and productivity. Energy efficiency is maximised when equipment is operated at optimal capacity. BCM's mine planning process optimises operational productivity through scheduling, haul ramp design and equipment selection.

5.2 Assessment of Potential Management Measures

BCM has incorporated a range of measures into the Proposed Modification design, with the aim of minimising potential greenhouse gas emissions and improving energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The Proposed Modification design inherently minimises greenhouse gas emissions from the mining operations. Key measures included in the Proposed Modification design to minimise emissions include:

- limiting the length of material haulage routes (where feasible), thus minimising transport distances and associated fuel consumption
- selecting equipment and vehicles that have high energy efficiency and
- scheduling activities so that equipment and vehicle operation is optimised.

The following sections assess the Proposed Modification's planned greenhouse gas mitigation measures against best practice greenhouse gas management.

5.2.1 Pre-draining Coal Mine Waste Gas

Fugitive emissions arise during the coal production/extraction process whereby methane and carbon dioxide gas trapped within the coal (coal mine waste gas) is released to the atmosphere. The volume and concentration of coal mine waste gas varies significantly from mine to mine.

In underground coal mines, mine waste gas is often drained from active coal seams and goaf environments (the fractured rock zone left once the coal has been extracted), to improve safety. Mine waste gas can be destroyed by flaring to reduce its greenhouse gas potential or combusted as a fuel source. Pre-drainage of open cut operations is not a common practice as seams targeted for open cut extraction typically have a lower gas content than deeper seams targeted for underground extraction.

Fugitive emissions are forecast to generate approximately 65 per cent of the Proposed Modification's scope 1 and 2 emissions. **Table 5.1** includes the greenhouse gas mitigation measures assessed for fugitive emissions.

Table 5.1 Fugitive Emission Mitigation Options Assessed

Fugitive emissions		
Potential Mitigation Measure	**Planned for Proposed Modification**	**Reason for Inclusion/Exclusion**
1. Pre-draining and capturing coal mine waste gas for combustion	No	Glencore has developed three critical criteria for selecting suitable sites for pre-draining waste mine gas for combustion. Glencore has found that pre-draining waste gas is only economically viable when waste gas is extracted from an environment which meets the following criteria: • gas production is greater than 3-4 m^3 of waste gas per tonne; • methane percentage is greater than 70%; and • seam permeability is greater than 50 mD. The production and permeability parameters are important to ensure drainage wells can produce enough pressure to feed flares without using suction pumps or technologies to improve permeability. The methane percentage is an important parameter to ensure the waste gas will continue to burn under the range of normal weather conditions experienced in the Hunter Valley. While it is technically possible to pre-drain and combust mine waste gas from the Proposed Modification Area, the capital and operational costs required to extract gas from the low gas environment is not economically feasible.

5.2.2 Improving the Diesel Use Efficiency of Haul Trucks and Equipment

Diesel consumption in haul trucks and equipment is forecast to generate approximately 27 per cent of the Proposed Modification's combined scope 1 and 2 emissions. **Table 5.2** includes the greenhouse gas mitigation measures assessed for improving diesel use efficiency.

Table 5.2 Diesel Use Efficiency Options Assessed

Energy use during extraction		
Potential Mitigation Measure	**Planned for Proposed Modification**	**Reason for Inclusion/Exclusion**
2. Limiting the length of material haulage routes	Yes	Length of haulage routes has been optimised to minimise dust, noise and fuel use.
3. Optimising ramp gradients	Yes	Ramp gradients have been optimised according to pit geometry parameters.

Energy use during extraction		
4. Fuel efficient haul trucks	Yes	Fuel use efficiency will be an important selection criteria when allocating trucks to operations. The fleet of trucks will all include modern engine management systems, which optimise fuel use efficiency. New fuel use technology will be adopted as new trucks are purchased over the life of the Proposed Modification.
5. Payload Management	Yes	Payload will be constantly monitored and actively managed to maintain efficiency.
6. Increasing haul truck payload	Yes	DT HiLoad trays will be fitted on some truck models. HiLoad trays are a hard wearing, light weight tray, which are custom built to maximise payloads.
7. Improving rolling resistance of haul roads	Yes	Haul roads are planned to be constructed on solid rock rather than on soil or subsoil material where practical.
8. Reducing idling times	Yes	Reducing idle times is an on-going performance measure. Initiatives to reduce idle times will continue to be introduced over the life of the Proposed Modification.
9. Scheduling activities so that equipment and vehicle operation is optimised	Yes	Scheduling activities to optimise plant and vehicle operation is a routine activity. BCM will continue to prepare long, medium and short term plans to optimise production.
10. Replacing trucks with conveyors	No	The use of conveyors is not feasible or cost effective given the short haul distances.
11. Fuel efficient equipment	Yes	Fuel use efficiency will be an important selection criteria when allocating equipment to operations. Equipment will include modern engine management systems, which optimise fuel use efficiency. Proven new fuel use technology will be adopted as new equipment is purchased over the life of the Proposed Modification.
12. Blasting strategies to improve extraction efficiency	Yes	Through seam blasting will be employed to minimise the need for ripping and parting.
13. Maximising resource recovery efficiency	Yes	Long, medium and short term operational plans will be developed to optimise the recovery of approved resources.
14. Working machines to their upper design performance	Yes	Glencore's business objectives support and promote effective equipment utilisation and performance rates.
15. Electric drills	No	Electric drills are not used at Bulga due to the lack of availability of in-pit supply of electricity and small work areas requiring regular walking of the drills or relocations.

Energy use during extraction		
16. Preventing unnecessary water ingress	Yes	The surface water management system is designed to maximise separation of clean and dirty water systems. Clean water is diverted away from mining areas.
17. In-pit servicing	Yes	A current operational practice that will continue.
18. Replace lighting plants with LED	Likely	Glencore have conducted review of LED lighting plants and are currently considering the implementation of LED technology.

5.2.3 Improving Electricity Efficiency

Electricity consumption is forecast to generate approximately 8 per cent of the Proposed Modification's combined scope 1 and 2 emissions. **Table 5.3** includes the greenhouse gas mitigation measures assessed for the Coal Handling and Preparation Plant (CHPP).

Table 5.3 CHPP Energy Use Options Assessed

Energy use during processing		
Potential Mitigation Measure	**Planned for Proposed Modification**	**Reason for Inclusion/Exclusion**
1. Reducing reject percentage	Yes	CHPP density set points are monitored each shift and product coal scan ash analysers are used to extract highest yield and thus lowest amount of reject.
2. Automatically shutting down CHPP when not in use	N/A	CHPP runs 24 hours, 7 days per week other than for maintenance, Christmas and Boxing Days.
3. High efficiency motors	Yes	These are installed and will be maintained for the life of the Proposed Modification.
4. Variable Speed Drives	Yes	These are installed and will be maintained for the life of the Proposed Modification.
5. Optimising motor size to load	Yes	This has been implemented at the CHPP.

The Proposed Modification is planning to utilise many of the common greenhouse gas mitigation measures available for an open cut operation. High impact mitigation measures such as pre-draining coal seam methane will not be implemented, as BCM does not believe the mitigation potential of pre-draining the new pit area, based on its experience across the Bulga Coal Complex, can be economically justified.

5.3 The Safeguard Mechanism

The Proposed Modification will be subject to the Safeguard Mechanism emission caps which are currently applied to the Bulga Open Cut Mine. The Safeguard Mechanism sets a maximum emissions cap (a Safeguard Number) for all Australian facilities that emit over 100,000 tonnes CO_2-e per year. If an Australian facility exceeds its Safeguard Number, it is nominally required to offset its exceedance by surrendering ACCUs to the Clean Energy Regulator (CER).

The Bulga Open Cut Mine Safeguard Number is currently set at 673,617 tonnes of CO_2-e, which corresponds to its highest level of emissions between 2009-10 and 2013-14. The Safeguard Mechanism will provide an incentive for BCM to manage annual greenhouse gas emissions.

5.4 Capping Production

Glencore is committed to transitioning to a low-carbon economy, and has recently announced publicly that it will limit coal production to broadly current levels. The Proposed Modification fits within Glencore's coal production cap commitment as it is focused on sustaining current coal production.

As the Proposed Modification meets an existing demand, and fits within Glencore's committed production cap, Glencore considers that the Proposed Modification is aligned with the global energy market. Glencore's full statement on capping coal production can be found at **Appendix C**.

6.0 Scope 3 Emissions

Scope 3 emissions are indirect emissions that are associated with the Proposed Modification, but occur at sources owned or controlled by other entities. Scope 3 emissions simply acknowledge that products will continue to generate greenhouse gas emissions as they move through a value chain. Approximately 76% of the Proposed Modification's Scope 3 emissions are forecast to be generated by electricity generators burning coal in countries such as China, India, Japan, Malaysia, Philippines, South Korea and Taiwan. The proponent is not seeking approval to generate Scope 3 emissions, as they are not generated by the Proposed Modification, and approval for Scope 3 emissions has been or will be granted via other approval pathways.

6.1 Double counting

In assessing the impacts of Scope 3 emissions, it is important not to double count Scope 1 and Scope 3 emissions. Scope 1 and Scope 3 emissions can be the same emissions once greenhouse gas inventories start to capture multiple facilities and entire value chains. For example, the Scope 1 emissions forecast for Proposed Modification's consumers are the same emissions as the "Product Use" Scope 3 emissions forecast for the Proposed Modification.

The classification of different emission scopes was deliberately developed to avoid double counting, and all IPCC level greenhouse gas reporting only considers Scope 1 emissions to avoid double counting. The Katowice Climate Change Package (a UNFCCC initiative developed in December 2018) provides NDC guidance on reporting clarity, transparency and double counting. The importance of avoiding double counting is well-recognised under international and Australian greenhouse gas reporting frameworks. The Paris Agreement, and the subsequent Katowice Climate Change Package, requires member states to:

- avoid double counting consistent with the guidance adopted by the UNFCCC
- apply robust accounting to avoid double counting consistent with the guidance adopted by the UNFCCC
- provide information on how their cooperative approach applies robust accounting to ensure the avoidance of double counting
- avoid double counting when accounting for anthropogenic emissions and removals corresponding to their NDCs.

The NGER Act in Australia does not provide for double counting and only regulates Scope 1 and Scope 2 emissions. There is no requirement or obligation under Australian law to report Scope 3 emissions, as Scope 3 emissions will be captured by the controlling corporations directly responsible for generating emissions (i.e. Scope 1 emissions). The exclusion of Scope 3 emissions from the reporting requirements under Australian law effectively avoids double counting of Scope 3 emissions.

6.2 Uncertainty

The Scope 3 emissions calculated as part of this assessment use default emission factors. The actual emissions generated at the emission source will depend on the technologies employed by electricity generators.

Thermal coal electricity generators have started to employ High Efficiency Low Emissions (HELE) technology, which improves the greenhouse gas emissions intensity of coal fuelled electricity generation. Supercritical (SC) and ultra-supercritical (USC) coal-fuelled generators with advanced emissions controls are considered to meet the HELE technology classification. Many coal-importing countries are leaders in the deployment of higher efficiency coal-fuelled generators, as efficiency drives improved economic performance. The International Energy Agency Clean Coal Centre has found that new HELE units can produce up to 40% lower CO_2 emissions than older generators (Barnes 2018).

Improving the certainty of Scope 3 emissions forecasts requires site based emission factors for every facility that consumes the Proposed Modification's products. **Appendix B** provides the range of technologies that are being employed by key market destinations.

6.3 Management of Scope 3 emissions

Glencore (owner of BCM) manages a significant product stewardship and market development program which aims to mitigate the downstream impacts of its products.

Glencore supports low-emission coal technology projects via the Australian coal industry's $1 billion COAL21 Fund. Projects supported by this fund include the Callide Oxyfuel project and the Otway Basin Carbon Capture and Storage project.

Separately, Glencore is involved in the following Projects:

- member of the Callide Oxyfuel project in Queensland
- member of the FutureGen CCS project in the USA
- investigating options for carbon capture and storage in the Wandoan area in Queensland.

Glencore has also completed a number of research projects related to low emission technologies, including direct injection coal engines, biochar, nanotechnology, chemical looping and membrane research for power station applications. Glencore is also a Foundation member of the International Energy Centre with a number of Australian Universities which offers a Masters of Energy Studies.

Most of the product coal generated by the Proposed Modification will be exported to countries who are parties to the Paris Agreement. These countries have, or are in the process of developing, domestic laws, policies, and measures to mitigate greenhouse gas emissions (to achieve their NDC targets). The domestic efforts to achieve NDC targets for each market are summarised in the **Table 6.1**.

Table 6.1 A summary of greenhouse gas mitigation policies in major markets

Country	Summary of the domestic climate change framework in the relevant export customer countries for the Modification
China	• has introduced several policies to limit emissions (including policies to shut down coal-fired power plants, increase the efficiency of its coal generation fleet and place caps on the annual production capacity of coal), and to promote the development of commercially-viable CCUS technology in order to achieve its NDC of lowering carbon intensity by 60% to 65% from 2005 levels • has introduced carbon pricing policies and has committed to extend their scope and value
India	• has imposed a coal tax on all domestic and imported coal since 2010 (which has been increased three times since its inception), though its NDC indicates that coal (from both domestic and imported sources) will continue to dominate power generation into the future and India has included constructing coal-fuelled power plants with higher efficiency.
Japan	• has highlighted carbon pricing and the use of CCUS technologies as key to achieving its emissions reductions NDC of 25% below 2013 levels by 2030 • made significant progress with several CCUS projects • has imposed import taxes for coal and LNG • aims to pursue high efficiency in thermal power generation using high-efficiency technologies such as ultra-supercritical and advanced ultra-supercritical.
Malaysia	• has set a renewable energy target of 20% by 2025 (an 18% increase from current levels) as a key mechanism for achieving its NDC of reducing emissions by 40% by 2030 relative to 2005 levels • may present an ideal site for CCUS opportunities in the future (though currently lacks the legal and regulatory frameworks to support such projects).
Philippines	• has resolved to increase the share of renewable energy in its generation mix and is considering the introduction of a carbon tax as some of the strategies for meeting its NDC of reducing emissions to approximately 70% below BAU levels by 2030, though has acknowledged that coal will continue to play a key role in the country • plans to continue constructing new coal-fired power plants into the future.
South Korea	• is looking to increase the share of renewable energy and natural gas while decreasing the share of coal as a key measure for achieving its NDC of 37% below business-as-usual (BAU) levels by 2030 • has imposed import taxes for coal and LNG which act as a carbon tax and seeks to encourage a transition away from coal to renewables and LNG
Taiwan	• has legislated toward reducing reliance on both domestic and imported sources of coal, with plans to increase reliance on renewable energy and impose tax mechanisms on imported fossil fuels as a part of its plan to achieving emissions reductions of 50% below BAU levels by 2030 per its NDC.
Vietnam	• has targeted an increase in reliance on renewable energy, while not discounting the continued use of coal, in its plans to reach its NDC of emissions reductions of 8% below BAU by 2030.

The countries that consume the Proposed Modification's coal (i.e. the primary source of the Modification's Scope 3 emissions) have, or will have, numerous domestic laws and policies in place to achieve long term greenhouse gas mitigation. It is both appropriate, and consistent with the overarching international climate change framework, for the Proposed Modification's Scope 3 emissions to be regulated and reported by the respective export destinations as Scope 1 emissions generated in those countries.

7.0 Conclusion

The Proposed Modification is a short term extension of a large scale operation that will produce significant energy commodities over 21 years. The Proposed Modification's forecast energy use intensity is considered to fall within the normal range when compared with operations across Australia, however, given the nature and the scale of the Proposed Modification, the Proposed Modification is expected to generate approximately 4,651,000 t CO_2-e of Scope 1 and 2 emissions.

The Proposed Modification is also forecast to be associated with approximately 109,717,000 t CO_2-e of Scope 3 emissions. The Proposed Modification's Scope 3 emissions are beyond the operational control of BCM, and the majority of Scope 3 emissions will be generated downstream of the Proposed Modification, when coal products are combusted by electricity generators and/or coking plants.

The Proposed Modification may increase the national effort required to reach Australia's 2030 greenhouse gas mitigation target, however, the increase will be negligible and the Proposed Modification in isolation is unlikely to affect Australia achieving its national mitigation targets.

BCM has incorporated a range of measures into the Proposed Modification's design to minimise potential greenhouse gas emissions, and improve energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The Proposed Modification's design inherently minimises greenhouse gas emissions from the mining operations, primarily through energy use reduction initiatives.

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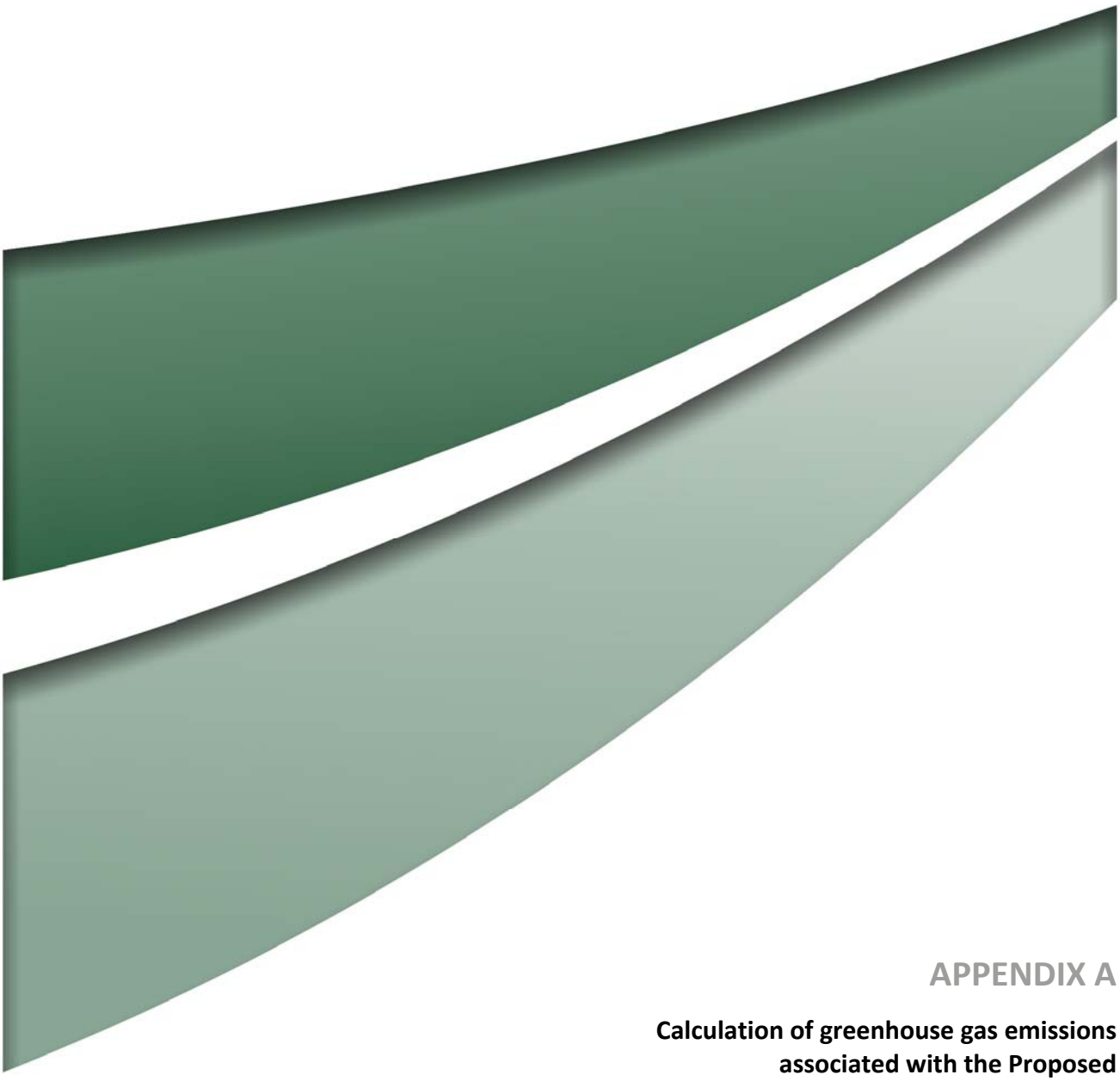

APPENDIX A

Calculation of greenhouse gas emissions associated with the Proposed Modification

Appendix A – Calculation of greenhouse gas emissions associated with the Proposed Modification

Stationary Diesel Use

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
kL	GJ/kL	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
456,965	38.6	17,638,849	69.9	0.1	0.2
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			1,232,956	1,764	3,528
Total GHG Emissions (t CO_2-e)					**1,238,248**

Fugitive Emissions

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
ROM (t)	-	-	kg CO_2-e/ROM t	kg CO_2-e/ROM t	kg CO_2-e/ROM t
63,000,000	N/A	N/A	N/A	48	N/A
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			N/A	3,024,000	N/A
Total GHG Emissions (t CO_2-e)					**3,024,000**

Electricity

Activity Data	Energy Use	Emission Factors		
		CO_2	CH_4	N_2O
GJ	GJ	kg CO_2-e / GJ	kg CO_2-e / GJ	kg CO_2-e / GJ
1,704,592	1,704,592	228	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		388,647	N/A	N/A
Total GHG Emissions (t CO_2-e)				**388,647**

Product Use

Activity Data		Energy Production		Emission Factors		
				CO_2	CH_4	N_2O
Product	Product (t)	GJ/Product t	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Thermal coal	32,514,727	27.0	877,897,629	90	0.03	0.2
Coking coal	9,190,831	30.0	275,724,930	91.8	0.02	0.2
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG Emissions (t CO_2-e)				104,322,336	31,851	230,725
Total GHG Emissions (t CO_2-e)						**104,584,912**

Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Diesel – stationary	17,638,851	3.6	N/A	N/A
Diesel – explosives	96,761	3.6	N/A	N/A
Electricity	1,704,592	28	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG Emissions (t CO_2-e)		111,577	N/A	N/A
Total GHG Emissions (t CO_2-e)				**111,577**

Product Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	**Product (t)**	**Distance (km)**	**Tonne km (tkm)**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**
Rail	41,705,558	92	3,836,911,336	0.0054	N/A	N/A
Ship	41,705,558	9,500	396,202,801,000	0.0126	N/A	N/A
				t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG Emissions (t CO_2-e)				5,012,874	N/A	N/A
Total GHG Emissions (t CO_2-e)						**5,012,874**

Materials Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	Materials (t)	Return Distance (km)	Diesel use (kL)	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Truck – diesel	459,469	200	1,320	73.5	0.1	0.5
Truck - explosives	465,204	200	1,337	73.5	0.1	0.5
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG Emissions (t CO_2-e)				7,538	10	51
Total GHG Emissions (t CO_2-e)						**7,599**



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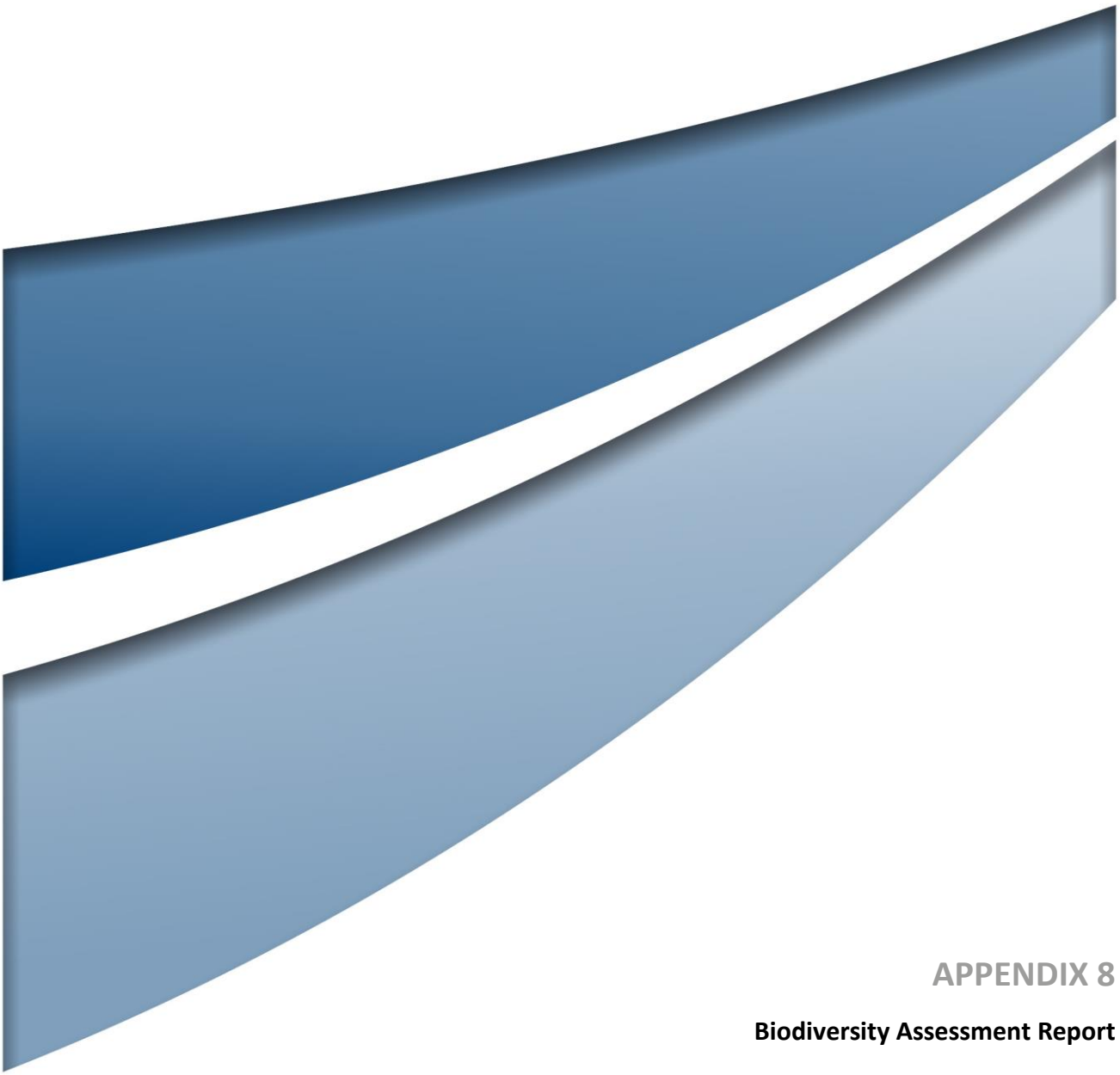

APPENDIX 8

Biodiversity Assessment Report

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BULGA OPTIMISATION PROJECT MODIFICATION

Biodiversity Assessment Report

FINAL

June 2019

GLENCORE

BULGA OPTIMISATION PROJECT MODIFICATION

Biodiversity Assessment Report

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Bulga Coal Management Pty Ltd

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Report No.	4100/R04/V4
Date:	June 2019

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Executive Summary



This Biodiversity Assessment Report (BAR) has been prepared by Umwelt Environmental and Social Consultants (Umwelt) to assess the biodiversity impacts of the Proposed Modification. The BAR forms part of the Statement of Environmental Effects (SEE) for the Proposed Modification. It has been prepared in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (Offsets Policy) (OEH 2014a), the Framework for Biodiversity Assessment (FBA) (OEH 2014b) which sits under the policy and as applicable under Clause 27(1)(g) of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* and the Commonwealth Environmental Assessment Requirements (dated 11 January 2019). This report has been prepared to accompany the application for approval of the Proposed Modification.

The Proposed Modification to the current NSW State planning approval (SSD 4960) generally comprises:

- open cut mining at up to the same rate as that currently approved (12.2 Million tonnes per annum (Mtpa) of run-of-mine (ROM) coal)
- utilisation of existing coal handling and coal processing infrastructure located in the eastern extent of the Approved BOP Project Area
- removal and relocation of the tailings material currently stored in existing TSFs to the Main Pit TSF
- relocation of infrastructure servicing the open cut and Bulga Underground operations including workshops, gas infrastructure, fuel and oil storage
- construction of new water management facilities to manage site surface water catchments
- the use of all existing or approved infrastructure and equipment, including the East Pit Muster Areas, with some minor additions to the existing mobile equipment fleet over the life of the Project.

The Proposed Modification comprises an additional 293 Hectares of mining area outside the currently approved mining area to the south and east, mostly within previously approved and mined areas. The Proposed Modification is required to access additional resources in the proposed extension area, as well as accessing deeper resources within the currently approved mining area. This will require additional disturbance of 20.2 hectares within the additional disturbance area.

Following the application of appropriate avoidance and mitigation measures, the FBA identified the following biodiversity credits required to offset the impacts of the Proposed Modification:

- 63 ecosystem credits for HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion
- 868 ecosystem credits for HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter
- 931 total ecosystem credits required.

The Proposed Modification will deliver a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values in accordance with the FBA and the Offsets Policy. It is intended that in-perpetuity conservation will be achieved through the retirement of biodiversity credits through the establishment of a Stewardship site. Other offsetting options that will be considered in the final offset strategy include purchasing credits on the open market and/or paying into the Biodiversity Conservation Fund will also be considered.

Glossary

BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BC Act	NSW *Biodiversity Conservation Act 2016*
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority Area
Development Footprint	The total impact zone associated with the Bulga Surface Operations Modification 3. The additional disturbance area is referred to throughout this report as the Development Footprint in accordance with the FBA methodology.
DoEE	Commonwealth Department of the Environment and Energy
DNG	Derived Native Grasslands
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site.
EEA	Eastern Emplacement Area
EEC	Endangered Ecological Community
EP	Endangered Population
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
GDEs	Groundwater-dependent Ecosystems
Glencore	Glencore Coal Pty Limited
GIS	Geographical Information System
IBRA	Interim Biogeographic Regionalisation for Australia (Version 7)
LGA	Local Government Area
MGA	Map Grid of Australia
Bulga Coal Complex	Current mining operations at Bulga Surface Operations and Bulga Underground Operations.
Mtpa	Million tonnes per annum
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
PMST	Protected Matters Search Tool

Proposed Modification	Bulga Optimisation Project Modification 3
SAT	Spot Assessment Technique
SEARs	Secretary's Environment Assessment Requirements of the Department of Planning and Environment
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database.
Strahler Stream Order	Classification system that gives a waterway an 'order' according to the number of tributaries associated with it.
TEC	Threatened Ecological Community
TSC Act	NSW *Threatened Species Conservation Act 1995* (now repealed)
TSPD	Threatened Species Profile Database
UHSA	Upper Hunter Strategic Assessment
Umwelt	Umwelt (Australia) Pty Limited
VIS	Vegetation Information System

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1 Introduction

The Bulga Coal Complex (BCC) consists of two existing coal mining operations: the open cut operations (Bulga Surface Operations) and the underground operations (Bulga Underground Operations). The BCC is located approximately 4 kilometres (km) to the south-east of the Bulga township, approximately 4 kilometres to the north of Broke and is approximately 15 kilometres south-west of Singleton (refer **Figure 1.1**).

Open cut mining was approved at the BCC in 1981 and has been carried out since 1982. Bulga Coal Management Pty Ltd (BCM) was granted approval for the Bulga Optimisation Project (BOP) (SSD 4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD 4960 has subsequently been modified twice since it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund. The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). BCM also operates the BCC in accordance with Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval 2012/6637 (as modified).

The Proposed Modification relates to the proposed extension of open cut mining within the current Project Area. It is proposed to modify SSD 4960 under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A modification is also required for the Bulga Underground Operations consent (DA 376-8-2003) for the relocation of underground infrastructure required to facilitate the Proposed Modification.

1.1 Proposed Modification Overview

The Proposed Modification will maximise resource recovery within the current BOP Project Area by extending the open cut operations approved under the BOP consent (SSD 4960) to the south east into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit. The extension of the pit to the southeast also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Mtpa ROM and will enable extraction of an additional approximate 63Mt of coal over the life of the mine.

The Proposed Modification will extend the life of the existing operation by 4 years until 2039 providing for ongoing employment opportunities for the existing Bulga workforce. Bulga Surface Operations will continue to utilise the existing mining facilities, including the CHPP and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The proposed operations will not preclude the ability to access currently approved underground mining resources to the south and west of the proposed pit in the future.

The Proposed Modification generally comprises:

- extension of mining areas to the south and east to access an approximately 63 Mt of additional ROM coal by accessing deeper resources within the approved open cut pit and in the proposed extension area

- realignment of the western highwall to improve long term stability and allow access to additional coal resources
- an additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east
- removal and relocation of the tailings material currently stored in the existing TSF to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure
- relocation and removal of infrastructure servicing the open cut and Bulga Underground Operations including workshops, gas infrastructure and power station, fuel and oil storage
- continued use of the East Pit Muster Area
- construction of new water management structures to manage changes to the site surface water catchments
- the use of all existing or approved infrastructure and equipment with some additions to the existing mobile equipment fleet over the life of the Project
- reprocessing of tailings where practicable. Any reprocessed coal from tailings would form part of the 20 million tonnes of product coal approved from the BCC, and not included in the BOC annual limit of ROM coal mined.

Figure 1.2 illustrates the key features of the Proposed Modification.

1.2 Purpose and Scope of this Report

This report provides the findings of the Biodiversity Assessment of the Proposed Modification. It addresses the specific requirements of the Framework for Biodiversity Assessment (FBA) (OEH 2014b) and the EPBC Act.

Specifically, this assessment:

- describes the existing terrestrial environment of the Development Footprint (refer to **Section 1.4**) being the additional disturbance area
- identifies flora and fauna species and ecological communities within the Development Footprint that have the potential to be impacted by the Proposed Modification
- determines the presence or likelihood of occurrence of threatened flora and fauna species and populations and Threatened Ecological Communities (TECs) listed under the *Biodiversity Conservation Act 1995* (BC Act) and the EPBC Act.
- calculates the offset requirements for ecosystem credits and species credits generated as a result of the permanent impacts of the Proposed Modification in accordance with the FBA (OEH 2014b)
- provides an assessment of Matters of National Environmental Significance (MNES) under the EPBC Act and

- describes the offset strategy to satisfy the impacts of the Proposed Modification.

This report also addresses the Commonwealth Environmental Assessment Requirements (dated 11 January 2019).

1.3 Development Site Information

The additional disturbance area is here after referred to as the 'Development Footprint' and represents permanent impacts outside the existing approved disturbance area of the Bulga Optimisation Project Development consent, as shown in **Figure 1.3**. The Development Footprint will be subjected to a range of disturbances as outlined in **Section 5.0**.

1.3.1 Location

The Development Footprint is situated approximately 15 kilometres (km) south of Singleton in the Hunter Valley of NSW (refer to **Figure 1.1**) within the Sydney Basin IBRA bioregion and the Hunter IBRA subregion. Refer to **Figures 1.3** to **1.5** for the location of the Development Footprint and other relevant landscape features that pertain to the FBA assessment. Refer to **Table 1.1** for a summary of the Development Footprint's location in the landscape.

Table 1.1 Development Footprint Location in the Landscape

Bulga Emplacement Project	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Hunter
Major Catchment Area	Hunter-Central Rivers
Mitchell Landscape	Central Hunter Foothills
LGA	Singleton Council

1.3.2 Size

The Development Footprint covers the additional disturbance area of 20.2 hectares.

1.3.3 Local and Regional Ecological Context

The central Hunter Valley has been largely cleared of native vegetation, primarily for agriculture and other land uses, including mining and urban development. Similar land use patterns occur in the vicinity of the Bulga Coal Complex and the Development Footprint, which is surrounded by coal mining operations and agricultural land. Extensive native vegetation is present to the east of the Bulga Coal Complex in the Singleton Military Training Area and represents a significant link between remnant patches of vegetation in the central Hunter Valley to the Wollemi National Park.



FIGURE 1.1

Locality Plan

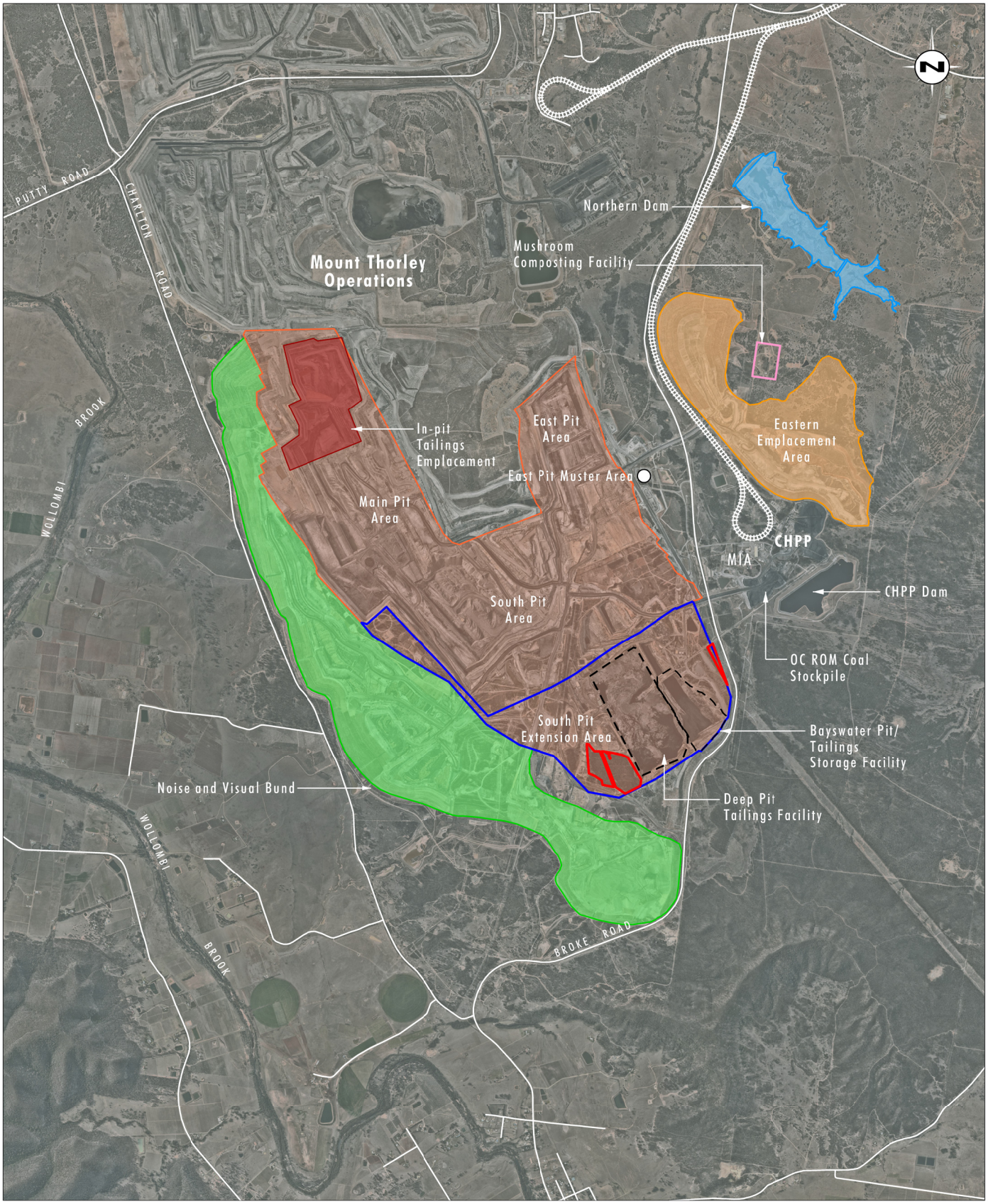

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

0 1 2 3km
1:60 000

Legend

- Project Area
- Additional Disturbance Area
- South Pit Extension Area
- Mining Area
- Noise and Visual Bund
- Eastern Emplacement Area
- In-pit Tailings Emplacement
- Northern Dam
- Rail Line

FIGURE 1.2

Proposed Modification

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20190529 10.20

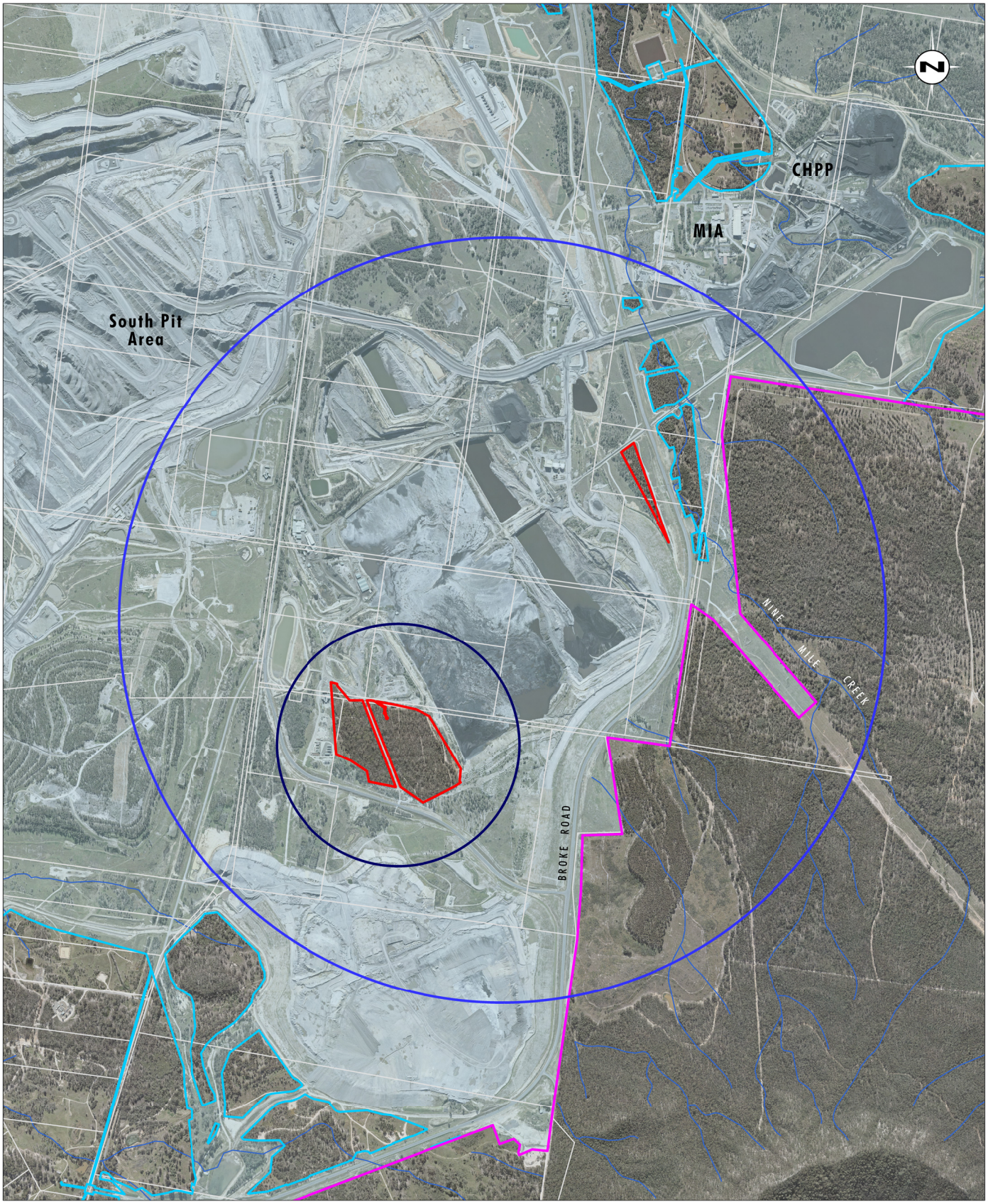

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Cadastre
- Drainage Line

FIGURE 1.3

Site Map

File Name (A4): R04/4100_025.dgn
20181130 11.26

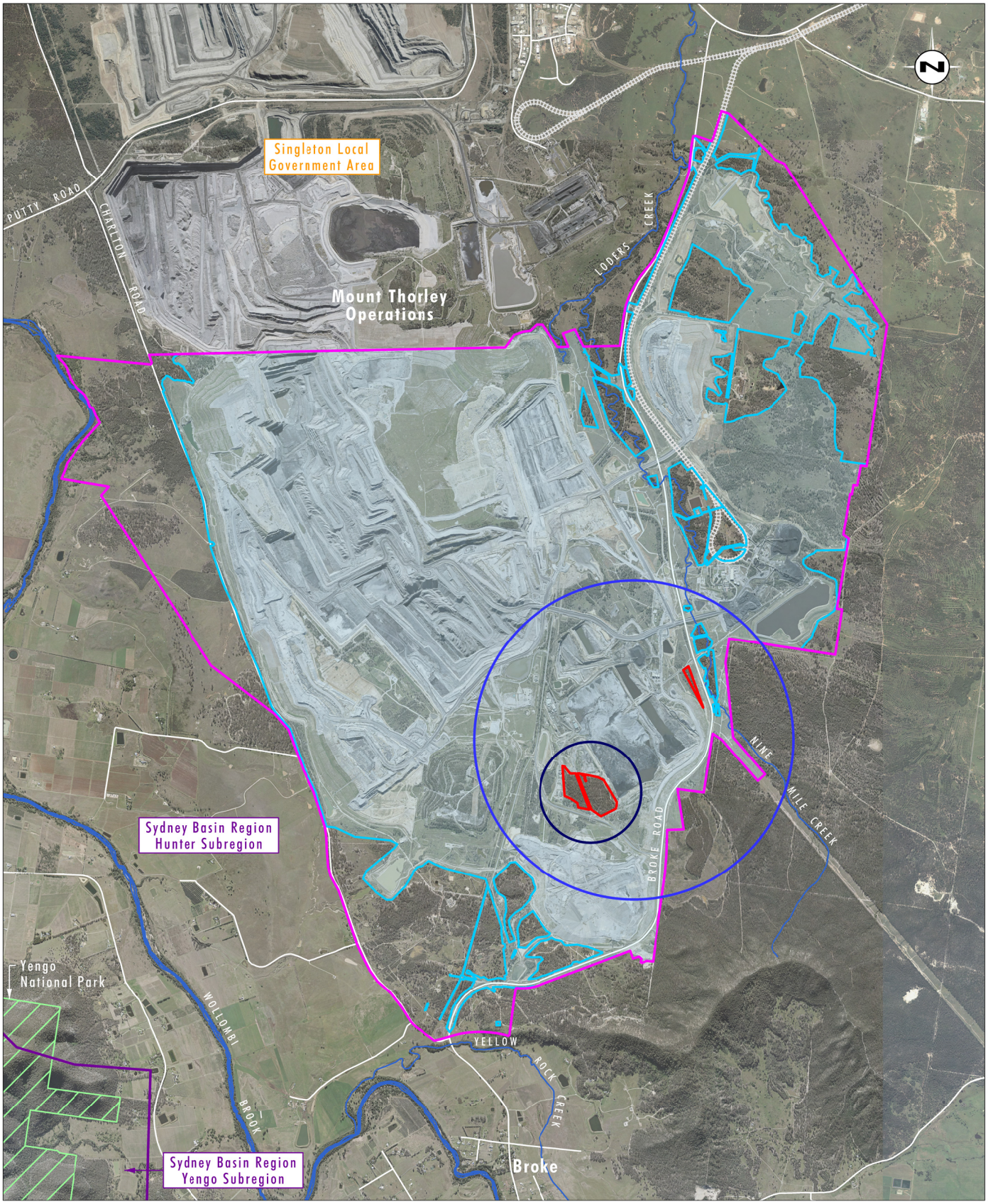

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- IBRA Region/Subregion
- National Park
- Road
- Railway
- Drainage Line

FIGURE 1.4

Location Map - IBRA Regions/Subregions and Local Government Area

File Name (A4): R04/4100_025.dgn
20181130 11.30

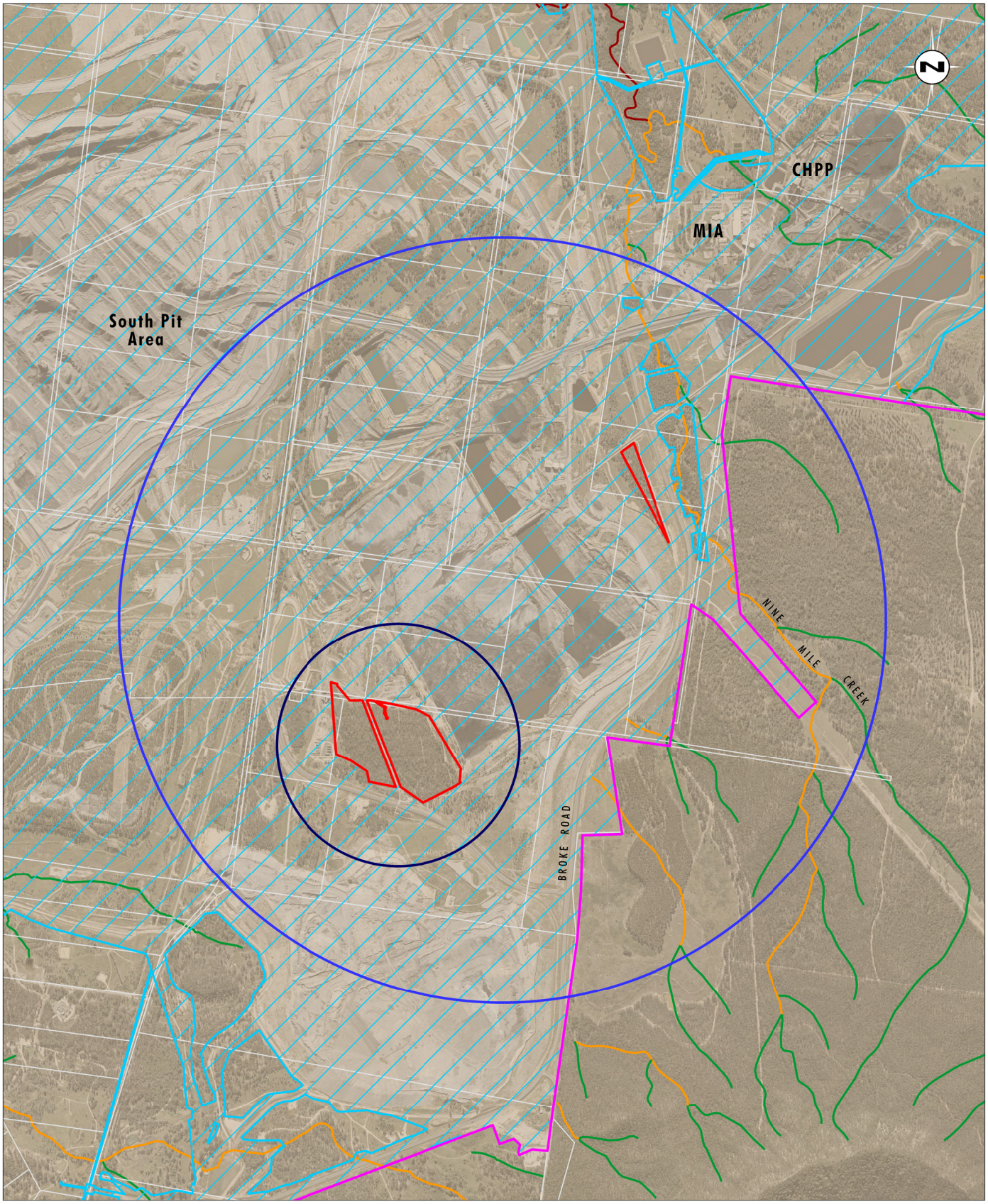

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle

Mitchell Landscape:

- Central Hunter Foothills

Stream Order:

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream

FIGURE 1.5

Location Map
Landscape Features

1.4 Key Resources, Policies and Documents

The following key resources, policies and documents were used during the preparation of this BAR for the Proposed Modification:

- NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a)
- Framework for Biodiversity Assessment (OEH 2014b)
- Credit Calculator for Major Projects and BioBanking Operational Manual (OEH 2016a)
- BioBanking Assessment Methodology 2014 (OEH 2014c)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities –Working Draft (DEC 2004)
- BioBanking Credit Calculator (Major Project Assessment Type) (BBCC 2018), accessed January 2018
- BioNet Atlas of NSW Wildlife database and mapping tool (OEH 2019), accessed January 2018
- OEH Threatened Species Profile Database (TSPD) (OEH 2018a), accessed archived datasets January 2018
- Vegetation Information System (VIS) Classification Database (OEH 2018b), accessed January 2018
- NSW Guide to Surveying Threatened Plants (OEH 2016b), and
- Department of the Environment and Energy (DoEE) Protected Matters Search Tool (DoEE 2018), accessed January 2018.

1.5 Report Preparation

This BAR was prepared by Ryan Parsons (Principal Ecologist - Botanist), with review and technical direction from Allison Riley (Principal Ecologist). Field surveys have been completed by several Umwelt ecologists, primarily by Ryan Parsons (Senior Ecologist – Botanist), Trish Robinson (Senior Ecologist – Botanist), Amy Nelson (Ecologist), James Garnham (Ecologist) and Rhys Osborne (Ecologist). Allison Riley, Ryan Parsons and Amy Nelson are accredited under the TSC Act as BioBanking Assessors. In addition to this Allison Riley and Ryan Parsons are both accredited under the BC Act as BAM Assessors. **Table 1.2** below outlines the details of the accredited BioBanking Assessors involved in the survey, calculations and reporting for the Proposed Modification.

Table 1.2 Accredited BioBanking Assessors and their Role on this Proposed Modification

Name	Assessor ID	Role on Proposed Modification
Allison Riley ***Principal Ecologist***	183	• Technical review
Ryan Parsons ***Senior Ecologist – Botanist***	113	• Field surveys and biometric data collection • Application of the BioBanking Credit Calculator (BBCC) • Report preparation

Name	Assessor ID	Role on Proposed Modification
Amy Nelson ***Ecologist - Botanist***	230	• Field surveys and biometric data collection • Report Preparation

1.5.1 Structure of the Report

The structure of the report is outlined below as per the requirements of Appendix 7 of the FBA (OEH 2014b):

- **Stage 1:**
  - Section 1 – provides the introduction to the report
  - Section 2 – outlines the methods used in the assessment
  - Section 3 - outlines the results of the field surveys and BioBanking credit calculator application
- **Stage 2:**
  - Section 4 – describes the avoidance measures implemented and minimisation of impacts as part of the Proposed Modification
  - Section 5 – provides a summary of impacts in accordance with the FBA
  - Section 6 – summarises the credit requirements for the Proposed Modification
- **Stage 3:**
  - Section 7 – outlines the Biodiversity Offset Strategy
- **Other sections:**
  - Section 8 – provides an assessment of Matters of National Environmental Significance (MNES)
  - Section 9 - provides a list of references used throughout the report and assessment.

2 Methods

2.1 Landscape Features

2.1.1 Identifying Landscape Features

Landscape features within the Development Footprint and the inner and outer assessment circles were determined through reviewing aerial photography and relevant GIS layers. Landscape features that were reviewed included:

- IBRA bioregions and IBRA subregions
- Mitchell landscapes
- rivers, streams and estuaries (using the Strahler (1952) ordering system)
- wetlands
- native vegetation extent, and
- State and/or Regional Biodiversity Links.

2.1.2 Determining Landscape Value

Determining the 'Landscape Value' of the Development Footprint is calculated by assessing the following landscape attributes:

- Per cent Native Vegetation Cover
- Connectivity Value, and
- Patch Size.

2.1.2.1 Per cent Native Vegetation Cover

'Per cent Native Vegetation Cover' is determined by the current per cent native vegetation cover and the future per cent native vegetation cover within the outer assessment circle. This was determined using digital aerial photography interpretation using the Manifold GIS software package. Aerial photographs captured during July 2017 were used to digitise all native vegetation within the outer assessment circle. Further refinement of these areas was undertaken following field surveys of the Development Footprint.

The inner and outer assessment circles must be at a 1:10 ratio and one of the combinations from Table 8 of Appendix 4 of the FBA (OEH 2014b). Due to the size and configuration of the Development Footprint, it was determined that a 100 hectare inner assessment circle and 1,000 hectare outer assessment circle was the most appropriate combination. The outer circle was centred on the Development Footprint, with the inner circle centred on the native vegetation area most impacted by the Proposed Modification.

2.1.2.2 Connectivity Value

To determine the connectivity value, the Development Footprint was assessed for the presence of native vegetation connecting links, state, regional or local biodiversity links as required by the FBA (OEH 2014b).

Connecting links are present when an area of native vegetation in a Development Footprint is adjoined to and it is:

- in moderate to good condition, and
- has a patch size of > 1 hectare, and
- is separated by a distance of < 100 metres (or ≤ 30 metres for non-woody ecosystems), and
- is not separated by a large waterbody, dual carriageway, wider highway or similar hostile link.

State biodiversity links are defined as links which have been identified as important on a state scale. State biodiversity links are identified in a plan approved by the Chief Executive of OEH or are a riparian buffer either side of a 6th order stream (using the Strahler (1952) ordering system) or greater, or either side of an important wetland or estuarine area.

Regional biodiversity links are recognised as important links at a regional scale. Regional biodiversity links are identified in a plan approved by the Chief Executive of OEH or are a riparian buffer either side of a 4th or 5th order stream.

2.1.2.3 Patch Size

A 'Patch' is an area of native vegetation that:

- occurs in the Development Footprint, and
- is in moderate to good condition, and
- includes native vegetation that has a gap of less than 100 metres from the next area of moderate to good condition native vegetation (or ≤ 30 metres for non-woody vegetation).

For site-based developments, the patch size is calculated for the Mitchell Landscape occurring within the Development Footprint. The patch may extend onto adjoining land that is not part of the Development Footprint. An assessment of the patch size class and the patch size score was then determined using Table 15 of the FBA (OEH 2014b).

2.2 Native Vegetation Assessment

2.2.1 Literature and Database Review

A review of previous documents and reports relevant to the Proposed Modification was undertaken. This included regional and sub-regional vegetation mapping reports, annual monitoring reports, ecological surveys undertaken in the vicinity of the Development Footprint and also relevant ecological database searches. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring threatened and migratory species, endangered populations (EPs) and Threatened Ecological Communities (TECs). Relevant documents included:

- Ecological Impact Assessment for the Bulga Optimisation Project (Umwelt 2013)

- Bulga Extension Project – Environmental and Social Impact Pre-feasibility Reporting (Umwelt 2017)
- 2016 Ecological Monitoring Report (DnA Environmental 2016)
- Bulga Coal Annual Review – 1 January to 31 December 2016 (SLR Consulting Australia Pty Ltd 2017)
- Upper Hunter Strategic Assessment – Bulga Biodiversity Certification Assessment Report (Umwelt 2015a)
- The Vegetation of the Central Hunter Valley, NSW (Peake 2006)
- Greater Hunter Native Vegetation Mapping (Sivertsen *et al.* 2011)
- VIS Classification Database (OEH 2018b), accessed January 2018
- OEH Online Search Tool (OEH 2018c) for known/predicted threatened communities in the Hunter IBRA subregion
- DoEE Protected Matters Search Tool for known/predicted EPBC Act-listed TECs, accessed January 2018.

2.2.2 Digital Aerial Photograph Interpretation

Digital imagery (aerial photographs) of the Development Footprint was viewed prior to and after vegetation survey to identify spatial patterns in vegetation, land use and landscape features. These informed field survey design and implementation, ecological assessment and vegetation community mapping of the Development Footprint.

Vegetation communities in the Development Footprint were mapped on-screen overlaying the July 2017 high resolution aerial photographs provided by Glencore. Mapping was undertaken using the Manifold System 8.0 Enterprise Edition GIS in a 32 bit mode. Use of GIS allowed zooming to a relatively large scale. Generally the minimum mapping unit for a vegetation zone was 0.1 hectare.

2.2.3 Systematic Plot/Transect Surveys

A total of 7 floristic plots and 5 rapid assessments were conducted across the Development Footprint during the surveys undertaken for this assessment (refer to **Figure 2.1**). Floristic plots and rapid assessments were undertaken over three days in August and October 2017. Floristic plot data was collected in accordance with minimum requirements under the FBA (OEH 2014a).

Table 2.1 outlines the floristic survey effort in the Development Footprint.

Table 2.1 Adequacy of Vegetation Survey in the Development Footprint

Veg. Zone	Biometric Vegetation Type (BVT) ID/Plant Community Type (PCT) ID and Common Name *Condition Class*	Area in the Development Footprint (ha)	Number of Floristic Plots/Transects		Number of Rapid Assessments Completed
			Required	Completed	
1	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	2.1	2	2	2
2	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	0.7	1	1	0
3	HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	16.4	3	4	1
N/A	Disturbed Land	1.0	0	0	2
Total		**20.2**	**7**	**7**	**5**

2.2.3.1 Plot/Transect Data Collected

At each plot/transect data was recorded according to Section 5 of the FBA (OEH 2014b). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. The location of the 7 plots/transects undertaken within the Development Footprint is shown in **Figure 2.1**.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

For each flora species recorded in the plot, the following data was collected in accordance with Table 1 of the FBA (OEH 2014b):

- stratum/layer in which the species occurs
- growth form
- scientific name and common name
- cover and
- abundance.

At each standard flora plot, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover, and
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other) and
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

2.2.4 Meandering Transects

Meandering transects were walked through vegetation units across much of the Development Footprint. Opportunistic sampling of vegetation was undertaken along these transects, particularly searches for threatened and otherwise significant species, endangered populations and TECs. Meandering transects enable floristic sampling across a much larger area than plot-based survey. Records along transects supplemented floristic sampling carried out in plots, however, the data collected are in the form of presence records, rather than semi-quantitative cover abundance scores.

Meandering transects provided invaluable information on spatial patterns of vegetation that informed vegetation community mapping of the Development Footprint.

2.2.5 Previous Floristic Survey Effort in the Bulga Coal Complex

Extensive previous floristic survey effort has been undertaken in the Bulga Coal Complex within and adjacent to the Development Footprint, resulting in a detailed understanding of the biodiversity occurring in the surrounding area. This includes:

Bulga Optimisation Project

Flora field surveys were carried out in the Bulga Optimisation Project Disturbance Footprint (approved disturbance area) in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013. Survey methods included vegetation survey plots, meandering transects, rapid assessment points and field reconnaissance to identify spatial arrangement of vegetation across the approved disturbance area.

Figure 2.2 shows the floristic survey effort in the areas surrounding the Development Footprint undertaken for the Bulga Optimisation Project.

Bulga Upper Hunter Strategic Assessment

Floristic surveys in the Bulga Upper Hunter Strategic Assessment (UHSA) (adjacent to the Development Footprint), were undertaken in March and May 2014 and focused on assigning vegetation mapping to biometric vegetation types (BVTs) as per the Vegetation Information System (VIS) database (OEH 2018b). This included:

- plot and transects as per BioBanking Assessment Methodology (BBAM) (OEH 2014b)
- qualitative and semi-quantitative rapid sampling plots
- meandering transects, and
- digital photograph interpretation.

Figure 2.2 shows the floristic survey effort in the areas surrounding the Development Footprint undertaken for the Bulga UHSA.

2.2.6 Plant Identification and Nomenclature Standards

All vascular plants recorded or collected within plots and on meandering transects were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002). Where known, changes to nomenclature and classification have been incorporated into the results. Updated taxonomy has been derived from PlantNET (Botanic Gardens Trust 2017).

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

2.2.7 Vegetation Mapping

Vegetation mapping was undertaken using best-practice techniques to delineate vegetation communities across the Development Footprint. Vegetation mapping involved the following key steps:

- preliminary review of digital airborne imagery to explore vegetation distribution patterns as dictated by change in canopy texture, tone and colour, as well as topography
- predicting the distribution of particular vegetation communities based on understanding the distribution of BVTs (OEH 2018b) and using existing vegetation mapping completed as part of the Bulga Optimisation Project (Umwelt 2013)
- preparation of a draft vegetation community map based on interpretation of digital airborne imagery and preliminary delineation of vegetation community floristics
- ground-truthing of the vegetation map based on survey effort documented in **Section 2.2.3** to **2.2.5.**
- revision of vegetation community floristic delineations based on plot data, and
- revision of the vegetation map based on ground-truthing.

Vegetation communities were delineated through the identification of repeating patterns of plant species assemblages in each of the identified strata.

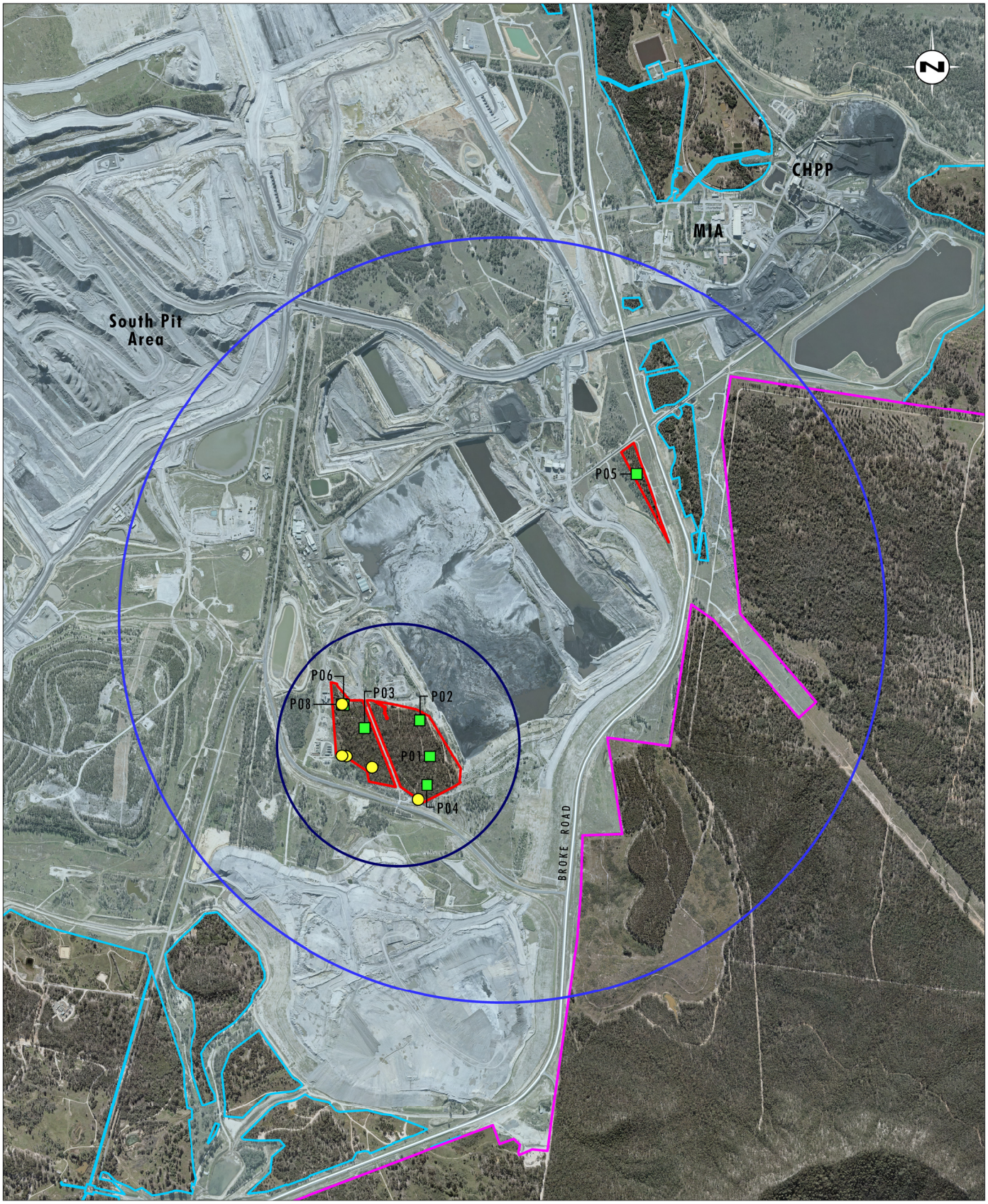

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Floristic Plot
- Semi-quantitative Rapid Assessment

FIGURE 2.1

Flora Survey Effort

File Name (A4): R04/4100_028.dgn
20190412 13.56

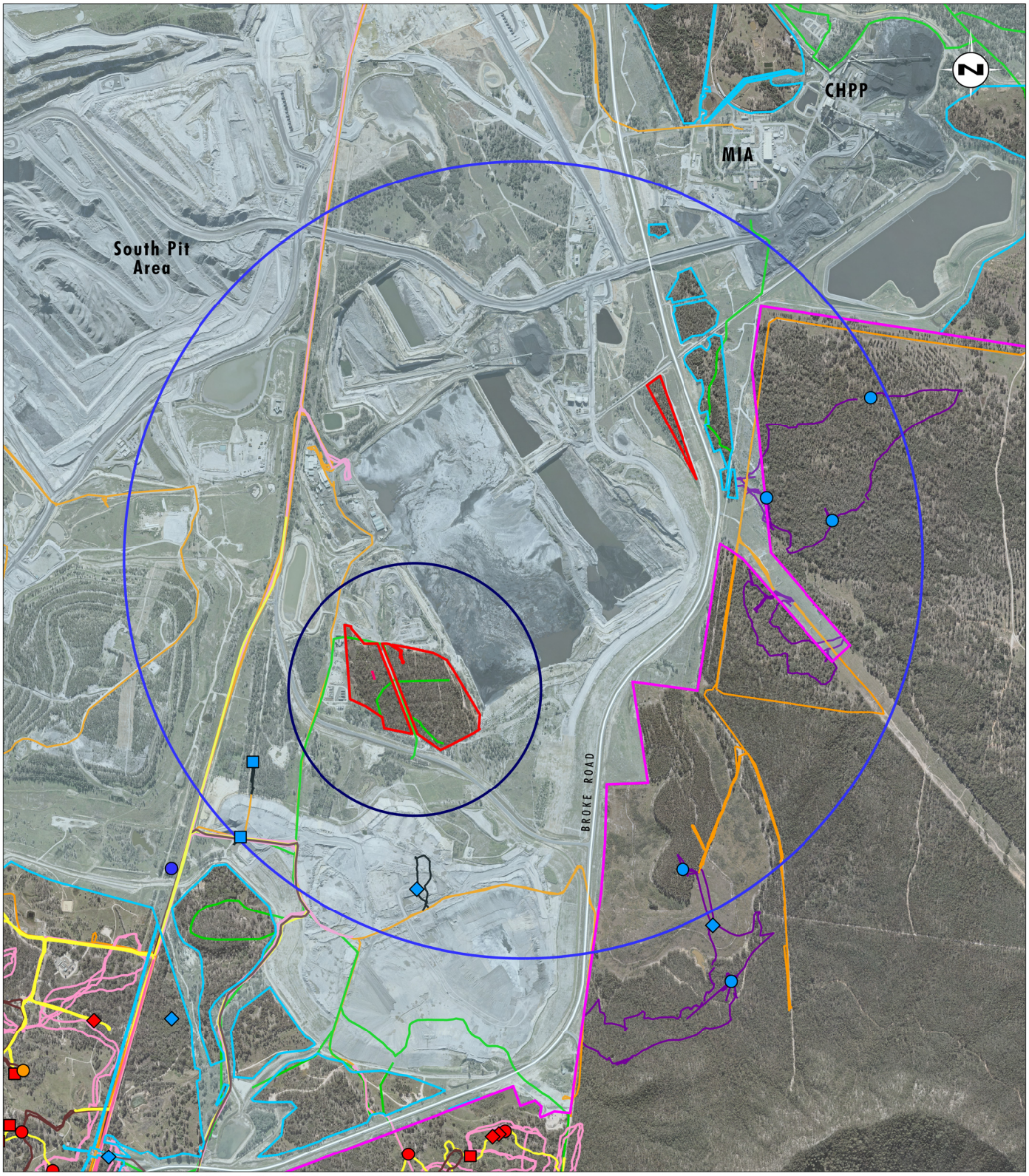

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Permanent Monitoring Transect

BOP Survey:

- Flora Quadrat (Autumn 2011)
- Flora Quadrat (Autumn 2013)
- Rapid Assessment Point
- White/Grey Box Sampling Location
- Driving and Walking Transect (Summer 2009)
- Driving Transect (Summer 2009)
- Meandering Transect (Autumn 2011)
- Meandering Transect (Winter 2011)

UHSA Survey:

- Flora Plots/Transects (Kleinfelder April 2012)
- Flora Plots/Transects (May 2014)
- Semi-quantitative Rapid Sampling Plots
- Qualitative Rapid Assessments
- Meandering Transect (September 2013)
- Meandering Transect (March 2014)
- Meandering Transect (May 2014)

FIGURE 2.2

Flora Survey Locations from Previous Projects

File Name (A4): R04/4100_029.dgn
20190319 11.25

2.2.8 Threatened Ecological Community Delineation Techniques

Vegetation communities identified in the Development Footprint were compared to TECs listed under the EPBC Act and BC Act and an assessment of similarity with the NSW Scientific Committee Final Determinations and the Commonwealth Threatened Species Scientific Committee Listing and Conservation Advice. The following approach was used:

- full-floristic quadrat assessment, rapid assessments and meandering survey to determine floristic composition and structure of each ecological community
- comparison with published species lists, including lists of 'important species' as identified on the listing advice provided by the NSW Scientific Committee and/or Commonwealth Threatened Species Scientific Committee
- comparison with habitat descriptions and distributions for listed TECs
- assessment using guidelines and recovery plans published by the Commonwealth DoEE and the NSW OEH
- comparison with other assessments of TECs in the region.

2.2.9 Biometric Vegetation Type (BVT)/Plant Community Type (PCT) Allocation

Each of the vegetation communities described within the Development Footprint were aligned with an equivalent Biometric Vegetation Type (BVT)/Plant Community Type (PCT) as detailed in the VIS Classification Database (OEH 2018b). For each vegetation community described in the Development Footprint, the dominant and characteristic species were entered into the online plant community identification tab and an initial list of BVTs/PCTs was generated. The profiles for each of the possible BVTs/PCTs were then interrogated and the most appropriate match assigned based on floristic, structure, soil, landform and distribution details.

Further detail regarding this allocation for individual BVTs/PCTs is outlined in **Section 3.2.1.**

2.3 Threatened Species Assessment

2.3.1 Literature and Database Review

A review of previous documents and reports relevant to the Proposed Modification was undertaken. This included ecological reports, previous ecological surveys undertaken in the vicinity of the Development Footprint and also relevant ecological database searches. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring ecosystem-credit and species-credit species. Relevant documents and resources included:

- Ecological Impact Assessment for the Bulga Optimisation Project (Umwelt 2013)
- Bulga Extension Project – Environmental and Social Impact Pre-feasibility Reporting (Umwelt 2017)
- Upper Hunter Strategic Assessment – Bulga Biodiversity Certification Assessment Report (Umwelt 2015)
- 2016 Ecological Monitoring Report (DnA Environmental 2016)

- 2016 Annual Fauna Monitoring Report (RPS 2017)
- Final Ecological Monitoring Report: Ponds 1, 2, 5 and 6, Longwalls 2 and 3 Blakefield South Underground Mine (Kleinfelder 2016)
- Bulga Coal Annual Review – 1 January to 31 December 2016 (SLR Consulting Australia Pty Ltd 2017)
- OEH BioNet Atlas of NSW Wildlife database and mapping tool (OEH 2019), accessed January 2018
- OEH Threatened Species Profile Database (OEH 2018a) for known/predicted threatened species in the Hunter IBRA subregion, accessed January 2018 through the archived dataset (http://www.environment.nsw.gov.au/projects/biometric-dataset.htm)
- PlantNET (Botanic Gardens Trust) database search for threatened plants within a 10 kilometre radius search from Broke, accessed January 2018
- DoEE Protected Matters Search Tool (DoEE 2018) for known/predicted EPBC Act-listed TECs, accessed January 2018.

A preliminary assessment using the TSPD was undertaken which provided a list of species-credit species that might require survey and the suitable survey periods for each species. The results of these database searches, literature review and TSPD review were used to design the survey requirements for species-credit species so that adequate surveys were undertaken as part of the FBA.

Note: Ecosystem-credit species are predicted by the landscape attributes and are not required to be specifically targeted during field surveys.

2.3.2 Species-credit Flora Surveys

Targeted surveys and transects for cryptic and seasonal species-credit flora species were undertaken over the following survey periods, being:

- 17 to 18 August 2017
- 18 October 2017, and
- 10 November 2017.

Species-credit flora surveys considered the following survey guidelines:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* – Working Draft (DEC 2004)
- *NSW Guide to Surveying Threatened Plants* (OEH 2016b)
- *Draft Survey Guidelines for Australia's Threatened Orchids* (DoE 2013).

Extensive previous ecological surveys including targeted surveys for threatened flora species has been undertaken in the Bulga Coal Complex within and adjacent to the Development Footprint. This has included:

- targeted threatened flora surveys in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013, for the Bulga Optimisation Project (Umwelt 2013)

- targeted threatened flora surveys in September 2013, March 2014 and May 2014 for the Bulga Upper Hunter Strategic Assessment (Umwelt 2015) and

- opportunistic observations during the Annual Bulga Coal Complex flora monitoring (DnA Environmental 2016).

Table 2.2 identifies the species-credit flora species that were determined to potentially occur in the Development Footprint and therefore require targeted surveys and further assessment. Species-credit flora survey locations are shown in **Figure 2.3**.

Appendix A outlines the species-credit species identified in the literature review that were not considered likely to occur due to lack of suitable habitat and/or absence of local records and therefore did not warrant further assessment as per Section 6.5.1.6 of the FBA (OEH 2014b).

Table 2.2 Species-credit Flora Species Requiring Further Assessment and Survey

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
Weeping Myall (*Acacia pendula*) population in the Hunter catchment	EP	-	1, 2, 4	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this population includes grasslands and woodlands on heavy soils.
Trailing Woodruff *Asperula asthenes*	V	V	1	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes damp sites, often along river banks.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
Eucalyptus camaldulensis **population in the Hunter catchment**	EP	-	2, 4	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). This species occurs on floodplains and riparian areas.
Cymbidium canaliculatum **population in the Hunter Catchment**	EP	-	4	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes sclerophyll forest and woodlands.
white-flowered wax plant ***Cynanchum elegans***	E	E	1, 2, 3, 4	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes edges of dry rainforest, littoral rainforest, coastal tea-tree scrub, forest and woodlands.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
Dillwynia tenuifolia	V	-	2	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes dry sclerophyll woodland and forest.
pine donkey orchid ***Diuris tricolor***	V	-	1	September - October	Targeted threatened flora searches and walking transects were undertaken in October 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in October 2011 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013 (Umwelt 2015). Suitable habitat for this species includes grassy forest/woodland and grassland, often in disturbed habitats.
slaty red gum ***Eucalyptus glaucina***	V	V	1, 2, 3, 4	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes grassy woodland and dry eucalypt forest.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
small-flower grevillea *Grevillea parviflora* subsp. *parviflora*	V	V	1	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes heaths, shrubby woodland and open forests.
scant pomaderris *Pomaderris queenslandica*	E	-	1	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes sheltered woodlands with a shrubby understorey.
Prasophyllum petilum	E	E	1, 3	October	Targeted threatened flora searches and walking transects were undertaken in October 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in October 2011 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013 (Umwelt 2015). This species occurs in woodland and grassland communities.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
Singleton mint bush ***Prostanthera cineolifera***	V	V	1	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes open woodlands on exposed sandstone ridges.
Illawarra greenhood ***Pterostylis gibbosa***	E	E	1, 3	June - September	Targeted threatened flora searches and walking transects were undertaken in August 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in June and July 2011 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013 (Umwelt 2015). Suitable habitat for this species includes open forests and woodlands.
Heath Wrinklewort ***Rutidosis heterogama***	V	V	3	All year	Targeted threatened flora searches and walking transects were undertaken in August, October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009, autumn, winter and spring 2011, autumn 2012 and autumn 2013 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013, March 2014 and May 2014 (Umwelt 2015). Suitable habitat for this species includes heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
Austral toadflax ***Thesium australe***	V	V	3	September – February	Targeted threatened flora searches and walking transects were undertaken in October and November 2017 within the Development Footprint. Targeted threatened flora searches and walking transects were also undertaken in the wider locality as part of the Bulga Optimisation Project in summer 2009 and spring 2011 (Umwelt 2013) as well as part of the Bulga UHSA in September 2013 (Umwelt 2015). Suitable habitat for this species includes grassy woodlands associated with kangaroo grass (*Themeda triandra*).

^ Months that surveys are required according to the FBA Calculator and the archived datasets in the TSPD. Where this is unavailable, the relevant flowering/detection periods were sought from online species profiles (OEH or Commonwealth SPRAT).

1 = BioBanking Credit Calculator

2 = Bionet Atlas of NSW Wildlife

3 = Protected Matters Search Tool

4 = Record from literature review

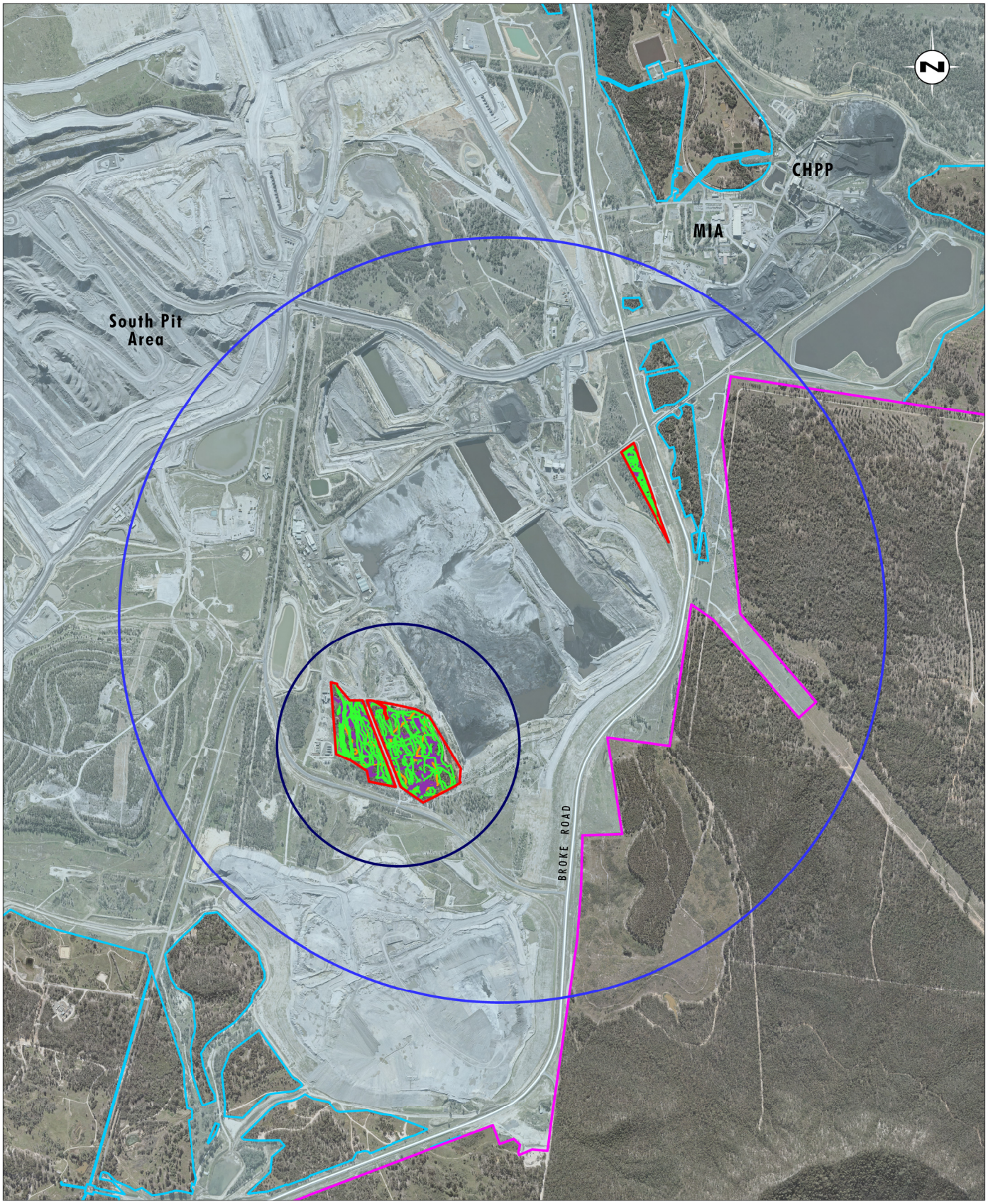

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Targeted Species-credit Flora Transect (August 2017)
- Targeted Species-credit Flora Transect (October 2017)
- Targeted Species-credit Flora Transect (November 2017)

FIGURE 2.3

Targeted Species-credit Flora Transect Locations

File Name (A4): R04/4100_030.dgn
20181130 14.07

2.3.3 Species-credit Fauna Surveys

Targeted surveys of seasonal species-credit fauna species were undertaken over the following survey periods, being:

- 17 to 18 August 2017, and
- 18 October 2017.

Species-credit fauna surveys considered the following survey guidelines:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* – Working Draft (DEC 2004)
- *Threatened Species Survey Guidelines – Amphibians* (DECC 2009)
- *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010a)
- *Survey Guidelines for Australia's Threatened Frogs* (DEWHA 2010b)
- *Survey Guidelines for Australia's Threatened Bats* (DEWHA 2010c)
- Survey Guidelines for Australia's Threatened Mammals (DSEWPC 2011a)
- *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPC 2011b).

Extensive previous ecological surveys including targeted surveys for threatened fauna species have been undertaken within and surrounding the Development Footprint. This has included:

- diurnal bird and reptile surveys, remote camera and anabat echolocation recordings over the last 14 years for the Bulga Coal Complex Annual Monitoring Surveys (RPS 2017)
- fauna surveys including bird searches, amphibian searches, spotlighting, stagwatching, Anabat echolocation call detection and remote camera recordings in July 2016 (Kleinfelder 2016)
- elliot and cage fauna trapping surveys, hair funnels, area searches, spotlighting surveys, reptile and amphibian searches, bird surveys (including winter bird surveys), micro-bat echolocation recordings, nocturnal call playback and habitat assessments (Umwelt 2013), and
- targeted species-credit fauna surveys including bird surveys targeting the black-breasted buzzard and comb-crested jacana, frog surveys targeting green and golden bell frog (*Litoria aurea*), spotlighting and SAT surveys targeting koala (*Phascolarctos cinereus*), bird surveys, remote camera surveys targeting brush-tailed phascogale (*Phascogale tapoatafa*), targeted broad-headed snake (*Hoplocephalus bungaroides*) searches, targeted habitat searches for the large-footed myotis (*Myotis macropus*) and Anabat echolocation call detection for threatened microbats for the Bulga UHSA (Umwelt 2015).

Table 2.3 identifies the species-credit fauna species that were determined to potentially occur in the Development Footprint and therefore require targeted surveys and further assessment. Species-credit fauna survey locations are shown in **Figure 2.4** and **Figure 2.5**.

Appendix A outlines the species-credit species identified in the literature review that were not considered likely to occur due to lack of suitable habitat and/or absence of local records and therefore did not warrant further assessment as per Section 6.5.1.6 of the FBA (OEH 2014b).

Table 2.3 Species-credit Fauna Species Requiring Further Assessment and Survey

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
brush-tailed phascogale ***Phascogale tapoatafa***	V	-	1, 2	All year	Bushnell Trophy Cam HD cameras were installed at 10 locations across the Development Footprint between October and November 2017, totalling 230 trap nights. At each site, a remote camera was mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing peanut butter, honey and tuna. Cameras were set to take three photos in quick succession when movement was detected. Nocturnal spotlighting searches were also undertaken in suitable habitat areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights and head torches. The surveys were undertaken over one night in October 2017 totalling approximately six person hours of survey across the Development Footprint and included walking and driving transects. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Remote camera surveys, spotlighting surveys and trapping surveys have also been undertaken in the wider locality as part of the Bulga Optimisation Project (Umwelt 2013), Bulga UHSA (Umwelt 2015,) and as part of annual monitoring surveys of the Bulga Coal Complex.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
eastern pygmy-possum ***Cercartetus nanus***	V	-	1	All year	Bushnell Trophy Cam HD cameras were installed at 10 locations across the Development Footprint between October and November 2017, totalling 230 trap nights. At each site, a remote camera was mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing peanut butter and honey. Cameras were set to take three photos in quick succession when movement was detected. Nocturnal spotlighting searches were also undertaken in suitable habitat areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights and head torches. The surveys were undertaken over one night in October 2017 totalling approximately six person hours of survey across the Development Footprint and included walking and driving transects. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Remote camera surveys, spotlighting surveys and trapping surveys have also been undertaken in the wider locality as part of the Bulga Optimisation Project (Umwelt 2013), Bulga UHSA (Umwelt 2015,) and as part of annual monitoring surveys of the Bulga Coal Complex.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
green and golden bell frog ***Litoria aurea***	E	V	1, 3	August – March	Nocturnal spotlighting surveys were conducted in October 2017 and involved walking a meandering transect within suitable habitat including one ephemeral drainage line location within the Development Footprint. Spotlight surveys involved searching the aquatic, fringing and terrestrial habitat and recording the number of any amphibian species seen or heard calling. Diurnal herpetological searches were undertaken in suitable terrestrial habitat in October 2017 and involved searching in fringing aquatic and terrestrial habitats. Diurnal surveys were conducted across one broad area of suitable aquatic habitat in the Development Footprint. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Spotlighting surveys were also undertaken in UHSA Hunter Strategic Assessment (Umwelt 2015) and the Bulga Optimisation Project (Umwelt 2013). Diurnal and nocturnal searches are also undertaken as part of the monitoring in the Bulga Coal Complex annually.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
koala *Phascolarctos cinereus*	V	V	1, 2, 3	All year	Searches for signs of the presence of koalas were undertaken at six locations across the Development Footprint in August 2017 using the Spot Assessment Technique (SAT). The koala SAT was undertaken in eucalypt dominated sites only as per the technique outlined in Phillips and Callaghan (2011). Searches were undertaken on and around the base of 30 trees at each survey site. The searches focused on signs of presence including scats at the base of trees and characteristic scratches on tree trunks. Furthermore, habitat assessments to determine the extent of potential koala feed trees were also undertaken across the vegetation communities of the Development Footprint. Surveys included call playback sessions which began with a period of quiet listening for approximately 5 minutes followed by playing koala calls for approximately four minutes. Following call playback sessions, nocturnal spotlighting searches were undertaken in suitable habitat areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights and head torches. The surveys were undertaken over one night in October 2017 totalling approximately six person hours of survey across the Development Footprint and included walking and driving transects. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Spotlighting and SAT surveys were also undertaken in the wider locality as part of the Bulga UHSA (Umwelt 2015) and the Bulga Optimisation Project (Umwelt 2013).

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
pale-headed snake ***Hoplocephalus bitorquatus***	V	-	1	October - April	Diurnal reptile searches were undertaken in suitable terrestrial habitat in October 2017 and involved searching under timber and rocks. Diurnal surveys were conducted by walking a meandering transects within suitable habitat across the Development Footprint. Nocturnal spotlighting surveys were conducted in October 2017 and involved walking a meandering transect within suitable habitat. A total of six person hours of nocturnal surveys were conducted across the Development Footprint. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Spotlighting surveys were also undertaken in the wider locality as part of the Bulga Upper Hunter Strategic Assessment (Umwelt 2015) and the Bulga Optimisation Project (Umwelt 2013).

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
regent honeyeater *Anthochaera phrygia*	CE	CE	1, 2, 3	All year	Targeted winter bird surveys were undertaken across the Development Footprint in five locations in August 2017. These sessions began with a period of quiet listening for approximately 5 minutes. Regent honeyeater (and swift parrot) calls were played using a 15 watt directional loud hailer for approximately four minutes, followed by a listening period of five minutes between species calls. Following call playback sessions, bird surveys were conducted at each site for a minimum of 30 minutes totalling one person hour of survey per site. This involved walking a meandering transect and recording the number of any bird species seen or heard calling. Species were visually identified using 10 x 40 magnification binoculars or by call recognition. The winter bird surveys targeted areas of better quality habitat and flowering resources for the regent honeyeater and were timed to coincide with the known presence of the species in the Hunter Valley. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Targeted winter bird surveys have been undertaken in the wider locality as part of the Bulga Optimisation Project (2013) and Bulga UHSA (Umwelt 2015). Diurnal winter bird searches are undertaken as part of the monitoring in the Bulga Coal Complex annually.

Common Name *Scientific Name*	BC Act Status	EPBC Act Status	Source	Required Survey Period^	Survey Technique, Timing and Location
grey-headed flying-fox ***Pteropus poliocephalus*** **(breeding/roosting habitat only)**	V	V	2, 3	September - May	Searches for signs of the presence of grey-headed flying-fox camps were undertaken opportunistically throughout the Development Footprint during all Umwelt survey periods outlined in **Section 2.3.3** above. Suitable roosting habitat usually consists of forested areas near streams, rivers and creeklines. Nocturnal spotlighting searches were also undertaken in suitable habitat areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights and head torches. The surveys were undertaken a single night in October 2017 totalling approximately six person hours of survey across the Development Footprint and included walking and driving transects. Areas targeted for spotlighting primarily comprised of woodland patches. Spotlighting surveys were also undertaken in the wider locality as part of the Optimisation Project (2013) and Bulga UHSA (Umwelt 2015).

^ Months that surveys are required according to the FBA Calculator and the TSPD. Where this is unavailable, the relevant flowering/detection periods were sought from online species profiles (OEH or Commonwealth SPRAT).

1 = BioBanking Credit Calculator

2 = Bionet Atlas of NSW Wildlife

3 = Protected Matters Search Tool

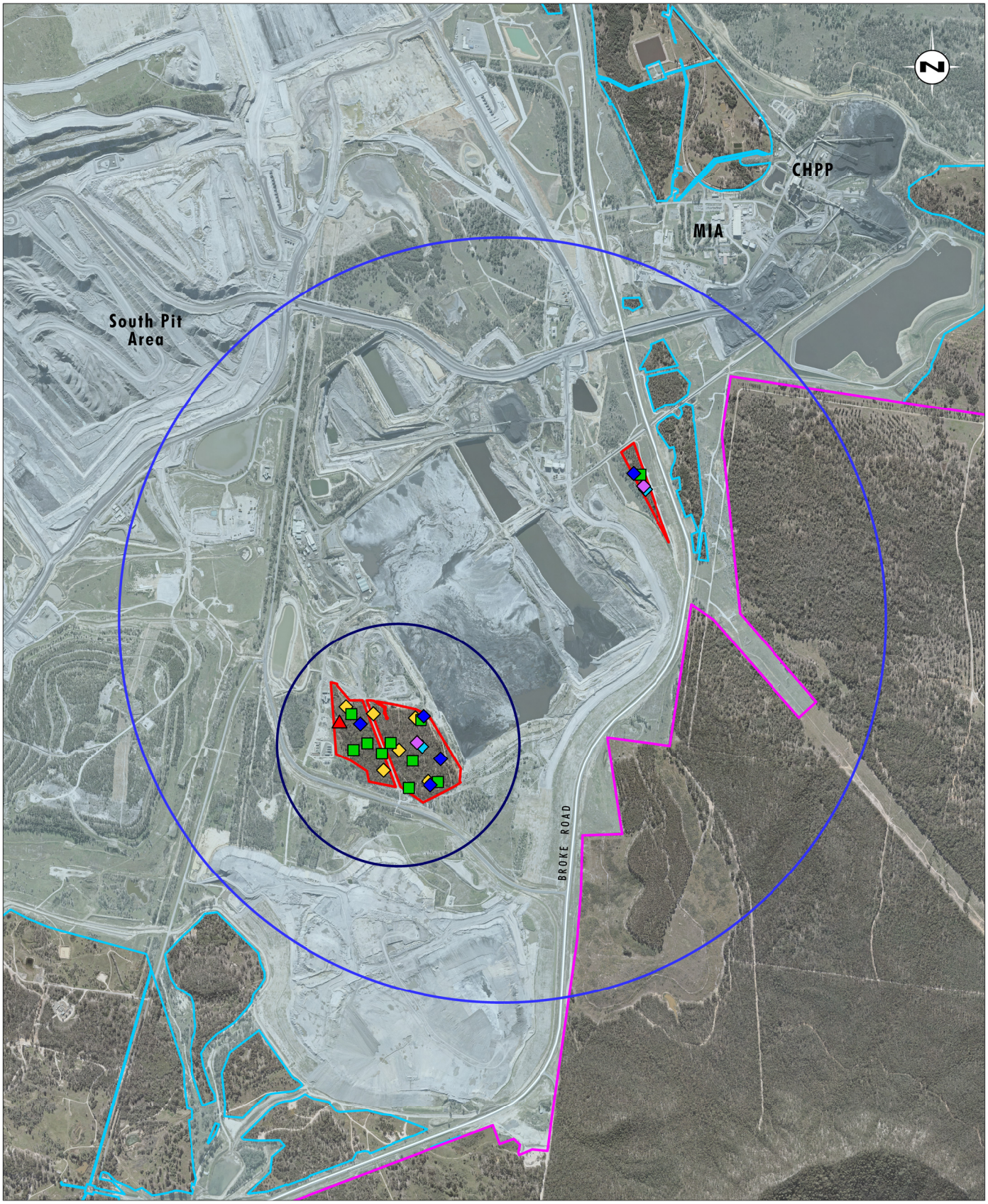

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

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1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Green and Golden Bell Frog and Green-thighed Frog Survey
- Koala Call Playback
- Koala SAT Survey
- Remote Camera
- Spotlight Survey
- Winter Bird Survey

FIGURE 2.4

Target Species-credit Fauna Survey Effort

File Name (A4): R04/4100_031.dgn
20190319 12.48

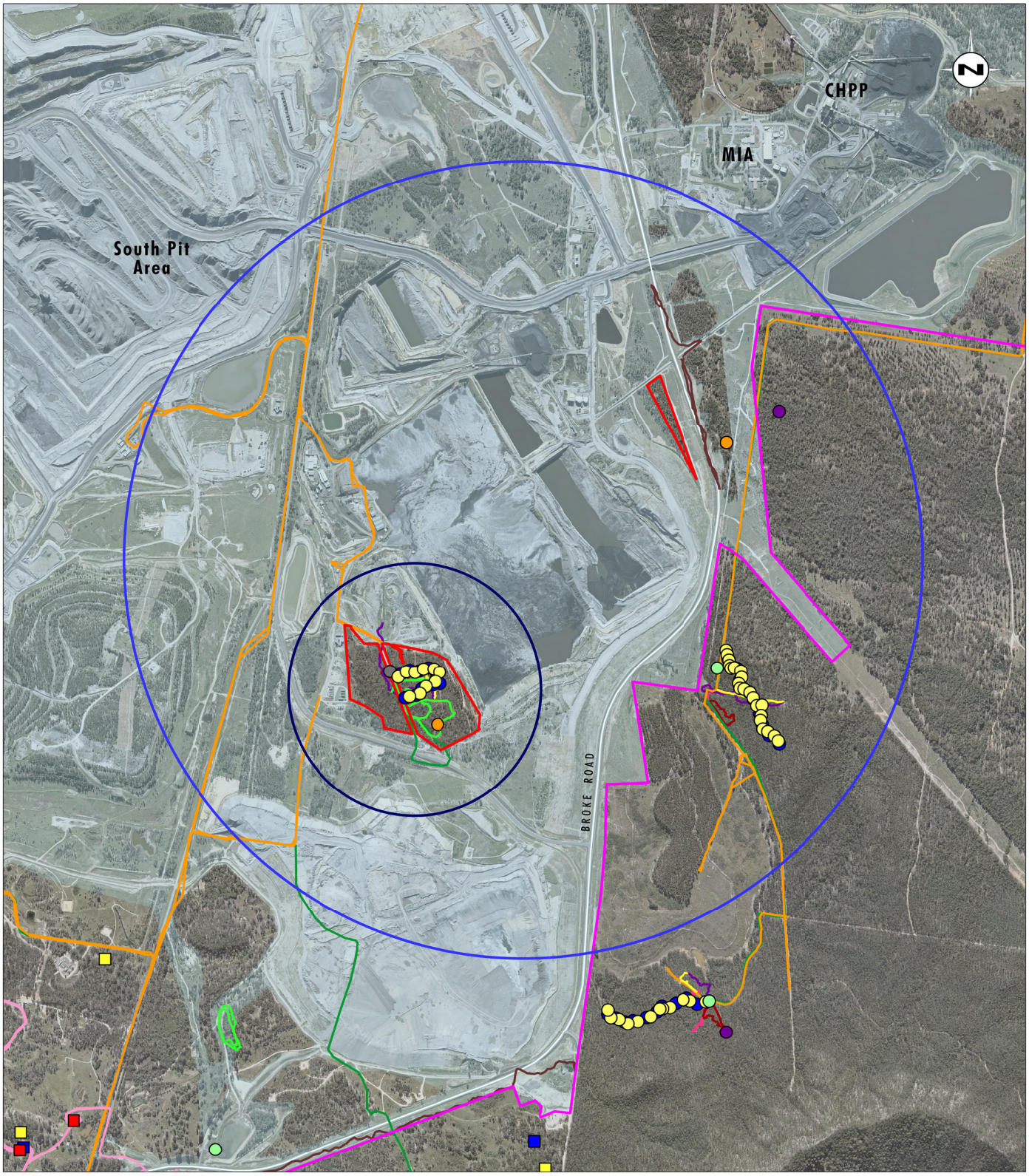

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

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1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle

BOP Survey:

- Anabat Echolocation Recorder
- Bird Survey Location
- Habitat Assessment
- Owl Call Playback
- Paired Arboreal and Terrestrial Hair Funnels
- Terrestrial Hair Funnel
- Bird Survey Track
- Diurnal Reptile and Amphibian Search Track
- Driving Spotlight Survey
- Nocturnal Reptile and Amphibian Search Track
- Opportunistic Driving Survey Track
- Walking Habitat Assessment
- Walking Spotlight Survey
- Winter Bird Survey

UHSA Survey:

- Anabat Survey
- Green and Golden Bell Frog Survey
- Koala SAT Search
- Spotlighting Transect

FIGURE 2.5

Fauna Survey Locations from Previous Projects

File Name (A4): R04/4100_032.dgn
20190319 12.50

3 Results

3.1 Landscape Value

3.1.1 Landscape Features

The outer assessment circle is contained entirely in the Central Hunter Foothills Mitchell landscape and sizeable areas of native vegetation occur to the east, along with areas to the west of mine rehabilitation dominated by native species. These landscape features are shown in **Figure 3.1**. Mitchell landscapes are shown on **Figure 1.5**.

Landscape features that were considered in the connectivity value scores for the Development Footprint are outlined in **Table 3.1** below.

Table 3.1 Landscape Features in the Development Footprint

Landscape Feature	Development Footprint
Mitchell Landscapes	Central Hunter Foothills
Rivers, Streams, Estuaries	2nd order streams: • Loders Creek
Wetlands	None identified
Native Vegetation	280 hectares in the outer assessment circle 28 hectares in the inner assessment circle
State or Regional Biodiversity Links	None identified

3.1.2 Landscape Value Scores

3.1.2.1 Per cent Native Vegetation Cover

Table 3.2 details the percent native vegetation cover before and after the proposed disturbance in the Development Footprint and the native vegetation percent class entered into the BioBanking Calculator as per Table 9 of Appendix 4 of the FBA (OEH 2014b).

Table 3.2 Native Vegetation Cover in Assessment Circles

Assessment Circle	Pre-Development			Post-Development		
	Area of Native Veg (ha)	Native Veg Cover (%)	Native Veg Per cent Class	Area of Native Veg (ha)	Native Veg Cover (%)	Native Veg Per cent Class
Outer (1000 ha)	280	28	26-30	261	26	26-30
Inner (100 ha)	28	28	26-30	11	11	11-15

3.1.2.2 Connectivity Value

No state or regionally significant biodiversity links were identified within a plan approved by the Chief Executive of OEH in the Sydney Basin IBRA Bioregion or as part of riparian buffers associated with 4th, 5th or 6th order streams, important wetlands or estuarine areas. The connectivity value was assigned according to the width and condition of the link before and after development. Given the highly fragmented nature of the locality the connecting link width was assigned as 0-5 metres before and after development (refer to **Figure 3.1**). The overstorey condition was assigned as absent before and after development, and the midstorey/ground cover condition was assigned at benchmark before and after development.

3.1.2.3 Patch Size

Table 3.3 below details the parameters that determined the Patch Size score as per Table 15 of Appendix 4 of the FBA (OEH 2014b).

Table 3.3 Patch Size Score Parameters

Mitchell Landscape	Central Hunter Foothills
Percent Native Vegetation Cleared	75%
Patch Size Class	>1001
Patch Size Score	**12**

3.1.2.4 Landscape Value Score

The landscape value score for the Development Footprint is 14.2, as calculated by the BBCC.

3.2 Native Vegetation within the Development Footprint

3.2.1 Biometric Vegetation Types and Vegetation Zones

Surveys of the Development Footprint identified Two Plant Community Types (PCTs) across 3 condition classes being:

- HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion
  - *Moderate to Good Condition* (Zone 1)
  - *Low condition* (Zone 2)
- HU817/1603 PCT Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter
  - *Moderate to Good Condition* (Zone 3).

These PCTs were aligned with types described as part of the VIS Classification Database (OEH 2018b). The PCTs were then categorised into three vegetation zones (refer to **Figure 3.2**). The composition of these vegetation zones is outlined in **Sections 3.2.1.1** to **3.2.1.3** below and a flora species list for all plots surveyed is included in **Appendix B**.

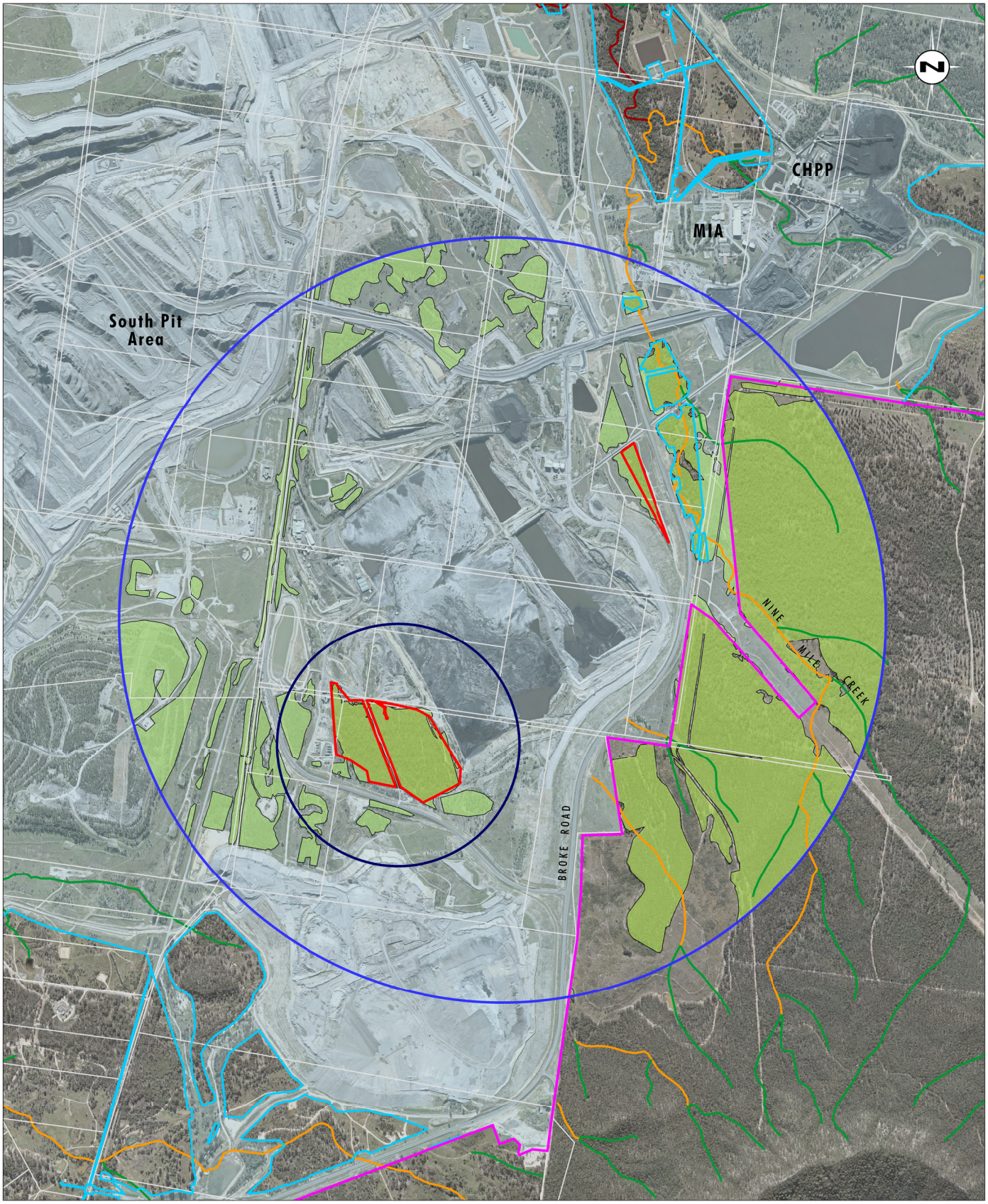

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Native Vegetation

Stream Order:
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream

FIGURE 3.1

Connectivity Value

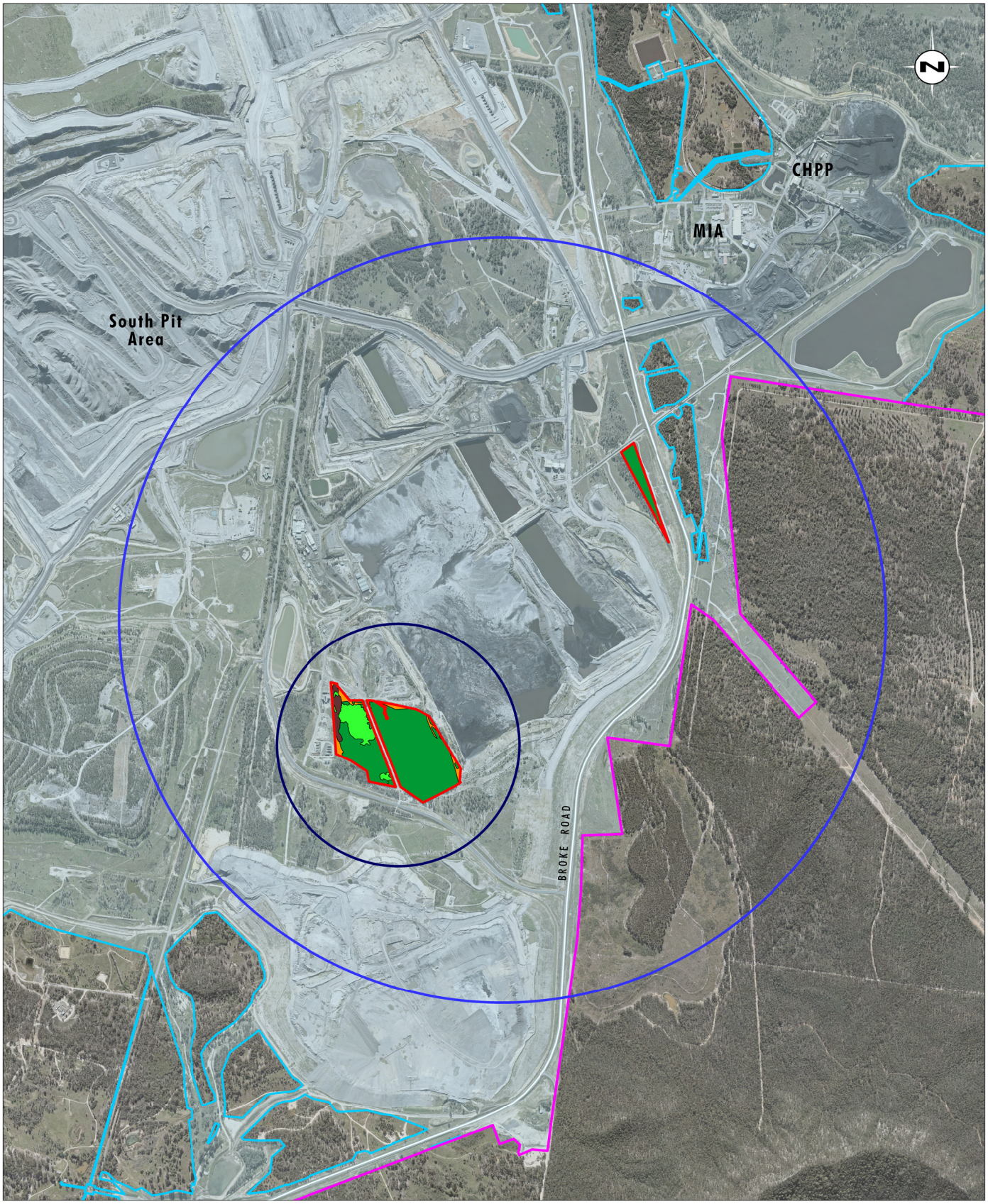

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Zone 1 - HU564/922 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion - Moderate to Good Condition
- Zone 2 - HU564/922 - Low Condition
- Zone 3 - HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter - Moderate to Good Condition
- Disturbed Land

FIGURE 3.2

Vegetation Zones in the Development Footprint

File Name (A4): R04/4100_034.dgn
20181130 14.20

3.2.1.1 Zone 1 – HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion – Moderate to Good Condition

PCT Name	*Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion	
Condition	Moderate to Good	
PCT Number	922	
BVT Number	HU564	
Area (ha)	2.1	
Plots/Transects	Two (P03 and P07)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU194 *Melaleuca decora* Shrubland of the Central Hunter Valley	
HRVP Map Unit (Peake 2006)	MU17 – Central Hunter Paperbark Soaks Woodland	
General Description	This vegetation zone comprises a low forest associated with a minor drainage line in the western portion of the Development Footprint and areas where there is likely to be impeded drainage.	
Canopy Description	This vegetation zone has a mid-dense canopy between 10-15 metres in height, dominated solely by *Melaleuca decora*. A very sparse emergent layer of narrow-leaved ironbark (*Eucalyptus crebra*) is present within this vegetation zone.	
Mid-storey Description	A very sparse mid-storey dominated by bull oak (*Allocasuarina luehmannii*), silver-stemmed wattle (*Acacia parvipinnula*) and wedge-leaf hop-bush (*Dodonaea viscosa* subsp. *cuneata*).	
Shrub Layer Description	A very sparse shrub layer less than a metre in height is present throughout this vegetation zone. Dominant species include fan wattle (*Acacia amblygona*) and peach heath (*Lissanthe strigosa*).	
Ground Cover Description	This vegetation zone is characterised by a very spare to sparse ground layer less than a metre in height. Common species include barbed wire-grass (*Cymbopogon refractus*), threeawn speargrass (*Aristida vagans*), weeping grass (*Microlaena stipoides* var. *stipoides*), paddock lovegrass (*Eragrostis leptostachya*), twining glycine (*Glycine clandestina*), ivy goodenia (*Goodenia hederacea*), slender wire lily (*Laxmannia gracilis*), *Lomandra filiformis* subsp. *filiformis*, amulla (*Eremophila debilis*) and poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Introduced species generally occur at low abundance in this vegetation zone. Introduced species recorded in this vegetation zone include *Juncus acutus* subsp. *acutus*, Rhodes grass (*Chloris gayana*), fireweed (*Senecio madagascariensis*) and cobblers pegs (*Bidens pilosa*).	
PCT Allocation	Vegetation Zone 1 is aligned with HU564/PCT922 as it supports a reasonable proportion of the characteristic species listed in the PCT description according to the VIS Classification Database (OEH 2018b). Of the 14 flora species listed on the database as characteristic for HU564/PCT922, Vegetation Zone 1 supports 5 of them (36 per cent).	
TSC Act Status	This vegetation zone is not consistent with any TEC listed under the BC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

3.2.1.2 Zone 2 – HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion – Low Condition

PCT Name	*Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion	
Condition	**Low**	
PCT Number	922	
BVT Number	HU564	
Area (ha)	0.7	
Plots/Transects	One (P08)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU194 *Melaleuca decora* Shrubland of the Central Hunter Valley	
HRVP Map Unit (Peake 2006)	MU17 – Central Hunter Paperbark Soaks Woodland	
General Description	This vegetation zone represents a very disturbed form of the vegetation zone 1. It is associated with the same drainage line, however there is observable dieback of the canopy and the understorey is dominated by the exotic species *Juncus acutus* subsp. *acutus*.	
Canopy Description	This vegetation zone supports a very sparse canopy between 10-12 metres in height, dominated solely by *Melaleuca decora*.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	This vegetation zone is characterised by a dense ground layer up to 2 metres in height dominated by the exotic species *Juncus acutus* subsp. *acutus*. Native ground layer species occur in low abundance and include broad-leaved Cumbungi (*Typha orientalis*), common reed (*Phragmites australis*) and common couch (*Cynodon dactylon*).	
Introduced Species	As detailed above, the ground layer of this vegetation is dominated by the exotic species *Juncus acutus* subsp. *acutus*. Other less common exotic species in this vegetation zone include fireweed (*Senecio madagascariensis*) and Rhodes grass (*Chloris gayana*).	
PCT Allocation	Vegetation Zone 2 is aligned with HU564/PCT92. Although this vegetation zone only supports a single characteristic species for this BVT/PCT, being *Melaleuca decora*, prior to disturbance it is likely to have supported more characteristic species. It also occurs adjacent and in a similar landscape position to the moderate to good condition form of this BVT/PCT.	
TSC Act Status	This vegetation zone is not consistent with any TEC listed under the BC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

3.2.1.3 Zone 3 – HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter – Moderate to Good Condition

PCT Name	Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter	
Condition	Moderate to Good	
PCT Number	1603	
BVT Number	HU817	
Area (ha)	16.4	
Plots/Transects	Four (P01, P02, P04 and P05)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU085 - Narrow-leaved Ironbark/ Bull Oak/ Grey Box Shrub/ Grass Open Forest of the Central and Lower Hunter	
HRVP Map Unit (Peake 2006)	MU 10 – Central Hunter Box – Ironbark Woodland	
General Description	This vegetation zone is the dominant vegetation community occurring within the Development Footprint, occurring on the lower slopes within the surrounding landscape.	
Canopy Description	This vegetation zone has a sparse canopy between 15-18 metres in height, dominated by narrow-leaved ironbark (*Eucalyptus crebra*), along with grey box (*Eucalyptus moluccana*).	
Mid-storey Description	Generally, a small tree mid-storey is present, dominated by bull oak (*Allocasuarina luehmannii*).	
Shrub Layer Description	The shrub layer is very sparse and includes fan wattle (*Acacia amblygona*), peach heath (*Lissanthe strigosa*), small-leaf bluebush (*Maireana microphylla*), native blackthorn (*Bursaria spinosa*) and sticky daisy bush (*Olearia elliptica*).	
Ground Cover Description	This vegetation zone is characterised by a sparse to mid-dense ground layer. Common ground layer species include purple wiregrass (*Aristida ramosa*), threeawn speargrass (*Aristida vagans*), red grass (*Bothriochloa macra*), barbed wire-grass (*Cymbopogon refractus*), tall chloris (*Chloris ventricosa*), paddock lovegrass (*Eragrostis leptostachya*), hairy panic (*Panicum effusum),* ivy goodenia (*Goodenia hederacea*), many-flowered mat-rush (*Lomandra multiflora*), blue trumpet (*Brunoniella australis*), *Lomandra filiformis* subsp. *filiformis*, amulla (*Eremophila debilis*), twining glycine (*Glycine clandestina*), variable glycine (*Glycine tabacina*), slender wire lily (*Laxmannia gracilis*) and poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Introduced species generally occur at low abundance within this vegetation zone. Introduced species recorded in this vegetation zone include common prickly pear (*Opuntia stricta*), fireweed (*Senecio madagascariensis*), spear thistle (*Cirsium vulgare*), common sowthistle (*Sonchus oleraceus*) and tiger pear (*Opuntia aurantiaca*).	

PCT Name	Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter
Condition	**Moderate to Good**
PCT Allocation	Vegetation Zone 3 is aligned with HU817/PCT 1603 as it supports a high proportion of the characteristic species listed in the PCT description according to the VIS Classification Database (OEH 2018b). Of the 14 flora species listed on the database as characteristic for HU817/PCT 1603, this vegetation Zone supports 10 of these species (71 per cent). Whilst this vegetation zone also has similarity to several other BVTs/PCTs, it has the highest number of positive diagnostic species listed for HU817/PCT 1603.
TSC Act Status	This vegetation zone is consistent with the *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* Endangered Ecological Community (EEC) listed under the BC Act. For further information, refer to **Section 3.2.3**.
EPBC Act Status	This vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland* Critically Endangered Ecological Community (CEEC) listed under the EPBC Act. For further information, refer to **Section 3.2.3**.

3.2.1.5 Disturbed Land and Dams

All other areas not mapped as part of a vegetation zone are cleared land. Cleared Land could not be aligned with a PCT or vegetation zone and is excluded from further assessment as per Section 9.5 of the FBA (OEH 2014b). Cleared land is land on which the native overstorey has been completely removed and there is no native mid-storey, and less than 50 per cent of the ground cover vegetation is indigenous species, or less than 10 per cent of the ground cover is present (whether dead or alive).

3.2.2 Current Site Value

Table 3.4 below details the current site value scores for each of the vegetation zones in the Development Footprint. The raw site condition attribute data for each of the vegetation zones is provided in **Appendix C**.

Table 3.4 Vegetation Zone Site Value Scores

Veg Zone	PCT Name	Current Site Value Score
1	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	65.10
2	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	29.69
3	HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	65.80

3.2.3 Threatened Ecological Communities

One vegetation zone (Zone 3) recorded in the Development Footprint conforms to two threatened ecological communities, (refer to **Figure 3.3**), being:

- *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act, and
- *Central Hunter Valley Eucalypt Forest and Woodland* listed under the EPBC Act.

Detailed analysis of the vegetation zones with respect to the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee determinations is provided in below in **Section 3.2.3.1** and **3.2.3.2**.

The remaining PCTs identified in the Development Footprint do not conform to any NSW or Commonwealth threatened ecological community listings.

3.2.3.1 Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC under the BC Act

HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter – moderate to good condition is considered to conform to the Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC. This vegetation zone conforms with the Final Determination of Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC (NSW Scientific Committee 2011), due to the following factors:

- this vegetation zone occurs on Permian sediments within the NSW Sydney Basin Bioregion
- this vegetation zone occurs in the Singleton Local Government Areas (LGA) where this EEC has previously been recorded
- this vegetation zone supports a canopy dominated by the characteristic species narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus moluccana*), and
- this vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the EEC:
    - 20 out of 54 (37 per cent) native species recorded in this unit are characteristic species in the EEC listing and
    - 20 out of 38 (53 per cent) species in the characteristic species list for the EEC were recorded in this unit.

3.2.3.2 Central Hunter Valley Eucalypt Forest and Woodland CEEC under the EPBC Act

Central Hunter Valley Eucalypt Forest and Woodland CEEC occurs in the Hunter Valley region on soils derived from Permian sedimentary bedrock (TSSC 2015a). Typically it is characterised as a eucalypt woodland and open forest, with a shrub layer of variable density and/or a grassy ground layer. Across its range, one or more of a complex of four eucalypt tree species, namely spotted gum (*Corymbia maculata*), narrow-leaved ironbark (*Eucalyptus crebra*), slaty gum (*Eucalyptus dawsonii*) or grey box (*Eucalyptus moluccana*) dominate the canopy (TSSC 2015a).

Targeted surveys to map *Central Hunter Valley Eucalypt Forest and Woodland CEEC* were undertaken in August 2017 in accordance with the sampling protocols and with consideration of the key diagnostic characteristics and condition thresholds provided within the Approved Conservation Advice (TSSC 2015a). These 'key diagnostic characteristics' and 'condition thresholds' provided by the Approved Conservation Advice formed the basis for delineating and identifying patches of native vegetation as being the threatened ecological community and distinguishing between patches of different quality.

The results of the assessment for vegetation patches within the Development Footprint against the key diagnostic characteristics according to the Approved Conservation Advice are detailed in **Table 3.5** below.

Table 3.5 Assessment of Vegetation Patches within the Development Footprint against the Key Diagnostic Features according to the Approved Conservation Advice (TSSC 2015a)

Key Diagnostic Characteristic as per Approved Conservation Advice (TSSC 2015a)	Vegetation patches within the Additional Disturbance Area
It occurs in the Hunter River catchment (typically called the Hunter Valley region)	Yes – the Development Footprint occurs within the Hunter River catchment.
It typically occurs on lower hillslopes and low ridges, or valley floors in undulating country; on soils derived from Permian sedimentary rocks	Yes – the Development Footprint is underlain by Permian derived soils on low hills of the valley floor.
It does not occur on alluvial flats, river terraces, Aeolian sands, Triassic sediments or escarpments	Yes – the Development Footprint does not occur on alluvial flats, river terraces, Aeolian sands, Triassic sediments or escarpments.
It is woodland or forest, with a projected canopy cover of trees of 10 per cent or more; or with a native tree density of at least 10 native tree stems per 0.5 ha (at least 20 native tree stems/ha) that are at least one metre in height	Yes – vegetation patches within the Development Footprint comprise a projected canopy of cover at least 10 per cent with a native tree density of at least 10 native tree stems per 0.5 ha that are at least one metre in height.
The canopy of the ecological community is dominated by one or more of the following four eucalypt species: *Eucalyptus crebra* (narrow-leaved ironbark), *Corymbia maculata* (syn. *E. maculata*) (spotted gum), *E. dawsonii* (slaty gum) and *E. moluccana* (grey box); OR a fifth species, *Allocasuarina luehmannii* (bulloak, buloke) dominates in combination with one or more of the above four eucalypt species, in sites previously dominated by one or more of the above four eucalypt species	Yes – Zone 3 HU817/1603 PCT Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter in Moderate to Good Condition comprises a canopy dominated by narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus moluccana)* in combination with a sparse small tree layer of bull oak (*Allocasuarina luehmannii*). The remainder of the vegetation within the Development Footprint has a canopy layer dominated by *Melaleuca decora* and is not consistent with the CEEC.
Allocasuarina torulosa (forest oak/ she-oak, rose she-oak/oak), *Eucalyptus acmenoides* (white mahogany) and *Eucalyptus fibrosa* (red/broad-leaved ironbark) are largely absent from the canopy of a patch. Largely absent: meaning no more than two trees per hectare on average across a patch.	Yes – the three contra-indicative species are absent from the Development Footprint.
A ground layer is present (although it may vary in development and composition), as a sparse to thick layer of native grasses and other native herbs and/or native shrubs	Yes – All vegetation patches within the Development Footprint have a sparse to mid-dense ground layer dominated by native grasses and other native herbs and/or native shrubs.

All of Zone 3 HU817/1603 PCT Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter in Moderate to Good Condition is considered to conform to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

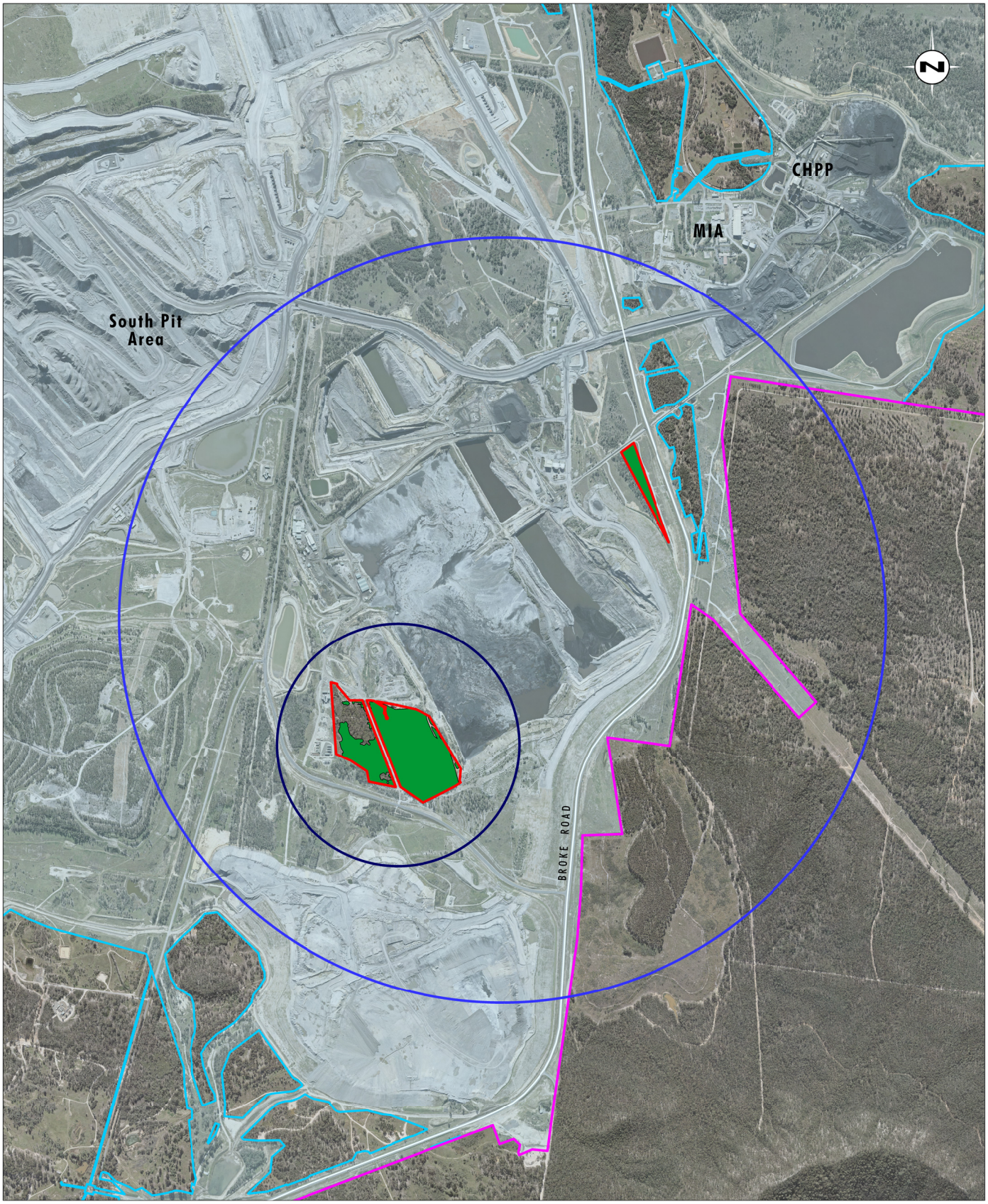

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

0 0.5 1.0 1.25km
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Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle
- *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC listed under the BC Act and *Central Hunter Valley Eucalypt Forest and Woodland* CEEC listed under the EPBC Act

FIGURE 3.3

Threatened Ecological Communities in the Development Footprint

3.3 Threatened Species within the Development Footprint

3.3.1 Ecosystem-credit Species

Table 3.6 below outlines the ecosystem-credit species predicted to occur by the BioBanking Credit Calculator and whether they were recorded within the Development Footprint or the wider Bulga Coal Complex during the surveys undertaken for this assessment or previous surveys (as shown on **Figure 3.4**). It also includes ecosystem species that were not predicted by the BioBanking Credit Calculator, however were recorded as part of surveys of the Development Footprint or wider Bulga Coal Complex.

Table 3.6 Ecosystem-credit Species Predicted to Occur by the BBCC or Recorded

Species Name	BC Act	EPBC Act	Threatened Species Offset Multiplier	Predicted by the BBCC	Recorded	
					Development Footprint	Bulga Coal Complex
barking owl *Ninox connivens*	V	-	3.0	Yes	No	No
black-chinned honeyeater *Melithreptus gularis* subsp. *gularis*	V	-	1.3	Yes	No	No
brown treecreeper *Climacteris picumnus* subsp. *victoriae*	V	-	2.0	Yes	No	Yes
bush stone curlew *Burhinus grallarius*	E	-	2.6	Yes	No	No
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	2.2	Yes	No	No
east coast freetail-bat *Mormopterus norfolkensis*	V	-	2.2	Yes	No	Yes
gang-gang cockatoo *Callocephalon fimbriatum*	V	-	2.0	Yes	No	No
glossy black-cockatoo *Calyptorhynchus lathami*	V	-	1.8	Yes	No	No
greater broad-nosed bat *Scoteanax rueppellii*	V	-	2.2	Yes	No	Yes
grey-crowned babbler *Pomatostomus temporalis* subsp. *temporalis*	V	-	1.3	Yes	Yes (individuals and a nest recorded)	Yes
hooded robin *Melanodryas cucullata* subsp. *cucullata*	V	-	1.7	Yes	No	Yes

Species Name	BC Act	EPBC Act	Threatened Species Offset Multiplier	Predicted by the BBCC	Recorded	
					Development Footprint	Bulga Coal Complex
little eagle *Hieraaetus morphnoides*	V	-	1.4	Yes	No	Yes
little lorikeet *Glossopsitta pusilla*	V	-	1.8	Yes	Yes	Yes
painted honeyeater *Grantiella picta*	V	V	1.3	Yes	No	No
speckled warbler *Chthonicola sagittata*	V	-	2.6	Yes	Yes	Yes
square-tailed kite *Lophoictinia isura*	V	-	1.4	Yes	No	No
swift parrot *Lathamus discolor*	E	CE	1.3	Yes	No	Yes
turquoise parrot *Neophema pulchella*	V	-	1.8	Yes	No	No
varied sittella *Daphoenositta chrysoptera*	V	-	1.3	Yes	Yes	Yes
yellow-bellied sheathtail-bat *Saccolaimus flaviventris*	V	-	2.2	Yes	No	Yes
squirrel glider *Petaurus norfolcensis*	V	-	n/a	No	Yes	Yes
grey-headed flying-fox *Pteropus poliocephalus* (foraging habitat)	V	V	n/a	No	Yes	Yes
eastern cave bat *Vespadelus troughtoni* (foraging habitat)	V	-	n/a	No	Yes	Yes
southern myotis *Myotis macropus* (foraging habitat)	V	-	n/a	No	Yes	Yes
large-eared pied bat *Chalinolobus dwyeri* (foraging habitat) and	V	V	n/a	No	Yes	Yes
little bentwing bat *Miniopterus australis* (foraging habitat)	V	-	n/a	No	Yes	Yes

Species Name	BC Act	EPBC Act	Threatened Species Offset Multiplier	Predicted by the BBCC	Recorded	
					Development Footprint	Bulga Coal Complex
diamond firetail ***Stagonopleura guttata***	V	-	n/a	No	No	Yes
eastern bent-wing bat ***Miniopterus schreibersii oceanensis*** **(foraging habitat)**	V	-	n/a	No	No	Yes
scarlet robin ***Petroica boodang***	V	-	n/a	No	No	Yes

Notes: V = vulnerable
E = endangered
CE = critically endangered

3.3.1.1 Survey Results

Three ecosystem-credit species were recorded in the Development Footprint during the surveys undertaken for this assessment (refer to **Figure 3.4**). These include:

- squirrel glider (*Petaurus norfolcensis*)
- speckled warbler (*Chthonicola sagittata*), and
- grey-crowned babbler (*Pomatostomus temporalis temporalis*) – recorded as a disused nest.

Other ecosystem-credit species records that have been previously recorded within the Bulga Coal Complex are outlined in **Table 3.6** and shown in **Figure 3.4**.

A full fauna species list from the surveys undertaken is included in **Appendix D**.

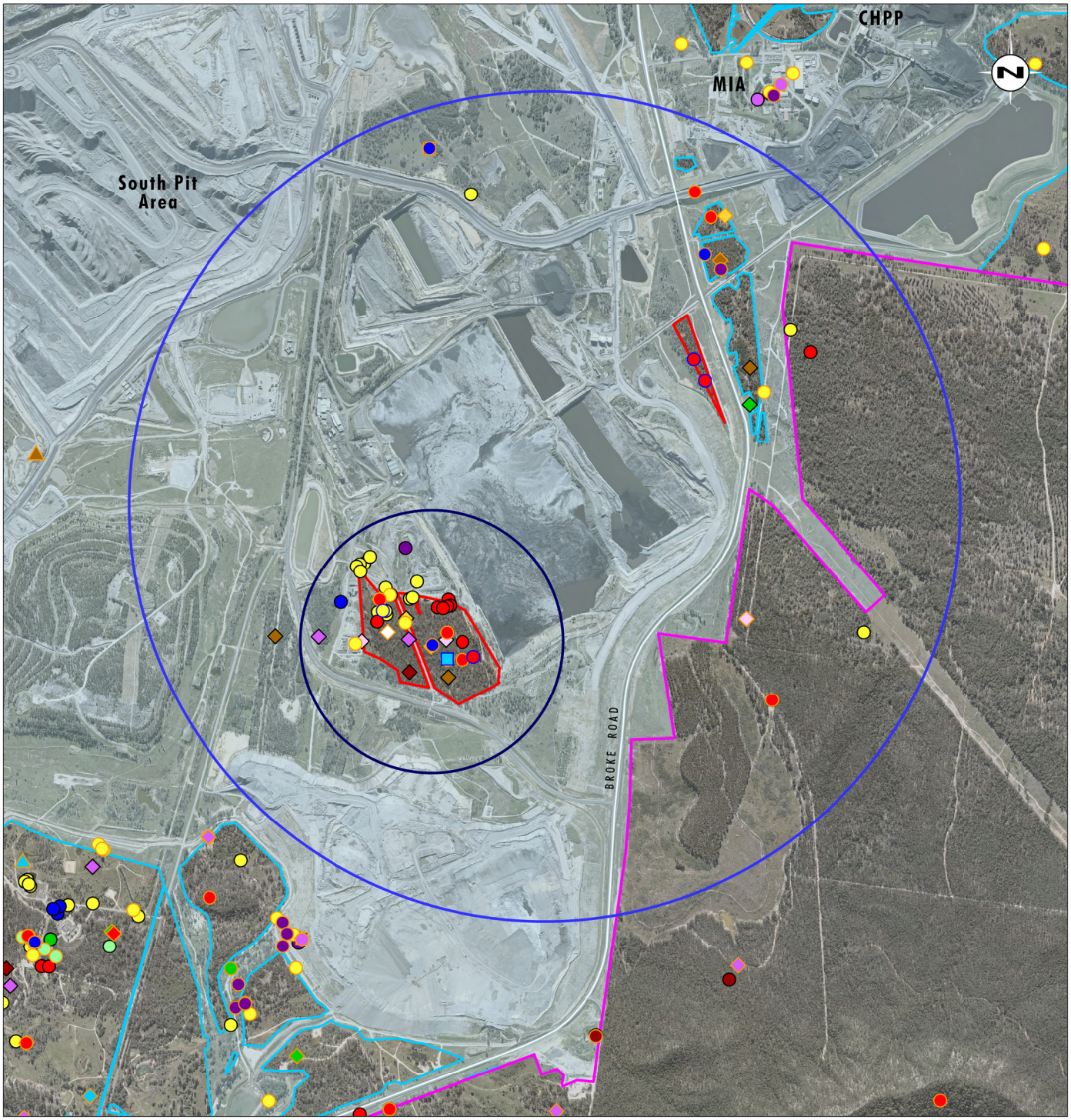

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017)

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Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle

Recorded as part of Current Assessment:
- Grey-crowned Babbler
- Specked Warbler
- Squirrel Glider

Atlas of NSW Wildlife Records:
- Black Falcon
- Brown Treecreeper
- Diamond Firetail
- Dusky Woodswallow
- East-coast Freetail-bat
- Eastern bentwing-bat
- Eastern Cave Bat
- Eastern False Pipistrelle
- Glossy Black-cockatoo
- Greater Broad-nosed Bat
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Hooded Robin
- Large-eared Pied Bat
- Little bentwing-bat
- Little Eagle
- Little Lorikeet
- Scarlet Robin
- Southern Myotis
- Specked Warbler
- Swift Parrot
- Varied Sittella

Recorded from Previous Projects:
- Brown Treecreeper
- Diamond Firetail
- East-coast Freetail-bat
- Eastern bentwing-bat
- Eastern Cave Bat
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Large-eared Pied Bat
- Little Lorikeet
- Scarlet Robin
- Southern Myotis
- Specked Warbler
- Squirrel Glider
- Swift Parrot
- Varied Sittella

FIGURE 3.4

Fauna Ecosystem Credit Species

3.3.2 Species-credit Species

3.3.2.1 Predicted Species-Credit Species

Table 3.7 below outlines the species-credit species predicted to occur by the BBCC or identified from database searches/literature reviews and whether they are considered to occur in the Development Footprint. Record information is derived from the BioNet Atlas of NSW Wildlife (OEH 2019), unless otherwise noted. **Figure 3.5** includes the records of species credit species known to occur within the vicinity of the Bulga Coal Complex.

Table 3.7 Predicted Species-credit Species

Species Name	Impacted by the Proposed Modification^	Justification for Impact
Flora Species		
Weeping Myall (*Acacia pendula*) population in the Hunter catchment	No	This population was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Weeping myall individuals are known to occur adjacent to Charlton Road to the west of the Development Footprint on Glencore-owned land. Despite this, no individuals have been recorded in the Development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Trailing Woodruff ***Asperula asthenes***	No	This species was not recorded within the Development Footprint despite extensive flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record of this species occurs approximately 60km to the east of the Development Footprint near Raymond Terrace. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Dillwynia tenuifolia	No	This species was not recorded within the Development Footprint despite extensive flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record of this species occurs approximately 8km to the west of the Development Footprint near Bulga. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
Illawarra greenhood ***Pterostylis gibbosa***	No	This species was not recorded within the Development Footprint despite extensive flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. This is species is known from a small number of populations in the Hunter region in open forest or woodland, on flat or gently sloping land. The closest record of this species occurs approximately 9km west of the Development Footprint near Milbrodale. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
pine donkey orchid ***Diuris tricolor***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record occurs approximately 20km east of the Development Footprint near North Rothbury, representing an outlier record for this species which typically occurs in the western portion of the Hunter Valley. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
scant pomaderris ***Pomaderris queenslandica***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record of this species occurs approximately 55km to the north-west of the Development Footprint near Denman. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Singleton mint bush ***Prostanthera cineolifera***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The species is restricted to a few localities around Walcha, Scone, Cessnock and St Albans. The closest record of this species occurs approximately 8km to the south-east near Pokolbin State Forest and the Singleton Military Area. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
slaty red gum ***Eucalyptus glaucina***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). This species is known to occur within the wider locality, having been recorded as part of the Bulga Optimisation Project (Umwelt 2013). The nearest record of this species is approximately 2 km to the north-east. Despite this, no individuals have been recorded in the development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
small-flower grevillea ***Grevillea parviflora* subsp. *parviflora***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record occurs approximately 23km south-east of the Development Footprint near Cessnock. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
white-flowered wax plant ***Cynanchum elegans***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). White-flowered wax plant is known to occur to the south-east of the Development Footprint approximately 2.5km away within the Singleton Military Area. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
***Cymbidium canaliculatum* population in the Hunter Catchment**	No	This population was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer **to Table 2.2**). *Cymbidium canaliculatum* is known to occur approximately 6km to the north-west of the Development Footprint on Glencore-owned land. Despite this, no individuals have been recorded in the Development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
***Eucalyptus camaldulensis* population in the Hunter catchment**	No	This population was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Planted individuals of *Eucalyptus camaldulensis* are known to occur 2.5 km to the south-west of the Development Footprint on Glencore-owned land along. Despite this, no individuals have been recorded in the Development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
Prasophyllum petilum	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). *Prasophyllum petilum* is found further to the west of the Development Footprint with the closest known records occurring west of Muswellbrook. According to the NSW Atlas of Wildlife the closest record of *Prasophyllum petilum* is approximately 60 kilometres to the north-west of the Development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Heath Wrinklewort ***Rutidosis heterogama***	No	This species was not recorded within the Development Footprint despite extensive and repeated flora transects in the known detection period for the species (refer to **Table 2.2**). Heath wrinklewort (*Rutidosis heterogama*) is found further to the east of the Development Footprint, with the closest known records occurring near approximately 40 km from the Development Footprint. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Austral toadflax ***Thesium australe***	No	This species was not recorded within the Development Footprint despite extensive flora transects in the known detection period for the species (refer to **Table 2.2**). Furthermore, the species has not been recorded in the wider locality despite extensive survey effort across multiple seasons and years. The closest record of this species occurs approximately 55km to the north-west of the Development Footprint near Denman. This species will not be impacted by the Proposed Modification and no species credits have been generated for this species.
Fauna Species		
brush-tailed phascogale ***Phascogale tapoatafa***	No	This species was not recorded within the Development Footprint despite spotlighting and remote camera surveys of suitable woodland habitats across the Development Footprint. Furthermore, the species has not been recorded in the wider locality during surveys for the Bulga Optimisation Project (Umwelt 2013), Bulga UHSA (Umwelt 2015) or the annual monitoring surveys of the Bulga Coal Complex. The closest record for this species is from approximately 5 km to the south of the Development Footprint near Broke. While suitable habitat for the species occurs within the Development Footprint, this species was not recorded within this area despite extensive and repeated surveys in suitable habitat and in the known detection period for the species (refer to **Table 2.3**). It is unlikely that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
eastern pygmy-possum ***Cercartetus nanus***	No	This species has been recorded in intact habitats in Wollemi National Park. The closest record occurs approximately 5 km to the west of the Development Footprint in Yengo National Park. While suitable habitat for the species occurs within the Development Footprint, this species was not recorded within this area despite extensive and repeated surveys in suitable habitat and in the known detection period for the species (refer to **Table 2.3**). There is no potential that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.
green and golden bell frog ***Litoria aurea***	No	This species was not recorded within the Development Footprint despite extensive surveys undertaken in the known detection period for the species (refer to **Table 2.3**). The closest record of this species occurs approximately 30 km to the south-east of the Development Footprint near Paxton, recorded in 1993. Other records to the north-west of the Development Footprint are associated with the Upper Hunter green and golden bell frog key population. The Upper Hunter green and golden bell frog key population consists of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell area and bordering areas of the Singleton and Muswellbrook LGA. No records of the population in the Upper Hunter have been found since 2009. Furthermore, there is not suitable habitat within the Development Footprint that provides potential habitat for the species. The absence of individuals in the locality following annual monitoring surveys indicates that the Development Footprint is unlikely to provide habitat for the species. It is unlikely that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.
koala ***Phascolarctos cinereus***	No	The koala (or signs of the koala) was not recorded within the Development Footprint during the targeted SAT or spotlighting surveys undertaken for this assessment. This species has been previously recorded within 2 km of the Development Footprint in the woodland habitats adjacent to the Singleton Military Area. The closest two records are old, having been recorded in 1901 and 1994. Preferred feed trees were recorded in low abundance the Development Footprint and the koala has not been recorded in the wider locality as part of the targeted surveys for the Bulga Optimisation Project (Umwelt 2013), Bulga UHSA (Umwelt 2015) or the annual monitoring surveys for the Bulga Coal Complex (RPS 2016). It is unlikely that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
pale-headed snake ***Hoplocephalus bitorquatus***	No	This species is not generally known to occur in the Hunter Valley. The closest record of this species occurs approximately 50 km to the east of the Development Footprint near Paterson in 1994. While suitable habitat for this species occurs within the Development Footprint in the form of tree hollows, this species was not recorded despite targeted surveys in suitable habitat and in the known detection period for the species (refer to **Table 2.3**). It is unlikely that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.
regent honeyeater ***Anthochaera phrygia***	No	This species has not been recorded within the Development Footprint or the locality despite targeted winter bird surveys undertaken in August 2017 as well as monitoring surveys undertaken annually in the Bulga Coal Complex. This species has only been recorded at Bulga Coal on one occasion in 2011 (a single individual was recorded in planted eucalypts in the Bulga Coal Complex site office carpark) during the surveys for the Bulga Optimisation project (Umwelt 2013). Other records of this species occur in the Singleton Military Area and Pokolbin State Forest, which contains key foraging habitat. While the Development Footprint contains potential foraging habitat for the species, it has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency and localised occurrence of a small number (5 trees out of 25 in a 400m^2 plot) of reasonably young key feed trees (DoE 2016) and the small number of individuals remaining in the population utilising other higher quality habitats in NSW. All trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH) according to the OEH Biodiversity Assessment Method. It is unlikely that this species would be impacted by the Proposed Modification and no species credits have been generated for this species.

Species Name	Impacted by the Proposed Modification^	Justification for Impact
grey-headed flying-fox ***Pteropus poliocephalus*** **(breeding/roosting habitat only)**	No	The grey-headed flying-fox, or signs thereof, was not recorded within the Development Footprint during nocturnal searches. This is a wide ranging species that can travel up to 50 km from a camp to forage. This species has been recorded in the wider locality during surveys for the Bulga Optimisation Project (Umwelt 2013) as well as several records near Bulga, Mount Thorley and the Singleton Military Area; however these are for foraging individuals. The closest camp for this species is located approximately 20 km north of the Development Footprint in Singleton. No camps for this species were recorded within the Development Footprint during surveys undertaken in August and October 2017. While the Development Footprint contains potential foraging habitat for the species, it has not been recorded utilising the habitats of the Development Footprint. It is unlikely that breeding habitat for this species would be impacted by the Proposed Modification and no species credits have been generated for this species.

^ As entered into the 'Threatened Species Survey Results' tab in the BBCC.

3.3.2.2 Species Habitat Polygons

As detailed in **Section 3.3.2.1** no species credit species are considered likely to be impact by the Proposed Modification. Given this, no species credits have been generated for the Proposed Modification. **Figure 3.5** includes records of species credits species in the wider locality.

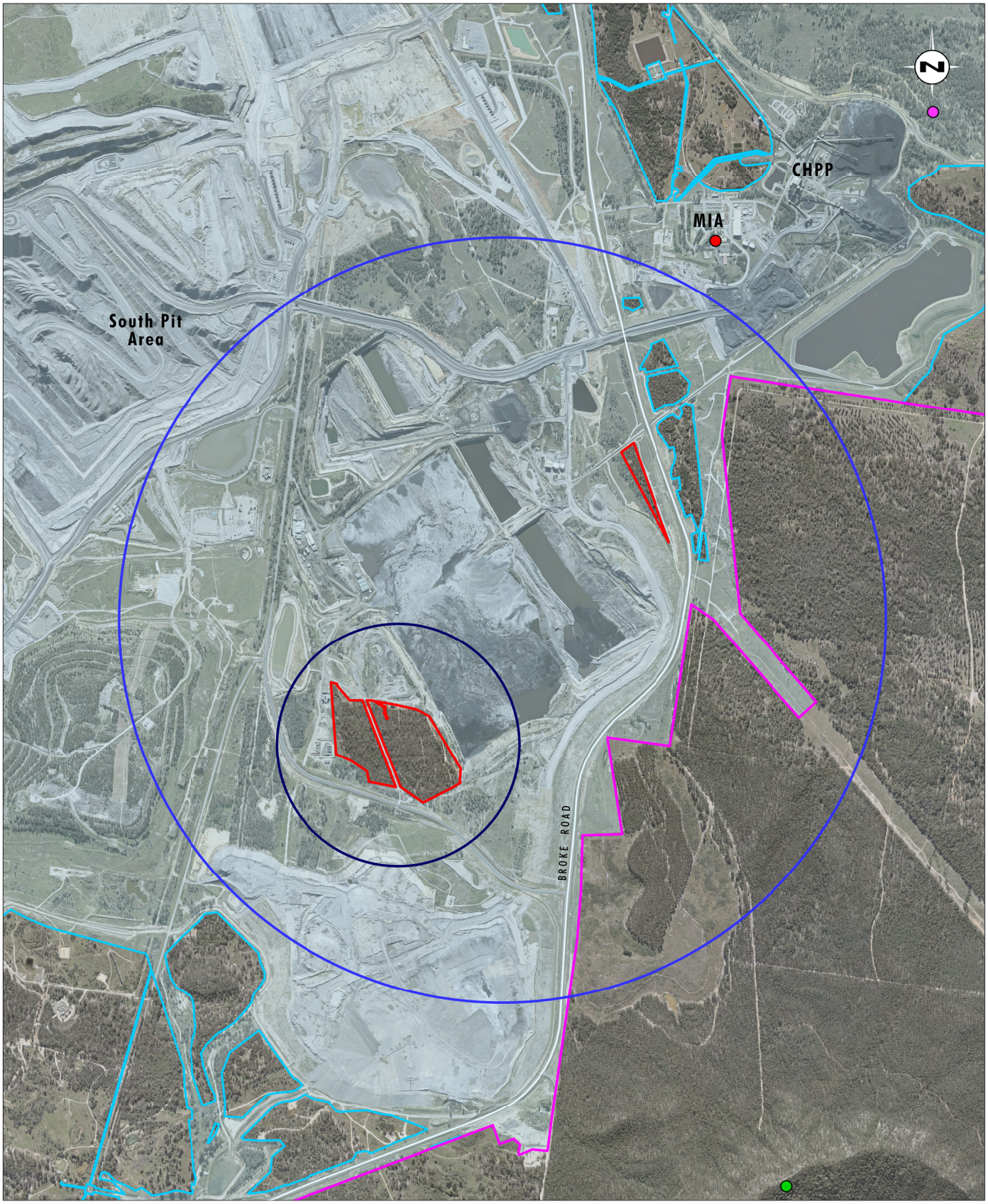

Image Source: Glencore (2012), Google Earth (2017), Bulga (2017)
Data Source: Bulga (2017), Umwelt (2013), Umwelt (2015), OEH (2018a)

0 0.5 1.0 1.25km
1:25 000

Legend

- Project Area
- Approved Disturbance Footprint
- Additional Disturbance Area (Development Footprint)
- 100ha Assessment Circle
- 1000ha Assessment Circle

Recorded from Previous Projects:
- *Eucalyptus glaucina*
- Regent Honeyeater

Atlas of NSW Wildlife Record:
- *Cynanchum elegans*

FIGURE 3.5

Species Credit Flora and Fauna Species Locations in the Locality

4 Avoidance and Minimisation of Impacts

4.1 Avoidance

4.1.1 Site Selection and Planning

Given the location of the Development Footprint within the overall Project Area and the relatively small size, it was not possible to avoid all biodiversity values without compromising the viability of the Proposed Modification. Given this, detailed minimisation/mitigation measures are proposed as detailed in **Section 4.2** below.

4.2 Construction and Operational Phase Minimisation/Mitigation Measures

Bulga Coal Management has committed to the implementation of a comprehensive biodiversity mitigation strategy to minimise the unavoidable impacts of the Proposed Modification. The following specific control measures, as detailed in the existing approved Bulga Coal Biodiversity Management Plan (Bulga Coal Management 2018 – prepared under SSD-4960 and DA 376-8-2003 and Commonwealth EPBC Act Approval EPBC 2012/6637), are considered to be integral to the mitigation of impacts on the biodiversity features of the Development Footprint (Bulga Coal Management, 2018). The proposed mitigation measures for the Proposed Modification, where relevant, consider the UHSA Guidelines for the Mitigation of Coal Mining Impacts on Biodiversity (OEH 2016c). The following specific control measures are proposed to mitigate the impacts on the biodiversity features of the Development Footprint and surrounds:

- landform and rehabilitation establishment as mining progresses
- salvage of biodiversity features (hollow-bearing trees)
- pre-clearance and tree-felling procedures
- weed management
- feral animal control
- access control
- bushfire management
- erosion and sedimentation control
- salinity management, and
- providing appropriate environmental management measures as part of the mining operations to minimise the potential for indirect impacts.

Each of these control measures will contribute to the maintenance of habitat quality adjacent to the Development Footprint outside existing approved disturbance.

Should the Proposed Modification be approved, Bulga Coal Management will review and revise the existing approved Bulga Coal Biodiversity Management Plan in accordance with any additional development consent requirements. The revised Biodiversity Management Plan will guide the implementation of the mitigation steps and will be reviewed and adapted in response to new information.

4.2.1 Landform Establishment and Rehabilitation

Changes to landform, geology and drainage regimes associated with mining have the potential to impact adjacent and nearby habitat areas. For example the creation of overburden emplacement areas typically results in changes in surface water and groundwater movement, availability and quality. The following mitigation controls will be undertaken to mitigate such potential impacts:

- appropriate drainage will be integrated in the design of rehabilitation areas to effectively manage drainage of the final landform without resulting in adverse impacts
- provision of micro-relief in the landform, and
- revegetation of native vegetation communities as soon as practical to prevent erosion. Identified areas of moderate to severe erosion will be remediated as soon as practicable.

4.2.2 Salvage of Biodiversity Features

Resources that will be salvaged (where practical) from clearing activities include topsoil, vegetation and hollow-bearing trees/logs and native seed. These resources will be re-used in rehabilitation areas to improve revegetation outcomes and to augment habitat features.

4.2.3 Pre-clearance and Tree-felling

Tree felling processes are implemented at Bulga Coal Complex to minimise the potential for impacts on native fauna species (including threatened species) as a result of the clearing of hollow-bearing trees (Bulga Coal Management, 2018). Pre-clearance surveys and tree-felling supervision will be implemented according to the Bulga Coal Biodiversity Management Plan and are generally consistent with the recommendations outlined in Section 5.10 of the Mitigation Guidelines (OEH 2016c).

4.2.3.1 Pre-clearance Surveys

Pre-clearance surveys are to be undertaken prior to tree felling works by a suitably qualified and experienced person according to the existing practices and objectives of the Bulga Coal Biodiversity Management Plan (Bulga Coal Management, 2018). The purpose of the pre-clearance survey is to:

- identify and mark habitat trees
- identify habitat resources for salvage (hollow-bearing logs etc.)
- identify presence of any threatened fauna
- identify potential seed collection resources
- identify any requirements for weed control to be undertaken prior to clearing
- recommend protocols to manage any known archaeological sites, and
- identify and mark out suitable areas for topsoil and vegetation stockpiles.

4.2.3.2 Tree-felling Procedure

A detailed tree-felling procedure is included in Appendix B of the Bulga Coal Biodiversity Management Plan for felling of habitat trees and non-habitat trees (Bulga Coal Management, 2018 – refer to the reference list in **Section 9** of this report for a hyperlink).

4.2.4 Weed Management

Weed species could be inadvertently brought into the Development Footprint with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species has the potential to be an impediment to revegetation and regeneration activities. In addition, the presence of weed species has the potential to decrease the value of vegetation for native species, particularly threatened species.

Existing weed management controls as specified in the Bulga Coal Biodiversity Management Plan will be applied to the Proposed Modification. Weed control will be undertaken in accordance with current mine practices and, for noxious weed species identified as requiring control.

Regular weed inspections will be undertaken across the Development Footprint and appropriate weed control methods will be implemented.

4.2.5 Feral Animal Control

Introduced fauna species such as foxes, rabbits, pigs, wild dogs and feral cats could change in distribution and abundance in the Development Footprint and adjoining areas as future areas are cleared, mined and then rehabilitated. Clearing, thinning of vegetation and the creation of tracks through existing dense vegetation could assist the penetration of introduced fauna species such as pigs, cats and foxes, and allow them to establish in new areas. An increase in feral species within the Development Footprint and adjoining areas has the potential to increase impacts on existing native species, particularly via predation and habitat destruction.

Feral animal control will be undertaken in accordance with current mine practices and as outlined in the Bulga Coal Biodiversity Management Plan. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

4.2.6 Access Control

Unauthorised access into buffer lands and remnant vegetation has the potential to impact on the biodiversity values of these areas through:

- unauthorised clearing
- illegal waste dumping
- weed invasion
- erosion and sedimentation, and
- native fauna injury.

Areas of remnant vegetation surrounding the mining operations are fenced and all external gates are locked to prevent unauthorised access. Regular inspections are undertaken of fence lines and gates to identify any unauthorised access and repairs are undertaken as needed.

4.2.7 Bushfire Management

The vegetation that will be retained within areas adjoining of the Development Footprint in the Bulga Coal Complex will require appropriate bushfire management to protect life and property, while supporting appropriate conditions for the significant ecological features identified. Bulga Coal Management has developed a Bushfire Management Plan in consultation with the NSW Rural Fire Service (RFS).

Bushfire management controls undertaken on an annual basis include slashing of boundary fences to provide fire-breaks and access points, maintenance of fire trails and fuel load assessments.

If controlled burning is requested/initiated by the RFS on surrounding land, Bulga Coal Management will assist where possible in maintaining similar fire regimes within the Bulga Coal Complex. However, any controlled burning will take into account the following factors:

- exclusion of bushfire from rehabilitation, revegetation and regeneration areas to allow replanted and regenerating communities to mature to a stage where they are able to withstand bushfire and regenerate naturally following such an event
- consideration of known records of threatened species, endangered populations and TECs, and
- asset and livestock protection.

4.2.8 Erosion and Sediment Control

Erosion and sediment control is critical to the long term stability of the land surface and downstream water quality. Bulga Coal Management has developed a Bulga Coal Complex Erosion and Sediment Control Plan to protect soil resources and maintain local water course quality. The Bulga Coal Complex Erosion and Sediment Control Plan outlines the requirements for erosion and sediment control across the Bulga Coal Complex.

Measures outlined in the Bulga Coal Complex Erosion and Sediment Control Plan include:

- completion of a Ground Disturbance Permit prior to any land disturbance
- temporary erosion and sediment controls to be in place prior to any construction activity outside of an existing dirty water management system
- use of diversion structures to separate ‘clean’ water runoff from disturbed areas runoff, to minimise volumes of sediment-laden and mine water for management
- using designated sediment control devices to control sediment-laden runoff
- revegetation of disturbed areas as soon as possible following the completion of construction activities, and
- timely rehabilitation of subsided ground as required.

4.2.9 Salinity Management

The Bulga Coal Complex has established segregated sediment and mine water systems to prevent environmental harm from sediment laden or saline water runoff. All areas that are exposed to runoff from coaly or other saline material are managed as part of the mine water system.

4.2.10 Environmental Management Measures

Appropriate environmental management measures will be used as part of the mining operations to minimise the potential for indirect impacts through currently approved management plans, including:

- water management systems that seek to minimise the potential for damage to flora and fauna and their habitats from erosion and unnatural flooding events
- noise control systems to minimise noise impacts
- dust control measures to minimise dust impacts
- lighting controls to minimise night light impacts, and
- blasting controls to minimise blast overpressure and vibration impacts.

4.3 Direct Impacts Unable to be Avoided

The development of the Proposed Modification will result in direct impacts on biodiversity values within the Development Footprint. Direct impacts include the loss of native vegetation and fauna habitats as a result of clearance works and subsequent mining activity.

Table 4.1 below outlines these impacts as they were entered into the BBCC, which totals 19.2 hectares of direct impacts to native vegetation communities.

Avoidance and mitigation measures associated with minimising the impacts of these direct impacts are discussed in **Section 4.2** above.

Table 4.1 Direct Impacts of the Proposed Modification on Native Biodiversity Features

Ecological Feature	Area within the Development Footprint (ha)
Biometric Vegetation Type	
Zone 1 – HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	2.1
Zone 2 – HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	0.7

Ecological Feature	Area within the Development Footprint (ha)
Zone 3 – HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter[#] *Moderate to Good*	16.4
Total	**19.2***

[#] Conforms to *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* EEC (BC Act) and *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

*Total area of native vegetation excluding 1.0 hectare of disturbed land.

4.4 Assessment of Indirect Impacts on Biodiversity

The Proposed Modification is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands greater than that of currently approved operations. Some minor indirect impacts associated with habitat connectivity, fugitive light emissions, dust, noise, surface water flow changes, groundwater changes, weeds and feral animals may occur during the current operations and the Proposed Modification of the approved operations. This is further discussed in the sections below in accordance with Section 8.4 of the FBA (OEH 2014b).

4.4.1 Indirect Impacts on Connectivity and Corridors

To an extent, the potential loss of local and regional connectivity is already factored into the credit calculation in that the Assessment Circle and associated Landscape Value Scores take into account the pre- and post-clearing percentage of native vegetation cover (excluding the proposed post-mine rehabilitation). It is unlikely that any further indirect impact through reduced connectivity and loss of corridors would be of any significant level. Additionally, future mine rehabilitation of the Development Footprint (and approved disturbance area) will re-instate connectivity at a local and regional scale in the long-term.

The removal of native vegetation from within the Development Footprint could affect the ability of some local fauna species to move throughout the landscape by removing patches of native vegetation that provide a fragmented 'stepping-stone' corridor in the highly disturbed landscape. Isolated or fragmented areas of suitable habitat for species provide short to medium term refuges (or 'stepping stones' for species as they move from one area of habitat to another, travelling across unsuitable habitat areas between the 'stepping stones') for species as they disperse, migrate or move throughout the landscape. The loss of 'stepping stone' habitat areas for some species could result in an increased level of isolation of populations where species are unable or unwilling to travel across the increased distance between habitat areas.

A potential corridor of fauna movement (comprising fragmented remnant woodland and rehabilitation patches) exists between the southern portion of the Development Footprint linking woodland and forest habitats to the south with those in the east. Removal of the vegetation in the Development Footprint may reduce the dispersal, migration and movement ability of some fauna species within the local area.

4.4.2 Fugitive Light Emissions

Fugitive light emissions resulting from the Proposed Modification may result in adverse impacts on adjacent habitats and fauna species such as nocturnal fauna species, particularly birds and bats. Potential impacts may include:

- a reduction in the navigational signal ability for some nocturnal animals
- delaying bats from emerging from roost access points and shortening the amount of time available to them for foraging.

Current lighting controls are implemented to minimise impacts and will be implemented as part of the Proposed Modification as necessary (providing that these actions do not compromise site safety issues). There will be no measurable incremental change to fugitive light emissions on adjoining habitat areas given that the Development Footprint is located within an existing mining operation with existing impacts.

Any additional impacts resulting from fugitive light emissions are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.3 Noise Impacts

Noise impacts have the potential to adversely impact native species. Potential impacts include:

- noise disturbing the roosting and foraging behaviour of fauna species
- noise reducing the occupancy of areas of otherwise suitable habitat.

The Proposed Modification will be operated in accordance with the approved Noise Management Plan for Bulga Coal Complex. Details of the noise controls that will be implemented as part of the Proposed Modification are outlined in the SEE.

In regard to potential impacts on biodiversity, there will be no measurable incremental change to noise impacts on adjoining habitat areas given that the Development Footprint is located within, an already existing mining operation with existing impacts.

Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.4 Dust Impacts

Dust impacts have the potential to adversely impact native species during ground disturbing works, including blasting. Potential impacts include dust covering vegetation thereby potentially reducing vegetation health and growth.

The design and operation of the Proposed Modification will be undertaken in accordance with the existing approved Dust Management Plan impact mitigation measures to minimise the potential for adverse dust impacts. These include:

- progressive rehabilitation and stabilisation of disturbed land
- dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions
- a range of other dust control measures as discussed in the main text of the SEE.

In regard to potential impacts on biodiversity, there will be no measurable incremental change to dust impacts on adjoining habitat areas given that the Development Footprint is within an already existing mining operation with existing impacts.

Any additional impacts resulting from dust are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.5 Weed and Feral Animal Encroachment

Weed species could be inadvertently brought into the Development Footprint with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species within the Development Footprint has the potential to decrease the value of extant vegetation to native species, particularly threatened species. Mitigation measures outlined in **Section 4.2.4** will be implemented to minimise the potential for weed dispersal.

Populations of feral fauna species such as foxes, rabbits, pigs, deer, dogs and cats can increase and quickly populate new areas as a result of disturbance. Clearing, thinning of vegetation and the creation of tracks have the ability to assist the establishment and spread of feral fauna species. Mitigation measures outlined in **Section 4.2** will minimise the potential for feral animal spread and impacts into surrounding areas around the Development Footprint.

There will be no substantial change to impacts on adjoining vegetation areas from weeds or feral animals, given that the Development Footprint is within an existing mining operation with existing impacts.

Any additional impacts resulting from weeds or feral animals are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.6 Cumulative habitat loss and vegetation clearance impacts on agricultural and mining areas of the Hunter Valley

The Development Footprint is situated in a landscape that is characterised by mining land and grazing land. The history of land clearing, agriculture and mining development has resulted in an incremental loss of vegetation and fauna habitat surrounding the Development Footprint, and within the central Hunter Valley more generally. The Proposed Modification will result in a relatively small loss of approximately 19.2 hectares of native woodland and forest vegetation.

It is recognised that the Proposed Modification will remove vegetation and further increase fragmentation and isolation of habitats, and thus contribute to cumulative habitat loss and vegetation clearance in the locality. To address these impacts, a mitigation and offsetting strategy is proposed including the provision of:

- the delineation of clearance areas to avoid unnecessary impacts and clearance of surrounding vegetation
- habitat enhancement measures such as the installation of nest boxes, salvaged hollows, fallen timber, hollow logs and rocks to supplement mine rehabilitation areas
- progressive rehabilitation of the mining area, including the Development Footprint, and
- the implementation of a biodiversity offset strategy in accordance with the FBA.

5 Impact Summary

5.1 Impacts Not Requiring Further Assessment

Impacts not requiring further assessment under the FBA include areas of land without native vegetation. The Development Footprint contains approximately 1 hectare of cleared land/non-native vegetation that will be removed as a result of the Proposed Modification. This impact does not require further assessment under the FBA.

5.2 Impacts Not Requiring Offset

Impacts on native vegetation not requiring offsets under the FBA include native vegetation that has a site value score of less than 17 and are not identified as an endangered or critically endangered ecological community, and/or associated with threatened species habitat (as represented by ecosystem credits).

All areas of native vegetation within the Development Footprint have a site value score greater than 17 and require offsetting under the FBA.

5.3 PCTs and Threatened Species Requiring Offset

A range of PCTs and ecosystem-credit species were found to require offsetting for the Proposed Modification as discussed in the sections below. As previously discussed, no species credit species were recorded as part of targeting surveys or are expected to occur based on habitats present. As a result no species credits are required for the Proposed Modification.

5.3.1 Ecosystem Credits

Table 5.1 outlines the ecosystem-credit species requiring offset as a result of the Proposed Modification through the use of ecosystem credits linked to vegetation zones. The highest threatened species offset multiplier determines the credit requirements for the vegetation zones these species are predicted to occur in.

Table 5.1 Ecosystem-credit species requiring offset as a result of the Proposed Modification

Common Name	Species Name	Threatened Species Offset Multiplier
barking owl	*Ninox connivens*	3.0
black-chinned honeyeater (eastern subspecies)	*Melithreptus gularis* subsp. *gularis*	1.3
brown treecreeper (eastern subspecies)	*Climacteris picumnus* subsp. *victoriae*	2.0
bush stone-curlew	*Burhinus grallarius*	2.6
eastern false pipistrelle	*Falsistrellus tasmaniensis*	2.2
eastern freetail-bat	*Mormopterus norfolkensis*	2.2

Common Name	Species Name	Threatened Species Offset Multiplier
gang-gang cockatoo	*Callocephalon fimbriatum*	2.0
glossy black-cockatoo	*Calyptorhynchus lathami*	1.8
greater broad-nosed bat	*Scoteanax rueppellii*	2.2
grey-crowned babbler (eastern subspecies)	*Pomatostomus temporalis* subsp. *temporalis*	1.3
hooded robin (south-eastern form)	*Melanodryas cucullata* subsp. *cucullata*	1.7
little eagle	*Hieraaetus morphnoides*	1.4
little lorikeet	*Glossopsitta pusilla*	1.8
painted honeyeater	*Grantiella picta*	1.3
speckled warbler	*Chthonicola sagittata*	2.6
square-tailed kite	*Lophoictinia isura*	1.4
swift parrot	*Lathamus discolour*	1.3
turquoise parrot	*Neophema pulchella*	1.8
varied sittella	*Daphoenositta chrysoptera*	1.3
yellow-bellied sheathtail-bat	*Saccolaimus flaviventris*	2.2

Table 5.2 outlines the PCTs to be impacted as a result of the Proposed Modification and the ecosystem credits required to offset those impacts. The full Credit Calculator report is included in **Appendix C**.

Table 5.2 Plant Community Types Requiring Offset and the Total Ecosystem Credits Required

Vegetation Zone	Plant Community Type	Total Area to be Impacted (ha)	Highest Threatened Species or EEC Offset Multiplier	Total Ecosystem Credits Required
1	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	2.1	1.4	55
2	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	0.7	1.0	8
3	HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	16.4	3.0	868
TOTAL		**19.2**	-	**931**

5.3.2 Species Credits

No species credits are required for the Proposed Modification.

5.4 Impacts on Biodiversity that Require Further Consideration

Under the FBA, certain impacts on biodiversity values may require further consideration by the consent authority. These are impacts that are considered to be complicated or severe and include:

- impacts on landscape features, being:
    - impacts that will reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas (in accordance with Section 9.2.3 of the FBA), or
    - impacts that will prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state (in accordance with Section 9.2.3 of the FBA), and
- impacts on native vegetation that are likely to cause the extinction of an EEC/CEEC from an IBRA subregion or significantly reduce its viability (in accordance with Section 9.2.4 of the FBA), and
- impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability (in accordance with Section 9.2.5 of the FBA).

In accordance with Sections 9.2.3, 9.2.4 and 9.2.5 of the FBA (OEH 2014b), impacts on the following biodiversity values require further consideration in the BAR. This information is provided in **Sections 5.4.1, 5.4.2** and **5.4.3** below.

- Central Hunter Valley Eucalypt Forest and Woodland CEEC under the EPBC Act
- Swift parrot (*Lathamus discolor*)
- Regent honeyeater (*Anthochaera phrygia*).

5.4.1 Impacts on Native Vegetation that Require Further Consideration

As per Section 9.2.4.1 of the FBA (OEH 2014b), impacts on native vegetation that require further consideration include impacts on:

(a) any CEEC, unless the CEEC is specifically excluded by the SEARs

(b) an EEC specifically nominated in the SEARS as an EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion.

Table 5.3 below provides further consideration of the impacts of the Proposed Modification on the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act in accordance with Section 9.2.4.2 of the FBA (OEH 2014b).

Table 5.3 Impacts on Native Vegetation that Require Further Consideration

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
(a) the area and condition of the CEEC or EEC to be impacted directly and indirectly by the proposed development	16.4 hectares of the CEEC will be directly impacted by the Proposed Modification in the Development Footprint. This CEEC occurs throughout the Development Footprint represented by HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter. This CEEC occurs in moderate condition across the Development Footprint in the form of relatively young woodland. The CEEC generally contains a predominately native groundcover with low occurrences of weed species.
(b) the extent and overall condition of the CEEC or EEC within an area of 1000 ha and then 10,000 ha surrounding the proposed development footprint	Based on the regional mapping outlined in the Hunter Valley Remnant Vegetation Project (Peake 2006), the likely area of the CEEC surrounding the Development Footprint, comprises approximately: • 184 hectares (18%) in 1000 ha buffer area, and • 2,148 hectares (22%) in the 10,000 ha buffer area. It is noted that this regional mapping is over 10 years old and vegetation clearance and substantial regeneration has occurred following this. In addition to this, the escarpment to the south-east of the Development Footprint comprises soils derived from Triassic sandstone and would not conform to the CEEC. The remnant patches of this CEEC are generally fragmented occurrences in a largely agricultural and mining landscape.
(c) an estimate of the extant area and overall condition of the CEEC or EEC remaining in the IBRA subregion after the impact of the proposed development has been taken into consideration	The CEEC is known to occur primarily in the Hunter IBRA subregion. The EPBC Act Conservation Advice (TSSC 2015a) predicts that the current extent of the community (as at 2006) is approximately 37,000 hectares. It is noted however, that extensive clearing but also regeneration has occurred in the Hunter since 2006. The 16.4 hectares of disturbance of the CEEC in the Development Footprint represents approximately 0.04 per cent of the remaining extent of the CEEC.
(d) the development proposal's impact on: **i. abiotic factors critical to the long-term survival of the CEEC or EEC. For example, will the impact lead to a reduction of groundwater levels or substantial alteration of surface water patterns?**	No abiotic factors critical to the survival of the community are listed in the EPBC Act Conservation Advice (TSSC 2015a). The CEEC typically occurs on soils derived from the Permian sedimentary bedrock found on the Hunter Valley floor. The CEEC is not a Groundwater Dependent Ecosystem (GDE). The Proposed Modification would be unlikely to adversely modify or destroy abiotic factors necessary for the long-term survival of this CEEC in the locality.

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
ii. characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants	The Proposed Modification will result in the removal of areas of CEEC within the Development Footprint as described in the sections above. Where this disturbance will occur, the Proposed Modification will remove characteristic and functionally important species to the CEEC. These include, but are not limited to, narrow-leaved ironbark (*Eucalyptus crebra*), grey box (*Eucalyptus moluccana*) and a range of important native groundcover species as per the characteristic species in the EPBC Act Conservation Advice (TSSC 2015a). The Proposed Modification would be unlikely to impact these characteristic and functionally important species for this CEEC outside the Development Footprint in the wider locality.
iii. the quality and integrity of an occurrence of the CEEC or EEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the CEEC or EEC.	Vegetation clearing and landscape fragmentation in association with mining is a key threat for the CEEC. Once the topsoil is stripped these areas cannot easily be recovered to a pre-mining state (TSSC 2015a). Mining activities also have the potential to introduce new weeds and facilitate the spread of existing ones. Land clearing activities have resulted in the proliferation of exotic species; notably galenia (*Galenia pubescens*), Rhodes grass (*Chloris gayana*), African lovegrass (*Eragrostis curvula*) and bridal creeper (*Asparagus asparagoides*) (TSSC 2015a). As outlined in **Section 4.2**, management measures will be put in place as part of the Proposed Modification to minimise weeds. The Proposed Modification is not expected to cause regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the surrounding extent of this CEEC.
(e) direct or indirect fragmentation and isolation of an important area of the CEEC or EEC.	An important area (as defined by the FBA (OEH 2014b)) comprises an area of a CEEC or EEC that is necessary for the entity's long-term persistence and recovery. This may include areas identified in recovery plans, and/or an area large in comparison to other stands of the CEEC or EEC or occurrences of the CEEC or EEC at the limit of the community's range. Areas critical to the survival of the community, as identified in the EPBC Act Conservation Advice (TSSC 2015a), include areas that meet the minimum condition thresholds (i.e. all areas that conform to the CEEC). While the occurrence of the CEEC within the Development Footprint is unlikely to be necessary for the CEEC's long-term persistence and recovery, this area would be considered critical to the survival of the community as per the EPBC Act Conservation Advice (TSSC 2015a). While the Proposed Modification will result in an increase in the level of fragmentation of this CEEC at the local scale, the level of increase is considered negligible given the already highly fragmented nature of this CEEC across the Hunter region.

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
(f) the measures proposed to contribute to the recovery of the CEEC or EEC in the IBRA subregion.	As part of the Proposed Modification, a Biodiversity Offset Strategy will be prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). This will require the identification of suitable land-based or non-land based offsets as outlined in this Policy. In the case of land-based offsets, these may be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank site, as per BBAM (2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the Proposed Modification is discussed in **Section 7.0**. This includes in-perpetuity conservation through the establishment of a proponent-managed offset site.

5.4.2 Impacts on Threatened Species that Require Further Consideration

As per Section 9.2.5.1 of the FBA (OEH 2014b), impacts on threatened species that require further consideration include impacts on:

(a) any critically endangered species, unless the critically endangered species is specifically excluded in the SEARs

(b) a threatened species or population that is specifically nominated in the SEARS as a species or population that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development, or

(c) where the survey or expert report undertaken in Section 6.6 confirms that a threatened species is present on the proposed development site, and the threatened species has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.

Table 5.4 below provide further information for the regent honeyeater and swift parrot, which is listed as critically endangered under the EPBC Act, in accordance with Section 9.2.5.2 of the FBA (OEH 2014b).

Table 5.4 Impacts on Threatened Species that Require Further Consideration

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*
(a) the size of the local population directly and indirectly impacted by the development	This species has not been recorded within the Development Footprint or the locality despite targeted winter bird surveys undertaken in August 2017 as well as monitoring surveys undertaken annually in the Bulga Coal Complex. This species has been recorded in 2012 in the wider locality (in planted eucalypts in the Bulga Coal Complex site office carpark) during the surveys for the Bulga Optimisation Project (Umwelt 2013). Other records of this species occur in the Singleton Military Area and Pokolbin State Forest, which contains key foraging habitat. The Proposed Modification will remove approximately 16.4 hectares of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young key tree species (spotted gum – *Corymbia maculata*) listed for the swift parrot as per the National Recovery Plan for the species (Saunders and Tzaros 2011). Overall the vegetation within the Development Footprint is highly fragmented and dominated by the non-key tree species for the swift parrot comprising narrow-leaved ironbark (*Eucalyptus crebra*), grey box (*Eucalyptus moluccana*), bulloak (*Allocasuarina luehmannii*) and *Melaleuca decora*. It is expected that the total population size for the swift parrot is less than 2,000 individuals (Saunders and Tzaros 2011).). The closest records of the species occur approximately 1km from the Development Footprint recorded in 2012 (Umwelt 2013). No known populations of the swift parrot occur within the Development Footprint and given the low abundance of young spotted gum (*Corymbia maculata*) key feed trees it is considered that the species is not likely to be impacted as a result of the Proposed Modification.	This species has not been recorded within the Development Footprint or the locality despite targeted winter bird surveys undertaken in August 2017 as well as monitoring surveys undertaken annually in the Bulga Coal Complex. This species has been recorded in 2011 in the wider locality (in planted eucalypts in the Bulga Coal Complex site office carpark) during the surveys for the Bulga Optimisation project (Umwelt 2013). Other records of this species occur in the Singleton Military Area and Pokolbin State Forest, which contains key foraging habitat. The Proposed Modification will remove approximately 16.4 hectares of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young of key tree species listed for the regent honeyeater as per the National Recovery Plan for the species (DoE 2016a). Overall the vegetation within the Development Footprint is highly fragmented and dominated by the non-key tree species for the swift parrot comprising narrow-leaved ironbark (*Eucalyptus crebra*), grey box (*Eucalyptus moluccana*), bulloak (*Allocasuarina luehmannii*) and *Melaleuca decora*. As at 2010, the total population size is estimated at 350–400 mature individuals (DoE 2016). Previous records of the species in the locality include one record within 900 metres to the north of the Development Footprint in 2011. No known populations of the regent honeyeater occur within the Development Footprint and given the low abundance of young spotted gum (*Corymbia maculata*) key feed trees it is considered that the species is not likely to be impacted as a result of the Proposed Modification.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: **i. an estimate of the change in habitat available to the local population as a result of the proposed development**	The swift parrot breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March). Most of the population winters in Victoria and NSW. While in NSW, the species occurs in areas of box-gum woodlands and areas of suitable winter-flowering foraging habitat. The Development Footprint contains low quality foraging habitat for the species, with the low abundance of key feed trees. The Proposed Modification will remove approximately 16.4 hectares of vegetation that contains very low abundance of young spotted gum (*Corymbia maculata*) key tree species listed for the swift parrot as per the National Recovery Plan for the species (Saunders and Tzaros 2011) which is considered to be negligible to the Hunter Valley populations. No known populations of the swift parrot are known to occur within the Development Footprint and no change in known habitat will occur as a result of the Proposed Modification.	The Regent honeyeater primarily breeds in four known key breeding areas where the species is regularly recorded. The species is known to disperse to foraging habitats in the non-breeding season. The species occurs in areas of box-gum woodlands and areas of suitable foraging habitat. One key feed species (spotted gum (*Corymbia maculata*)) (DoE 2016) has been recorded in the Development Footprint in very low densities. The Proposed Modification will remove approximately 16.4 hectares of low quality habitat which is considered to be negligible to the Hunter Valley populations. No known populations of the regent honeyeater are known to occur within the Development Footprint and no change in known habitat will occur as a result of the Proposed Modification.
ii. the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and	The Proposed Modification will remove native vegetation communities within the Development Footprint including fragmented young eucalypt woodland. None of the habitats in the Development Footprint have been recorded as being used by the swift parrot. No known habitat for the swift parrot occurs within the Development Footprint, however the Proposed Modification will result in the loss, of potential low quality habitat for the species.	The Proposed Modification will remove native vegetation communities within the Development Footprint including fragmented young eucalypt woodland. None of the habitats in the Development Footprint have been recorded as being used by the regent honeyeater. No known habitat for the regent honeyeater occurs within the Development Footprint, however the Proposed Modification will result in the loss of potential low quality habitat for the species.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*
iii. modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	The swift parrot breeds exclusively in Tasmania and migrates to mainland Australia during the non-breeding season. There is no potential for breeding habitat to occur in the Development Footprint. No breeding or nesting habitat for swift parrot occurs within the Development Footprint and the Proposed Modification will not result in the modification of habitat important to the species' life cycle.	The regent honeyeater mainly breeds in four key sites, being the Bundarra-Barraba, Capertee Valley and Hunter Valley districts in NSW, and the Chiltern area in north-east Victoria (DoE 2016). Locally, the species has been recorded breeding in forest habitats around Kurri Kurri, NSW. No breeding or nesting habitat for regent honeyeater has been recorded within or in the vicinity of the Development Footprint and the Proposed Modification will not result in the modification of habitat important to the species' life cycle.
(c) the likely impact on the ecology of the local population. At a minimum, address the following: - **breeding** - **foraging** - **roosting, and** - **dispersal or movement pathways**	No breeding or nesting habitat for the swift parrot occurs within the Development Footprint. Roosting habitat may be available in the eucalypt woodlands within the Development Footprint and native woodland vegetation containing very low densities of key feed trees may provide some winter foraging habitat for the species, although this has not been recorded. The Proposed Modification is unlikely to affect dispersal or movement pathways for this highly mobile species. The Proposed Modification is unlikely to affect the ecology and biology of any population of the swift parrot in the locality.	No breeding or nesting habitat for the regent honeyeater has been recorded within the Development Footprint. Roosting habitat may be available in the eucalypt woodlands within the Development Footprint and native woodland vegetation containing very low densities of key feed trees may provide some foraging habitat for the species, although this has not been recorded. The Proposed Modification is unlikely to affect dispersal or movement pathways for this highly mobile species. The Proposed Modification is unlikely to affect the ecology and biology of any population of the regent honeyeater in the locality.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*
(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	The swift parrot has not been recorded within the Development Footprint. This species is highly dispersive and it is unlikely that the Proposed Modification will create a significant change to the species dispersal capacity or create a significant barrier to the movement of the species in the already highly fragmented local landscape.	The regent honeyeater has not been recorded within the Development Footprint. This species is highly dispersive and it is unlikely that the Proposed Modification will create a significant change to the species dispersal capacity or create a significant barrier to the movement of the species in the already highly fragmented local landscape.
(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	The swift parrot occurs as a single population in Australia. The species is known to occur regularly in the winter months in the Hunter Valley in the habitats of the Singleton Military Base, several kilometres to the east of the Development Footprint. The Development Footprint is not at the limit of extent of the species known range. It is unlikely that the Proposed Modification will impede the ability of the swift parrot population to interact for dispersal and genetic viability or diversity.	Despite minor differences between regent honeyeaters in the areas inhabited by the species and the direction and extent of movements, the lack of discernible genetic differences suggest that the regent honeyeater occurs as a single, contiguous population. Seasonal movements outside breeding season in autumn and winter appear to be related to foraging resource availability (DoE 2016). The Development Footprint is not at the limit of extent of the species known range. It is unlikely that the Proposed Modification will impede the ability of the regent honeyeater population to interact for dispersal and genetic viability or diversity.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Key threats for the swift parrot include habitat loss and alteration, climate change, collision mortality and psittacine beak and feather disease (PBFD). The Proposed Modification will exacerbate habitat loss and alteration for the species in potential winter foraging habitat in the Hunter Valley. The species has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency of key feed trees in this area. The Proposed Modification will not result in an increase of threats related to collision mortality or PBFD.	Key threats for the regent honeyeater include habitat loss and fragmentation, habitat degradation and the species' small population size. The Proposed Modification will exacerbate habitat loss and fragmentation for the species in potential foraging habitat in the Hunter Valley. The species has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency of key feed trees and the small number of individuals remaining in the population utilising other higher quality habitats in NSW.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	As part of the Proposed Modification, a Biodiversity Offset Strategy has been prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a).. As the swift parrot is an ecosystem-credit species, the offsets will be matched as per the offsetting rules for like-for-like PCTs that will contain suitable habitat for the species. Land-based offsets will be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank/Stewardship site, as per BBAM (OEH 2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the proposal is discussed in **Section 7.0**.	As part of the Proposed Modification, a Biodiversity Offset Strategy has been prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). While no species credits for the regent honeyeater are generated for this Proposed Modification, the offsets will be matched as per the offsetting rules for like-for-like PCTs that will contain suitable habitat for the species. Land-based offsets will be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank/Stewardship site, as per BBAM (OEH 2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the Proposed Modification is discussed in **Section 7.0**

5.5 Seven Part Tests of Significance

Threatened species impact assessment is an integral part of environmental impact assessment. The objective of Section 5A of the EP&A Act, the *assessment of significance*, is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

Although it is understood that the preparation of a BioBanking Assessment under the FBA was intended to supersede the requirement to prepare Seven Part Tests, the Department of Planning and Environment (DPE) has advised that the requirements of Section 5A of the EP&A Act are to be considered in the BAR. The preparation of a BAR under the FBA addresses the components of the Seven Part Tests by use of the BBCC. A summary of the requirements of the Seven Part Tests of Significance and where they are addressed in the FBA Assessment is outlined in **Table 5.5** below.

Table 5.5 Seven Part Tests of Significance and the FBA

Seven Part Test of Significance	Where Addressed in the FBA Process
a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;	Threatened species (ecosystem-credit and species-credit) are predicted in the BBCC by the landscape features of the Development Footprint (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b) identify impacts on critically endangered threatened species, impacts that may cause the extinction of a species in a IBRA subregion and impacts that significantly reduce the viability of a species.
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction	Endangered populations are predicted in the BBCC by the landscape features of the Development Footprint (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b)) identify impacts that may cause the extinction of an endangered population in an IBRA subregion and impacts that significantly reduce the viability of a population.
c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed; **i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; and** **ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;**	Endangered ecological communities are predicted in the BBCC by the plant community types and biometric community types identified from the field surveys and entered into the BBCC. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b) are identified as impacts on any critically endangered or endangered ecological community that may cause the extinction of the EEC/CEEC in a IBRA subregion or significantly reduce the viability of an EEC/CEEC.

Seven Part Test of Significance	Where Addressed in the FBA Process
d) in relation to the habitat of a threatened species, population or ecological community; **i. the extent to which habitat is likely to be removed or modified as a result of the action proposed;** **ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and** **iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;**	Habitat loss is assessed in the BBCC via the 'Site Values' tab and the loss in site value score entered for each vegetation zone. Fragmentation of habitat is addressed as part of the 'Landscape Value' score including consideration of features before and after the development including per cent native vegetation cover, connectivity value and vegetation condition. The per cent cleared scores for the dominant Mitchell Landscape is also calculated in the 'Landscape Value' score. Important habitat features are identified through determining geographic and habitat features relevant for particular species-credit species and the assessment of landscape features (such as riparian buffers, important wetlands and state or regionally significant biodiversity links). The extent of habitat loss is ultimately determined by the measure of ecosystem credits and species credits calculated in the BBCC.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);	Critical habitat is addressed under impacts that require further consideration by the consent authority (refer to Section 9.2 of the FBA (OEH 2014b)).
f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and	Recovery plans are not directly addressed in the FBA. It is likely that the Proposed Modification would be inconsistent with any recovery plans prepared for the threatened species impacted by the modification as it relates to impacts on habitat for the species. However the Proposed Modification will not impede the implementation of these recovery plans. If supplementary offsetting measures are used (as per Appendix B of the NSW Biodiversity Offset Policy for Major Projects) to offset species or communities impacted by projects, reference can be made to the key objectives and actions in the relevant recovery plans.

Seven Part Test of Significance	Where Addressed in the FBA Process
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	Key threatening processes are not directly assessed under the FBA. In this case, the Proposed Modification is likely to contribute to the following key threatening processes through the clearing of vegetation: • Clearing of native vegetation (TSC Act and EPBC Acts) • Loss of hollow-bearing trees (TSC Act) • Removal of dead wood and dead trees (TSC Act). The Proposed Modification may to contribute to the following key threatening processes through clearing of vegetation, edge effects and the operation of the modification: • Aggressive exclusion of birds by noisy miners (*Manorina melanocephala*) (TSC and EPBC Acts) • Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) (TSC and EPBC Acts) • Predation by the European red fox (*Vulpes vulpes*) (TSC and EPBC Acts) • Invasion of native plant communities by exotic perennial grasses (TSC Act). While the Proposed Modification is considered likely to contribute to the function of the above key threatening processes, the Proposed Modification as a whole, or any component of the Proposed Modification would not be classified as a key threatening process.

5.6 Environmental Values not Assessed under the FBA

As per Section 2.3 of the FBA (OEH 2014b), biodiversity values not considered under the FBA include marine mammals, wandering sea birds and biodiversity that are endemic to Lord Howe Island. None of these biodiversity values occur or have the potential to occur within the Development Footprint and as such have not been specifically assessed as part of this assessment.

In addition, the FBA does not assess the direct impacts of the Proposed Modification that are not associated with clearing of vegetation. Examples of these impacts include, but are not limited to:

- bird and bat strike associated with wind farm developments
- vehicle strike
- subsidence and cliff falls associated with mining developments
- downstream impacts on hydrology and environmental flows on surface vegetation and groundwater dependent ecosystems, and
- impacts on karst ecosystems.

The Proposed Modification will not involve impacts related to wind farms, substantial changes to vehicle strike risk, or on karst ecosystems. The Proposed Modification will not lead to subsidence associated impacts as it is an open cut mine. Cliff falls are a risk associated with the highwall within the mining activity, however, no natural cliff areas will be impacted by the Proposed Modification.

The potential impacts on groundwater dependent ecosystems and downstream impacts on hydrology and environmental flows on vegetation are outlined in the main text of the SEE (Umwelt 2018). It was concluded that the Proposed Modification would not result in significant downstream impacts on surface vegetation. The SEE also contained a detailed assessment of impacts on GDEs, with drawdowns determined to be within levels previously assessed as not being significant as part of the Bulga Optimisation Project (Umwelt 2019).

6 Biodiversity Credit Report

A full Biodiversity Credit Report is included in **Appendix C**. A summary of the key outcomes in provided in the following sections.

6.1 Credits Required to Offset the Proposed Modification

Table 6.1 below provides a summary of the ecosystem credits that require offsetting as a result of the Proposed Modification.

Table 6.1 Credits Required to Offset the Proposed Modification

Name	Credits Required
Ecosystem Credits	
Zone 1 HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	55
Zone 2 HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Low*	8
Zone 3 HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good*	868
Total	**931**

7 Biodiversity Offset Strategy

BCM is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Proposed Modification, in consideration of the FBA and the *NSW Biodiversity Offsets Policy for Major Projects* (Offsets Policy) (OEH, 2014).

The following offsetting options are available under the FBA:

- in-perpetuity conservation through the establishment of proponent-managed Stewardship site established in accordance with Part 5 of the *Biodiversity Conservation Act 2016*, achieved through the retirement of credits
- securing required credits through the open credit market and/or
- payments to the Biodiversity Conservation Fund (established under the *Biodiversity Conservation Act 2016*).

The final biodiversity offset strategy to be delivered for the Proposed Modification will meet the offset requirements identified in **Section 6.0**.

BCM has undertaken surveys of one Glencore owned land parcel proximate to the Proposed Modification (hereafter referred to as the proposed Vere Offset Site) which contains the required biodiversity credits for the Proposed Modification. Details of the proposed Vere Offset Site, the biodiversity values and credits generated are provided in **Section 7.1** below. The location of the proposed Vere Offset Site is shown on **Figure 7.1**. As part of the development of the biodiversity offset strategy BCM also considered nearby properties for sale, checked the BioBanking public register for credits available and lodged an expression of interest on 7 November 2018. As part of this process no suitable properties or biodiversity credits were identified.

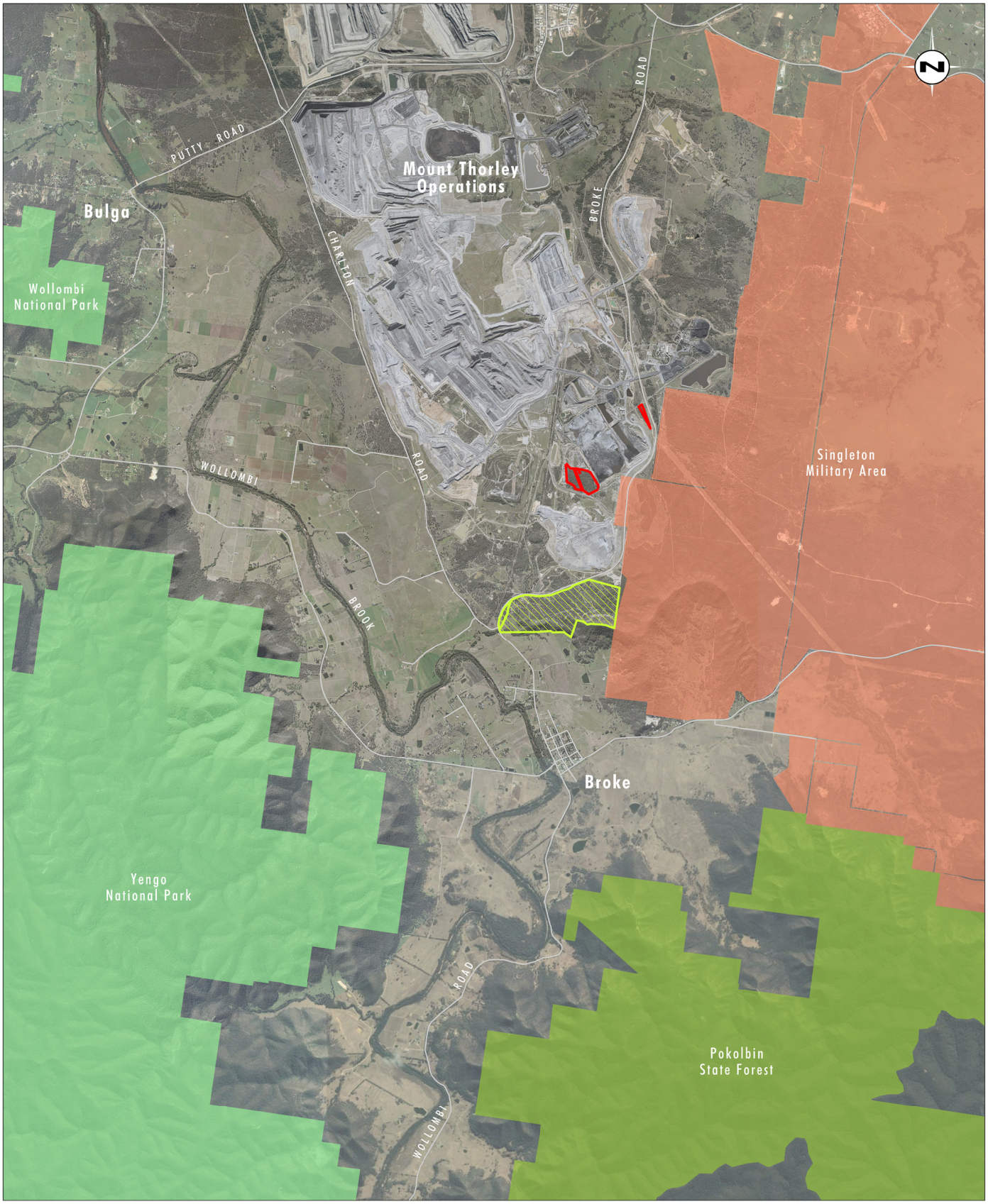

Image Source: Bulga (2017), Google Earth (2018)
Data Source: Bulga (2019)

0 1.0 2.5 5.0km
1:100 000

Legend

- Additional Disturbance Area (Development Footprint)
- Proposed Vere Offset Site
- State Forest
- National Park
- Singleton Military Area

FIGURE 7.1

Location Map
Biodiversity Offset Strategy

7.1 Proposed Vere Offset Site

The proposed Vere Offset Site is located proximate to the Development Footprint, conserving vegetation and habitats near Yengo National Park and Pokolbin State Forest (refer to **Figure 7.1**). The proposed Vere Offset Site contains the following key biodiversity features relevant for the offsetting strategy for the Proposed Modification:

- 81.1 hectares of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC comprising HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter and HU906/PCT1692 Bull Oak grassy woodland of the central Hunter Valley communities.

- Proximity to the impacts of the Proposed Modification (i.e. approximately 1.5 km to the south of the Development Footprint).

7.1.1 Site Details

The proposed Vere Offset Site will be secured in perpetuity in accordance with a Stewardship agreement and is located immediately south of the Development Footprint. It comprises land owned by BCM, located in the Broke area (refer to **Figure 7.1**).

Table 7.1 below provides general information on the Proposed Vere Offset Site as required by Table 22 of the FBA (OEH 2014b).

Table 7.1 Proposed Vere Offset Site Details

Falbrook Offset Site	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Hunter
Major Catchment Area	Hunter-Central Rivers
Rivers, Creeks, etc	5th order (Yellow Rock Creek)
Mitchell Landscape	Majority in Central Hunter Foothills, along with a small portion in the Central Hunter Alluvial Plains
LGA	Singleton
Zoning	RU1 Primary Production
Size	153.7 hectares
Land Use History	The historical land use of the Proposed Vere Offset Site has been agricultural, primarily grazing, as well as old gravel quarry activities and gas drainage activities for underground mining
General Description	The Proposed Vere Offset Site is 153.7hectares in size, comprised predominately with open forest (refer to **Figure 7.2**). The site is positioned approximately 3 km north of Broke, with Yengo National Park to the south-west. An easement runs through the western portion of the Proposed Vere Offset Site which has been excluded.

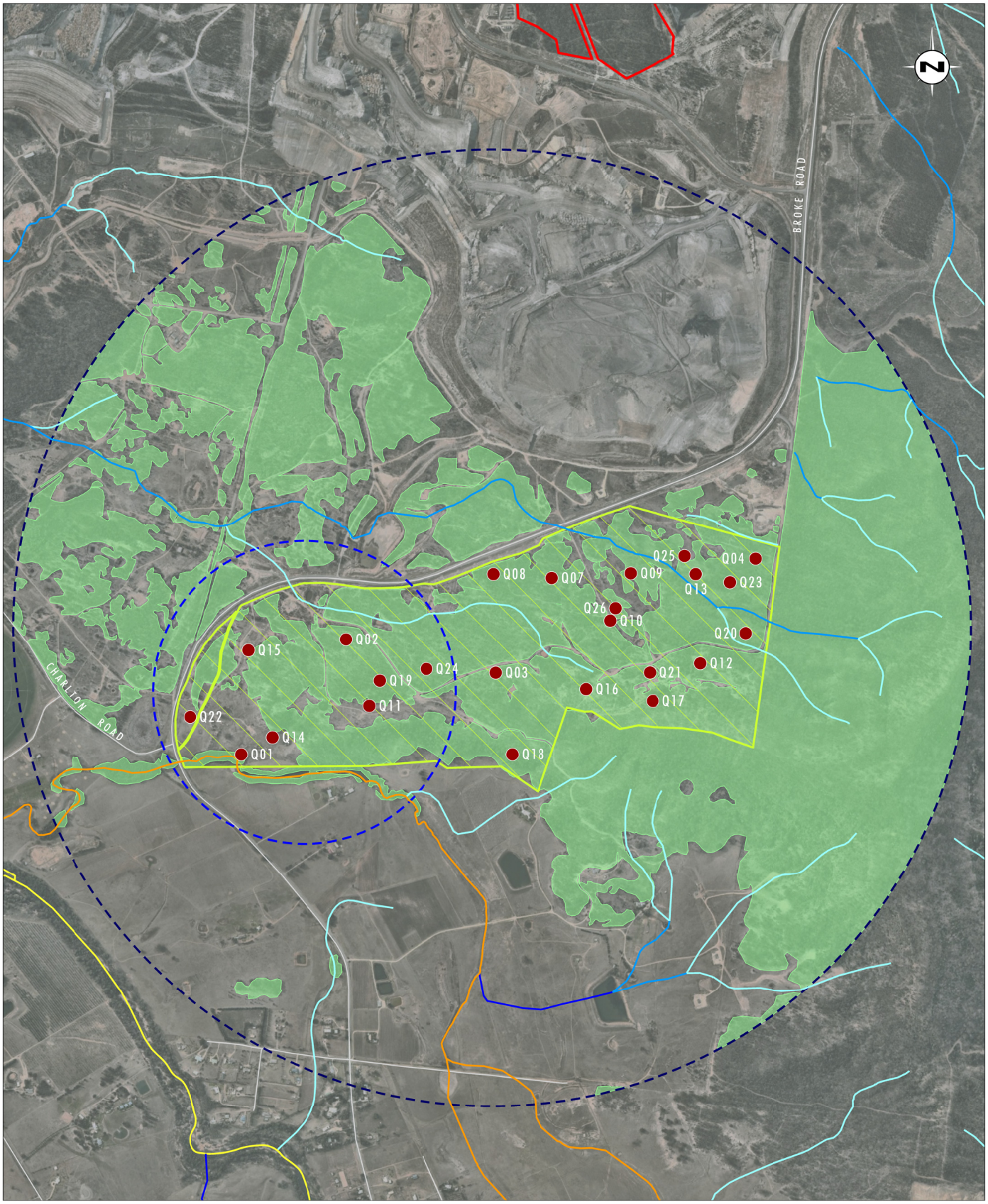

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

0 0.25 0.5 1.0km
1:20 000

Legend

- Additional Disturbance Area (Development Footprint)
- Proposed Vere Offset Site
- Native Vegetation
- 100 Hectare Circle
- 1000 Hectare Circle
- Floristic Plots/Transects
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 5th Order Stream
- 8th Order Stream

FIGURE 7.2

Proposed Vere Offset Site
Native Vegetation and Survey Effort

File Name (A4): R04/4100_168.dgn
20190523 9.33

7.1.2 Survey Effort and Methods

Detailed floristic and vegetation mapping surveys of the proposed Vere Offset Site were undertaken in August/September 2018 and May 2019 and included:

- A total of 24 systematic plot-based surveys, six rapid vegetation assessment points and collection of biometric data in accordance with BBAM 2014 (OEH 2014c) to allow a BioBanking credit calculator (BBCC) assessment to be completed.
- Targeted surveys and review of soil and geological mapping to determine the extent of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC within the Proposed Vere Offset Site.

7.1.3 Survey Results

7.1.3.1 Vegetation Zones

Surveys of the Proposed Vere Offset Site identified five BVTs/PCTs in several condition zones in accordance with the requirements under BBAM (OEH 2014c) (refer to **Figure 7.3**), including:

- HU815/PCT1601 – Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Shrubland*
    - *Moderate to Good Condition – Derived Native Grassland*
    - *Moderate to Good Condition – Previous Ground Disturbance*
    - *Low Condition – Exotic Grassland*
- HU906/PCT1692 Bull Oak grassy woodland of the Central Hunter Valley
    - *Moderate to Good Condition*
- HU812/PCT1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter
    - *Moderate to Good Condition*
- HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion
    - *Moderate to Good Condition*
- HU945/PCT1731 Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley
    - *Moderate to Good Condition*

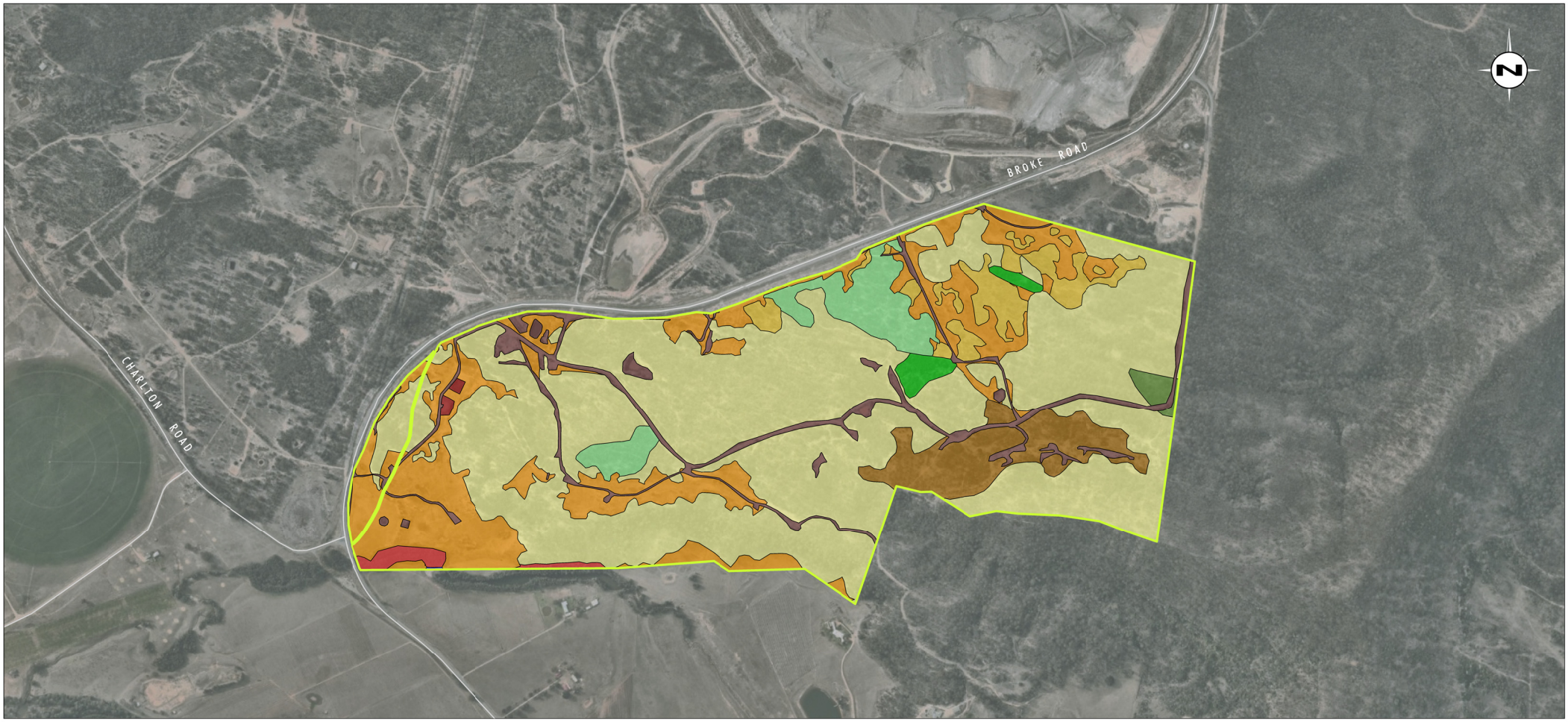

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

0 250 500 750m
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Legend

- Proposed Vere Offset Site
- Cleared Land
- Water Body
- Zone 1 - PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter - Moderate to Good
- Zone 2 - PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter - Moderate to Good Shrubland
- Zone 3 - PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter - Moderate to Good Derived Native Grassland
- Zone 4 - PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter Moderate to Good - Previous Ground Disturbance
- Zone 5 - PCT1692/HU906 Bull Oak grassy woodland of the central Hunter Valley - Moderate to Good
- Zone 6 - PCT1598/HU812 Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good
- Zone 7 - PCT922/HU564 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion - Moderate to Good
- Zone 8 - PCT1731/HU945 Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley - Moderate to Good
- Zone 9 - PCT1601/HU815 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter - Low Condition Exotic Grassland

FIGURE 7.3

Proposed Vere Offset Site Vegetation Map

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7.1.3.2 *Central Hunter Valley Eucalypt Forest and Woodland* CEEC

Figure 7.4 details the extent of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC within the proposed Vere Offset Site. The following vegetation zones in part currently conform to the key diagnostic features and condition thresholds of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC Approved Conservation Advice (TSSC 2015a):

- HU815/PCT1601 – Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter
    - *Moderate to Good Condition* (excluded areas where the contra-indicative species *Eucalyptus fibrosa* occur at greater than two trees per hectare)
    - *Moderate to Good Condition – Shrubland* (includes only areas within 30 metres between patches or gaps at the edges of patches)
    - *Moderate to Good Condition – Derived Native Grassland* (includes only areas within 30 metres between patches or gaps at the edges of patches)
- HU906/PCT1692 Bull Oak grassy woodland of the central Hunter Valley

Moderate to Good Condition (includes areas of this vegetation zone where there are sufficient other characteristic CEEC canopy species as per previous advice provided by OEH for the United project).In addition to this, the following vegetation zones can be actively restored to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC:

- HU815/PCT1601 – Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter
    - *Moderate to Good Condition – Shrubland*
    - *Moderate to Good Condition – Derived Native Grassland*
    - *Moderate to Good Condition – Previous Ground Disturbance*

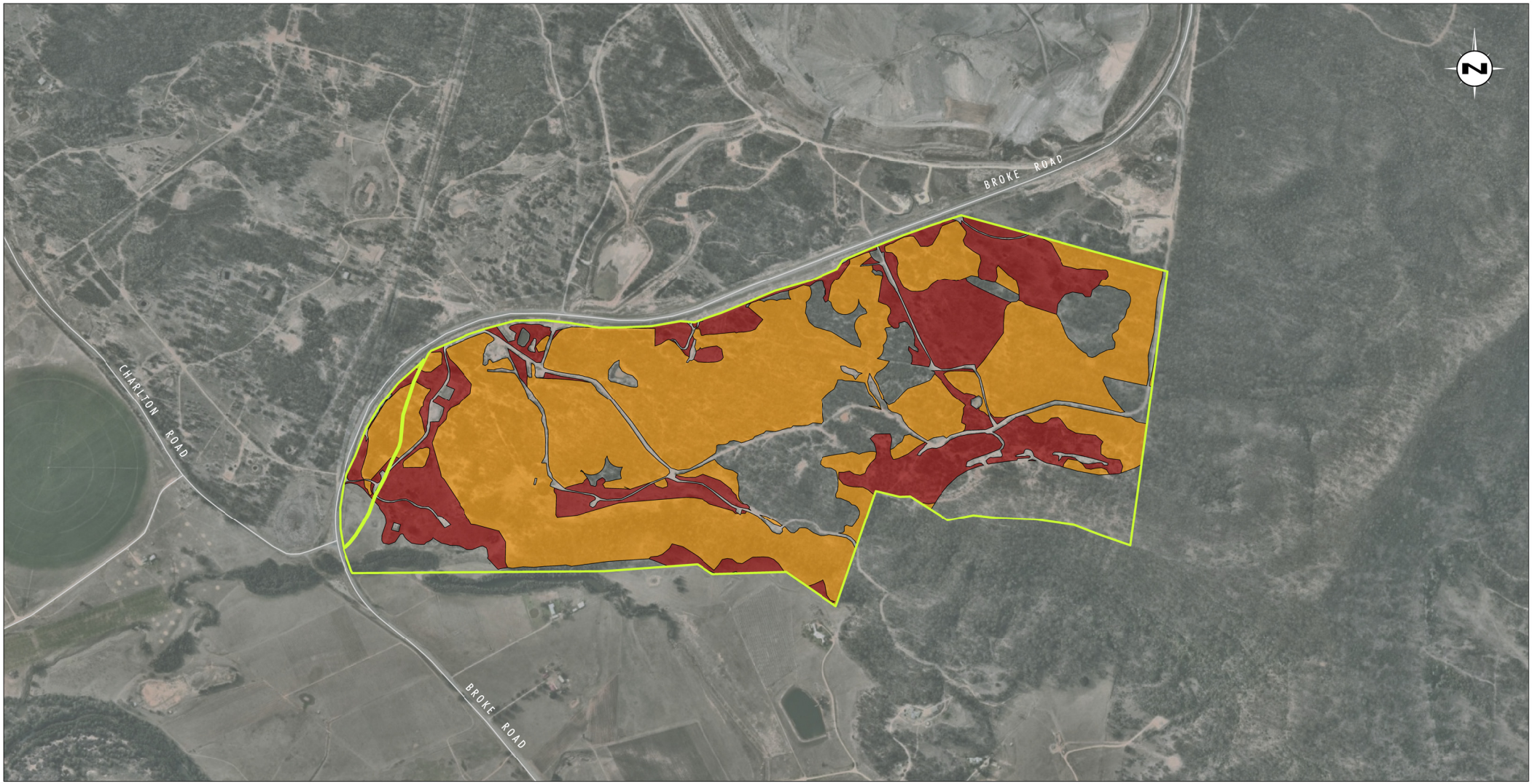

Image Source: Nearmap (Sep 2018)
Data Source: Bulga (2019)

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Legend

- Proposed Vere Offset Site
- Central Hunter Valley Eucalypt Forest and Woodland CEEC
- Central Hunter Valley Eucalypt Forest and Woodland CEEC to be Restored

FIGURE 7.4

Proposed Vere Offset Site
Central Hunter Valley Eucalypt Forest and Woodland

7.1.4 Credits Generated

Table 7.2 below outlines the BVTs/PCTs at the proposed Vere Offset Site and the biodiversity credits generated at this site as part of a BBCC assessment. **Table 7.3** details the amount of existing and proposed restoration of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC and also identifies areas and credits that could be established through the restoration of BVTs/PCTs that do not currently meet the key diagnostic thresholds of the CEEC.

Appendix D includes a full Biodiversity Credit Report for the proposed Vere Offset Site.

Table 7.2 Biodiversity Credits Generated at the Proposed Vere Offset Site

Veg Zone	Plant Community Type/Species Credit Species *Condition Class*	Area (ha)	Credits Generated
Ecosystem Credits			
1	HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good*	91.6	1,041
2	HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Shrubland*	6.3	81
3	HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Derived Native Grassland*	28.2	282
4	HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good - Previous Ground Disturbance*	8.4	104
5	HU906/PCT1692 Bull Oak grassy woodland of the central Hunter Valley *Moderate to Good*	7.0	78
6	HU812/PCT1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good*	0.8	8
7	HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	1.5	15
8	HU945/PCT1731 Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley *Moderate to Good*	1.3	16

Veg Zone	Plant Community Type/Species Credit Species *Condition Class*	Area (ha)	Credits Generated
9	HU815/PCT1601 Spotted Gum - Narrow-leaved Ironbark – Red Ironbark shrub - grass open forest of the central and lower Hunter Low Condition Exotic Grassland	0.2	2
-	Cleared Land (including water bodies)	8.4	0
Total		**153.7**	**1,627**

* Averted loss in site value assigned to the Vere Offset Site to maximise ecosystem credit yield as the land is zoned as RU1 – Primary Production.

Table 7.3 Biodiversity Credits Associated with Existing and Proposed Restoration of Central Hunter Valley Eucalypt Forest and Woodland CEEC

EPBC Act Status	Area (ha)	Credits Generated
Central Hunter Valley Eucalypt Forest and Woodland CEEC	81.1	917
Central Hunter Valley Eucalypt Forest and Woodland CEEC to be restored	33.8	371
Total	**114.9**	**1,288**

7.1.5 Adequacy of the Proposed Vere Offset Site

BCM propose to offset the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC for the Proposed Modification in a like-for-like manner in accordance with the Offsets Policy.

The Offsets Policy, which commenced on 1 October 2014, applies to state significant development under the *Environmental Planning and Assessment Act 1979* (NSW) and therefore applies to the Proposed Modification. This is subject to Clause 27 (1) (d) of Part 7 of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, based on formal advice from the Department of Planning and Environment (DPE) that substantial environmental assessment for the Proposed Modification was undertaken prior to the commencement of the NSW Biodiversity Conservation Act 2016 (25 August 2017).

The stated aim of the Offsets Policy is to strike an effective balance between the needs of proponents, communities and the environment by:

- *"providing clear, efficient and certain guidance for stakeholders*
- *improving outcomes for the environment and communities and*
- *providing a practical and achievable offset scheme for proponents."*

The default position under the Offsets Policy is that impacts are offset in a like-for-like manner, and that *"plant community types must be offset with **closely related** plant community types"* (emphasis added).

Principle 3 of the Offsets Policy contains the following statement:

"Offsets must have a relationship to the biodiversity values being lost. Under the policy, where a proponent has demonstrated that they are unable to locate like-for-like offsets, offsets can be targeted to a ***similar or higher conservation priority****, but will still need to have a relationship to the biodiversity being lost."* (emphasis added)

However, the strict use of like-for-like offsetting rules for ecosystem credits under the FBA requires that offset site PCTs meet the following criteria (as per Subsection 10.5.3.1 and Table 5 of the FBA):

a) be the same PCT for which the ecosystem credit is required for the impacts of development

b) be any PCT of the same vegetation class as identified that has:

- a percent cleared value of the PCT in the major catchment area equal to or greater than the percent cleared of the PCT to be impacted, or
- a percent cleared value up to 10% lower than the PCT to be impacted, if the percent cleared of the PCT to be impacted is less than or equal to 70% cleared.

The offset variation rules under the FBA are not applicable for ecosystem credits associated with TECs listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (assessed in **Section 8** below).

The FBA therefore does not consider that the formal listing of the Ce*ntral Hunter Valley Eucalypt Forest and Woodland* CEEC under the EPBC Act is such that it includes a number of PCTs and vegetation classes. In relation to this particular ecological community, this results in unintended consequences and practical implementation issues if the like-for-like offsetting requirement is to be applied at the PCT level as opposed to the listed level.

The *Central Hunter Valley Eucalypt Forest and Woodland* CEEC listing under the EPBC Act covers a number of PCTs as defined by OEH. The Proposed Modification impact on the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC comprises PCTs from the Coastal Valley Grassy Woodlands vegetation class. The *Central Hunter Valley Eucalypt Forest and Woodland* CEEC at the proposed Vere Offset Site mainly comprises a PCT from the Hunter-Macleay Dry Sclerophyll Forests vegetation class. Both the Grassy Woodland and the Dry Sclerophyll Forest types are vegetation classes that are ascribed to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

The use of the proposed Vere Offset Site would result in a suitable like-for-like outcome for the offsetting and conservation of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC. This approach results in an outcome where like-for-like offsetting is prioritised at the highest levels of the biodiversity conservation hierarchy (refer to the flow chart in **Figure 7.5** below).

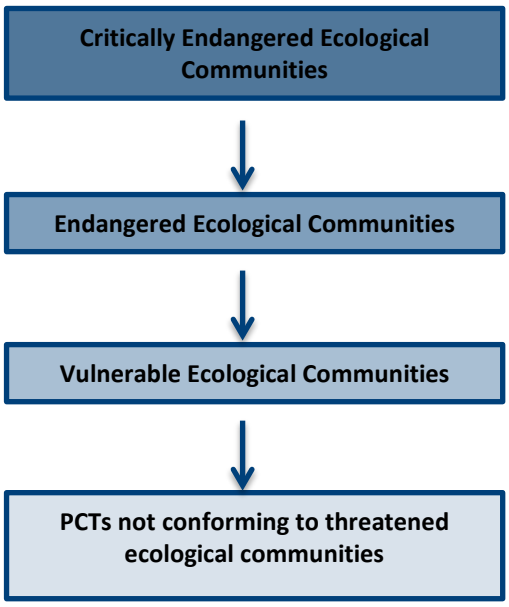

Figure 7.5 Biodiversity Conservation Hierarchy of Threatened Ecological Communities

This approach is considered to be consistent with the Offsets Policy as it provides a like-for-like offsetting outcome for the CEEC and will be protecting and improving biodiversity that is under the same level of threat, in accordance with the EPBC Act listing for the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC. This approach also addresses the practical implementation issue that arises with the strict application of Subsection 10.5.3.1 (referring to Table 5) of the FBA offsetting rules which inadvertently results in limitations on the proposed like-for-like offset for this CEEC.

7.1.6 Proposed Biodiversity Offset Outcomes

The proposed offsetting approach seeks to offset *Central Hunter Valley Eucalypt Forest and Woodland* CEEC for the same *Central Hunter Valley Eucalypt Forest and Woodland* CEEC, which when defined at the highest level of threat (listed as critically endangered), provides the best and most credible offset outcome for the Proposed Modification.

Further to this, an assessment of the ecosystem credit species associated with HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter proposed to be offset using the 'CEEC for CEEC' approach are either associated with (BBAM credit calculator) or are expected to occur in the vegetation zones within the proposed Vere Offset Site.

Table 7.4 below details the outcomes of the 'CEEC for CEEC' approach for the Proposed Modification. **Table 7.5** details the FBA 'like for like' approach in terms of PCTs after the ecosystem credits have been allocated for the 'CEEC for CEEC' approach. **Table 7.4** and **Table 7.5** demonstrate that the proposed Vere Offset Site exceeds the biodiversity credit requirements.

Table 7.4 Offset Credit Outcomes Following Inclusion of the Proposed Vere Offset Site under the 'CEEC for CEEC' Approach

Name	Credits Required	Vere Offset Available Credits (under 'CEEC for CEEC' Approach)	Residual Existing CEEC Credits
Ecosystem Credits			
HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter *Moderate to Good* Conforms to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC listed under the EPCBC Act and *Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions* EEC listed under the BC Act	868	917 existing credits	49
Total	**868**	**917**	**49**

Table 7.5 Offset Credit Outcomes Following Inclusion of the Proposed Vere Offset Site under the 'Like for Like' PCT Approach (after allocating credits to the 'CEEC for CEEC' Approach)

Name	Credits Required	Vere Offset Available Credits (under 'like for like' PCT Approach')	Residual Credits
Ecosystem Credits			
HU564/PCT922 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion *Moderate to Good Condition and Low Condition* Not listed as a TEC under the BC Act or EPBC Act	63	706 including PCT922/HU564 and HU815/PCT1601)	643
Total	**63**	**706**	**643**

7.1.7 Improvement in Site Values

There are no pre-existing conservation obligations in relation to the proposed Vere Offset Site and could be developed for agricultural purposes under existing legislative arrangements.

The BBCC calculated the conservation management zones across the proposed Vere Offset Site using the predicted gain in site value scores based on standard management practices. These include:

- management of grazing for conservation
- weed control
- ecological fire management
- management of human disturbance
- retention of regrowth and remnant native vegetation
- replanting or supplementary planting where natural regeneration is not sufficient
- retention of dead timber
- erosion control
- retention of rocks.

Additional management actions that are required include:

- exclude commercial apiaries
- exclude miscellaneous feral species
- fox control
- control of feral pigs
- feral and/or over-abundant native herbivore control
- slashing, as appropriate in terms of intensity and location.

The Proposed Vere Offset Site described in this section was assessed in accordance with BBAM (2014) and the BioBanking credit calculator assessment was conducted to enable direct comparison to be made with the impact credits which were determined in accordance with the FBA. The mechanism to secure the Proposed Vere Offset Site will likely be a Stewardship Agreement prepared in accordance with the Biodiversity Assessment Method (BAM) under *the Biodiversity Conservation Act 2016* (BC Act).

7.1.8 Summary

A total of 931 ecosystem credits are required to offset the biodiversity impacts associated with the Proposed Modification. The proposed Vere Offset Site generates a total of 1,627 ecosystem credits, which exceeds the ecosystem credit requirements of the Proposed Modification using the FBA 'like for like' rules and the proposed 'CEEC for CEEC' approach.

8 Matters of National Environmental Significance

On 17 December 2018, the Commonwealth Department of Energy and Environment (DoEE) confirmed the Proposed Modification was a controlled action for potentially significant impacts on the following:

- Central Hunter Valley Eucalypt Forest and Woodland – Critically Endangered
- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered
- Swift Parrot (*Lathamus discolor*) – Critically Endangered
- a water resource, in relation to coal seam gas development and large coal mining development.

This section seeks to assess the significance of impacts to threatened species and communities listed under the EPBC Act and to address the DoEE Assessment Requirements for the Proposed Modification.

BCM currently operates under two EPBC approvals 2002/773 and 2012/6637. The EPBC Act approval relevant to the Bulga Surface Operations is EPBC 2012/6637. The components of the Project Modification that are not covered under EPBC 2012/6637 have been referred under the EPBC Act. The referral specifically covered:

- extension of mining areas to the south and east by to access an additional 63 Mt of coal within the proposed extension area
- additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east within the proposed extension area
- accessing deeper resources beneath part of the currently approved open cut.

A detailed report was submitted to the DoEE to provide supporting information for the referral of the Proposed Modification submitted under the EPBC Act (Umwelt 2018).

No other MNES (relating to biodiversity) are likely to be significantly impacted as a result of the Proposed Modification. The assessment path for the proposed action will be under the State's accredited assessment process under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* in accordance with the bilateral agreement between the NSW and Commonwealth governments.

The sections below provide a detailed response to the Commonwealth DoEE Assessment Requirements. These are listed in **Table 8.1** and it is outlined where the requirements have been addressed.

Table 8.1 DoEE Requirements and where they have been addressed in this document

Requirement	Relevant Section
The Applicant must consider each of the protected matters under the triggered controlling provisions that may be impacted by the action. Note that this may not be a complete list and it is the responsibility of the Applicant to undertake an analysis of the relevant impacts and ensure all protected matters that are likely to be impacted are assessed for the Commonwealth Minister's consideration.	Refer to Section 8 of this report and the SEE
General Requirements	
The applicant must address the matters outlined in Schedule 4 of the EPBC Regulations and the matters outlined below in relation to the controlling provisions.	
The title of the action, background to the action of the action and current status.	Refer to the SEE
The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Refer to the SEE
How the action relates to any other actions that have been, or are being taken in the region affected by the action.	Refer to the SEE
How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	Refer to the SEE
The SEE must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including: i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts; ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; iii. analysis of the significance of the relevant impacts; and iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	8.1.1, 8.1.2 and Appendix E
For each of the relevant matters protected that are likely to be significantly impacted by the action, the SEE must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: i. a description, and an assessment of the expected or predicted effectiveness of the mitigation measures, ii. any statutory policy basis for the mitigation measures; iii. the cost of the mitigation measures; iv. an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; v. the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	8.1.2 and the SEE

Requirement	Relevant Section
Where a significant residual adverse impact to a relevant protected matter is considered likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	8.1.4
Biodiversity (threatened species and communities and migratory species)	
The removal of 16.4 ha of EPBC Act listed Central Hunter Valley Eucalypt Forest and Woodland will result in a reduction in the amount of this ecological community and a reduction in foraging habitat for the EPBC Act listed Regent Honeyeater and Swift Parrot.	
For each of the relevant matters likely to be impacted by the action the SEE must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: i. conservation advice or recovery plan for the species or community, ii. relevant threat abatement plan for a process that threatens the species or community iii. wildlife conservation plan for the species iv. any strategic assessment. [Note: the relevant guidelines and policy statements for each species and community are available from the Department of the Environment Species Profiles and Threats Database.	8
For each of the EPBC Act listed species predicted to occur in the project site, and each of the EPBC Act listed ecological communities likely to be significantly impacted, the SEE must provide: a. survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements and/or the NSW Framework for Biodiversity Assessment (FBA); b. a description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices and recovery plans, threat abatement plans and wildlife conservation plans; and c. maps displaying the above information (specific to each EPBC protected matter) overlaid with the proposed action. [Note - it is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the FBA as the basis for identifying EPBC Act-listed species and communities. The SEE must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act listed species or community, and provide individual maps for each species or community.]	2 and 3 8.1.1 and Appendix E Figure 3.2 and Figure 3.3
The SEE must describe the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act listed species and communities. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act listed species or community.	8.1.2

Requirement	Relevant Section
For each of the EPBC Act listed species and communities likely to be impacted by the development, the SEE must provide information on proposed avoidance and mitigation measures to deal with the impacts of the action, and a description of the predicted effectiveness and outcomes that the avoidance and mitigation measures will achieve.	8.1.3
The SEE must identify each EPBC Act listed species and community likely to be significantly impacted by the proposed action. Where a significant impact is likely, the SEE must provide information on the proposed offset strategy, including discussion of the conservation benefit, how offsets will be secured, and timing of protection. [Note - not all of the offset options under the NSW Biodiversity Conservation Act 2016 are endorsed under the EPBC Act for approval purposes. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same EEC or habitat being impacted, or funding to provide a direct benefit to the matter being impacted i.e. threat abatement, breeding and propagation programs or other relevant conservation measures.]	8.1.4 and 8.1.5

8.1 Biodiversity Related Matters of National Environmental Significance

The detailed biodiversity surveys undertaken for the Proposed Modification are detailed in **Section 2** and **Figures 2.1** – **2.5.** Survey methodologies specific to the controlled action determination are outlined in **Table 8.2**.

Table 8.2 Survey Methodology for EPBC Listed Threatened Species and Communities

Common Name *Scientific Name*	Targeted Surveyed (Yes/No)	Survey Technique, Timing and Location
Central Hunter Valley Eucalypt Forest and Woodland CEEC	Yes	Targeted surveys to map Central Hunter Valley Eucalypt Forest and Woodland CEEC were undertaken in August 2017 in accordance with the sampling protocols and with consideration of the key diagnostic characteristics and condition thresholds provided within the Approved Conservation Advice (TSSC 2015a). These 'key diagnostic characteristics' and 'condition thresholds' provided by the Approved Conservation Advice formed the basis for delineating and identifying patches of native vegetation as being the threatened ecological community and distinguishing between patches of different quality. In particular, the assessment included consideration of the following: • occurrence in the Hunter River catchment; • landform and soil type; • vegetation structure; • dominant overstorey species and overall floristics; • and patch size. A total of 4 biometric plot/transects were sampled within vegetation conforming to this CEEC, in accordance with the FBA and as described in **Section 2.2**.
regent honeyeater ***Anthochaera phrygia***	Yes	Targeted winter bird surveys were undertaken across the Development Footprint in five locations in August 2017. These sessions began with a period of quiet listening for approximately 5 minutes. Regent honeyeater calls were played using a 15 watt directional loud hailer for approximately four minutes, followed by a listening period of five minutes between species calls. Following call playback sessions, bird surveys were conducted at each site for a minimum of 30 minutes totalling one person hour of survey per site. This involved walking a meandering transect and recording the number of any bird species seen or heard calling. Species were visually identified using 10 x 40 magnification binoculars or by call recognition. The winter bird surveys targeted areas of better quality habitat and flowering resources for the regent honeyeater and were timed to coincide with the known presence of the species in the Hunter Valley. Opportunistic observations were completed throughout all Umwelt survey periods outlined in **Section 2.3.3** above. Targeted winter bird surveys have been undertaken in the wider locality as part of the Bulga Optimisation Project (2013) and Bulga UHSA (Umwelt 2015). Diurnal winter bird searches are undertaken as part of the monitoring in the Bulga Coal Complex annually. Extensive survey has been conducted in the Bulga Coal Complex for this species.

Common Name *Scientific Name*	Targeted Surveyed (Yes/No)	Survey Technique, Timing and Location
swift parrot ***Lathamus discolor***	Yes	Targeted winter bird surveys were undertaken across the Development Footprint in five locations in August 2017. These sessions began with a period of quiet listening for approximately 5 minutes. Swift parrot calls were played using a 15 watt directional loud hailer for approximately four minutes, followed by a listening period of five minutes between species calls. Following call playback sessions, bird surveys were conducted at each site for a minimum of 30 minutes totalling one person hour of survey per site. This involved walking a meandering transect and recording the number of any bird species seen or heard calling. Species were visually identified using 10 x 40 magnification binoculars or by call recognition. The winter bird surveys targeted areas of better quality habitat and flowering resources for the swift and were timed to coincide with the known presence of the species in the Hunter Valley. Opportunistic observations were completed throughout all Umwelt survey periods outlined in in **Section 2.3.3** above. Targeted winter bird surveys have been undertaken in the wider locality as part of the Bulga Optimisation Project (2013) and Bulga UHSA (Umwelt 2015). Diurnal winter bird searches are undertaken as part of the monitoring in the Bulga Coal Complex annually. Extensive survey has been conducted in the Bulga Coal Complex for this species.

8.1.1 Relevant Impacts of the Action on Biodiversity

The Proposed Modification would result in the removal of 20.2 hectares of land to access coal resources directly beneath. Most of this land (except for 1 hectare of cleared areas) is vegetated, and 16.4 hectares is comprised of HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter, which conforms to the EPBC listed *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

In addition to conforming to this CEEC, DoEE has identified this ecological community as potential foraging habitat for Critically Endangered species swift parrot (*Lathamus discolor*) and regent honeyeater (*Anthochaera phrygia*) on the basis of the presence of spotted gum (*Corymbia maculata*), a known feed tree for both these species. Spotted gum has been identified as occurring in low frequency in the CEEC within the Development Footprint (5 trees out of 25 in a 400m^2 plot) and these individuals are reasonably young. All trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH according to the OEH Biodiversity Assessment Method) were identified. Approximately 0.1 hectares of this CEEC is anticipated to contain suitable foraging habitat for swift parrots and regent honeyeaters, as defined in the relevant recovery plans (CoA 2013; Saunders and Tzaros 2011).

The relevant impacts of the Proposed Modification are considered to be well known and predictable based on the extensive knowledge of the ecological values of the Development Footprint and a sound understanding of the impacts of the Proposed Modification. The direct impacts of the Proposed Modification, as they relate to the clearing of threatened and migratory species habitat is predicted to be permanent, however these direct impacts will be offset in accordance with the FBA and the *NSW Biodiversity Offsets Policy for Major Projects*.

8.1.1.1 Central Hunter Eucalypt Forest and Woodland CEEC

Central Hunter Eucalypt Forest and Woodland is listed as a CEEC under the EPBC Act. This community occurs in the Hunter Valley region on soils derived from Permian sedimentary bedrock (TSSC 2015a). Typically it is characterised as a eucalypt woodland and open forest, with a shrub layer of variable density and/or a grassy ground layer. Across its range, one or more of a complex of four eucalypt tree species, namely spotted gum (*Corymbia maculata*), narrow-leaved ironbark (*Eucalyptus crebra*), slaty gum (*Eucalyptus dawsonii*) or grey box (*Eucalyptus moluccana*) dominate the canopy (TSSC 2015a).

The results of the assessment for vegetation patches within the Development Footprint against the key diagnostic characteristics listed above identified the presence of the necessary Permian derived soils in areas with floristic potential to be part of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and the CEEC was found to be present within the Development Footprint.

Approximately 16.4 hectares of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC was identified within the Development Footprint and will be directly impacted as a result of the Proposed Modification. The following PCT in the Development Footprint was identified as conforming to the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (refer to **Figure 3.3**):

- HU817/PCT1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter

The conservation advice for the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC identifies any areas that meet the minimum moderate quality condition class as being areas critical to the survival of the community. Areas of moderate/high quality condition of the CEEC occur within the Development Footprint, however given the current approximate extent of the community over its range (37,000 hectares), the

removal of the small area of CEEC resulting from the Proposed Modification is considered unlikely to affect the survival of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC.

The approximately 16.4 hectares of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC within the Development Footprint would be critical to the survival of the CEEC, in accordance with the criteria prescribed in the Approved Conservation Advice for the CEEC (TSSC 2015a). The Proposed Modification would result in the removal of habitat critical to the survival of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC, however the extent of proposed clearing represents a small area in the context of the broader range of the community both in NSW and in Australia.

Vegetation occurring within the Development Footprint is currently highly fragmented as a result of historic agricultural land practices. The removal of 16.4 hectares of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC will result in an increase in the fragmentation of the community. The level of fragmentation will increase in the local area with the removal of remnants totalling 16.4 hectares, however given the current extent of approximately 37,000 hectares of the CEEC, the level of increase in fragmentation is considered to be negligible across its range (approximately 0.044 per cent of the current extent). However, the DoEE has assessed the Proposed Modification as having a likely significant impact on the CEEC, and will be assessed as such through this document. Refer to **Appendix E** for further details.

8.1.1.2 Regent honeyeater (*Anthochaera phrygia*)

The regent honeyeater (*Anthochaera phrygia*) is listed as critically endangered under the EPBC Act and has a patchy distribution extending from south-east Queensland, into NSW and the Australian Capital Territory, to central Victoria (CoA 2016). The species is highly mobile, capable of travelling large distances and occurs only irregularly at most sites in varying numbers. Adding further difficulty to the survey and study of this species is its ability to often go long periods without being observed anywhere (CoA 2016).

The regent honeyeater is endemic to mainland south-eastern Australia and mostly inhabits inland slopes of the Great Dividing Range (TSSC 2015b). The regent honeyeater comprises a single population, with some exchange of individuals between regularly used areas (CoA 2016). As at 2010, the total population size is estimated at 350–400 mature individuals (CoA 2016).

As the species occurs as a single population in Australia, any record of the species would constitute part of a population as described above. The population of regent honeyeater has not been recorded within the Development Footprint, however it has been recorded approximately one kilometre north of the Development Footprint in planted eucalypts in the Bulga Coal Complex site office carpark in 2011 during the surveys for the Bulga Optimisation Project (Umwelt 2013).

The regent honeyeater's primary habitat is box-ironbark eucalypt woodland and dry sclerophyll forest, however it does utilise riparian vegetation and lowland coastal forest. Habitat critical to the survival of the regent honeyeater includes any breeding or foraging areas where the species is likely to occur and any newly discovered breeding or foraging locations (CoA 2016).

The Development Footprint is not known as a historical or important foraging site for this species. The Development Footprint contains one known foraging tree species (according to the approved National Recovery Plan (CoA 2016)). The Proposed Modification will result in the loss of approximately 16.4 hectares of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young spotted gum (*Corymbia maculata*), which is a key tree species listed for the regent honeyeater (CoA 2016).

This area of habitat occurs within HU817/PCT1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter. This PCT occurs across approximately 16.4 hectares, however potential feed tree species were only observed in an area of 0.1 hectares of this vegetation

community. This area represents critical habitat as the Hunter Valley region has been mapped in the recovery plan as 'species likely to occur' despite a lack of recent records in the Project Area (BioNet 2019).

The regent honeyeater mainly breeds in three key sites in NSW being the Bundarra-Barraba area, the Capertee Valley, and the Lower Hunter Valley (CoA 2016 & OEH 2019). Other breeding areas are known in the Pilliga woodlands and the Mudgee-Wollar areas of NSW. The regent honeyeater has not been recorded in the Development Footprint and it is unlikely to contain breeding or nesting habitat for the species.

Although the area proposed to be disturbed has existing poor connectivity and the regent honeyeater has not been recorded utilising the potential habitat within the Development Footprint or in the immediate surrounds for eight years, the Development Footprint provides 16.4 hectares of potential foraging habitat for this species. The DoEE has assessed the Proposed Modification as having a likely significant impact on the regent honeyeater, and will be assessed as such through this document. Refer to **Appendix E** for further details.

8.1.1.3 Swift Parrot (*Lathamus discolor*)

The swift parrot (*Lathamus discolor*) is listed as critically endangered under the EPBC Act. The species breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March) (Saunders and Tzaros 2011). Most of the population winters in Victoria and NSW where it disperses across broad landscapes foraging on nectar and lerps in eucalypts. Until recently it was believed that in NSW, swift parrots forage mostly in the coastal and western slopes region along the inland slopes of the Great Dividing Range but are widely distributed along the north and south coasts including the Sydney region (Saunders and Tzaros 2011). However, evidence is gathering that the forests on the coastal plains from southern to northern NSW are also important. They return to Tasmania in spring (September-October). The movements of this species on the mainland are poorly understood, but it is considered to be nomadic and irruptive, moving in response to food supply.

The swift parrot occurs as a single population that migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders and Tzaros 2011). Approximately 200 mature birds (10 per cent of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Roderick et al. 2013).

As the species occurs as a single population in Australia, any record of the species would constitute a part of a *population* as described above. There have been few records of the species within the Hunter Valley in the past few years, however recent sightings have been recorded in the winter 2017 season in the lower Hunter areas (Birdline NSW 2019). This species has the potential to make use of the forest and woodland habitat of the Development Footprint, particularly where there are prolific flowering eucalypts and this migratory species is likely to move throughout the area in response to mass flowering events. This species does not breed on mainland Australia, and as such the Development Footprint only represents potential foraging habitat for this species.

Priority sites for this species have been identified within the National Recovery Plan for the species (Saunders and Tzaros 2011). This species is likely to utilise coastal forest and river-flat vegetation associations within the coastal natural resource management region (which includes the Hunter-Central Rivers), in communities dominated by swamp mahogany (*Eucalyptus robusta*), blackbutt (*Eucalyptus pilularis*), forest red gum (*Eucalyptus tereticornis*) and spotted gum (*Corymbia maculata*) (Saunders and Tzaros 2011).

The Development Footprint contains moderate quality potential foraging habitat for this species. In accordance with the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011) approximately 16.4 ha of potential woodland foraging habitat occurs within the Development Footprint, based on the presence of spotted gum (*Corymbia maculata*) which has been identified as a key foraging resource for the swift parrot in the Hunter Valley . This area of habitat occurs within HU817/PCT1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter. Analysis of vegetation survey data and habitat assessment results indicates that additional key foraging species that provide habitat for the species in the Hunter Valley, as per the Recovery Plan, were not recorded in the Development Footprint.

We note that *Central Hunter Valley Eucalypt Forest and Woodland* CEEC is broadly known to provide habitat for this species in the Hunter Valley, where it contains spotted gum (*Corymbia maculata*). Analysis of the constituent canopy species in this CEEC was undertaken to determine the extent of potential foraging habitat for the swift parrot within this vegetation communities. It was found that characteristic species spotted gum (*Corymbia maculata*) was present in the Development Footprint albeit at very low abundances and localised occurrence constituting a small number of reasonably young trees.

Habitat critical to the survival of the swift parrot includes those areas of priority habitat for which the species has a level of site fidelity or possess phenological characteristics likely to be of importance to the swift parrot (Saunders and Tzaros 2011). The swift parrot has not been recorded within the Development Footprint or the immediate locality and has not shown site fidelity to the habitats of the Development Footprint. The Development Footprint does include 16.4 hectares of vegetation that contains a very low abundance of reasonably young spotted gum, which is a key feed tree species for the swift parrot in the Hunter-Central Rivers (Saunders and Tzaros 2011). This vegetation community occurs across approximately 16.4 hectares, however potential feed tree species were only observed in an area of 0.1 hectares of this vegetation community.

Overall, the vegetation within the Development Footprint is highly fragmented and dominated by non-key tree species that are not considered to comprise likely foraging habitat for the swift parrot. Furthermore, the swift parrot (*Lathamus discolor*) has not been recorded within the Development Footprint despite targeted survey over multiple years. However, the Department of Energy and Environment has assessed the Proposed Modification as having a likely significant impact on the swift parrot, and will be assessed as such through this document. Refer to **Appendix E** for further details.

8.1.2 Assessment of impacts to listed Threatened Species and Communities

The development of the Proposed Modification will result in direct, indirect and consequential impacts on biodiversity values within the Development Footprint. Direct impacts include the loss of native vegetation and fauna habitats as a result of clearance works and subsequent mining activity. The Proposed Modification is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands. However, some minor indirect impacts associated with habitat connectivity, fugitive light emissions, dust, noise, groundwater changes, weeds and feral animals may occur during the life of the operations. The indirect impacts will generally be consistent with those approved for BOP.

It is recognised that the Proposed Modification will remove vegetation and further increase fragmentation and isolation of habitats, and thus contribute to cumulative habitat loss and vegetation clearance in the locality.

These impacts are summarised in **Table 8.3**.

Table 8.3 Predicted Impacts from the Proposed Modification on EPBC Act listed threatened species and communities

Impact Type	Description	Timing of Impact	Area (ha)
Direct	Loss of 16.4 ha of open forest that conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC	Medium – long term	**16.4**
Direct	Loss of potential foraging habitat for regent honeyeater (*Anthochaera phrygia*)	Medium – long term	**16.4**
Direct	Loss of potential foraging habitat for swift parrot (*Lathamus discolor*)	Medium – long term	**16.4**
Indirect	Removal of vegetation and further increase fragmentation and isolation of habitats, and thus contributing to cumulative habitat loss and vegetation clearance in the locality.	Medium – long term	**19.2**
Indirect	Fugitive light emissions resulting from the Proposed Modification may result in adverse impacts on adjacent habitats and cause behavioural changes in nocturnal birds and bats.	Medium term	**Project Area**
Indirect	Noise and blasting impacts may have a minor indirect impact on fauna species. Potential impacts include noise disturbing the roosting and foraging behaviour of fauna species and/or reducing the occupancy of areas of otherwise suitable habitat. Given that the proposed action is part of, and adjacent to an existing mine operation with existing impacts, any additional impacts resulting from noise emissions are not expected to be substantial for threatened species, populations and communities.	Medium term	**Project Area**
Indirect	Air quality impacts have the potential to adversely impact native species from dust generating activities during ground disturbing works. Potential impacts include dust covering vegetation thereby potentially reducing vegetation health and growth and increased air pollutants for native species (flora and fauna). Given that the proposed action is part of, and adjacent to an existing mine operation with existing impacts, any additional impacts resulting from air quality not expected to be substantial for threatened species, populations and communities.	Medium term	**Project Area**

Impact Type	Description	Timing of Impact	Area (ha)
Indirect	Weed species could be inadvertently brought into the Project Area with imported materials or could invade naturally through removal of native vegetation. The presence of weed species within the Project Area has the potential to decrease the value of extant vegetation to native species, particularly threatened species. Populations of feral fauna species such as foxes, rabbits, pigs, deer, dogs and cats can increase and quickly populate new areas as a result of disturbance. There will be no substantial change to impacts from weeds or feral animals, given that the proposed mine is part of, and adjacent to, an existing operation with existing impacts. Any additional impacts resulting from weeds or feral animals are not expected to be of any level of significance in relation to threatened species, populations and communities.	Medium term	**Project Area**
Cumulative	The history of land clearing, agriculture and mining development has resulted in an incremental loss of vegetation and fauna habitat surrounding the Project Area, and within the Hunter Valley more generally. The Proposed Modification will result in a loss of approximately 19.2 hectares of native woodland and forest vegetation. The Proposed Modification will remove vegetation and further increase fragmentation and isolation of habitats, and thus contribute to cumulative habitat loss and vegetation clearance in the locality.	Medium – long term	**Wider locality**

The relevant impacts of the Proposed Modification are considered to be well known and predictable based on the extensive knowledge of the ecological values of the additional disturbance area and a sound understanding of the impacts of the Proposed Modification (e.g. clearing of vegetation, earthworks and water management). The direct impacts of the Proposed Modification, as they relate to the clearing of EPBC listed CEEC and threatened species habitat is predicted to be permanent; however, a detailed rehabilitation program will be proposed as part of the Proposed Modification in order to compensate for the residual impacts of habitat loss that cannot be adequately avoided or minimised. The proposed rehabilitation and reinstatement of habitat will mean that, over time, impacts will not be completely irreversible as most key ecological features will be recovered. Rehabilitation and regeneration of the mine site, in addition to an appropriate biodiversity offset strategy will ensure that there is no residual significant impact to the landscape in the medium-long term as a result of the Proposed Modification.

8.1.3 Avoidance and Mitigation of Impacts

8.1.3.1 Avoidance Strategies

Given the location of the Development Footprint within the overall Project Area and the relatively small size, it was not possible to avoid all biodiversity values without compromising the viability of the Proposed Modification. Given this, detailed minimisation/mitigation measures are proposed as detailed in **Section 8.1.3.2** below.

8.1.3.2 Mitigation Measures

BCM has committed to the implementation of a comprehensive biodiversity mitigation strategy, as detailed in the existing approved Bulga Coal Biodiversity Management Plan (Bulga Coal Management 2018 – prepared under SSD-4960 and DA 376-8-2003 and Commonwealth EPBC Act Approval EPBC 2012/6637), to minimise the unavoidable impacts of the Proposed Modification. The impact mitigation measures proposed are based on best available practices and are widely used to mitigate the impact of coal mining developments in the Hunter Valley and elsewhere. Residual impacts of the Proposed Modification on EPBC listed threatened species and communities include:

- direct habitat loss for threatened species and ecological communities
- dust and air quality impacts
- fugitive light emission
- noise and blasting impacts
- weed encroachment
- impacts to corridors resulting in reduced connectivity for fauna movement
- introduction of feral animals.

Table 8.4 provides an outline of the avoidance and minimisation measures to be implemented by BCM for the impacts described above.

Table 8.4 Avoidance and mitigation methods for residual impacts on EPBC listed threatened species and communities

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
Central Hunter Eucalypt Forest and Woodland CEEC	Direct impact – removal of 16.4 ha of vegetation	The final biodiversity offset strategy to be delivered for the Proposed Modification will meet the offset requirements determined by the BioBanking Credit Calculator (BBCC) in accordance with the FBA and will include the in-perpetuity conservation of the proponent-managed Vere Offset Site which will be secured using a Stewardship agreement. Further details of the proposed biodiversity offset strategy are detailed in **Section 7** of this report.
	Air quality impacts; dust covering vegetation impacting health and growth	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.
	Weed encroachment	Existing weed management controls as specified in the Bulga Coal Biodiversity Management Plan will be applied to the Proposed Modification. Weed control will be undertaken in accordance with current mine practices and, for noxious weed species identified as requiring control. Regular weed inspections will be undertaken across the Project Area and appropriate weed control methods will be implemented.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Cumulative impacts of land clearing	Landform establishment and rehabilitation of native vegetation communities will occur as soon as practical following the completion of mining activities. Pre-clearance activities will identify and salvage biodiversity features to be used in the rehabilitation process. Resources that will be salvaged (where practical) from clearing activities include topsoil, vegetation and hollow-bearing trees/logs and native seed. These resources will be re-used in rehabilitation areas to improve revegetation outcomes and to augment habitat features.
Regent honeyeater (*Anthochaera phrygia*) **Swift parrot (*Lathamus discolor*)**	Direct impact – loss of 16.4 ha of potential foraging habitat	The final biodiversity offset strategy to be delivered for the Proposed Modification will meet the offset requirements determined by the BioBanking Credit Calculator (BBCC) in accordance with the FBA and will include the in-perpetuity conservation of the proponent-managed Vere Offset Site which will be secured using a Stewardship agreement. Further details of the proposed biodiversity offset strategy are detailed in **Section 7** of this report.
	Removal of vegetation and further increasing fragmentation and isolation of habitats, thus contributing to cumulative habitat loss and vegetation clearance in the locality.	Bulga Coal Management is committed to a mitigation and offsetting strategy including the provision of: • the delineation of clearance areas to avoid unnecessary impacts and clearance of surrounding vegetation • habitat enhancement measures such as the installation of nest boxes, salvaged hollows, fallen timber, hollow logs and rocks to supplement mine rehabilitation areas • rehabilitation of the Development Footprint post mining • the implementation of a biodiversity offset strategy (refer to **Section 7.0** of this report).

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Fugitive light emissions may result in behavioural changes in fauna; disruption of seasonal day length, trigger changes in foraging behaviour	Appropriate lighting controls to minimise impacts will be implemented as part of the Proposed Modification as necessary (providing that these actions do not compromise site safety issues). There will be no substantial change to fugitive light emissions given that the Proposed Modification is already part of, and adjacent to an operation with existing impacts. Any additional impacts resulting from fugitive light emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Visual mitigation controls will continue to be implemented including: • ongoing management of mobile lighting to reduce the impacts of lighting at night, including the use of shields as required and the ongoing implementation of procedures about the appropriate placement of mobile lighting plant • night lighting will be kept to a minimum needed for operational management and safety to limit the extent of night lighting glow • all lighting will be installed and maintained in accordance with Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting.
	Noise and blasting impacts may disturb the roosting and foraging behaviour of fauna species and/or reduce the occupancy of areas of otherwise suitable habitat.	In regard to potential impacts on biodiversity, there will be no substantial change to noise impacts given that the Proposed Modification is part of, and adjacent to, an already existing operation with existing impacts. Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Noise minimisation strategies include: • continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages • monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management • operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria • blasts undertaken at the BCC will be managed so that relevant blast criteria is not exceeded at residences or other blast sensitive locations. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Air quality impacts; increased air pollutants for native species	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.
	Introduction of feral animals	Feral animal control will be undertaken in accordance with current mine practices and as outlined in the BMP. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Noise and blasting impacts may disturb the roosting and foraging behaviour of fauna species and/or reduce the occupancy of areas of otherwise suitable habitat.	In regard to potential impacts on biodiversity, there will be no substantial change to noise impacts given that the proposed mine operation is part of, and adjacent to, an already existing operation with existing impacts. Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities. Noise minimisation strategies include: • continuation of regular sound power screening testing that will assist in managing equipment sound power levels, and identify plant items requiring maintenance to noise attenuation packages • monitoring of real time meteorological conditions and forecasts will be continued to assist in noise management • operations will be modified, including relocation of noise generating equipment and/or progressive shutdown of equipment to maintain compliance with approved noise criteria • blasts undertaken at the BCC will be managed so that relevant blast criteria is not exceeded at residences or other blast sensitive locations. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place.
	Air quality impacts; increased air pollutants for native species	The design of the Proposed Modification will include inherent measures to minimise the potential for adverse air quality impacts. These include: • plant operator training and awareness of potentially adverse conditions • implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation • discussion of the dust forecast at daily pre-shift meetings • modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts • progressive rehabilitation and stabilisation of disturbed land • dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions.

EPBC Act Listed Threatened Species or Community	Impact	Avoidance and Mitigation Measures
	Introduction of feral animals	Feral animal control will be undertaken in accordance with current mine practices and as outlined in the BMP. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

8.1.3.3 Assessment of Outcomes and Effectiveness

The avoidance and mitigation measures proposed are expected to be effective in minimising the impact on the ecological features of the Development Footprint during construction and operation of the Proposed Modification.

As discussed in **Section 4**, it was not possible to avoid all biodiversity values without compromising the viability of the Proposed Modification given the location of the Development Footprint within the Project Area. However, given the small size of the habitat that will be impacted, the proposed mitigation measures will adequately compensate for the loss of biodiversity values.

The Proposed Modification will impact 19.2 hectares of open forest/woodland and 1 hectare of disturbed land in the Development Footprint. This area represents a small amount of moderate quality native vegetation that is extensively fragmented and has little to no connectivity value as the impact areas occur completely within mining operational areas. Extensive native vegetation is present to the east of the Bulga Coal Complex in the Singleton Military Training Area and represents a significant link between remnant patches of vegetation in the central Hunter Valley to the Wollemi National Park. These high quality forest and woodland areas will be included in the Biodiversity Offset Strategy, as detailed in **Section 7**.

Indirect impacts of the construction and operation of the project (i.e. noise, light, blasting impacts) on surrounding biodiversity values are expected to be minor as the Proposed Modification is already part of, and adjacent to, existing mining operations with existing indirect impacts. Potential impacts on EPBC listed threatened species and communities as a result of mine operations will continue to be managed as per existing site practices.

The Biodiversity Offset Strategy proposed as part of the Proposed Modification is expected to result in an increase in habitat quality at the proposed Vere Offset Site for the range of flora and fauna species and Critically Endangered Ecological Community impacted by the Proposed Modification. The increase in habitat quality is expected to result from the range of proposed management actions such as passive regeneration , as well as feral animal and over-abundant native herbivore control for certain zones of the offset sites. Following the implementation of these management measures, the proposed Biodiversity Offset Site has the potential to support an increased abundance of biodiversity in higher quality habitat.

BCM's rehabilitation objectives are to establish native woodland vegetation across majority of the operation including highwall benches and battered low wall slopes (except where benches used for drainage flows). The proposed extension of the mine life associated with the Proposed Modification will result in a delay to the implementation of some areas of rehabilitation at the Bulga Open Cut relative to the current approved operations however will not have a material impact on the final land use. A minimum of 2,500 hectares of woodland/open forest will be regenerated as part of the existing operations, and this number will not change as a result of the Proposed Modification.

8.1.4 Proposed Biodiversity Offset Strategy

A Biodiversity Offset Strategy is proposed to compensate for residual impacts on those species, vegetation communities and ecological features that are likely to be, or could potentially be, significantly impacted by the Proposed Modification at both the State and Commonwealth level. The Biodiversity Offset Strategy compensates for these residual impacts by using a direct land-based offset site.

BCM is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Proposed Modification.

It is currently proposed that the biodiversity offset strategy will consist of the in perpetuity conservation of one large Glencore owned land parcel proximate to the Proposed Modification which contains the required biodiversity credits for the Proposed Modification. The Proposed Vere Offset Site is located proximate to the Proposed Modification, conserving vegetation and habitats close to the Development Footprint and nearby Yengo National Park and Pokolbin State Forest.

A total of 931 ecosystem credits are required to offset the biodiversity impacts associated with the Proposed Modification. The proposed Vere Offset Site generates a total of 1627 ecosystem credits, which exceeds the ecosystem credit requirements of the Proposed Modification using the FBA 'like for like' rules and the proposed 'CEEC for CEEC' approach.

All offset methods proposed are considered 'like for like' in accordance with the Commonwealth Environmental Offsets Policy and the NSW Biodiversity Offset Policy for Major Projects. **Section 7.0** provides a description of the proposed Vere Offset Site.

8.1.5 Offset Liability and Conservation Benefit.

The Biodiversity Offset Strategy has been developed with the aim to maintain or improve the biodiversity values of the surrounding region in the medium to long term. With the various impact mitigation and offset strategies to be employed as part of the Proposed Modification, it is likely that such an improvement will occur, particularly given that the land-based offset component is strategically located adjacent to an existing Singleton Military Area.

The conservation benefit from the establishment of the proposed Vere Offset Site includes the in-perpetuity conservation of 81.1 hectares of PCTs conforming to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC. Overall the in-perpetuity conservation of the proposed Vere Offset represents 153.7 hectares of land (comprising 145.3 hectares of native vegetation) to offset 20.2 hectares of land (19.2 hectares of native vegetation) impacted in the Development Footprint. The offset lands have similar ecological values and are of a comparable quality to the impacted land in the Development Footprint, which will only improve as the offset site is managed for threats and passively regenerated. It is expected that the offset could provide suitable foraging habitat for the regent honeyeater and swift parrot, as the vegetation structure is comparable to that of the impacted area, and most of the vegetation communities are directly offset.

It is envisaged that based on the above, the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term for the EPBC Act listed threatened species and communities addressed in this document, as both the size and future ecological value of the offset sites far exceeds those of the Development Footprint.

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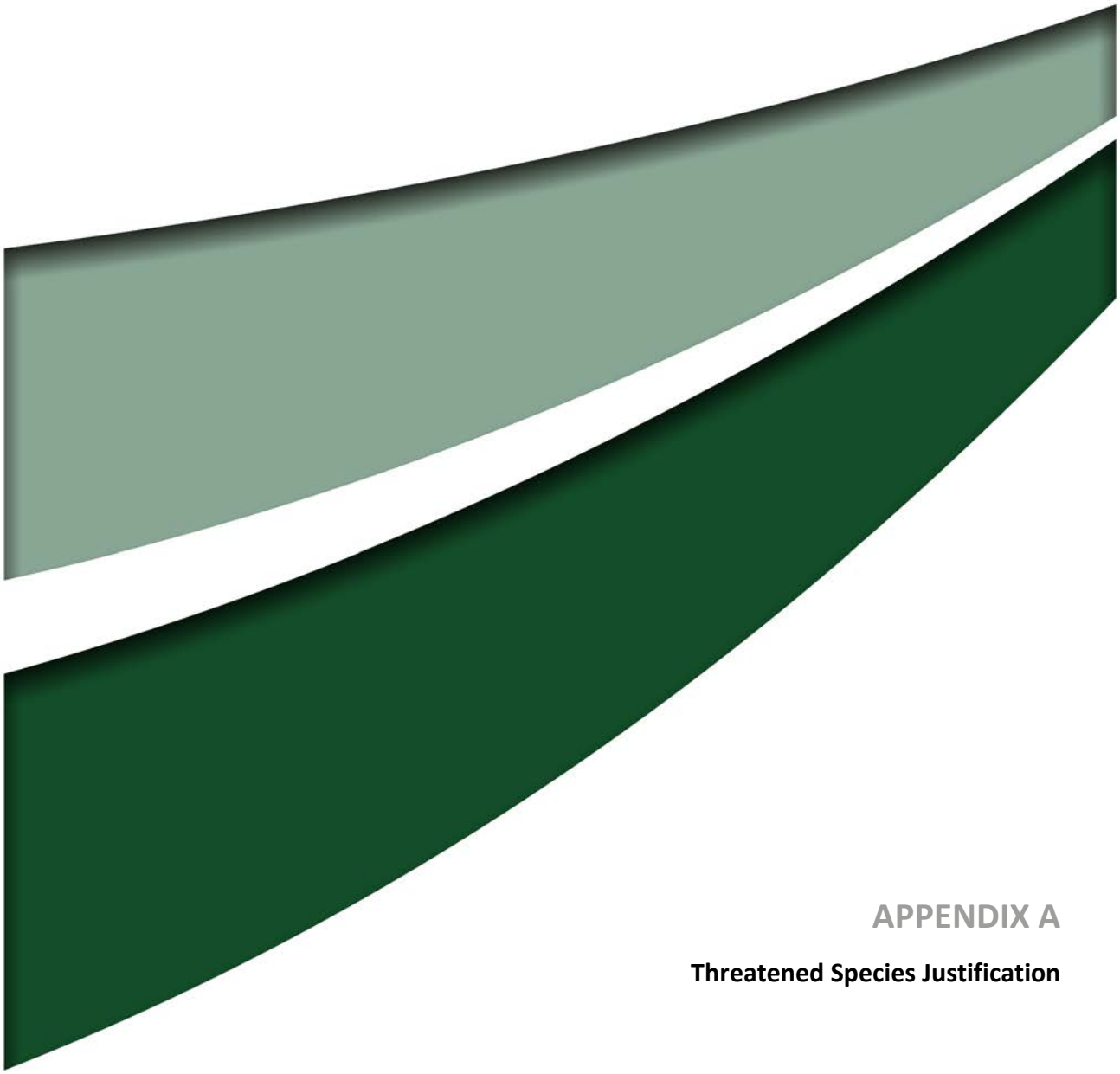


APPENDIX A

Threatened Species Justification

Threatened Species Assessment Justification

Table A1 below lists the flora and fauna species-credit species that were identified during database searches, a literature review and an assessment using the BioBanking Credit Calculator that are considered unlikely to occur due to lack of suitable habitat and/or absence of local records. **Table A1** provides an individual description of why each of the species was excluded from further assessment within the Development Footprint as per Section 6.5.1.6 of the FBA (OEH 2014b). In many cases, the seasonal survey requirements for these species were adequately covered during the species-credit flora and fauna species surveys outlined in **Section 2.3**.

Habitat and record information is derived from the BioNet Atlas of NSW Wildlife (OEH 2017a), OEH threatened species profiles (OEH 2017b), and DoEE (SPRAT) profiles (DoEE 2018b), unless otherwise noted.

1 BioBanking Credit Calculator
2 BioNet Atlas of NSW Wildlife
3 Protected Matters Search Tool
CE Critically Endangered
E Endangered
V Vulnerable

Table A1 – Threatened Species Assessment Justification

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Flora Species				
Bynoe's wattle *Acacia bynoeana*	E	V	3	This species is not known from the central Hunter Valley area. This species is known to occur from Morisset in Lake Macquarie, south to the Southern Highlands and west to the Blue Mountains and is associated with heath or dry sclerophyll forest on sandy soils. The nearest record of this species is over 20 kilometres to the east of the Development Footprint near Branxton. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (September-March) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Allocasuarina glareicola	E	E	3	This species is not known from the central Hunter Valley area. Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. The nearest record of this species is over 90 km to the southeast of the Development Footprint near Richmond. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since there are no nearby records.
Charmhaven Apple *Angophora inopina*	V	V	1	This species is not known from the central Hunter Valley area and is found close to the coast. Endemic to the Central Coast region of NSW, with a northern limit near Karuah. The nearest record of this species is approximately 25 km to the north of the Development Footprint near Mitchells Flat. This record represents an outlier of this typically more coastal species, with the next closest record 40 km near Mulbring. This species occurs in open woodland on deep white sandy soils over sandstone (Botanic Gardens Trust, 2017). Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
leafless tongue orchid *Cryptostylis hunteriana*	V	V	3	This species is not known from the central Hunter Valley area. This species occurs in a wide variety of habitats however is generally restricted to the coastal areas of NSW. The nearest record of this species is approximately 50 km to the south-east of the Development Footprint near Freemans Waterhole. Targeted floristic surveys and opportunistic observations undertaken during the detection period of this species (Nov-Feb) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since there are no nearby records.
Darwinia biflora	V	V	2	This species is all but absent from the central Hunter Valley area, with two outlier records of this species approximately 7 km to the west of the Development Footprint. This species distribution is centred around Sydney, with the northern, southern, eastern and western limits of its range comprising Maroota, North Ryde, Cowan and Kellyville. Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Targeted floristic surveys and opportunistic observations undertaken during the detection period of this species (Sep-Feb) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.
Broken Back Ironbark *Eucalyptus fracta*	V	-	2	This species is generally confined to the Broken Back Range, with no records on the Hunter Valley floor. The closest record is approximately 8 km to the south-east of the Development Footprint. Grows in dry eucalypt woodland in shallow soils on sandstone. Targeted floristic surveys and opportunistic observations undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Pokolbin mallee *Eucalyptus pumila*	V	V	3	This species is generally confined to the Broken Back Range. The closest record is approximately 12km away in Pokolbin State Forest. Targeted floristic surveys and opportunistic observations undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.
Euphrasia arguta	CE	CE	3	This species is not known from the central Hunter Valley area. This species was rediscovered in 2008 in the Nundle area and has since been recorded in the Barrington Tops. The nearest of these records is over 100 km to the north of the Development Footprint in the Barrington Tops. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since there are no nearby records.
Grove's Paperbark *Melaleuca groveana*	V	-	2	This species is not known from the central Hunter Valley area. Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. The nearest record of this species is approximately 9 km to the south-east of the Development Footprint in Yengo National Park. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
large-leafed monotaxis *Monotaxis macrophylla*	E	-	1	This species is not known from the central Hunter Valley area. This species only appears to be detectable following fire events and is known to grow on rocky ridges and hillsides. The nearest record of this species is over 45 km to the west of the Development Footprint in Wollemi National Park. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (June-Nov) did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable rocky habitat for this species. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
Olearia cordata	V	V	3	This species is not known from the central Hunter Valley area. Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges within the Wollemi and Yengo National Parks and further south near Wisemans Ferry. The nearest record of this species is over 20 km to the west of the Development Footprint in Wollemi National Park. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Omeo Storksbill *Pelargonium* sp. (G.W. Carr 10345)	E	E	3	This species is not known from the central Hunter Valley area. This species is known from four locations in NSW, with three on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst and grows at the edges of inundated and ephemeral lakes. The nearest record of this species is over 290 km to the south of the Development Footprint. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (Sept to May) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
hairy geebung *Persoonia hirsuta*	E	E	3	This species is not known from the central Hunter Valley area. The closest record occurs approximately 35km to the south in Yengo National Park. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Rufous Pomaderris *Pomaderris brunnea*	E	V	3	This species is not known from the central Hunter Valley area. This species is found in a very limited area around the Colo, Nepean and Hawkesbury Rivers and is also known near Walcha. This species is found in moist woodland or forest on clay and alluvial soils of floodplains and creek lines. The nearest record of this species is over 85 km to the west of the Development Footprint. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
Magenta Lilly Pilly *Syzygium paniculatum*	E	V	3	This species is not known from the central Hunter Valley area. The nearest record of this species is close to 30 kilometres to the east of the Development Footprint. This species mainly occurs in coastal littoral rainforest. Floristic surveys and targeted threatened flora walking transects undertaken during the detection period of this species (all year) did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable rainforest communities for this species. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Fauna Species (Species-credit)				
Booroolong frog *Litoria booroolongensis*	E	E	3	This species generally occurs west of the Great Dividing Range and the closest record is over 50km to the north in Mount Royal National Park. Nocturnal and diurnal amphibian surveys undertaken in October 2017 did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable aquatic habitat for this species. The booroolong frog has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
green thighed frog *Litoria brevipalmata*	V	-	1	This species occurs along the coast and ranges from just north of Wollongong to south-east Queensland and inhabits dry to moist eucalypt forest habitats. The closest record of the species occurs approximately 35 km to the east of the Development Footprint near Kurri Kurri. Nocturnal and diurnal amphibian surveys undertaken in October 2017 did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable aquatic habitat for this species. The green thighed frog has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Littlejohns tree frog *Litoria littlejohni*	V	-	3	This species occurs predominantly in the upper reaches of permanent streams and perched swamps along plateaus and eastern slopes of the Great Dividing Range. The closest record of the species occurs approximately 25 km to the south of the Development Footprint near Wollombi National Park and was recorded in 1980. Targeted nocturnal and diurnal amphibian surveys in October 2017 did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain permanent stream or swamp habitat for this species and it has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
giant burrowing frog *Heleioporus australiacus*	V	V	3	This species occurs in south-eastern NSW and is not known to occur north of the Wollemi National Park. In this area, this species occurs in hanging swamps on sandstone shelves and beside perennial creeks. The closest record of the species occurs approximately 30 km to the southwest of the Development Footprint in Wollemi National Park. Targeted nocturnal and surveys in October 2017 did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable hanging swamp or sandstone habitat for this species and it has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.

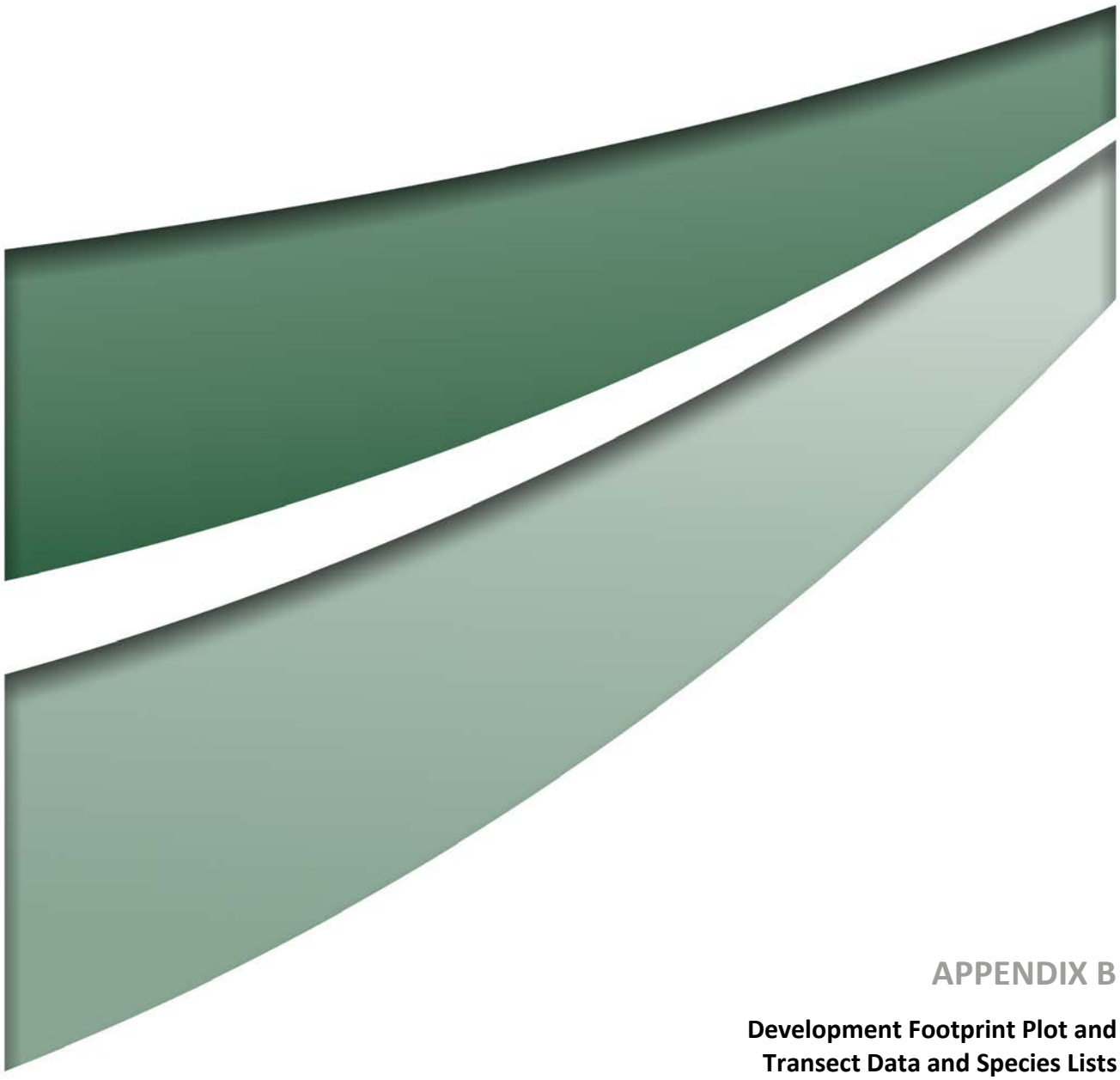
Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
broad-headed snake *Hoplocephalus bungaroides*	E	V	3	This species is largely confined to Triassic and Permian sandstones, where it shelters in rock crevices and under flat sandstone rocks on exposed cliff edges. During summer, it will shelter in hollows of large trees within 500 m of escarpments. Diurnal surveys undertaken for this assessment did not record this species in the Development Footprint. The closest records for this species occur approximately 70 km to the south of the Development Footprint in Yengo National Park. Furthermore, the Development Footprint does not contain suitable rocky escarpment habitat suitable for this species and it has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
black-necked stork *Ephippiorhynchus asiaticus*	E	-	2	This wide ranging species inhabits floodplain wetlands, coastal wetlands, minor floodplains and estuaries along coastal eastern Australia. Breeding habitat includes tall trees close to water where the species builds a large stick nest. Diurnal bird surveys and opportunistic surveys undertaken in August and October 2017 across the Development Footprint did not record the species. Moreover, there is limited low quality ephemeral drainage line habitat within the Development Footprint. The closest records of the species occur approximately 10 km to the west and north of the Development Footprint near Bulga and Mount Thorley, respectively. The species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since low quality habitat is present within the Development Footprint.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Australasian bittern *Botaurus poiciloptilus*	E	E	3	This species is typically confined to more coastal regions where the species is found in swamps and water bodies with dense tall stands of reeds. The closest record of the species occurs approximately 30 km to the south of the Development Footprint near Cessnock. Diurnal and nocturnal surveys undertaken for this assessment did not record this species in the Development Footprint. Furthermore, there is low quality drainage line habitat within the Development Footprint which does not contain dense tall stands of reeds suitable for this species. The species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint and there are no nearby records.
Eastern bristlebird *Dasyornis brachypterus*	E	E	3	This species typically occurs in dense coastal vegetation, with the closest known population occurring south of Sydney. Diurnal bird surveys undertaken in August 2017 across the Development Footprint did not record the species. Moreover, there is limited habitat within the Development Footprint. The closest records of the species occur approximately 41km to the south of the Development Footprint in Olney State Forest. The species has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.
common planigale *Planigale maculata*	V	-	1	This species has rarely been recorded in the Hunter Valley and all records occur north of Dungog and east of the Barrington Tops over 60 km from the Development Footprint. Remote camera surveys undertaken for this assessment did not record this species in the Development Footprint. Furthermore, remote camera surveys and spotlighting have been conducted as part of annual monitoring in the Bulga Coal Complex has not recorded this species in the wider locality in over 14 years of survey. This species does not require further assessment since there are no nearby records.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
brush-tailed rock-wallaby *Petrogale penicillata*	E	V	3	This species occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges. There are three records of the species within 10 km of the Development Footprint; one near Broke and the other two approximately 5 km to the south-west of the Development Footprint in Yengo National Park. These records occurred from 1995, 2003 and 2004. Diurnal surveys undertaken for this assessment did not record this species in the Development Footprint. Furthermore, the Development Footprint does not contain suitable rocky escarpment habitat suitable for this species and it has not been detected following many years of ecological surveys in the locality. This species does not require further assessment since suitable habitat is not present within the Development Footprint.
large-eared pied bat *Chalinolobus dwyeri* (breeding habitat only)	V	V	2, 3	Found mainly in areas with extensive cliffs and caves. Foraging records of this species have been recorded in the Development Footprint and wider locality as part of the historical fauna monitoring, Bulga Operations Project (Umwelt 2013) and the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). Potential breeding habitat along the escarpment to the south-east of the Development Footprint was also identified as part of the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). The species-credit component of this species includes breeding habitat in the form of escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels. The Development Footprint does not contain any aforementioned breeding habitat for this species. While it is acknowledged that suitable foraging habitat may occur, breeding habitat was not identified within the Development Footprint. Therefore, this species does not require further assessment.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
little bentwing-bat *Miniopterus australis* (breeding habitat only)	V	-	2	Breeding habitat for this species includes caves or similar structures. This species has not been recorded in the Development Footprint but foraging records have been recorded in wider locality as part of the Bulga Operations Project (Umwelt 2013) and the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). The species-credit component of this species includes breeding habitat comprising land containing caves or similar structures. The Development Footprint does not contain suitable breeding habitat for this species. While it is acknowledged that suitable foraging habitat may occur, breeding habitat is not present within the Development Footprint. Therefore, this species does not require further assessment.
eastern bentwing-bat *Miniopterus schreibersii oceanensis* (breeding habitat only)	V	-	2	Breeding habitat for this species includes caves or similar structures. This species has not been recorded in the Development Footprint but foraging records have been recorded in wider locality as part of the Bulga Operations Project (Umwelt 2013) and the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). The species-credit component of this species includes breeding habitat comprising land containing caves or similar structures. The Development Footprint does not contain suitable breeding habitat for this species. While it is acknowledged that suitable foraging habitat may occur, breeding habitat is not present within the Development Footprint. Therefore, this species does not require further assessment.

Common Name *Scientific Name*	BC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
southern myotis *Myotis macropus* (breeding habitat only)	V	-	2	Foraging records of this species have been recorded in the Development Footprint and wider locality as part of the historical fauna monitoring, Bulga Operations Project (Umwelt 2013) and the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). Habitat assessments to determine the extent of potential breeding habitat for the southern myotis (as per the OEH Guidelines for Assessing Myotis Breeding Habitat – OEH 2016d) were also undertaken within the Development Footprint. This did not identify any potential hollow roosting within areas of woodland within 200 metres of a water body. While it is acknowledged that suitable foraging habitat may occur, breeding habitat was not identified within the Development Footprint. Therefore, this species does not require further assessment.
eastern cave bat (*Vespadelus troughtoni*) (breeding habitat only)	V	-	2	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs. Foraging records of this species have been recorded in the Development Footprint and wider locality as part of the historical fauna monitoring, Bulga Operations Project (Umwelt 2013) and the Bulga Upper Hunter Strategic Assessment (Umwelt 2015). The species-credit component of this species includes breeding habitat in the form of land within 5 km of cliffs, caves, mines or tunnels. The Development Footprint does not contain any aforementioned breeding habitat for this species. While it is acknowledged that suitable foraging habitat may occur, breeding habitat was not identified within the Development Footprint. Therefore, this species does not require further assessment.



APPENDIX B

Development Footprint Plot and Transect Data and Species Lists

Plot and Transect Data

The following plot and transect data was collected from surveys of the Development Footprint. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the FBA (OEH 2014b). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Credit Calculator (Major Project type) to assess the site value of each PCT in the Development Footprint.

The following abbreviations or symbols are used in the list:

NPS	native plant species
NOC	native overstorey cover
NMC	native midstorey cover
NGCG	native ground cover (grasses)
NGCS	native ground cover (shrubs)
NGCO	native ground cover (other)
EPC	exotic plant cover
NTH	number of trees with hollows
OR	overstorey regeneration, and
FL	total length of fallen logs.

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 1: HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion – Moderate to Good													
4100_P03_Q	31	16.5	32.5	4	10	4	0	0	1	18	322581	6380278	56
4100_P07_Q	31	50.5	1.7	16	2	12	0	0	1	19	322484	6380386	56
Zone 2: HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion – Low													
4100_P08_Q	4	1	0	0	0	23	100	2	0	5	322477	6380388	56
Zone 3: HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter – Moderate to Good													
4100_P01_Q	32	28.5	5.5	10	24	2	0	0	1	20	322887	6380146	56
4100_P02_Q	27	14.5	6	10	14	2	0	0	1	14	322838	6380314	56
4100_P04_Q	32	13	0.2	46	10	6	0	1	1	37	322872	6380012	56
4100_P05_Q	24	6	2	30	22	22	0	0	1	0	323847	6381461	56

Flora Species List

The following list was developed from the systematic plot and transect surveys of the Development Footprint by Umwelt as outlined in **Section 2.2.3**. It includes all species of vascular plants observed during these surveys. It is acknowledged that the list is not comprehensive, as not all species are readily detected at any one time of the year. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

sp.	specimens that are identified to genus level only.

The following abbreviations or symbols are used in the list:

AR	denotes abundance rating according to BBAM 2014
C	cover measure according to BBAM 2014
asterisk (*)	denotes species non-native species
subsp.	subspecies and
var.	variety.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002) and Wheeler *et al.* (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from PlantNET (Botanic Gardens Trust 2017), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Family	Scientific Name	Common Name	P01		P02		P03		P04		P05		P07		P08	
			AR	C	AR	C	AR	C	AR	C	AR	C	AR	C	AR	C
Filicopsida (Ferns)																
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*	rock fern	5	0.1			10	0.1	10	0.1	5	0.1	10	0.1		
Magnoliopsida – Liliidae (monocots)																
Anthericaceae	*Dichopogon strictus*	chocolate lily					2	0.1								
Anthericaceae	*Laxmannia gracilis*	slender wire lily	2	0.1			10	0.1	20	0.1	10	0.1	1	0.1		
Cyperaceae	*Gahnia aspera*	rough saw-sedge			1	0.1										
Juncaceae	*Juncus acutus* subsp. *acutus**												1000	20	100	92
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*		5	0.1	2	0.1	10	0.1	20	0.1	100	0.2	10	0.1		
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush	10	0.5					1	0.1	5	0.2				
Phormiaceae	*Dianella caerulea*	blue flax-lily							1	0.1						
Phormiaceae	*Dianella revoluta*	blueberry lily	10	0.25												
Poaceae	*Ancistrachne uncinulata*	hooked-hairy panic grass											10	2.5		
Poaceae	*Aristida ramosa*	purple wiregrass	50	7	20	1			50	5	100	10	50	2		
Poaceae	*Aristida vagans*	threeawn speargrass	20	3	50	10	50	5	50	5	100	10	20	0.2		
Poaceae	*Austrostipa scabra* subsp. *falcata*	rough speargrass	5	0.2	20	0.25										
Poaceae	*Bothriochloa macra*	red grass	3	0.1	3	0.1			10	0.1	10	0.2				
Poaceae	*Chloris gayana**	Rhodes grass											2	0.1	30	0.1
Poaceae	*Chloris truncata*	windmill grass					2	0.1								
Poaceae	*Chloris ventricosa*	tall chloris	3	0.1	5	0.1			50	5	5	0.1				
Poaceae	*Cymbopogon refractus*	barbed wire grass	20	0.5	20	2	10	0.1	1	0.1	50	15	10	0.2		
Poaceae	*Cynodon dactylon*	common couch											100	2.5	50	0.1
Poaceae	*Echinopogon caespitosus*	bushy hedgehog-grass							1	0.1						
Poaceae	*Enteropogon acicularis*	curly windmill grass							3	0.1						
Poaceae	*Eragrostis brownii*	Browns lovegrass					10	0.1	100	5						
Poaceae	*Eragrostis leptostachya*	paddock lovegrass			100	1	50	0.25					3	0.1		
Poaceae	*Microlaena stipoides* var. *stipoides*	weeping grass					20	0.5								
Poaceae	*Panicum effusum*	hairy panic	1	0.1	5	0.1	3	0.1	5	0.25	10	0.2				
Poaceae	*Paspalidium distans*						20	1					1	0.1		
Poaceae	*Phragmites australis*	common reed											2	0.1	200	2
Poaceae	*Setaria sphacelata**	south African pigeon grass														
Poaceae	*Themeda australis*												1	0.1		
Typhaceae	*Typha orientalis*	broad-leaved cumbungi													100	1
Magnoliopsida – Magnoliidae (dicots)																
Acanthaceae	*Brunoniella australis*	blue trumpet	5	0.1	5	0.1	20	0.1	50	0.1			20	0.1		
Asteraceae	*Bidens pilosa**	Cobblers pegs					1	0.1								
Asteraceae	*Calotis lappulacea*	yellow burr-daisy														
Asteraceae	*Chrysocephalum apiculatum*	common everlasting							5	0.2	20	0.1				
Asteraceae	*Cirsium vulgare**	spear thistle			6	0.1										
Asteraceae	*Conyza bonariensis**	flaxleaf fleabane														
Asteraceae	*Olearia elliptica*	sticky daisy-bush	7	1	5	0.2							2	0.2		
Asteraceae	*Ozothamnus diosmifolius*	white dogwood					1	0.1			1	0.1				

Family	Scientific Name	Common Name	P01		P02		P03		P04		P05		P07		P08	
			AR	C	AR	C	AR	C	AR	C	AR	C	AR	C	AR	C
Asteraceae	*Senecio madagascariensis**	Fireweed					1	0.1	2	0.1	4	0.1	1	0.1	1	0.1
Asteraceae	*Solenogyne bellioides*	Solengyne			5	0.1	3	0.1	20	0.1						
Asteraceae	*Sonchus oleraceus**	common sowthistle			1	0.1										
Asteraceae	*Vernonia cinerea*												10	0.1		
Asteraceae	*Vittadinia* sp.	Fuzzweed	1	0.1												
Brassicaceae	*Lepidium africanum**	common peppercress									3	0.1				
Cactaceae	*Opuntia aurantiaca**	tiger pear	1	0.1												
Cactaceae	*Opuntia stricta**	common prickly pear	2	0.1			1	0.1	1	0.1						
Campanulaceae	*Wahlenbergia* sp.	Bluebell											1	0.1		
Casuarinaceae	*Allocasuarina luehmannii*	Bulloak	2	0.1	20	15	20	5	8	5	20	15	20	5		
Casuarinaceae	*Casuarina glauca*	swamp oak														
Celastraceae	*Maytenus silvestris*	narrow-leaved orangebark	3	0.3												
Chenopodiaceae	*Einadia hastata*	berry saltbush											2	0.1		
Chenopodiaceae	*Einadia nutans*	climbing saltbush	1	0.1												
Chenopodiaceae	*Einadia nutans subsp. nutans*	climbing saltbush					1	0.1			1	0.1				
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush	2	0.1							1	0.1				
Chenopodiaceae	*Maireana microphylla*	small-leaf bluebush									2	0.3				
Convolvulaceae	*Dichondra repens*	kidney weed									10	0.1	10	0.1		
Ericaceae	*Lissanthe strigosa*	peach heath	10	2	10	1	5	0.3	20	3	1	0.2	5	0.5		
Fabaceae (Faboideae)	*Daviesia ulicifolia*	gorse bitter pea							1	0.1						
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*										2	0.1				
Fabaceae (Faboideae)	*Glycine clandestina*	twining glycine	1	0.1	1	0.1	1	0.1	10	0.1			1	0.1		
Fabaceae (Faboideae)	*Glycine* sp.						1	0.1								
Fabaceae (Faboideae)	*Glycine tabacina*	variable glycine	5	0.1					1	0.1	20	0.1	50	0.1		
Fabaceae (Mimosoideae)	*Acacia amblygona*	fan wattle	10	2.5	10	0.5	3	0.2	10	2	10	0.5	10	2.5		
Fabaceae (Mimosoideae)	*Acacia parvipinnula*	silver-stemmed wattle					3	0.2					1	0.2		
Goodeniaceae	*Goodenia hederacea*	ivy goodenia	20	0.1	5	0.1	2	0.1	20	0.25	1	0.1	5	0.1		
Haloragaceae	*Haloragis heterophylla*	variable raspwort							1	0.1						
Loranthaceae	*Amyema* sp.	Mistletoe			1	0.5			1	0.25						
Myoporaceae	*Eremophila debilis*	Amulla	20	0.2	5	0.1	4	0.1	3	0.1	20	0.2	20	0.5		
Myrtaceae	*Angophora floribunda*	rough-barked apple														
Myrtaceae	*Corymbia maculata*	spotted gum	5	2.5												
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	20	15	7	6	5	3	20	15	2	5	5	1		
Myrtaceae	*Eucalyptus moluccana*	grey box			20	12										
Myrtaceae	*Melaleuca decora*						10	45	1	0.5			50	60	8	3
Phyllanthaceae	*Phyllanthus hirtellus*	thyme spurge					1	0.1								
Pittosporaceae	*Bursaria spinosa*	native blackthorn	10	5	5	1			3	0.5						
Plantaginaceae	*Veronica plebeia*	trailing speedwell	1	0.1					5	0.1						
Rubiaceae	*Opercularia diphylla*	Stinkweed					3	0.1								
Rubiaceae	*Pomax umbellata*	Pomax	3	0.1												
Santalaceae	*Choretrum* sp. A		2	1.5	2	1.5	1	0.1	1	0.2			1	0.2		
Santalaceae	*Exocarpos* sp.															
Sapindaceae	*Dodonaea viscosa subsp. cuneata*	wedge-leaf hop-bush	1	0.2			2	0.1					7	2.5		
Solanaceae	*Solanum nigrum**	black-berry nightshade														

Family	Scientific Name	Common Name	P01		P02		P03		P04		P05		P07		P08	
			AR	C	AR	C	AR	C	AR	C	AR	C	AR	C	AR	C
Solanaceae	*Solanum prinophyllum*	forest nightshade			1	0.2										
Stackhousiaceae	*Stackhousia muricata*	Stackhousia					1	0.1					1	0.1		
Stackhousiaceae	*Stackhousia* sp.				50	0.1										
Sterculiaceae	*Brachychiton populneus*	Kurrajong			1	0.2										
Verbenaceae	*Verbena bonariensis**	Purpletop														

Fauna Species List

The following list was developed from surveys of the Development Footprint. This species list was compiled from species data recorded during field surveys undertaken by Umwelt in 2017.

The following abbreviations or symbols are used in the list:

asterisk (*)	Denotes species not indigenous to Australia
subsp.	Subspecies
V	Vulnerable under Schedule 2 of the Biodiversity Conservation (BC) Act 2016
E	Endangered under Schedule 1 of the BC Act.

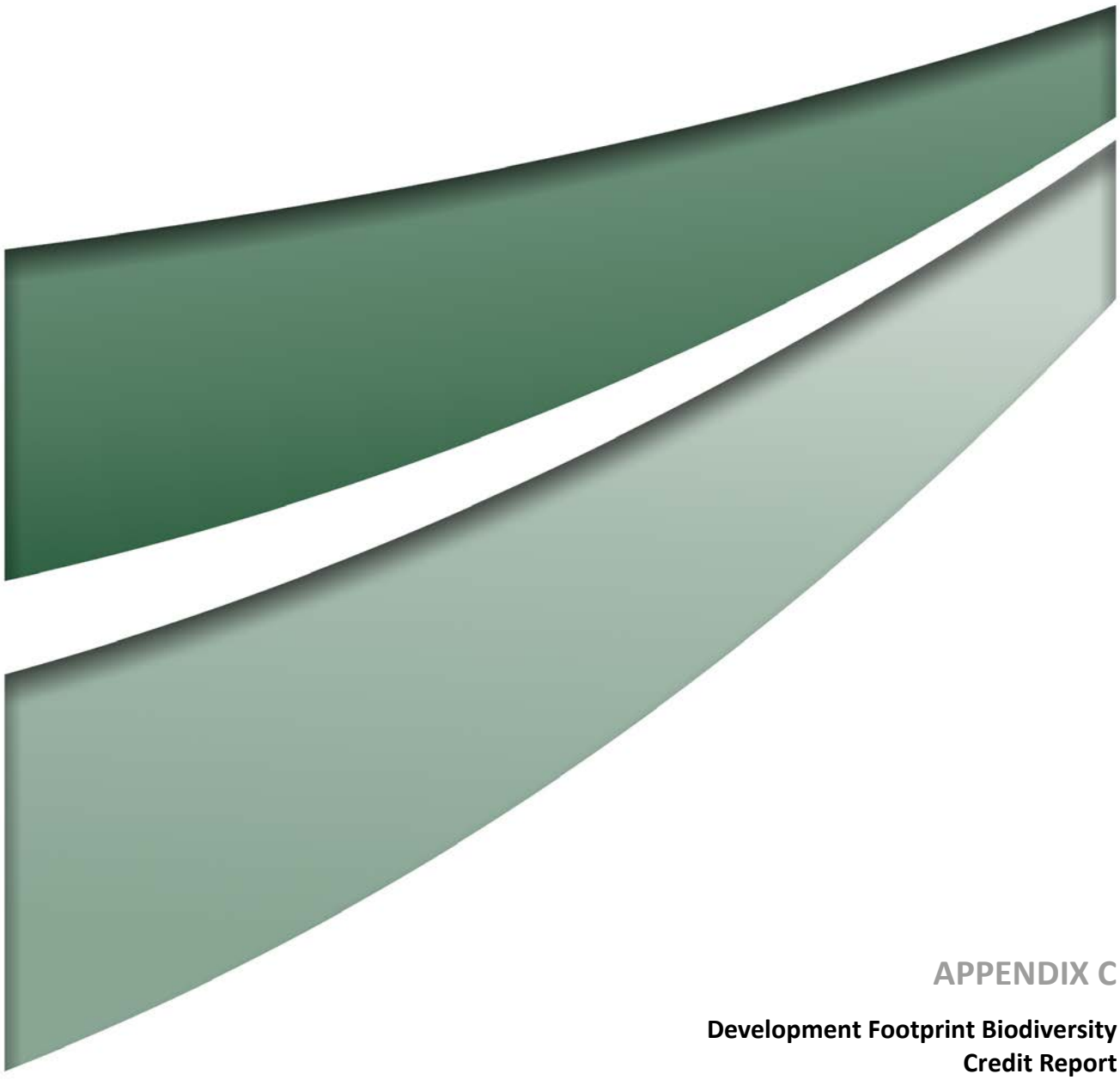
Birds recorded were identified using descriptions in Slater *et al.* (2009) and the scientific and common name nomenclature of BirdLife International Taxonomic Checklist (2017) (formerly Birds Australia). Reptiles recorded were identified using keys and descriptions in Cogger (2014), Swan *et al.* (2004), Weigel (1990) and Wilson and Swan (2003) and the scientific and common name nomenclature of Cogger (2014).

Amphibians recorded were identified using keys and descriptions in Cogger (2014), Robinson (1998), Anstis (2013) and Barker *et al.* (1995) and the scientific and common name nomenclature of Cogger (2014). Mammals recorded were identified using keys and descriptions in Strahan (2002), Van Dyck, D. and Strahan, R. (2008) and Menkhorst and Knight (2010) and the scientific and common name nomenclature of Strahan (2002) and Van Dyck, D. and Strahan, R. (2008) for non-bat species.

Scientific Name	Common Name	Conservation Status	
		BC Act	EPBC Act
BIRDS			
Falconidae			
Falco cenchroides	nankeen kestrel		
Podargidae			
Podargus strigoides	tawny frogmouth		
Psittacidae			
Trichoglossus haematodus	rainbow lorikeet		
Maluridae			
Malurus cyaneus	superb fairy-wren		
Pardalotidae			
Pardalotus punctatus	spotted pardalote		
Acanthizidae			
Acanthiza chrysorrhoa	yellow-rumped thornbill		
Acanthiza nana	yellow thornbill		
Acanthiza reguloides	buff-rumped thornbill		
Chthonicola sagittata	speckled warbler	V	
Smicrornis brevirostris	weebill		

Scientific Name	Common Name	Conservation Status	
		BC Act	EPBC Act
Meliphagidae			
Lichenostomus chrysops	yellow-faced honeyeater		
Manorina melanocephala	noisy miner		
Melithreptus brevirostris	brown-headed honeyeater		
Philemon corniculatus	noisy friarbird		
Petroicidae			
Eopsaltria australis	eastern yellow robin		
Petroica goodenovii	red-capped robin		
Petroica rosea	rose robin		
Pomatostomidae			
Pomatostomus temporalis temporalis	grey-crowned babbler (eastern subsp.) **(nest)**	V	
Pachycephalidae			
Pachycephala pectoralis	golden whistler		
Pachycephala rufiventris	rufous whistler		
Dicruridae			
Grallina cyanoleuca	magpie-lark		
Rhipidura fuliginosa	grey fantail		
Rhipidura leucophrys	willie wagtail		
Campephagidae			
Coracina novaehollandiae	black-faced cuckoo-shrike		
Lalage tricolor	white-winged triller		
Oriolidae			
Oriolus sagittatus	olive-backed oriole		
Artamidae			
Cracticus nigrogularis	pied butcherbird		
Gymnorhina tibicen	Australian magpie		
Strepera graculina	pied currawong		
Corvidae			
Corvus coronoides	Australian raven		
Corcoracidae			
Corcorax melanorhamphos	white-winged chough		
Hirundinidae			
Hirundo neoxena	welcome swallow		
Zosteropidae			

Scientific Name	Common Name	Conservation Status	
		BC Act	EPBC Act
Zosterops lateralis	silvereye		
REPTILES			
Gekkonidae			
Diplodactylus vittatus	stone gecko		
Varanidae			
Varanus varius	lace monitor		
Agamidae			
Amphibolurus muricatus	jacky lizard		
Pogona barbata	eastern bearded dragon		
Scincidae			
Carlia tetradactyla	southern rainbow skink		
Cryptoblepharus virgatus	cream-striped shinning-skink		
Egernia striolata	tree skink		
MAMMALS			
Tachyglossidae			
Tachyglossus aculeatus	short-beaked echidna		
Petauridae			
Petaurus norfolcensis	squirrel glider	V	
Phalangeridae			
Trichosurus vulpecula	common brushtail possum		
Macropodidae			
Macropus giganteus	eastern grey kangaroo		
Macropus rufogriseus	red-necked wallaby		
Muridae			
Rattus fuscipes	bush rat		
**Rattus rattus*	black rat		
Canidae			
**Canis familiaris*	dog **(scats)**		
**Vulpes vulpes*	fox		
Felidae			
**Felis catus*	cat		



APPENDIX C

Development Footprint Biodiversity Credit Report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 3/12/2018 Time: 2:46:50PM Calculator version: v4.0

Major Project details

Proposal ID:	0113/2017/4585MP
Proposal name:	Bulga Extension Project
Proposal address:	na Mount Thorley NSW 2330
Proponent name:	Glencore
Proponent address:	na na NSW 2330
Proponent phone:	na
Assessor name:	Ryan Parsons
Assessor address:	75 York Street TERALBA NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	0113

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion	2.80	62.68
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	16.40	868.00
Total	19.20	931

Credit profiles

1. Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter, (HU817)

Number of ecosystem credits created	868
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter, (HU817) Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley, (HU652) White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley, (HU730) Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter, (HU905)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564)

Number of ecosystem credits created	8
IBRA sub-region	Hunter

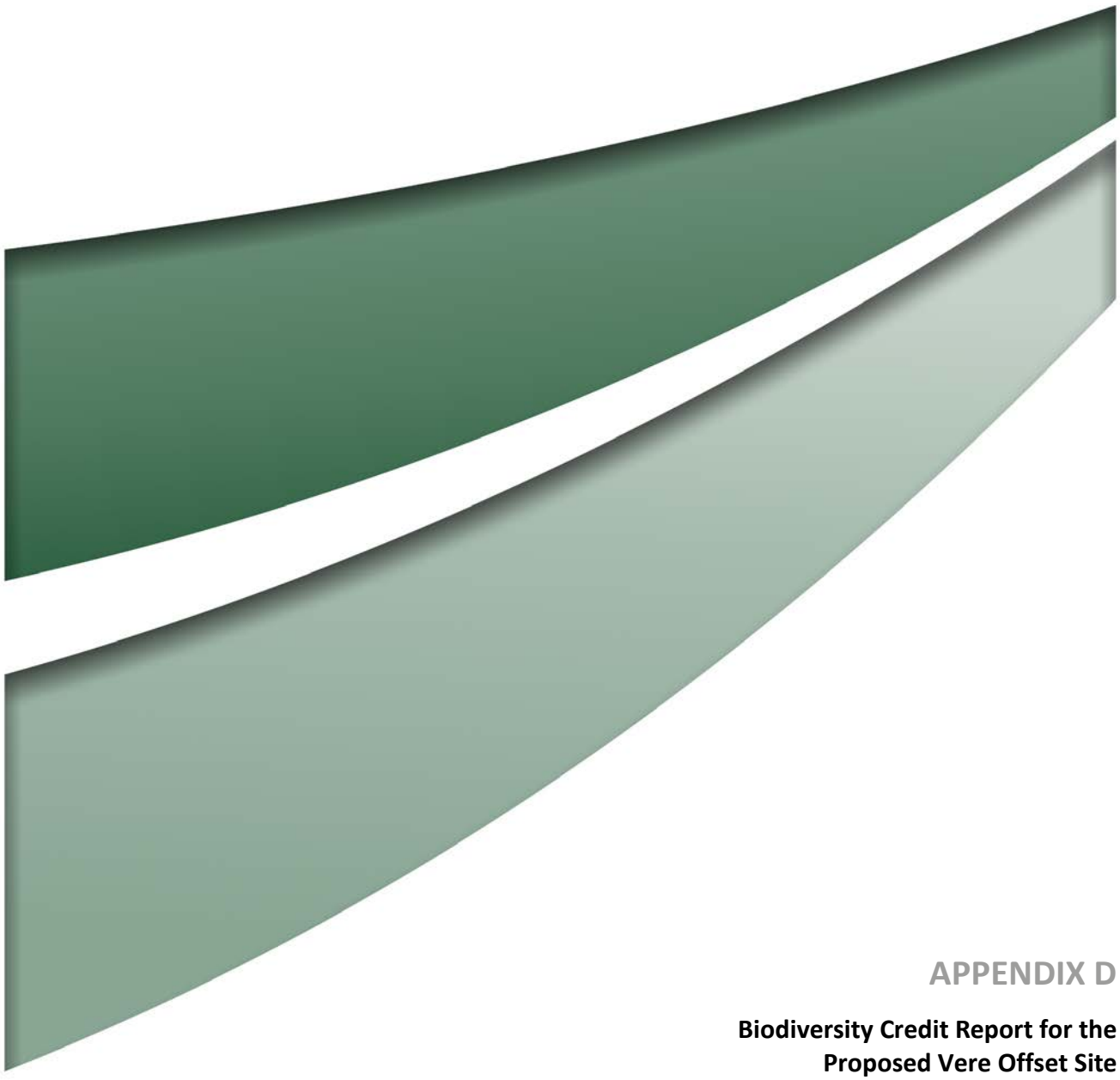
Offset options - Plant Community types	Offset options - IBRA sub-regions
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast, (HU802) Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter, (HU814) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815) Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816) Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter, (HU822)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564)

Number of ecosystem credits created	55
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast, (HU802) Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter, (HU814) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815) Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816) Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter, (HU822)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required



APPENDIX D

Biodiversity Credit Report for the Proposed Vere Offset Site

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 27/05/2019 Time: 5:07:46PM Calculator version: v4.0

Biobank details

Proposal ID:	0113/2018/4919B
Proposal name:	Bulga Vere Offset
Proposal address:	Broke Road Bulga NSW 2330
Proponent name:	Bulga Coal
Proponent address:	Broke Road Bulga NSW 2330
Proponent phone:	0
Assessor name:	Ryan Parsons
Assessor address:	75 York Street TERALBA NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	0113

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Bull Oak grassy woodland of the central Hunter Valley	7.00	78.00
Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.80	8.00
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion	1.50	15.00
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	134.70	1,510.00
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	1.30	16.00
Total	145.30	1,627

Credit profiles

1. Bull Oak grassy woodland of the central Hunter Valley, (HU906)

Number of ecosystem credits created	78
IBRA sub-region	Hunter

2. Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564)

Number of ecosystem credits created	15
IBRA sub-region	Hunter

3. Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815)

Number of ecosystem credits created	1,508
IBRA sub-region	Hunter

4. Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815)

Number of ecosystem credits created	2
IBRA sub-region	Hunter

5. Forest Red Gum grassy open forest on floodplains of the lower Hunter, (HU812)

Number of ecosystem credits created	8
IBRA sub-region	Hunter

6. Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley, (HU945)

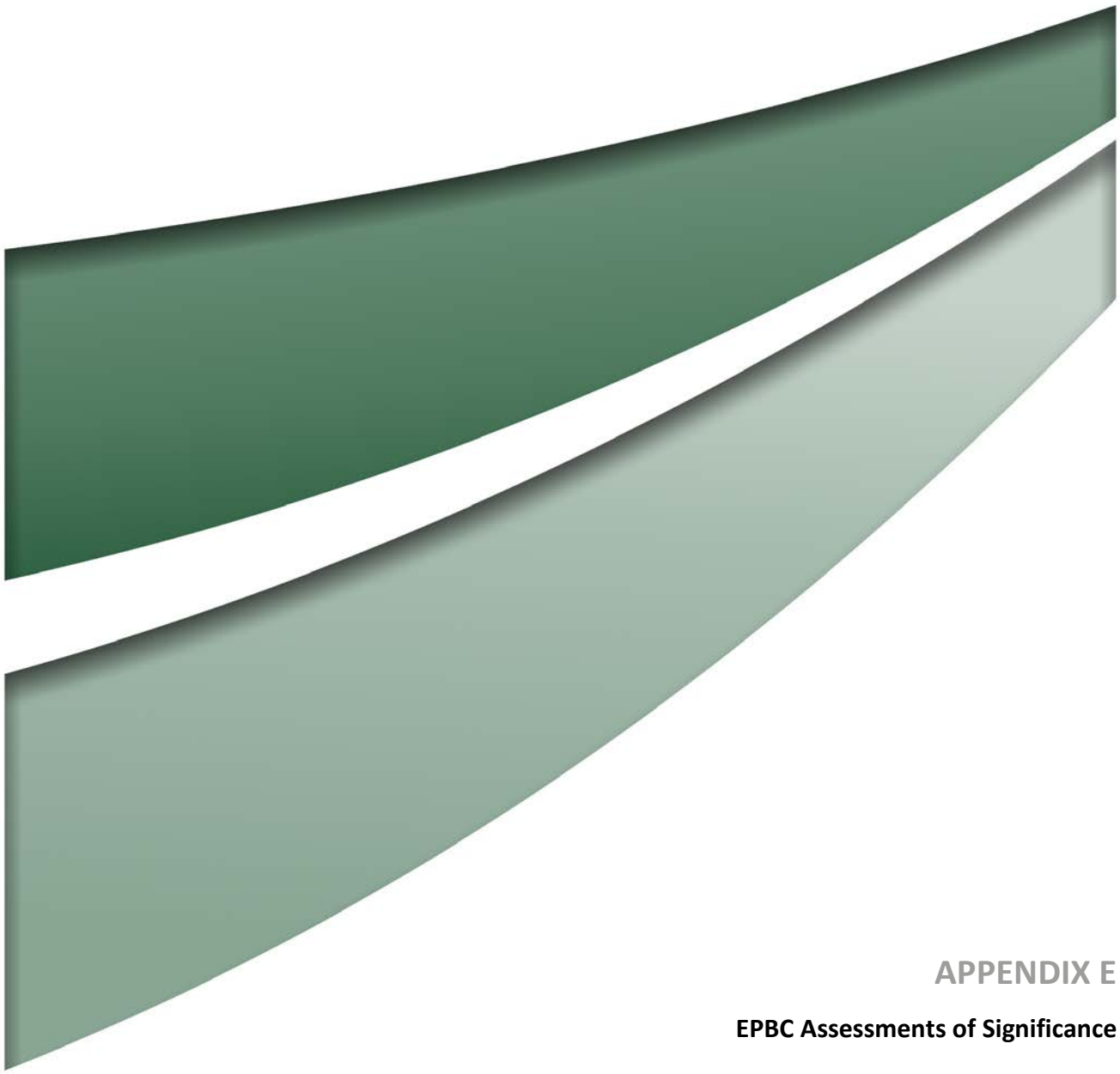
Number of ecosystem credits created	16
IBRA sub-region	Hunter

Species credits summary

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Bull Oak grassy woodland of the central Hunter Valley	Exclude commercial apiaries
Bull Oak grassy woodland of the central Hunter Valley	Exclude miscellaneous feral species
Bull Oak grassy woodland of the central Hunter Valley	Feral and/or over-abundant native herbivore control
Bull Oak grassy woodland of the central Hunter Valley	Fox control
Bull Oak grassy woodland of the central Hunter Valley	Slashing
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Exclude commercial apiaries
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Exclude miscellaneous feral species
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Feral and/or over-abundant native herbivore control
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Fox control
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion	Fox control
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	Exclude commercial apiaries
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	Exclude miscellaneous feral species
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	Feral and/or over-abundant native herbivore control
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	Fox control
Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	Slashing
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Control of feral pigs
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Exclude miscellaneous feral species
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Feral and/or over-abundant native herbivore control
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Fox control



APPENDIX E

EPBC Assessments of Significance

Appendix E Assessment of Significance

The information in **Table E1, E2** and **E3** provides a detailed assessment of the impact of the Proposed Action on MNES that DoEE have identified as being significantly impacted by the Proposed Modification in their Controlled Action decision.

The EPBC Act requires an Assessment of Significance relating to the potential impacts of a proposed action on listed MNES. These assessments have been conducted in accordance with the Significant Impact Guidelines 1.1 (DoE 2013b) and is based on the current mine plan.

As outlined in **Section 8**, the following EPBC Act listed species and communities are considered by DoEE to be significantly impacted by the Proposed Action and are subject to an Assessment of Significance below:

Critically Endangered or Endangered Ecological Communities

- *Central Hunter Valley Eucalypt Forest and Woodland*

Critically Endangered and Endangered Species

- regent honeyeater (*Anthochaera phrygia*)
- swift parrot (*Lathamus discolor*).

Table E1 Central Hunter Eucalypt Forest and Woodland CEEC

Central Hunter Eucalypt Forest and Woodland CEEC	
Criteria (Critically Endangered Ecological Community)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community	Approximately 16.4 hectares that conforms to the CEEC was identified within the Development Footprint and will be directly impacted as a result of the Proposed Action. The total current extent of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* is estimated to be approximately 37,000 hectares (TSSC 2015a). The permanent loss of approximately 16.4 hectares of the CEEC as a result of the Proposed Action represents a negligible reduction in the estimated current extent of the community across its range, estimated to be approximately 0.044 per cent of the current extent of the community.
Fragment or increase fragmentation of an ecological community	This ecological community has been heavily cleared across most of its range. The remaining extent of the ecological community is highly fragmented, occurring in small isolated patches, most of which are less than 10 hectares in size (TSSC 2015a). Vegetation occurring within the Development Footprint is currently highly fragmented as a result of historic agricultural land practices. The removal of 16.4 hectares of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* will result in an increase in the fragmentation of the community. The level of fragmentation will increase in the local area with the removal of remnants totalling 16.4 hectares, however given the current extent of approximately 37,000 hectares of the CEEC, the level of increase in fragmentation is considered to be negligible across its range.
Adversely affect habitat critical to the survival of an ecological community	The approved conservation advice for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* identifies any areas that meet the minimum moderate quality condition class as being areas critical to the survival of the community. Areas of moderate/high quality condition of the CEEC occur within the Development Footprint, however given the current approximate extent of the community over its range (37,000 hectares), the removal of the small area of CEEC resulting from the Proposed Action is considered unlikely to affect the survival of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.
Modify or destroy abiotic factors necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	While approximately 16.4 hectares of the CEEC will be removed from the Development Footprint, the Proposed Action is not expected to adversely affect retained areas of the CEEC occurring outside the Development Footprint as the Proposed Action has been designed to avoid offsite impacts. The Proposed Modification is unlikely to modify or destroy the abiotic factors that affect the survival of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* in surrounding areas.

Central Hunter Eucalypt Forest and Woodland CEEC	
Criteria (Critically Endangered Ecological Community)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
Cause substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species	The Proposed Action will result in removal of approximately 16.4 hectares of *the Central Hunter Valley Eucalypt Forest and Woodland CEEC* within the Development Footprint. This reduction in the extent of the CEEC is not expected to result in a substantial change in native species composition in the wider locality such that the composition of species in adjacent areas of CEEC is affected.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species that are harmful to the listed ecological community to become established	No substantial reduction in the quality or integrity of the surrounding or nearby occurrences of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* is considered likely to occur as a result of the Proposed Action. The removal of approximately 16.4 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* is unlikely to result in assisting any invasive species that is harmful to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* to become established.
• causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	The Proposed Action is not expected to cause regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the surrounding extent of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.
Interfere with the recovery of an ecological community	The removal of 16.4 hectares of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* as a result of the Proposed Action will interfere with the recovery of the CEEC in a minor way. A comprehensive offset strategy will be implemented to offset the impacts associated with the Proposed Action in accordance with the Commonwealth Environmental Offsets Policy and the NSW Biodiversity Offset Policy for Major Projects.
Conclusion: The proposed action is considered to constitute a minor impact on the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. DoEE has determined that the Proposed Action is likely to result in a significant impact and Section 8 of this report further details the predicted impacts associated with the Proposed Modification.	

Table E2 Regent Honeyeater (*Anthochaera phrygia*)

Regent Honeyeater (*Anthochaera phrygia*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	The regent honeyeater is endemic to mainland south-eastern Australia and mostly inhabits inland slopes of the Great Dividing Range (Saunders and Tzaros 2011). The regent honeyeater comprises a single population, with some exchange of individuals between regularly used areas (CoA 2016). As at 2010, the total population size is estimated at 350–400 mature individuals (CoA 2016). The population of regent honeyeater has not been recorded within the Development Footprint, however it has been recorded approximately 1 kilometre north of the Development Footprint in planted eucalypts in the Bulga Coal Complex site office carpark in 2011 during the surveys for the Bulga Optimisation Project (Umwelt 2013). The Project may result in the loss of approximately 0.1 hectares of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young spotted gum (*Corymbia maculata*), a key tree species listed for the regent honeyeater. The Development Footprint is not known as a historical or important foraging or nesting site for this species. It is considered unlikely that the Proposed Action will lead to a decrease in the size of the population of regent honeyeater.
Reduce the area of occupancy of the species	The impact of the proposed development will reduce 16.4 hectares of potential foraging habitat in the form of *Central Hunter Eucalypt Forest and Woodland CEEC*. While the Development Footprint contains potential foraging habitat for the species, it has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency and localised occurrence of a small number (5 trees out of 25 in a 400m2 plot) of reasonably young key feed trees (CoA 2016) and the small number of individuals remaining in the population utilising other higher quality habitats in NSW. All trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH) according to the OEH Biodiversity Assessment Method. While the Project will remove potential foraging habitat for the regent honeyeater, it is not likely to lead to a significant reduction in foraging habitat in the locality or the wider region.
Fragment an existing population into two or more populations	The population of the regent honeyeater has not been recently recorded within the Development Footprint and has only been occasionally recorded in the wider locality. As some habitat containing key feed trees will be removed as part of the Project, the level of fragmentation will increase for this species in the locality. However, given the highly dispersive nature of the regent honeyeater and the extensive areas of suitable and known foraging habitat in the surrounding area, it is unlikely that the Project would create a significant change to the species' dispersal capacity or create a significant barrier to the movement of the species that would result in the existing population being fragmented.

Regent Honeyeater (*Anthochaera phrygia*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
Adversely affect habitat critical to the survival of a species	Habitat critical to the survival of the regent honeyeater includes any breeding or foraging areas where the species is likely to occur and any newly discovered breeding or foraging locations (CoA 2016). The species has not been recorded breeding in the Development Footprint and is not considered likely to occur. The Development Footprint does include vegetation containing spotted gum which is a key feed tree species for the regent honeyeater (CoA 2016) in the Hunter Valley, however this is in the form of a small number of reasonably young individuals. All trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH) according to the OEH Biodiversity Assessment Method. These reasonably young spotted gums comprise approximately 0.1 ha of potential woodland foraging habitat for the regent honeyeater, which will be removed as part of the Proposed Action. Given the small area of potential low quality habitat to be removed, the Proposed Action is unlikely to adversely affect habitat that is critical to the survival of a population of the regent honeyeater.
Disrupt the breeding cycle of a population	The regent honeyeater mainly breeds in three key sites in NSW being the Bundarra-Barraba area, the Capertee Valley, and the Lower Hunter Valley and one key site the Chiltern area in north-east Victoria (CoA 2016). Other breeding areas are known in the Pilliga woodlands and the Mudgee-Wollar areas of NSW. The regent honeyeater has not been recorded in the Development Footprint and it is unlikely to contain breeding or nesting habitat for the species. The Proposed Action is not expected to disrupt the breeding cycle of the population of regent honeyeater.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The regent honeyeater is considered to have potential to occur in areas of appropriate winter-flowering eucalypt habitat. The Proposed Action will remove approximately 0.1 hectares of vegetation that contains very low abundance and localised occurrence of a small number of reasonably young spotted gum (*Corymbia maculata*), which is a key tree species listed for the regent honeyeater as per the National Recovery Plan for the species (CoA 2016). The lower Hunter area supports other areas of habitat that contain suitable woodland and forest vegetation that would also provide potential habitat for this species such as the Wollemi National Park and Mt Royal National Park. It is considered unlikely that the Proposed Action would modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that a *population* of the regent honeyeater would decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	According to the National Recovery Plan (CoA 2016) the regent honeyeater faces increased competition from larger, more aggressive nectarivores, such as the noisy friarbird (*Philemon corniculatus*), red wattlebird (*Anthochaera carunculata*) and the noisy miner (*Manorina melanocephala*). Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners was listed as a key threatening process under the EPBC Act in May 2014. Surveys of the Development Footprint indicate that noisy friarbirds and noisy miners are already established in this area, likely

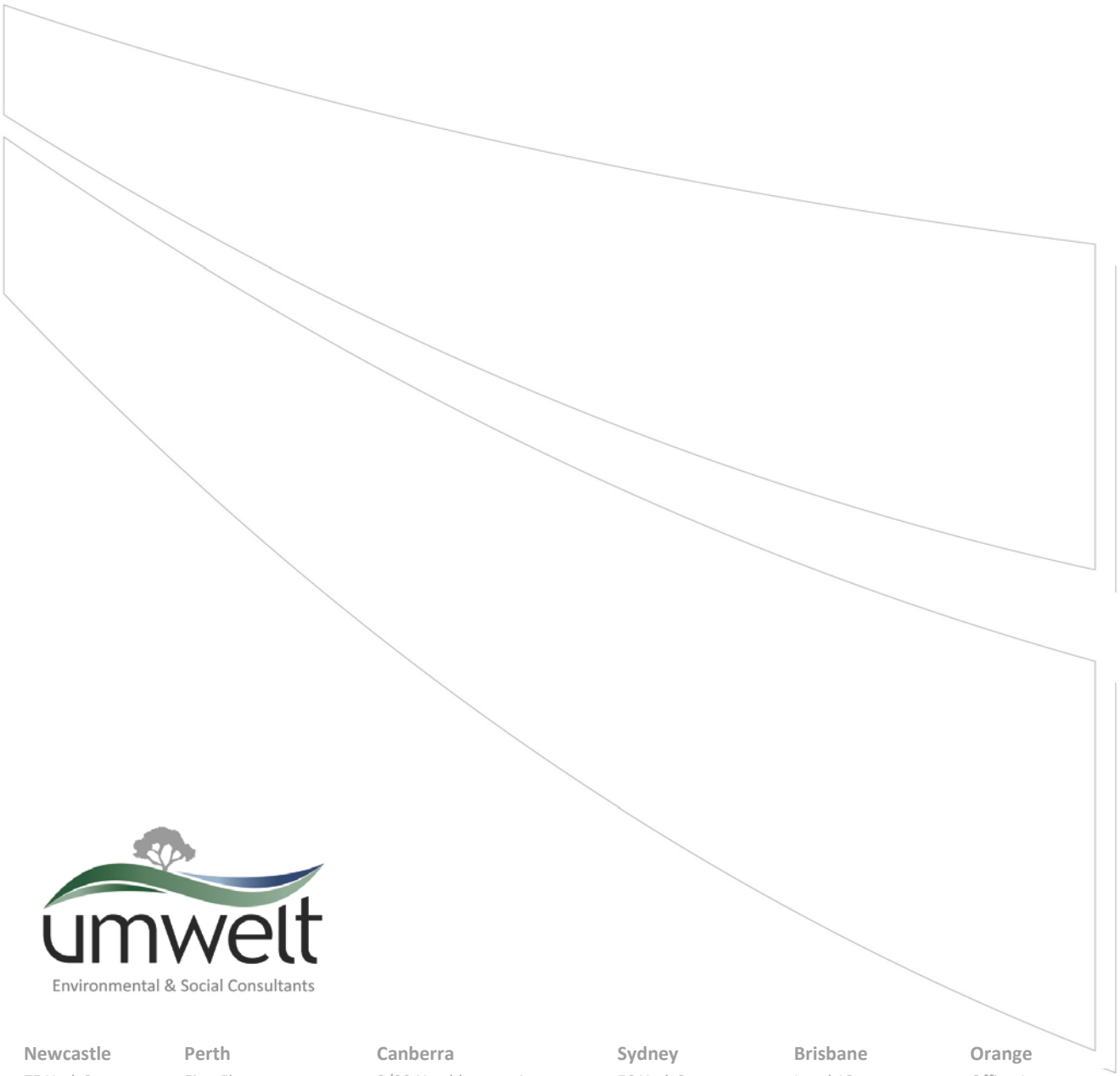
Regent Honeyeater (*Anthochaera phrygia*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
	due to the existing fragmented and young woodland habitat. The Project is not expected to result in an increase in additional invasive species that are harmful to the regent honeyeater becoming further established in the species habitat.
Introduce disease that may cause the species to decline, or	No diseases are directly attributed to the decline in the regent honeyeater population. The Project is not expected to introduce any disease that may cause the regent honeyeater to decline.
Interfere substantially with the recovery of the species.	The National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) (CoA 2016) has been prepared for this species. Any impacts to known habitat for the regent honeyeater will likely contravene the objectives of the recovery plan. The regent honeyeater has not been recorded within the Development Footprint, however potential foraging habitat has been identified. It is considered unlikely that the Proposed Modification will substantially interfere with the recovery of the regent honeyeater.
Conclusion: The proposed action is considered to constitute a minor impact on the *regent honeyeater*. DoEE has determined that the Proposed Action is likely to result in a significant impact and Section 8 of this report further details the predicted impacts associated with the Proposed Modification.	

Table E3 Swift Parrot (*Lathamus discolor*)

Swift Parrot (*Lathamus discolor*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	The swift parrot occurs as a single population that migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders and Tzaros 2011). Approximately 200 mature birds (10 per cent of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Roderick et al. 2013). As the species occurs as a single population in Australia, any record of the species would constitute a part of a population as described above. This species has not been recorded within the Development Footprint or the locality despite targeted winter bird surveys undertaken in August 2017 as well as monitoring surveys undertaken annually in the Bulga Coal Complex. This species has been recorded in 2012 in the wider locality (in planted eucalypts in the Bulga Coal Complex site office carpark) during the surveys for the Bulga Optimisation Project (Umwelt 2013). Other records of this species occur in the Singleton Military Area and Pokolbin State Forest, which contains key foraging habitat. The Development Footprint contains very low abundance and localised occurrence of potential foraging habitat for this species. In accordance with the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011) approximately 0.1 ha of potential woodland foraging habitat occurs within the Development Footprint, based on the presence of spotted gum (*Corymbia maculata*) which is identified as key foraging resources for the swift parrot in the Hunter Valley. We note that *Central Hunter Valley Eucalypt Forest and Woodland CEEC* is broadly known to provide habitat for this species in the Hunter Valley, where it contains spotted gum (*Corymbia maculata*). Analysis of the constituent canopy species in this CEEC was undertaken to determine the extent of potential foraging habitat for the swift parrot within this vegetation community and it was found that characteristic species spotted gum (*Corymbia maculata*) was present in the Development Footprint albeit at very low abundances and localized occurrence constituting a small number of reasonably young trees. Overall, the vegetation within the Development Footprint is highly fragmented and dominated by non-key tree species that are not considered to comprise likely foraging habitat for the swift parrot. It is considered unlikely that the Proposed Action will lead to a decrease in the size of the population of swift parrot.
Reduce the area of occupancy of the species	The impact of the proposed development will reduce 0.1 hectares of potential foraging habitat in the form of *Central Hunter Eucalypt Forest and Woodland CEEC*. While the Project will remove potential foraging habitat for the swift parrot, it is not likely to lead to a significant reduction in foraging habitat in the locality or the wider region.
Fragment an existing population into two or more populations	The population of the swift parrot has not been recently recorded within the Development Footprint and has only been occasionally recorded in the wider locality. As some habitat containing key feed trees will be removed as part of the Project, the level of fragmentation will increase for this species in the locality. However, given the highly dispersive nature of the swift

Swift Parrot (*Lathamus discolor*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
	parrot and the extensive areas of suitable and known foraging habitat in the surrounding area, it is unlikely that the Project would create a significant change to the species' dispersal capacity or create a significant barrier the movement of the species that would result in the existing population being fragmented.
Adversely affect habitat critical to the survival of a species	Habitat critical to the survival of the swift parrot includes those areas of priority habitat for which the species has a level of site fidelity or possess phenological characteristics likely to be of importance to the swift parrot (Saunders and Tzaros 2011). The swift parrot has not been recorded within the Development Footprint and has not shown site fidelity to the habitats of the Development Footprint. The Development Footprint includes approximately 0.1 hectares of vegetation that contains very low abundance of reasonably young spotted gum (*Corymbia maculata*), which is a key feed tree species for the swift parrot in the Hunter-Central Rivers area (Saunders and Tzaros 2011). However, all trees sampled in this area have a diameter at breast height (DBH) less than 49 cm (all but two are less than 29 cm) and no large trees (defined as greater than 50 cm DBH) according to the OEH Biodiversity Assessment Method. The Proposed Action will remove native vegetation communities within the Development Footprint including fragmented young eucalypt woodland. None of the habitats in the Development Footprint have been recorded as being used by the swift parrot. No known habitat for the swift parrot occurs within the Development Footprint, however the Proposed Action may result in the loss of potential low quality habitat for the species. Breeding habitat, which is restricted to Tasmania, will not be affected by the Proposed Action. The Proposed Action is unlikely to adversely affect habitat that is critical to the survival of the species.
Disrupt the breeding cycle of a population	The swift parrot breeds and nests exclusively in Tasmania and migrates to mainland Australia during the non-breeding season. There is no potential for breeding habitat to occur in the Development Footprint. The Project is not expected to disrupt the breeding cycle of the population of swift parrot.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The swift parrot has been recorded in the region near Cessnock, Broke, Yengo National Park, and the Singleton Military Area, however most records are concentrated in the lower Hunter Valley. The closest record is approximately 1.2 kilometres to the south of the Development Footprint in 2012, however this species has not been recorded within the Development Footprint despite targeted surveys. The swift parrot is considered to have potential to occur in areas of potential habitat dominated or co-dominated by spotted gum which is a key foraging tree species for the swift parrot as listed in the National Recovery Plans this species in the Hunter-Central Rivers (Saunders and Tzaros 2011). The Proposed Action will remove approximately 0.1 hectares of vegetation that contains very low abundance of reasonably young spotted gum (*Corymbia maculata*), which is a key tree species listed for the swift parrot as per the National Recovery

Swift Parrot (*Lathamus discolor*)	
Criteria (Critically Endangered Species)	**Assessment against Criteria**
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
	Plan for the species (Saunders and Tzaros 2011). It is considered unlikely that the Proposed Modification would modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that a population of the swift parrot would decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	According to the National Recovery Plan for the species (Saunders and Tzaros 2011), swift parrots are less likely to occur at known foraging sites where there is an abundance of large, aggressive nectar feeders such as noisy miner (*Manorina melanocephala*). Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners was listed as a key threatening process under the EPBC Act in May 2014. Surveys of the Development Footprint indicate that noisy minors are already established in this area, likely due to the existing fragmented and young woodland habitat. The Project is not expected to result in an increase in additional invasive species that are harmful to the swift parrot becoming further established in this habitat.
Introduce disease that may cause the species to decline, or	Psittacine beak and feather disease is a common and potentially deadly disease of parrots caused by a circovirus named beak and feather disease virus. The disease appears to have originated in Australia and is widespread and continuously present in wild populations of Australian parrots. Beak and feather disease affecting endangered psittacine species (parrots and related species) was listed in April 2001 as a key threatening process under the EPBC Act. It is considered unlikely that the Project will introduce beak and feather disease or any other disease that may cause the swift parrot to decline.
Interfere substantially with the recovery of the species.	The following recovery plan has been prepared: • National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (Saunders and Tzaros 2011). Any impacts to known habitat of the swift parrot will likely contravene the objectives of the recovery plan. The swift parrot has been recorded within 1.2 kilometres of the Development Footprint, however potential foraging habitat contains very low abundance of reasonably young spotted gum (*Corymbia maculata*). It is considered unlikely that the Proposed Action will interfere with the recovery of a population of the swift parrot throughout Australia.
Conclusion: The proposed action is considered to constitute a minor impact on the swift parrot. DoEE has determined that the Proposed Action is likely to result in a significant impact and Section 8 of this report further details the predicted impacts associated with the Proposed Modification.	



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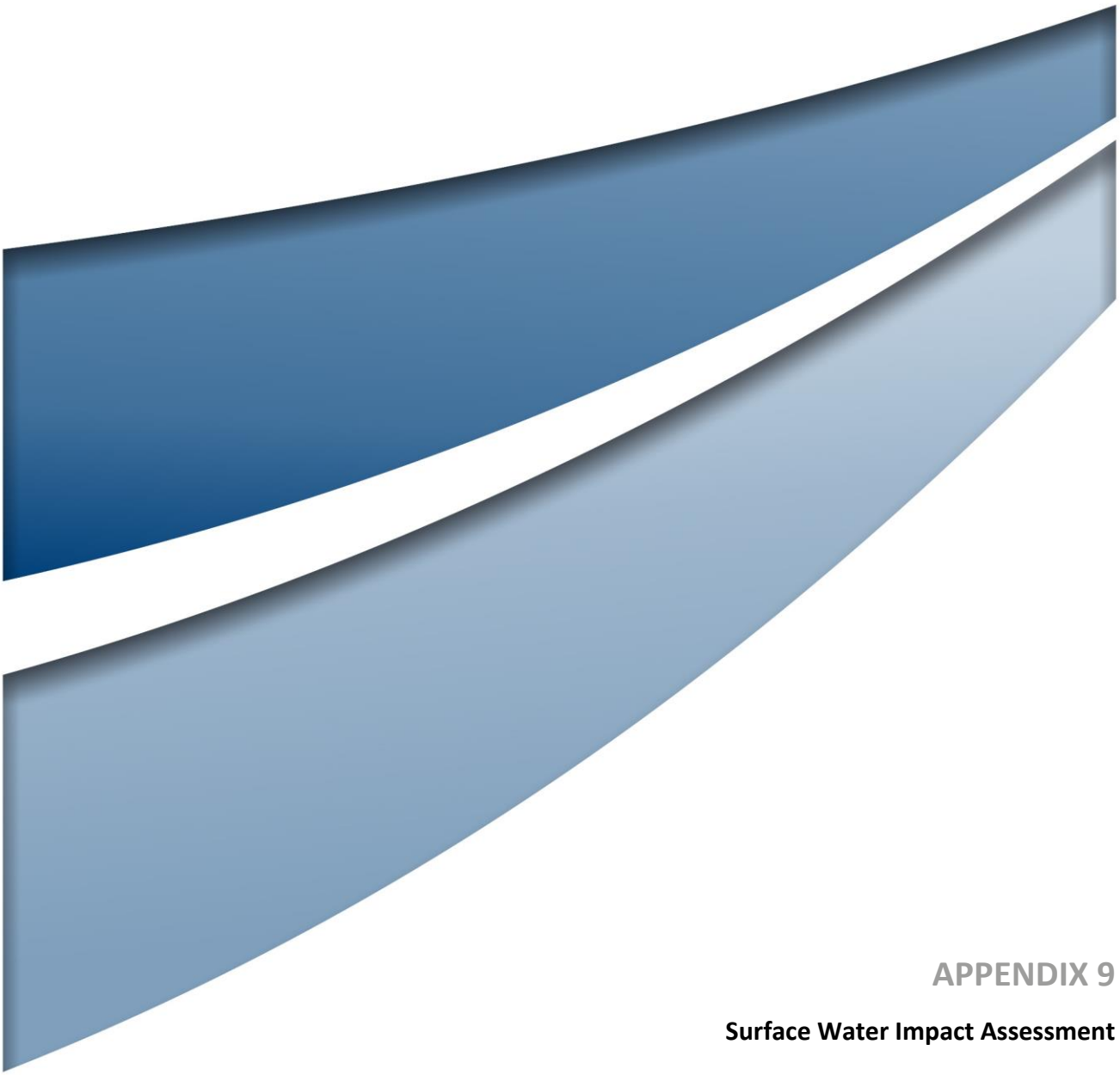


APPENDIX 9

Surface Water Impact Assessment

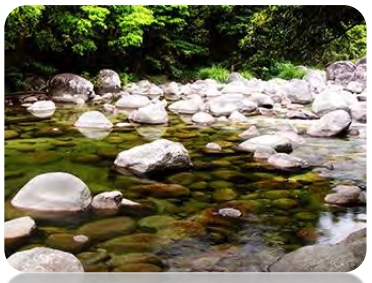
ENGENY
WATER MANAGEMENT

UMWELT (AUSTRALIA) PTY LTD

Bulga Optimisation Project Modification

Surface Water Impact Assessment



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1. INTRODUCTION

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located in the Hunter Valley, NSW. The BCC consists of two existing coal mining operations: the open cut operations (Bulga Open Cut) and the underground operations (Bulga Underground Operations) using shared coal washing and rail loading infrastructure. The BCC is located approximately 4 kilometres (km) to the south-east of Bulga village, approximately 4 km to the north of Broke village, and approximately 12 km south-west of the township of Singleton.

Mining operations have been occurring at the site for over 35 years with Bulga Coal Management Pty Ltd (BCM) currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014 which allowed ongoing operation of the Bulga Open Cut until 31 December 2035. SSD 4960 was subsequently modified (SSD 4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailings management strategy. Modification 2, approved in August 2018, involved an extension to the period of construction for the outer face of the noise and visual bund. The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). BCM also operates the BCC in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Approval 2012/6637 (as modified).

BCM is proposing a modification to SSD 4960 and DA 376-8-2003 to maximise resource recovery within the approved Bulga Optimisation Project Area by a relatively small extension of the open cut operations to the southeast into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit (the Proposed Modification).

The extension of the pit to the southeast also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation.

1.1 Proposed Modification Details

The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 Mtpa ROM while enabling the extraction of an additional approximately 63 Mt of coal over the life of the mine.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Open Cut will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- Extension of mining areas to the south and east to access an approximately 63 Mt of additional ROM coal by accessing deeper resources within the approved open cut pit and in the proposed extension area.
- Realignment of the western highwall to improve long term stability and allow access to additional coal resources.
- An additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east.
- Removal and relocation of the tailings material currently stored in the existing TSF to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings.
- Construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure.
- Relocation and removal of infrastructure servicing the open cut and Bulga Underground Operations including workshops, gas infrastructure and power station, fuel and oil storage.
- Continued use of the temporary MIA area known as East Pit Muster Area.
- Construction of new water management structures to manage changes to the site surface water catchments.
- The use of all existing or approved infrastructure and equipment with some additions to the existing mobile equipment fleet over the life of the Project.
- Reprocessing of tailings where practicable. Any reprocessed coal from tailings would form part of the 20 million tonnes of product coal approved from the BCC, and not included in the BOC annual limit of ROM coal mined.

The key aspects of the Proposed Modification are shown on Figure 1.1 and a summary of the key modifications is provided in Table 1.1.

Table 1.1 Comparison of SSD 4960 and Proposed Modification

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Extraction rate limit	Extraction limit of 12.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal	No change
Total Recoverable Resource (ROM)	162 Mt	An additional 63 Mt

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Project life	Mining operations until 31 December 2035	Extension to the life of mine until 31 December 2039 (an additional 4 years)
Project boundary / Schedule of Lands	Per SSD_4960 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit Mining undertaken within existing ML1547	Extension of mining areas to the south-east and west. Accessing deeper resources within the approved pit and the proposed extension area Mining undertaken within existing ML1547
Disturbance Areas	Approved mining disturbance footprint (3,786 hectares)	Additional disturbance area of approximately 20.2 hectares not currently part of the approved mining disturbance footprint
Key Infrastructure	Realignment of Broke Road (Complete) Relocation of 330kV transmission lines (Complete) Construction of new water storage dam (Complete) Upgrade to CHPP to improve yield and plant efficiency (Ongoing) Relocation of sections of Broke-Fordwich Private Irrigation District pipeline and Telstra infrastructure (Complete)	Relocation of some mine owned open cut infrastructure Demolishing of some open cut infrastructure to accommodate proposed mining Replacement / relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop Installation of tailings relocation infrastructure (pumps and pipelines, power lines and access tracks)
Coal Handling and Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput	Potential upgrade of CHPP to reprocess additional tailings No changes to CHPP throughput, ROM or product stockpiles
Coal Transport	20 million tonnes of product coal transported in any calendar year	No change
Equipment Fleet	Mining fleet as per BOP Amended Project Application Assessment (Umwelt 2013)	Minor increases to fleet numbers to provide flexibility for mining operations

Project Component	Approved Development (SSD 4960) (as modified)	Proposed Modification
Overburden, coarse reject	Overburden placed in-pit	No change to overburden and coarse reject management
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF. Main Pit TSF approved in SSD 4960 Mod 1	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining. Increased capacity of Main Pit TSF from approximately 7.5 Mm^3 to approximately 62 Mm^3 to cater for relocated tailings and ongoing tailings production
Final void	One void at the end of mining operations	One void proposed to be of similar size to the approved void
Rehabilitation and final landform	Conceptual final landform is shown in SSD 4960 and includes a final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing Increases to typical overburden emplacement heights from 160 mAHD to 160 mAHD. Selected areas emplaced up to 175 mAHD to accommodate the incorporation of micro-relief landform features Revised conceptual final landform includes 1 final void as per approved
Employee Numbers	Approximately 700 FTE employees	No change

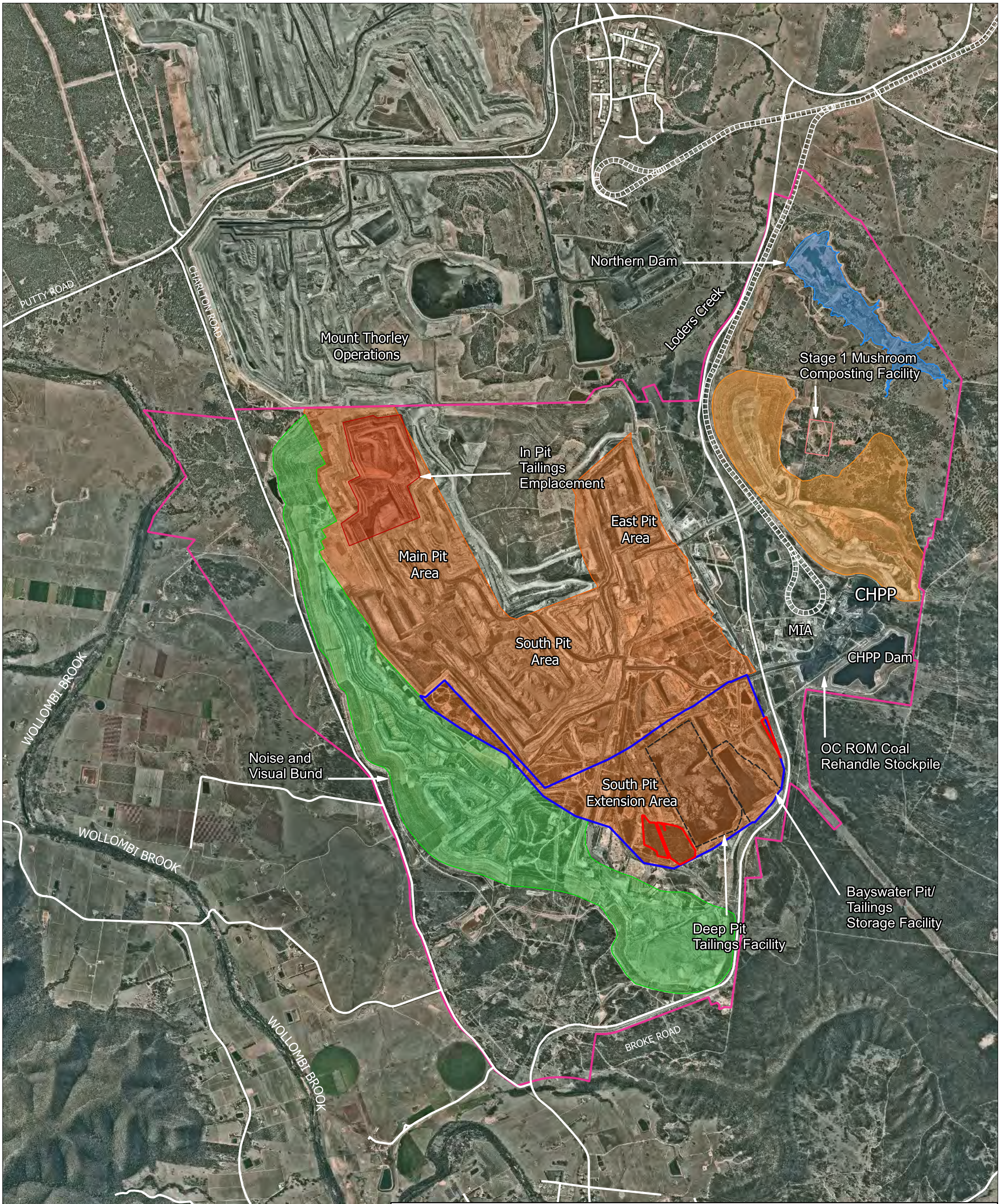
A modification to the current Bulga Underground consent (DA 376-8-2003) is also proposed for the relocation of infrastructure to allow for the extension of open cut mining. The Proposed Modification as it relates to DA 376-8-2003 includes:

- Demolition and relocation of the Bulga Underground Operations MIA.
- Allowance for the relocation of underground mine ventilation, as required.
- Relocation of the Gas Power Station and Waste Flare Station.
- Relocation of the Bulga Underground Operations electrical substation.

- Upgrading, relocation, construction and decommissioning of several mine owned transmission lines and associated access tracks.

DA 376-8-2003 will remain in place and while currently in a period of suspension will not otherwise be modified as part of this application.

A Statement of Environmental Effects (SEE) has been prepared for the Proposed Modification. This Surface Water Impact Assessment (SWIA) forms a component of the SEE.



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Bulga Optimisation Project Modification 3

Figure 1.1 Proposed Modification Overview

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1.2 Measures to Minimise or Avoid Potential Surface Water Impacts

Detailed environmental studies have been undertaken to inform the conceptual designs for the Proposed Modification. The consideration of the outcomes of these studies in the design of the Proposed Modification, along with a range of other key factors, minimise the potential for the Proposed Modification to impact on surface water resources. These factors include:

- Management of water take and discharge of water within regimes established by NSW water and pollution control legislation. NSW legislation provides for sustainable water take from water sources and management of water quality by licensing of discharges under the Hunter River Salinity Trading Scheme (HRSTS).
- Integration into the existing approved water management system (WMS) at the BCC.
- Design of WMS components to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas) (as described above).
- Continued maximised water recycling within the WMS to minimise the total volume of water extracted from the Hunter River and excess water discharged to the Hunter River under the HRSTS.

1.3 Potential Surface Water Impacts

Notwithstanding the measures to minimise impacts, the following aspects of the Proposed Modification have the potential to impact on surface water resources:

- Landform changes as a result of the open cut mining operations, including:
  - Open cut mining
  - Overburden emplacement areas
- Changes to the water balance for the BCC, including the import and export of water to and from the site. This aspect is covered in a separate assessment.

The additional disturbance area associated with changes to the open cut mining operations is located in the WMS catchment. The potential impacts on surface water catchments within the Wollombi Brook system are limited to impacts on baseflows (associated with groundwater depressurisation impacts) and changes to the location and shape of the final void and associated final landform.

The following surface water aspects were reviewed as part of the Surface Water Impact Assessment:

- Flow regimes in Wollombi Brook associated with potential impacts on baseflows.
- Catchment area changes in Loders Creek and Wollombi Brook catchment areas.

- Flooding, including flow rates, velocities and depths on Loders Creek.
- Water quality.
- Geomorphological and hydrological values.
- Riparian and ecological values.
- Water users.

A detailed assessment of these potential impacts has been undertaken for the Proposed Modification with consideration of downstream impacts.

1.4 Structure of this Report

The Surface Water Impact Assessment Report includes the following sections:

- Surface water context, including regulatory framework, catchments and watercourses, flow regimes, water quality and water users (refer to Section 2).
- Water Management System (refer to Section 3).
- Potential impacts, including consideration of cumulative impacts and proposed mitigation measures (refer to Section 4).
- Summary of assessment against Commonwealth Significant Impact Guidelines (refer to Section 5).
- Management, Monitoring, Licensing and Reporting (refer to Section 6).

2. SURFACE WATER CONTEXT

The BCC is located in the catchment areas of Wollombi Brook and Loders Creek (refer to Figure 2.1). Both Wollombi Brook and Loders Creek are tributaries of the Hunter River. The western parts of the BCC are located within the Wollombi Brook catchment area and the eastern parts of the BCC are located within the Loders Creek catchment area.

The changes to mining operations associated with the Proposed Modification are located within the BCC WMS and adjacent to Loders Creek. The extent of the BCC WMS is shown on Figure 2.1.

2.1 Regulatory Framework

2.1.1 Commonwealth Legislation

The Proposed Modification was referred to the Commonwealth Department of the Environment and Energy (DoEE) under the EPBC Act. The Proposed Modification was determined to be a controlled action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on biodiversity and a water resource in relation to coal seam gas development and large coal mine development. The assessment path for the Proposed Modification is under the bilateral agreement between the Commonwealth and NSW Governments.

A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE 2013) undertaken to support the referral is included in Section 5.

2.1.2 Relevant NSW Legislation

The Approved Operations and Proposed Modification exist within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take with consideration of environmental flow requirements of watercourses and the needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with Environment Protection Licence (EPL) requirements. Further details of the NSW surface water regulatory framework and how it will continue to be applied to the Proposed Modification is provided below.

There are two key acts that provide the regulatory framework for water management in NSW. These acts are the *Water Management Act 2000* (WM Act) and the *Water Act 1912*. The key provisions of these acts relevant to the Proposed Modification are outlined in Section 2.1.3.

PUTTY ROAD
CHARLTON ROAD
Mount Thorley Operations
Loders Creek
LDP 11
W8
North Blakefield Dump
W4
Northern Drainage Line
Bulga Open Cut Pit
South Blakefield Dump
FP2 (D2)
EIS28
EIS28A
W2
60ML Dam
O/C Portable Water Tank
D3 (Swan lake)
LDP 4
CHPP
Southern Extension
D13
Area Station Final Sed. Dam
Blakefield Sth. Bath House
Sump 4
Beltana Stat Dam
Blakefield Sth. Reedy Dam
Deep Pit
Wollombi Brook
EIS2
EIS36
EIS5
Nine Mile Creek
Beltana Dewatering Bore
EIS40
EIS46
Old Tailings dam
Southern Drainage Line
EIS54
EIS57
BROKE ROAD
Wollombi Brook
LR2

Legend

- Project Area
- Existing HRSTS Discharge Points
- Mine Water Monitoring Location
- Surface Water Monitoring Location
- Watercourse
- WMS Boundary

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Bulga Optimisation Project Modification 3

Figure 2.1 Surface Water Context

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At a State level, there is one other key water management regulation relevant to mining operations: *Protection of the Environment Operations Act 1997* (POEO Act). The POEO Act is the key piece of environmental protection legislation administered by the NSW Environment Protection Authority (EPA). The key components of the POEO Act relevant to surface waters are outlined in Section 2.1.5.

2.1.3 NSW Regulatory Requirements - Water Use/Take

The objective of the WM Act is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. The WM Act supersedes the provisions of the *Water Act* 1912 in regard to water take when a Water Sharing Plan (WSP) is in place and in regard to works adjacent to or within watercourses.

As part of the WM Act, WSP's have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSP's specify maximum water extractions and allocations. By complying with the requirements of the WSP's, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (Hunter Unregulated and Alluvial Water Sources WSP) applies to watercourses and alluvial groundwater in the vicinity of the BCC. The catchment of Wollombi Brook is located within the Lower Wollombi Brook Water Source and the catchment of Loders Creek is located within the Singleton Water Source.

As such water use from surface and alluvial waters in and adjacent to the Approved Operations are governed by the WM Act.

The *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (North Coast Fractured and Porous Rock Groundwater Sources WSP) commenced on 1 July 2016. The coal measure aquifers for the Approved Operations and Proposed Modification will be covered by this WSP (refer to Groundwater Assessment (KCB, 2019)).

2.1.4 Licensing

All water extraction in NSW, apart from some exemptions for government authorities and basic landholder rights extractions, must be authorised by a water licence. Harvestable rights, which are a Basic Landholder Right under the WM Act, allow a landholder to capture and use up to 10 per cent of the average regional runoff from a landholding. Basic landholder rights are exempt from licensing requirements.

Each water licence, referred to under the WSP system as a Water Access Licence (WAL), specifies a share component. The share components of specific purpose licences such as local water utility, major utility and domestic and stock are expressed as a number in

megalitres per year. The share components of high security, general security and supplementary WAL's are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWD's) as specified by Crown Land and Water Division (CLWD) (formerly known as DPI Water).

Details of the licences currently held by BCM are included in Section 3.2 and licences required for the Proposed Modification are discussed in Section 6.2.

2.1.5 Environment Protection Licences

Activities that may lead to pollution of waters in NSW are regulated by the EPA under the POEO Act. Where discharge of waters is permitted it is controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under Section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an EPL if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act).

Discharges from the BCC are licensed under the EPL, as well as operating in accordance with the HRSTS. The HRSTS is a cap-and-trade system designed to facilitate saline discharges into the Hunter River, without compromising sustainable water quality. The HRSTS is administered under the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002*.

A summary of water export requirements for the BCC, including the Approved Operations and for the Proposed Modification, is included in Section 6.2.

2.2 Catchment Areas and Watercourses

As discussed earlier the BCC is located in the catchment areas of Wollombi Brook and Loders Creek (refer to Figure 2.1).

Land uses within and immediately surrounding the BCC primarily include other mining operations, vineyards, agricultural land and rural residential land holdings. Downstream water users are discussed further in Section 2.4.

Previous mining operations have modified local catchments through the capture of runoff from mining areas within the WMS and diversion of upslope runoff around the mining operations. For each catchment area intersected by the Approved Operations, the stream order, pre-mining catchment area and current approved final landform catchment area are included in Table 2.1. No new catchment areas will be intersected by the Proposed Modification.

The additional disturbance area is located in the WMS catchment area.

Table 2.1 Catchment Areas

Watercourse	Schedule (order)[1]	Catchment Areas	
		Pre-mining (ha)	Approved Operations Final Landform (ha)
Wollombi Brook	3 (6th order)	200,000	199,931
Loders Creek	2 (4th order)	5,958	5,071

Notes 1) Strahler watercourse ordering classification.
2) Based on 1:25,000 LPI topographical map series.
3) Bulga Optimisation Project Surface Water Assessment (Umwelt, 2013), Bulga Surface Operations Eastern Emplacement Modification (Umwelt, 2016)

2.2.1 Wollombi Brook

Wollombi Brook is a tributary of the Hunter River and flows in a northerly direction from Paxton and Millfield in the south to join the Hunter River near Warkworth.

Wollombi Brook has a highly variable flow pattern and Erskine (2008) reports that the watercourse is constantly responding to, and recovering from, flooding. Paradoxically, Wollombi Brook also experiences significant dry periods when surface flows cease or are significantly reduced, during which the alluvial aquifer associated with Wollombi Brook has increased significance as a groundwater source for both ecosystems and water supply.

There are a variety of land uses within the Wollombi Brook catchment in the vicinity of the BCC. These include private residences, vineyards, agricultural land (including grazing, horticulture and arable land), and tourist facilities. BCM also has extensive landholdings within the catchment area, which includes vineyards and agricultural land, in additional to mining land.

2.2.2 Loders Creek

Loders Creek drains northwards towards the Hunter River. The confluence of Loders Creek with the Hunter River is approximately 5 km north of the BCC. The headwaters of Loders Creek are located within the BCC and the former catchment area is highly impacted by mining activities.

Loders Creek, and its main tributary Nine Mile Creek (refer to Figure 2.1) are ephemeral creek systems. Loders Creek has a well-defined flat U-shaped channel with convex banks and extensive tree coverage along sections of the banks. The soils within the both the Loders Creek and Nine Mile Creek catchment areas tend to be relatively shallow and sodic, frequently exhibiting a dispersive nature (Global Soil Systems, 2003). The Saltwater Creek coal measures also subcrop into Loders Creek (MER, 2012) which influences the electrical conductivity of the surface waters.

BCM owns a large portion of the Loders Creek catchment area. The Mount Thorley mining operations (MTO) are also located within the Loders Creek catchment. The existing Bulga

Open Cut MIA, coal stockpiles, the CHPP and associated rail loop are all located within the catchment area of Nine Mile Creek.

Doctors Creek flows into Loders Creek immediately upstream of the confluence of Loders Creek with the Hunter River. The Doctors Creek catchment has been substantially impacted upon by the mining operations at MTO. The BCC does not impact on the Doctors Creek catchment area.

2.3 Water Quality

2.3.1 Monitoring Program

BCM undertake surface water monitoring in accordance with the surface water monitoring program within the Bulga Coal Water Management Plan (approved June 2016). This plan includes monitoring of the following elements of the site water management system and surrounding catchment areas:

- Surface water quality and flows in upstream and downstream watercourses.
- Channel stability in downstream watercourses (including Nine Mile Creek, Loders Creek and Wollombi Brook).
- Stream health conditions in downstream watercourses.
- On-site water management.

The surface water monitoring program covers all three water category areas within the BCC: clean; dirty; and mine water systems. The clean water system consists of runoff from undisturbed or rehabilitated (once runoff is of acceptable quality) areas. The dirty water system consists of runoff from disturbed and rehabilitated areas (excluding mine water). The mine water system consists of runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas.

The surface water monitoring program requires monthly monitoring at each existing monitoring locations at various upstream and downstream locations on the streams and creeks impacted by BCC for the following parameters:

- pH;
- Electrical conductivity (EC);
- Total suspended solids (TSS); and
- Flow condition (by way of visual observation as streams are ephemeral).

2.3.2 Trigger Values

The NSW Water Quality and River Flow Objectives (as published by the Office of Environment and Heritage (OEH)) are the agreed environmental values and long-term goals for NSW surface waters. The objectives are consistent with the agreed national framework for assessing water quality as set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines (2000) (ANZECC guidelines).

The ANZECC guidelines provide default trigger values and methods to determine site specific trigger values. The ANZECC guidelines indicate the preferred use of site-specific trigger values. The trigger values are not assessment criteria however are used to characterise the water quality and estimate the ecological integrity of a water resource.

Historical data sets and methods outlined in the ANZECC guidelines, site specific water quality triggers can be developed. Due to insufficient data for BCC, temporary trigger values have been developed for pH, EC and TSS and are included in the approved Bulga Coal Water Management Plan. Trigger values for pH and EC have been determined using the 80th and 20th percentile, while the trigger value for TSS is provided by calculating the 80th percentile, in accordance with the ANZECC guidelines and statistical analysis. The developed trigger values are identified in Table 2.2.

Table 2.2 Water Quality Parameters and Trigger Values

Watercourse	Monitoring Location	Sample Count	pH		EC (µS/cm)		TSS (mg/L)
			Lower 20th %ile	Upper 80th %ile	Lower 20th %ile	Upper 80th %ile	80th %ile
Monkey Place Creek	LR2	100	7.55	8.02	1282	5006	40.0
Wollombi Brook#1	LR1#2	144	Reference site upstream of the operations (no impact triggers)				
	LR5	141	7.52	7.99	467	1140	12.0
	W2	122	7.18	7.70	447	838	10.8
	W4	140	7.33	7.80	492	852	10.0
Loders Creek#1	W8	78	8.03	8.62	4292	13960	52.4

#1 Due to the ephemeral nature of the watercourses there is insufficient data to develop triggers in accordance with the guidelines for sites other than LR2. Hence only temporary trigger values have been adopted.

#2 LR1 is upstream of the operations and is used as a reference site.

2.3.3 Geochemical Influences

Studies have been undertaken across the Project Area as part of the Bulga Optimisation Project (BOP) during 2012 by Environmental Geochemistry International Pty Ltd (EGI) that indicated:

- The vast bulk of overburden, interburden and floor materials were unlikely to be acid producing or release significant salinity and be acid consuming which is consistent with the current experience at BCC.

- In zones of higher acid rock drainage (ARD) risk the ratio of higher ARD risk material to available buffer material indicated there was substantial buffering capacity available.

- Testing indicated that drainage from the bulk of the overburden/interburden was unlikely to contain significant metal/metalloid concentrations.

2.3.4 Historical Surface Water Quality Monitoring Results

Water quality monitoring data for pH, EC and TSS and temperature are reported in the BCC Annual Reviews. Data presented in the 2015-2018 annual reviews indicate that mining activities had negligible impact on the water quality in downstream watercourses with monitoring results remaining within historical ranges.

Historical monitoring results from January 2004 to September 2018 for pH, EC and TSS are presented graphically in Appendix A. The results are presented for individual monitoring locations within the clean water system including LR1, LR2, LR5, W2, W4 and W8. The monitoring results indicate the following for the routine parameters of pH, EC and TSS (note the typical ranges presented below correspond to 20th percentile and 80th percentile values):

- pH typically ranges between 7.3 to 8.0 in the clean water system and 8.5 to 9.2 in both the dirty water and mine water systems. As such, waters are typically neutral to alkaline in the various systems. No significant variation occurs throughout the various systems with the lowest reading of pH being recorded in the clean water system (pH of 6.3 at LR2). Refer to Figure A in Appendix A.

- There are no visible temporal trends in the data available for pH for the clean or mine water management systems. Refer to Figures D to F in Appendix A.

- Historical EC typically ranges between 467 to 2363 µS/cm in the clean water system, 3120 to 6198 µS/cm in the dirty water system and 1788 to 6092 µS/cm in the mine water system. As such, waters are typically more saline in the dirty and mine water management systems. Refer to Figure B in Appendix A.

- TSS typically ranges between 5 to 17 mg/L in the clean water system, 16 to 120 mg/L in the dirty water system and 10 to 84 mg/L in the mine water system.

2.4 Water Users

The majority of land adjacent to the Approved Operations is owned by Glencore subsidiaries or Yancoal. The Commonwealth of Australia owns the majority of land to the east of the Approved Operations and there are also some parcels of Crown Lands within and adjacent to the Approved Operations.

Water is also extracted from the Hunter River to supplement on site supply. The supplementary water is transferred through the Mount Thorley Water Supply Scheme of which Bulga is a member. Potential impacts on downstream water users from the Proposed Modification are discussed in Section 4.9.3.

3. WATER MANAGEMENT SYSTEM

The objectives of water management at BCC are to:

- Minimise the contamination of clean water runoff from catchment areas upslope of the operations.
- Minimise potential effects of erosion and its associated impacts as a result of mining operations.
- Securely contain mine water (groundwater and surface water which reports to open cut and underground mining areas), and other site water that comes into contact with areas disturbed by mining activities – including overburden emplacement areas, coal stockpiles and the CHPP area.
- Maximise the re-use of mine water for onsite water use such as coal washing and dust suppression. Reusing mine water is preferred rather than using water from the Hunter River.
- Manage the discharge of excess water back to the Hunter River in accordance with the Hunter River Salinity Scheme.

3.1 Approved WMS

The approved WMS has the following key objectives and functions:

- Diversion of clean water around mining operations to minimise capture of upslope runoff and separate clean water runoff from mining activities.
- Segregating mine impacted water and runoff from undisturbed and revegetated areas with better water quality to minimise the volume of mine impacted water that requires reuse.
- Reuse of mine impacted water within the WMS to reduce reliance on raw/clean water (e.g. extraction from the Hunter River).
- Minimising adverse effects on downstream waterways (i.e. hydraulic and water quality impacts).
- Reducing the discharge of contaminants from the mine to the environment.

Water management at the BCC considers three categories of water, each with different potential to cause environmental harm. The target design criteria for each of the three categories of water are summarised in Table 3.1.

Table 3.1 WMS – Design Criteria

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or rehabilitated areas.	Release, where practicable, to downstream environment.
Dirty	Runoff from disturbed areas (does not include water captured in mining pit areas or runoff from mine infrastructure areas).	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E). Designed to manage runoff from the 5 day, 95th percentile rainfall event.
Mine	Runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas.	Contained for events up to and including the 1% annual exceedance probability (AEP) 24-hour storm event.

One of the key objectives of the WMS is to convey clean water around the mining operations or, when runoff water from rehabilitated areas becomes clean, enable the runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the WMS.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to storages within the WMS.

Mine water (i.e. runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas) is managed as part of the mine WMS.

3.2 Water Abstraction

The current WALs held by BCM are as follows:

- Hunter River allocation – High security – is via Singleton Council Mount Thorley Water Supply Scheme – 876 ML/yr.
- Wollombi Brook allocation licences – Unregulated River Licences – not used for mining operations. Irrigation licences on properties and total 1,710 units on Wollombi Brook and Monkey Place Creek (512 units are for alluvial aquifer systems).

3.3 Licensed Discharges

The EPL (No 563) for the BCC allows releases of surplus water via two licensed discharge points (LDPs) into the Loders Creek system (refer to Figure 2.1). Discharges occur in accordance with the conditions of the EPL and the HRSTS. BCM currently holds 121 salt credits under the HRSTS.

Table 3.2 Licenced Discharge Points

Limit	LDP 4	LDP 11
Volume	130 ML/d	500 ML/d
pH	6.5 – 9.5	6.5 – 9.5
TSS	120 mg/L	120 mg/L

Table 3.3 HRSTS Discharges

	HRSTS Discharge Point 4			HRSTS Discharge Point 11		
Reporting Period	Total Volume Discharged (ML)	Total Salt Load (Tonnes)	Number of Credits Held	Total Volume Discharged (ML)	Total Salt Load (Tonnes)	Number of Credits Held
2013/2014	No discharges			No discharges		
2014/2015	No discharges			No discharges		
2015/2016	167.9	383.1	54 - 95	No discharges		
2016/2017	631.3	2144.9	116	No discharges		
2017/2018	No discharges			No discharges		

3.4 Changes with the Proposed Modification

It is proposed to continue to utilise the existing WMS for the Proposed Modification. That is, the WMS for the additional disturbance area will continue to be integrated into the existing approved WMS. In addition, excess water that cannot be reused will continue to be discharged in accordance with regulatory arrangements.

The WMS components (major dams and drains only) in the additional disturbance area for 2022, 2026, 2031 and 2035 are presented in Figure 3.1 to Figure 3.4.

It is important to note that the plans presented in Figure 3.1 to Figure 3.4 are concept designs. While the concept designs establish the design objectives and performance standards, the detailed designs will be determined by construction and mining schedules. The WMS will be constructed and modified, as and when required, so as to support the infrastructure and mine development. Further, the plans indicate only the components of

the WMS which are required for a particular stage of the mine and does not preclude the construction of some components earlier.

Similarly, the conceptual storage capacities recommended for the various water management dams have been sized for the purposes of meeting environmental compliance requirements. The actual dam configuration and geometry for both the dirty water dams and dryland attenuation basins (detention basins) will be determined during future detailed engineering design stages.

The existing WMS will continue to be used to manage runoff with all pit water and mine surface runoff directed to the WMS. The existing approved clean water diversions will continue to divert runoff as required around the WMS. There are no new diversions proposed or required as part of the Proposed Modification.

During the operational mine life the water balance modelling (refer to Appendix 10 of the SEE) indicates that a median annual licensed Hunter River supply requirement of up to 1,670 ML per year, 1,990 ML per year or 1,550 ML per year (for the three cases simulated) during the dredging period, falling to less than approximately 430 ML/year following the completion of dredging. The water balance modelling (refer to Appendix 10 of the SEE) demonstrates that the existing approved WMS with the proposed additional water management system components (including sediment dams, pumps and pipelines) will enable water at the BCC to be managed in accordance with the current EPL.

N

PUTTY ROAD

CHARLTON ROAD

Mount Thorley Operations

LODERS CREEK

BROKE ROAD

Northern Dam

Clean Water Weir

Dam S6A

Dam S3

Whybrow Dam

EAST PIT

EASTERN EMPLACEMENT AREA

Existing Flood Levee

Dam S10

MAIN PIT

Dam S22

CHPP Area

CHPP Surge Dam

ROM Pad Dams

MWD2

Dam S53

DEEP PIT

Dam S7

WOLLOMBI BROOK

Dam S1

Dam S2

Dam S2A

Legend

- Project Area
- Clean Water Catch Drain
- Dirty Water Catch Drain
- Sediment Dam
- Mine Water Dam
- Clean Water Dam
- Active Overburden
- Active Pit
- Inactive Overburden
- Inactive Pit
- Tailings Storage Facility
- Tailings Storage Facility - Mining
- Rehabilitation
- Temp Rehabilitation
- Culvert
- Roads
- 5m Contour
- Drainage Line
- HRSTS Discharge Points

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ENGENY WATER MANAGEMENT

GLENCORE

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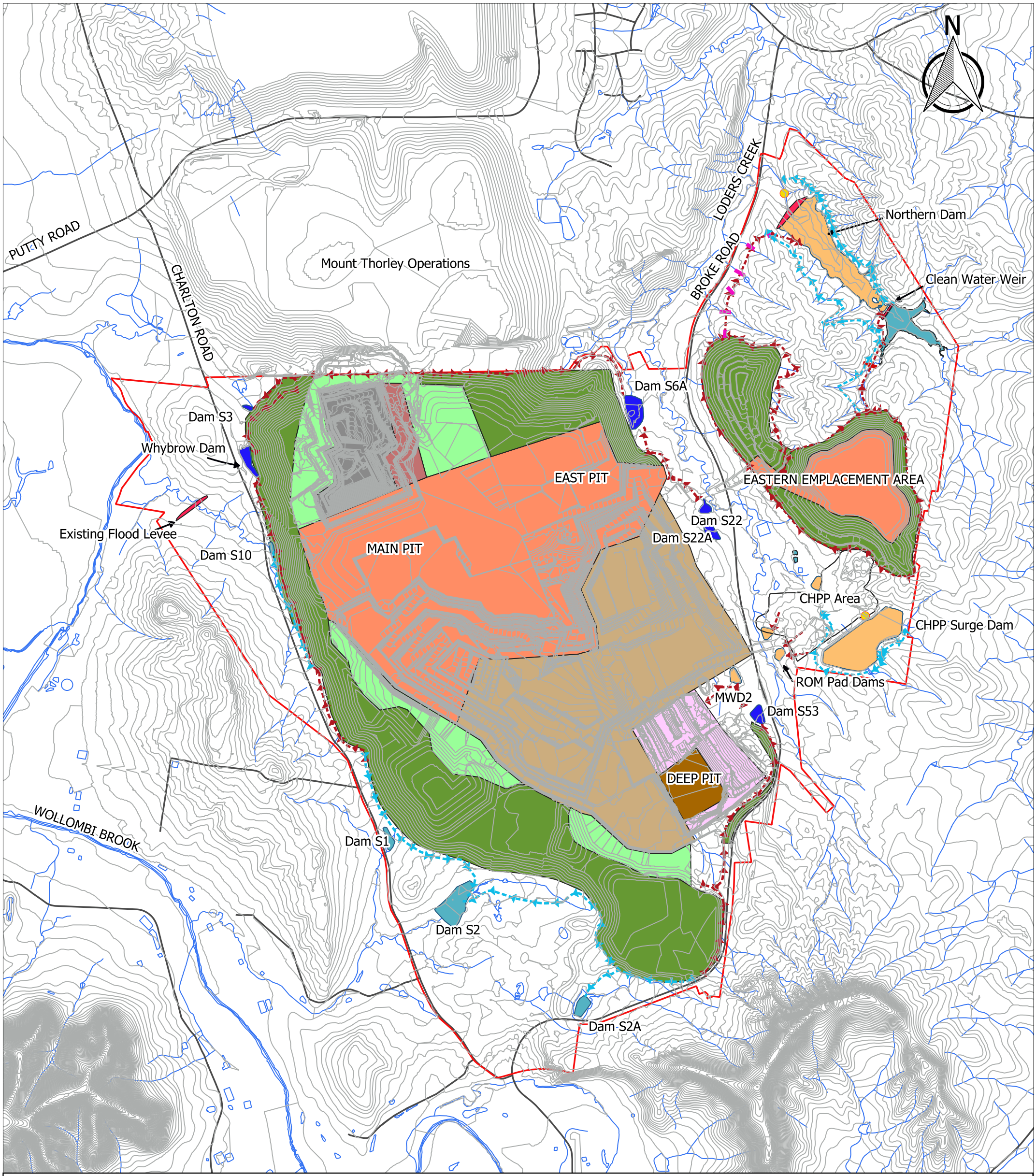
Bulga Optimisation Project Modification 3

Figure 3.1 Proposed Conceptual Water Management System - 2022

Job Number: N1600_007
Revision: 1
Drawn: LV
Checked: SS
Date: 8/7/2019



Legend

- Project Area
- Clean Water Catch Drain
- Dirty Water Catch Drain
- Sediment Dam
- Mine Water Dam
- Clean Water Dam
- Active Overburden
- Active Pit
- Inactive Overburden
- Inactive Pit
- Tailings Storage Facility
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Bulga Optimisation Project Modification 3

Figure 3.2 Proposed Conceptual Water Management System - 2026

Job Number: N1600_007
Revision: 1
Drawn: LV
Checked: SS
Date: 8/7/2019

N

PUTTY ROAD

CHARLTON ROAD

Mount Thorley Operations

LODERS CREEK

BROKE ROAD

Northern Dam

Clean Water Weir

Dam S6A

Dam S3

Whybrow Dam

EAST PIT

EASTERN EMPLACEMENT AREA

Existing Flood Levee

Dam S10

Dam S22

Dam S22A

CHPP Area

CHPP Surge Dam

MAIN PIT

ROM Pad Dams

Dam S53

DEEP PIT

WOLLOMBI BROOK

Dam S1

Dam S2

Dam S2A

Legend

- Project Area
- Clean Water Catch Drain
- Dirty Water Catch Drain
- Sediment Dam
- Mine Water Dam
- Clean Water Dam
- Active Overburden
- Active Pit
- Inactive Overburden
- Inactive Pit
- Tailings Storage Facility
- Rehabilitation
- Temp Rehabilitation
- Culvert
- Roads
- 5m Contour
- Drainage Line
- HRSTS Discharge Points

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Bulga Optimisation Project Modification 3

Figure 3.3 Proposed Conceptual Water Management System - 2031

Job Number: N1600_007
Revision: 1
Drawn: LV
Checked: SS
Date: 8/7/2019

N

PUTTY ROAD
CHARLTON ROAD
Mount Thorley Operations
LODERS CREEK
BROKE ROAD
Northern Dam
Clean Water Weir
Dam S6A
Dam S3
Whybrow Dam
EAST PIT
EASTERN EMPLACEMENT AREA
Existing Flood Levee
Dam S10
Dam S22
Dam S22A
CHPP Area
CHPP Surge Dam
MAIN PIT
ROM Pad Dams
Dam S53
DEEP PIT
WOLLOMBI BROOK
Dam S1
Dam S2
Dam S2A

Legend

- Project Area
- Clean Water Catch Drain
- Dirty Water Catch Drain
- Sediment Dam
- Mine Water Dam
- Clean Water Dam
- Active Overburden
- Active Pit
- Inactive Overburden
- Inactive Pit
- Tailings Storage Facility
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- Temp Rehabilitation
- Culvert
- 5m Contour
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Bulga Optimisation Project Modification 3

Figure 3.4 Proposed Conceptual Water Management System - 2035

Job Number: N1600_007
Revision: 1
Drawn: LV
Checked: SS
Date: 8/7/2019

Table 3.4 Conceptual WMS

Aspect	Indicative Description
2022 WMS for Proposed Modification	Continuation of mining to the south and deeper with overburden emplacement to the north and east of the Main Pit and at the Eastern Emplacement Area. Enlargement and continued use of Dam S6A and the eastern dams to manage dirty water from the north of Main and East Pits.
2026 WMS for Proposed Modification	Mining continuing further south into the proposed disturbance area with overburden emplacement to the north and west of the Main Pit and at the Eastern Emplacement Area. Continued use of Dam S6A, the Whybrow Dam and Dam S3 to manage dirty water from the north of Main and East Pits. The operations will mine through Dam S7 which will be replaced by Dam S53.
2031 WMS for Proposed Modification	Mining continuing further south through the previous Deep Pit area with overburden emplacement to the north and west of the Main Pit and west of Deep Pit. Continued use of Dam S6A, the Whybrow Dam, Dam S3 and Dams S22 and S22A to manage dirty water from the overburden emplacement areas. The operations will mine through Dam MWD2. Runoff from the overburden emplacement area to the south-west of Deep Pit will be returned to downstream catchment areas where possible.
2035 WMS for Proposed Modification	Continued mining in the Deep Pit area with overburden emplacement to the north of Main Pit and west of Deep Pit. Continued use of Dam S6A, the Whybrow Dam, Dam S3 and Dams S22 and S22A to manage dirty water from the overburden emplacement areas. Runoff from the Eastern Emplacement Area will be returned to downstream catchment areas where possible.

3.4.1 Additional Water Management Infrastructure During Operations

The conceptual WMS for the Proposed Modification includes one additional sediment dam (Dam SS53) (to replace Dam S7), enlargement of an existing dam (Dam S6A) and conversion of an existing borrow pit into water dam (Dam S22A) to manage runoff from disturbed areas (refer to Figure 3.1, Figure 3.2 and Figure 3.3) during the operations. The conceptual design sizes for each of these dams is included in Table 3.5.

The dirty water management system, including sediment dams, will be designed in accordance with Managing Urban Stormwater: Soils and Construction (the Blue Book), Volumes 1 and 2E - Mines and Quarries (Landcom 2004 and DECC 2008) to manage runoff from the 5 day, 95th percentile rainfall event. The selected design criteria is in excess of the minimum recommended design criteria for sediment dams as outlined in Volume 2E of the Blue Book (DECC, 2008). Volume 2E of the Blue Book (DECC, 2008) indicates that for the 95th percentile design storm event the indicative average annual sediment dam overflow frequency will be 1 to 2 overflows per year. The receiving waters in the event of overflows from the sediment dams during events that exceed the design criteria (refer to Table 3.1) from the WMS are Wollombi Brook and Loders Creek.

Table 3.5 Proposed Modification – Sediment Dams – Conceptual Design Sizes

Dam	Status	Design Capacity (ML)
Dam S6A	Existing to be enlarged	81.0 (Existing) 403.8 (Proposed)
Dam S22	Existing	17.7
Dam S22A	Proposed (existing borrow pit holding water to south of S22)	24
Dam MWD2	Existing	44.3
Dam S7 / 53	Existing	72.0
Dam S2A	Existing	40.0
Dam S2	Existing	155.0
Dam S1	Existing	52.5
Dam S10	Existing	10.5
Whybrow Dam	Existing	220.0

Pumps, pipes and drain infrastructure to support the management of existing and new water management dams/storages will also be constructed as part of the Proposed Modification.

The final detail of dam configuration, design of the drainage systems and associated licencing will be further investigated and resolved during preparation of the relevant stages of the Mining Operations Plan and in the detailed closure planning process.

4. SURFACE WATER IMPACTS AND MITIGATION MEASURES

4.1 Catchment Areas

The Proposed Modification is predicted to impact on the Wollombi Brook (final landform only) and Loders Creek catchment areas (refer to Table 4.1).

Table 4.1 Predicted Impacts on Catchment Areas

Catchment	Pre-Mining (ha)	Approved Final Landform (ha)	Proposed Modification Final Landform (ha)
Wollombi Brook	200,000	199,931	200,285
Loders Creek (at confluence with Hunter River)[1]	5,985	5,071	4,674

1. The Loders Creek catchment excludes the contribution from Doctors Creek. Doctors Creek joins Loders Creek immediately upstream of the confluence with the Hunter River. The catchment area of Doctors Creek has also been impacted on by mining at Mount Thorley Operations (MTO).

The impacts on catchment areas are driven by the increase in the catchment area associated with changes to the final void. That is an approved final void catchment area of approximately 756 hectares compared to a final void catchment area of 799 hectares with the Proposed Modification.

The assessment indicates that, compared to the currently approved operations:

- Loders Creek final landform will be reduced by approximately 397 ha (i.e. 8%) when compared to the Approved Final Landform catchment area.
- Wollombi Brook final landform catchment area will be increased by approximately 354 hectares (i.e. less than 0.2%) when compared to the Approved Final Landform catchment area.

4.2 Flow Regimes

Mining operations also have the potential to impact on flow regimes in watercourses by impacts on baseflow contributions.

The Groundwater Impact Assessment (KCB, 2019) indicates that the inferred leakage from the alluvial aquifers to the underlying Permian strata is similar to the predictions of the approved mine. The predicted additional impact on baseflow (where these may occur), are not predicted to have any measurable impact on surface water flows. Potential impacts on flow regimes in Wollombi Brook have been assessed using a combination of historical flow gauging data and modelled baseflow impacts (refer to the Groundwater Impact

Assessment, KCB 2019).The groundwater model predicts a reduced leakage from the Permian strata to the alluvial aquifer for the Proposed Modification compared to the approved case simulations. Reduced discharge of saline Permian strata groundwater will help reduce the contribution of salts to the alluvial aquifer.

4.2.1 Historical Flow Gauging Data

WaterNSW maintains three steam flow monitoring/gauging stations on Wollombi Brook. The Bulga gauge (gauge 210028) is located adjacent to the Bulga Coal Complex at the Putty Road crossing (refer to Figure 2.1). The data recorded at the Bulga gauge is considered to be representative of flows in Wollombi Brook adjacent to and downstream of the Bulga Coal Complex. The flow duration curve, which presents the total volume of flow in the brook during each day, indicates that flows are typically seasonal. The analysis (refer to Figure 4.1) indicates that flows are typically lower during summer compared to winter.

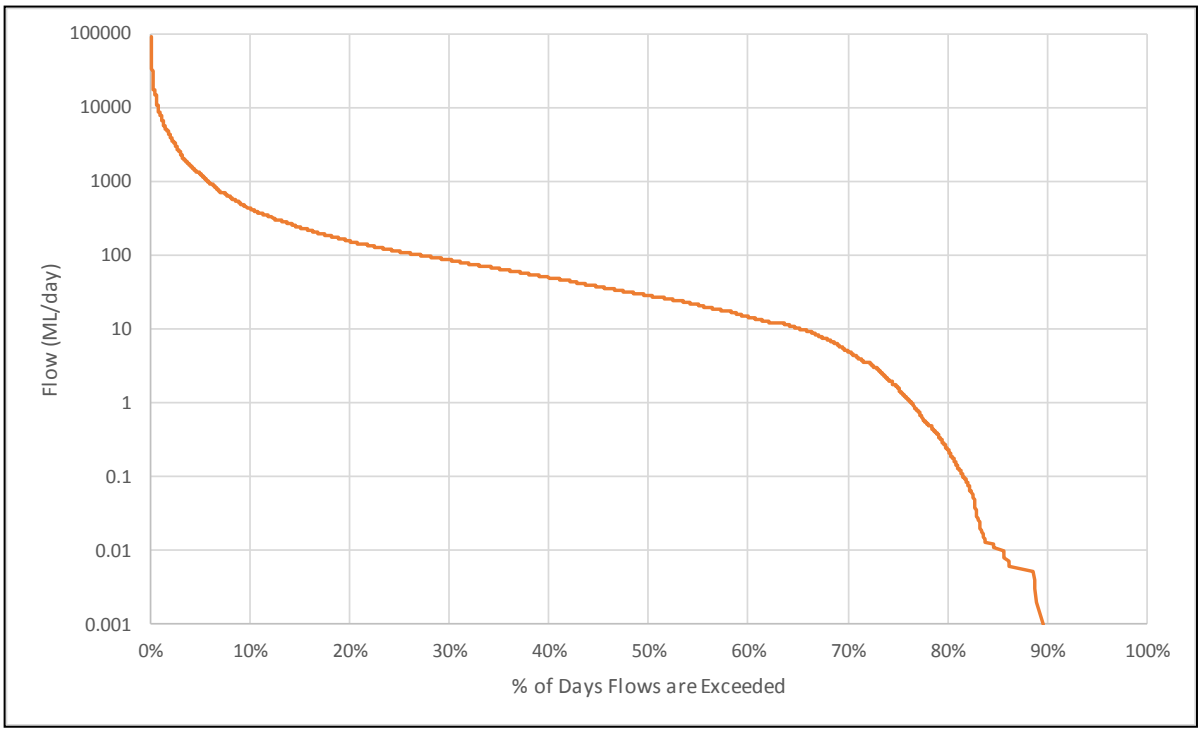

Figure 4.1 Historical Flow Gauging Data – Wollombi Brook at Bulga (gauge 210028)

4.2.2 Approved and Predicted Impacts

Baseflow impacts (refer to KCB, 2019) vary over the life of project and were assessed as part of the Groundwater Assessment (refer to Appendix 12 of the SEE). Modelling indicates that the Approved Project will decrease groundwater discharges to Wollombi Brook by approximately 1.392 ML per day. Modelling indicates that the Proposed Modification will decrease the rate of groundwater discharges to Wollombi Brook by up to 0.012 ML per day to 1.38 ML per day (i.e. a <1% flow reduction).

The analysis on regional flow impacts was undertaken for the greatest predicted change in net leakage from each watercourse associated with the current Approved Project and Proposed Modification. For the assessment it was assumed that the rate of leakage from Wollombi Brook to the alluvium will be in full translated to a loss of surface water flows. This is considered to be a conservative (i.e. worst case) analysis of the potential impacts.

Overall the analysis indicates that the Proposed Modification has negligible predicted impacts on baseflows in Wollombi Brook when compared to the Approved Project.

4.3 Flooding and Watercourse Stability

The Proposed Modification has the potential to influence flooding and watercourse stability in Loders Creek as a result of catchment changes associated with the mining operations and overburden emplacement areas.

4.3.1 Methodology

The potential impacts on flooding and watercourse stability were assessed using a one dimensional (1D) hydrodynamic model of Loders Creek. The model used for the assessment had been previously developed and was used to assess flood impacts for the Bulga Surface Operations Eastern Emplacement Area Modification Statement of Environmental Effects (Umwelt, 2016). The model utilises the XP-Storm modelling platform. OEH has confirmed for other studies that using an approach that is consistent with the previous flood modelling assessments is reasonable for proposed modifications.

The following events were modelled:

- 39% AEP storm event to assess potential impacts on watercourse stability (previously known as the 2 year Average Recurrence Interval (ARI) storm event).
- 5% and 1% AEP storm events to assess any potential flooding impacts compared to the Approved Project.
- 0.2% and 0.5% AEP storm events as proxies for climate change as per OEH Standard Environmental Assessment Requirements (SEARs) (2015).
- 0.1% AEP storm event to determine any required flood protection works in accordance with the Glencore flood protection requirements.
- Probable Maximum Flood (PMF) to map flood prone land as per the OEH Standard Environmental Assessment Requirements (SEARs) (2015).

Two scenarios were modelled for the assessment, as follows:

- Pre-Mining Landform.
- Proposed Modification Final landform.

The Proposed Modification final landform modelling scenario has been selected to represent the potential "worst case" for flooding impacts with the combined maximum catchment areas modelled simultaneously.

4.3.2 Hydrology Parameters used in XP-Storm Analysis

The model parameters used in the modelling process were consistent with those used in previous hydraulic modelling undertaken for the Bulga Surface Operations Eastern Emplacement Area Modification Statement of Environmental Effects (Umwelt, 2016).

The key hydrology parameters used in the XP-Storm model analysis were:

- Laurenson Equation S = BQn+1

  where n = -0.285

- Mannings Roughness n = 0.035 to 0.050

  n* = 0.25

- Horton Infiltration where $Fp = Fc + (Fo + Fc).e^{-kt}$

  Fp = Horton Infiltration (mm/hr)
  Fo = 25.4 mm/hr
  Fc = 1.27 mm/hr
  k = 0.002 1/sec
  t = time (sec)

The Mannings roughness for the catchment area (n*) is 0.25. This is consistent with the catchment being generally grazing land. The Mannings roughness (n) for the creek bed typically range between 0.035 to 0.060. The infiltration parameters used in the modelling are consistent with soils being typically clay.

4.3.3 Design Rainfall Depths

To maintain consistency with the previous assessment and approval and enable comparison to previous models the terminology and design flood estimation methodology as used in the 1987 version of the AR&R guideline has been used in this assessment. The critical design storm event for the Loders Creek catchment area downstream of the BCC is 12 hours.

The AR&R 1987 guidelines have been used in this assessment for modelling of the design rainfall events using IFD data sourced from the BoM 1987 Rainfall IFD Data System. The design rainfall depths for each event modelled are listed in Table 4.2.

Table 4.2 Design Rainfall Depths

Annual Exceedance Probability (AEP)	Rainfall Depth (mm)
39%	59.76
5%	103.68
1%	139.2
0.5%	149
0.2%	174
0.1%	194

The PMF event was modelled using the Probable Maximum Precipitation (PMP). The PMP can be estimated for any catchment in Australia using three generalised methods:

1. Generalised Short Duration Method (GSDM) – for durations up to 6 hours and areas up to 1,000 km^2.

2. Revised Generalised Tropical Storm Method (GTSMR) – for durations up to 120 hours and areas up to 150,000 km^2 in the regions of Australia where tropical storms are the source of the greatest depths of rainfall.

3. Generalised Southeast Australia Method (GSAM) – for durations up to 96 hours and areas up to 100,000 km^2 in the region of Australia where tropical storms are not the source of the greatest depths of rainfall.

The GSDM methods applies to Loders Creek due to the location of the catchment area and having a catchment area less than 1,000 km^2. The resulting rainfall depth was 620 mm over 6 hours for GSDM.

4.3.4 Assessment of Impacts

Modelled peak flows, velocities and depths on Loders Creek immediately downstream of the confluence with the tributary that the Northern Dam is located on are presented in Table 4.3.

The modelling indicates decreases in peak flows and depths in Loders Creek compared to the pre-mining scenario. Modelling indicates minor increases in peak velocities between 1% and 3% for the Proposed Modification final landform scenario when compared to the pre-mining scenario. The modelled increases in velocities, which are less than 3.1% compared to the pre-mining scenario is associated with peak velocities in the order of 1.13 m/s. As such it is considered unlikely this will increase erosive potential in Loders Creek. The modelled impacts are due to the changes in catchment areas and topography between the

pre-mining and Proposed Modification final landform scenarios. The reduction in peak flows also results in a small increase to peak velocity.

Table 4.3 Peak Flood Model Results for Loders Creek

Flood Event (AEP)	Pre-mining	Proposed Modification Final Landform
Peak Flow (m^3/s)		
39%	39.9	38.1
5%	93.6	79.5
1%	136.6	107.4
Peak Velocity (m/s)		
39%	1.04	1.05
5%	1.09	1.12
1%	1.10	1.13
Peak Depth (m)		
39%	2.16	2.12
5%	3.55	3.33
1%	4.19	3.75

Flood Protection for the Operations

Glencore's required flood immunity for open cut mining pits is the 0.1% AEP event. Flood modelling indicates that flood levels adjacent to the open cut pit range from approximately 62.8 mAHD to 84.9 mAHD. In the same locations the lowest elevation on the eastern side of the open cut pit (over the progressive mine stage plans) ranges from 70 mAHD to 90 mAHD (respectively). Freeboard estimates during the 0.1% AEP event adjacent the open cut pit range from 2.5 m to 17.5 m. Modelling indicates that the 0.1% AEP event flood levels are lower than the crest of the open cut pit.

Climate Sensitivity Analysis

The modelling indicates that the flood depths in Loders Creek increase in the order of 500 mm between the 0.5% and 0.2% AEP flood events (refer to Table 4.4). These events were modelled to act as proxies for assessing sensitivity to climate change. Similarly, the modelling shows that the maximum flow velocities within Loders Creek remain low (i.e. typically less than 1.13 m/s) and do not change due to the flow conveyance capacity of the floodplain.

Table 4.4 Peak Flood Model Results for Loders Creek – 0.5% and 0.2% AEP

Flood Event (AEP)	Pre-mining	Proposed Modification Final Landform
Peak Flow (m^3/s)		
0.5%	149.4	115.9
0.2%	175.7	139.04
Difference between 0.5% and 0.2%	26.3	23.1
Peak Velocity (m/s)		
0.5%	1.09	1.13
0.2%	1.09	1.12
Difference between 0.5% and 0.2%	-	-0.01
Peak Depth (m)		
0.5%	4.48	3.86
0.2%	5.02	4.33
Difference between 0.5% and 0.2%	0.54	0.47

The analysis indicates the impacts of climate change, that is, affecting rainfall intensities, in Loders Creek will have similar impacts on the assessment of flood/flow behaviour in the creek when comparing the pre-mining scenario to the Proposed Modification final landform scenario.

Flood Planning Information

Flood Prone Land is defined by the NSW Floodplain Development Manual (2005) (the Manual), as:

Land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.

The assessment indicates that there are regions within the existing approved operational areas that are located within Flood Prone Land for Loders Creek. Modelled elevations for the peak flood levels during the PMF event are predicted to be in the order of:

- 83.8 mAHD in Loders Creek adjacent to the existing Deep Pit (approximately 3.7 m deep).
- 77.6 mAHD in Loders Creek to the east of the CHPP Area (approximately 3.5 m deep).
- 57.2 mAHD in Loders Creek near the Northern Dam (over 10 m deep).

The assessment also indicates that the Proposed Modification will have negligible impact on flood flows or extents during the PMF and as such will not impact on the extent of flood prone land in the Loders Creek catchment area.

4.4 Water Quality

The existing WMS as outlined in Section 3.1, includes mine dewatering systems, water storages, sedimentation and retention basins, settling and tailings ponds, and drainage systems. The extensions to the WMS associated with the Proposed Modification have been designed to continue to divert clean water around mining operations and segregate, store and reuse mine impacted water to minimise adverse effects on water quality from mining operations to downstream waterways.

As set out in Section 3.4, the WMS required for the Proposed Modification forms part of the existing WMS and will limit the potential impacts on downstream water quality by managing water that has the potential to cause environmental harm. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during operational and rehabilitation phases of the Proposed Modification to manage water quality (refer to Section 4.8.1).

The Approved Operations WMS is designed to enable BCC to manage and operate the WMS to meet licence conditions within the requirements of the POEO Act, taking account of both historical and current water qualities in the surrounding watercourses, and current and future downstream water users. The risk of overflows during events that exceed the approved design criteria and potential impacts associated with overflows is currently managed by the BCC WMP. The WMP allows for the ongoing assessment of risk as mining operations progress, and the implementation of improvements and changes where required. The design strategy for the WMS (refer to Section 3) includes:

- Management (capture and storage) of mine water exposed to coal and/or coal processing for events up to and including the 1% AEP 24 hour storm event.
- Management of runoff from disturbed areas, including overburden emplacement areas, based on the Blue Book requirements (Landcom, 2004 and DECC, 2008).
- Ongoing evaluation of the WMS adequacy based on the design criteria validated through water quality sampling.

If the Proposed Modification is approved, BCC will update the existing WMP to reflect the changes to water management associated with the Proposed Modification.

Consistent with the Approved Operations, discharges will only occur from BCC under the HRSTS scheme in accordance with the EPL.

As such it is considered, that with the measures proposed above, the Proposed Modification will have minimal impact on water quality in downstream watercourses.

The groundwater model predicts a reduced leakage from the Permian strata to the alluvial aquifer for the Proposed Modification compared to the approved case. Reduced discharge of saline Permian strata groundwater will help reduce the contribution of salts to the alluvial aquifer.

4.5 Geomorphological and Hydrological Values

The Proposed Modification is not expected to have a significant impact on the geomorphological and hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Proposed Modification have been assessed and indicate that there is minimal risk of increased erosion or scour.

The Proposed Modification will result in lower peak flows with reduced flood levels in Loders Creek compared to the pre-mining scenario. It is considered that scour potential along Loders Creek will not be increased from the pre-mining scenario due to the Proposed Modification.

4.6 Riparian and Ecological Values

The predicted changes to flow regimes both during and following the mining operations associated with the Proposed Modification are predicted to be negligible on Wollombi Brook.

The changes to flow regimes are also considered to be negligible on a regional scale, i.e. Wollombi Brook and Loders Creek flows into the Hunter River regulated river system.

4.7 Water Users

There are no known licensed water users on Loders Creek downstream of the BCC.

The Proposed Modification will have minor impacts on the annual flow volumes in Loders Creek compared to the currently Approved Operations landform conditions and will result in a minor reduction with the final landform (refer to Table 4.1). As such only minimal impacts are expected on basic landholder rights on Loders Creek. The majority of the land adjacent to Loders Creek downstream of the BCC is owned by either Glencore (or subsidiaries of Glencore) or Mount Thorley Warkworth.

The proposed changes to baseflows in Wollombi Brook are considered to have negligible impact on downstream water users.

4.8 Summary of Proposed Mitigation Measures

In addition to extending the existing approved WMS (refer to Section 3), the following measures are proposed to minimise water quality impacts associated within disturbance areas.

4.8.1 Erosion and Sediment Control Measures

Erosion and sediment control will continue to be undertaken in accordance with the BCC Water Management Plan (WMP), which will be updated if the Proposed Modification is approved. The WMP provides a framework for the management of erosion and sedimentation at the BCC.

During operations, additional WMS components will be constructed as work progresses. The operational phase will involve the ongoing management of the WMS.

The objective of the WMP is to ensure that appropriate structures and programs of work are in place to:

- Identify activities that could cause erosion and generate sediment.
- Describe the location, function and capacity of erosion and sediment control structures required to minimise soil erosion and the potential for transport of sediment downstream.
- Ensure erosion and sediment control structures are appropriately maintained.
- Fulfil the statutory conditions of the project approval.
- Meet industry standards and best practice, specially:
  - Landcom 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.
  - Department of Environment and Climate Change (DECC) 2008. Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

4.9 Cumulative Impacts

The Mount Thorley Mine has surface operations in the Loders Creek catchment downstream of the BCC. Similarly, further downstream, in the Wollombi Brook catchment, Wambo Coal Mine and United Coal Mine operate. Recent assessment work undertaken by Umwelt (2018) indicated that the United Wambo Joint Venture would have negligible geomorphology or water quality impacts on Wollombi Brook.

4.9.1 Flows

The Proposed Modification will result in changes to the catchment area of Loders Creek compared to the catchment areas of the Approved Operations final landform. This is primarily due to the proposed final landform shaping and drainage systems.

The results of the flow analysis for Wollombi Brook, indicate a reduction in the frequency of very low flows (<1 ML per day) for both the Approved Operations and the Proposed Modification. However, the Proposed Modification indicates a reduction in the predicted impacts on the reduction in frequency of very low flows. Overall the analysis indicates that

the Proposed Modification has negligible predicted impacts on baseflows in Wollombi Brook when compared to the Approved Operations.

The analysis of watercourse stability indicates negligible changes to velocities with the Proposed Modification compared to the pre-mining scenario of Loders Creek. The Proposed Modification is consequently considered likely to have limited impact on waterway stability and scour potential.

The Proposed Modification is not expected to have any negative impact on cumulative flows in Wollombi Brook. The assessment indicates that the Proposed Modification will have negligible impact compared to the predicted impacts of the Approved Operations.

4.9.2 Water Quality

Management of potential water quality impacts throughout the life of the Approved Operations is undertaken using the WMS. It is proposed to integrate water management for the additional disturbance area with the existing WMS (as set out in Section 3). In conjunction with the proposed BCC WMS, a series of erosion and sediment control measures will be utilised during operation and rehabilitation phases of the operations to manage water quality.

The two mining operations located downstream on BCC on Wollombi Brook (Wambo Coal Mine and United Coal Mine), as well as Mt Thorley Operations (located downstream on Loders Creek) have well developed and document WMS and associated erosion and sediment control systems. The WMS and associated erosion and sediment control systems at these mining operations are required to meet specific design criteria based around industry standards to contain mine affected water and protect downstream environments from contamination.

Through management of dirty water and mine water within the integrated WMS over the life of the operations, it is not anticipated that water quality in downstream waterways will be adversely impacted as a result of the Proposed Modification.

As such the cumulative potential impacts on water quality in downstream watercourses is considered to be negligible.

4.9.3 Downstream Users

Loders Creek flows into the Hunter River which is a regulated river with a very large catchment area. Water quantity is not anticipated to be adversely impacted by the Proposed Modification on a sub-regional or regional scale.

As the Proposed Modification and adjacent mining operations operate in a highly regulated water system (refer to Section 2.1.3) any water take associated with the Proposed Modification or existing approved operations will need to meet the requirements of the WM Act in regards to licensing of water take. As such the Proposed Modification is considered to have negligible cumulative impacts on downstream water users.

5. SUMMARY OF ASSESSMENT AGAINST COMMONWEALTH SIGNIFICANT IMPACT GUIDELINES

The Proposed Modification was determined to be a controlled action and requires approval under the EPBC Act.

Detailed environmental studies have been undertaken to inform the proposed conceptual design for the Proposed Modification. The consideration of the outcomes of these studies in the design of the Proposed Modification and integration with the Approved Operations minimise the potential for the impacts on surface water resources. These factors include:

- The extent of existing and approved open cut and underground mining within and surrounding approved operations, with mining already significantly altering the water environment.
- The management of impacts within the regime established by NSW water and pollution control legislation, which provides for sustainable water take from water sources, management of water quality by imposition of discharge quality criteria and management of salt loads within sustainable targets by managing water discharges to the environment.
- By maintaining buffer distances to Wollombi Brook and Loders Creek.
- Water management system designed to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas).
- Minimisation of works within the flood prone areas of Loders Creek to minimise the potential to impact on flood behaviour.
- Maximised water recycling within the BCC.
- Discharges from the WMS to occur within the established NSW environment protection licence framework.

These factors reduce the potential for significant impacts on existing surface water resources. A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE 2013) is included in Table 5.1.

Table 5.1 Assessment Against Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

Aspect	Impact
Flow Regimes	The footprint of mining operations will increase with the Proposed Modification with water from this area continuing to be captured, treated and reused within the WMS. The assessment indicates that the Proposed Modification will have negligible impacts on flood flow velocities and associated potential impacts on downstream landholders and watercourse stability in Loders Creeks when compared to the pre-mining scenario. The detailed assessment of potential impacts on flow regimes includes assessment of impacts on catchment areas and flow durations including changes to catchment areas in Wollombi Brook and Loders Creek and flow duration impacts on Wollombi Brook. The assessment of potential impacts of flow regimes on riparian and ecological values is included in Section 4.6.
Recharge Rates; Aquifer pressure or pressure relationships between aquifers; Groundwater table levels	Refer to Groundwater Assessment (KCB, 2019)
Groundwater/surface water interactions	Groundwater interactions are discussed and assessed in the Groundwater Assessment (KCB, 2019). The surface water assessment indicates that the baseflow impacts will be similar to those currently approved for Wollombi Brook. In addition, the assessment of the final void (refer to Appendix 10 of the SEE) indicates that the void continues to be a self-contained system with a predicted freeboard of over 100 m, with no surface spills predicted to downstream watercourses.
River/floodplain connectivity	The Proposed Modification is not expected to have an impact on river / floodplain connectivity as no mining is proposed in floodplain areas. Portions of the existing BCC operational areas located within the flood prone land associated with Loders Creek. Loders Creek is a highly modified creek line with various historical diversion of its tributaries and changes in catchment areas due to mining in the catchment area for the last 30 years. It is considered that the Proposed Modification will not influence river/floodplain connectivity compared to the currently approved impacts. The detailed assessment of flood behaviour and potential impacts on flooding regimes, including impacts on river/floodplain connectivity is included in Section 4.3.4.
Inter-aquifer connectivity	Refer to Groundwater Assessment (KCB, 2019)
Coastal Processes	No impacts on coastal process are predicted as a result of the Proposed Modification, which is located well inland, being approximately 80 km from the coast.
Impact on water users	The assessment of impacts on water users indicates that there will be negligible impact on surface water users. All water take associated with the Proposed Modification will be licensed in accordance with the WM Act. The detailed assessment of impacts on surface water users is included in Section 4.7. Further details on licensing provisions are included in Section 6.2).

Aspect	Impact
State Water Resource Plans	The surface water and alluvial water sources within and adjacent to the Proposed Disturbance Area are managed under the Hunter Unregulated and Alluvial Water Sources WSP. In addition, water extraction from the Hunter River is managed under the Hunter Regulated River Water Source WSP. Both WSPs are State Water Resource Plans and are governed under the WM Act. The NSW Government WSPs provide a regional water balance for these water sources and consider cumulative water use. Water take for the BCC will continue to comply with the above listed WSPs and WM Act which are designed to provide for the sustainable use of NSW's water resources.
Water Quality	BCM has a comprehensive WMS in place at the BCC to manage the potential impacts of the existing mining operations on water resources. The WMS for the Proposed Modification will be designed in accordance with relevant government standards to limit potential impacts on downstream water qualities by managing water that has the potential to cause environmental harm. To manage water quality during operational and rehabilitation phases of the Proposed Modification, erosion and sediment control measures and other water quality control measures in accordance with the relevant government standards will be implemented to minimize any potential impact on water quality. Monitoring results will be assessed against the relevant trigger values. The risks to downstream environments associated with sediment laden water are mitigated by the design of the BCC WMS in accordance with design criteria established by the NSW Government specifically for sediment control at mining and quarry operations. These controls will effectively manage this risk. Through management of sediment laden (dirty) water and mine water within the WMS over the life of the operations, and based on flood assessment findings that indicate no changes to velocities and associated scour potential in Loders Creek, it is not anticipated that water quality in Wollombi Brook or Loders Creek will be adversely impacted by the Proposed Modification.

6. MANAGEMENT, MONITORING, LICENSING AND REPORTING

6.1 Water Management Plan and Monitoring

The existing BCC WMP (dated June 2016) includes details of erosion and sediment controls, surface water and groundwater monitoring programs, as well as a surface and groundwater response plan

This plan is available on the BCC website http://www.bulgacoal.com.au/en/publications/management-plans/Pages/default.aspx.

The management plans include specific monitoring for:

- Erosion and sediment control measures.
- Surface water quality monitoring.
- Stream health and channel stability monitoring.

If the Proposed Modification is approved, the BCC WMP and associated sub plans will be updated to include the WMS and water balance associated with the Proposed Modification,

There are no proposed changes to the monitoring programs with the Proposed Modification.

6.2 Licensing Requirements

6.2.1 Protection of the Environment Operations Act 1997

Licensing requirements for the operations under the POEO Act remain unchanged with the Proposed Modification (refer to Water Balance Report, Appendix 10 of SEE).

6.2.2 Water Act 1912 and Water Management Act 2000

The Hunter Unregulated and Alluvial Water Sources WSP applies to water take from watercourses and alluvial groundwater in the vicinity of the BCC. The operation of the Hunter Unregulated and Alluvial Water Sources WSP is governed by the WM Act.

6.2.3 Hunter Unregulated and Alluvial Water Sources WSP - During Operations

The Proposed Modification will not increase the capture of runoff take from clean catchment areas. Runoff from dirty and mine water catchments will be contained within the WMS to meet the requirements of the EPL. There are also no harvesting dams proposed as part of the Proposed Modification. As such the licensing regime for the Approved Operations

during the operational stages in regard to surface water is not predicted to change as a result of the Proposed Modification.

This review demonstrates that licensing for both during operations and the conceptual final landform for the Proposed Modification can be appropriately accommodated in the current water licence regime.

6.2.4 Hunter Unregulated and Alluvial Water Sources WSP - Final Landform

Dams may be required in the final landform for a number of reasons with the three primary purposes being:

- Long term management of drainage in the final landform (for example, their ongoing use as dryland attenuation basins / detention areas to reduce flow velocities downslope and continue the operation of the established clean water management systems whilst maintaining drainage and creek line stability).
- Use to support final land uses (e.g. farm dams for stock watering or water storages for other uses).
- Environmental purposes (for example, the retention of dams with developed ecosystems will have biodiversity value in the final landform).

The number of dams in the final landform will depend on the detailed design of the final landform and land use which will be progressively developed and refined over the life of the operation.

All dams to be retained in the final landform will be fully licensed in accordance with licensing requirements in force at the time. Dams which cannot be licensed due to limitations on available water allocations or other reasons will be removed prior to closure.

Water take associated with the catchment area of the final void for the Proposed Modification is estimated to be approximately 559 ML/year (i.e. 0.7 ML/ha/yr average regional runoff over 799 hectares).

The Proposed Modification final void is located within the water sources of Singleton and Lower Wollombi Brook of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*. Approximately 19 hectares of the final void catchment area lies within the Lower Wollombi Brook water source, with the remaining 780 hectares lying within the Singleton water source.

Required WALs for the final void water take are:

- Singleton water source – 546 units.
- Lower Wollombi water source – 13 units.

There are 1,170 unregulated river units in the Singleton Water Source. The licenced take in the Singleton Water Source is estimated to be on average 546 ML/yr (i.e. equivalent to 546 units) equating to approximately 47% of the total water entitlement. BCM will purchase these licences as required.

BCM currently hold 1710 units of WALs in the Lower Wollombi Water Source of a total of 6,663 units within the water source. These units will be used to provide licenses for the predicted final void water take of an average 13 ML/yr (i.e. 13 units).

6.2.5 Hunter Regulated River Water Sharing Plan

The water balance assessment (refer to Appendix 10 of the SEE) indicates that the existing licence allocations are not sufficient to meet the water requirements of the BCC with the Proposed Modification during operations. That is, the assessment indicates that additional WALs will need to be purchased in the Hunter Regulated River WSP as a result of the Proposed Modification.

BCM will source additional WAL to meet the Hunter River abstraction requirements either by temporary transfers or potentially purchasing additional licences.

6.3 Reporting

A summary of surface water monitoring results will continue to be provided in the Annual Review. As a minimum, the following information will be reported in the Annual Review:

- A summary of monitoring results;
- An analysis of monitoring results against impact assessment criteria, historical monitoring results;
- Annual site water balance and comparison against predictions in the see;
- An identification of any trends in the monitoring results;
- Any non-compliances reported during the year; and
- Actions taken to address any non-compliances.

In addition, any significant findings regarding the implementation of the WMP will be reported in the Annual Review, including:

- The effectiveness of the erosion and sediment controls;
- Changes to the site water balance; and
- Any identified issues or exceedances of trigger values.

The Annual Review will also document reviews and feedback relating to the maintenance and performance of the WMS.

7. QUALIFICATIONS

a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c. Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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   (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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e. This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report.

f. If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g. This report does not provide legal advice.

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APPENDIX A

Water Quality Data Analysis

Analysis of Routine Monitoring (data range from January 2004 to May 2018)

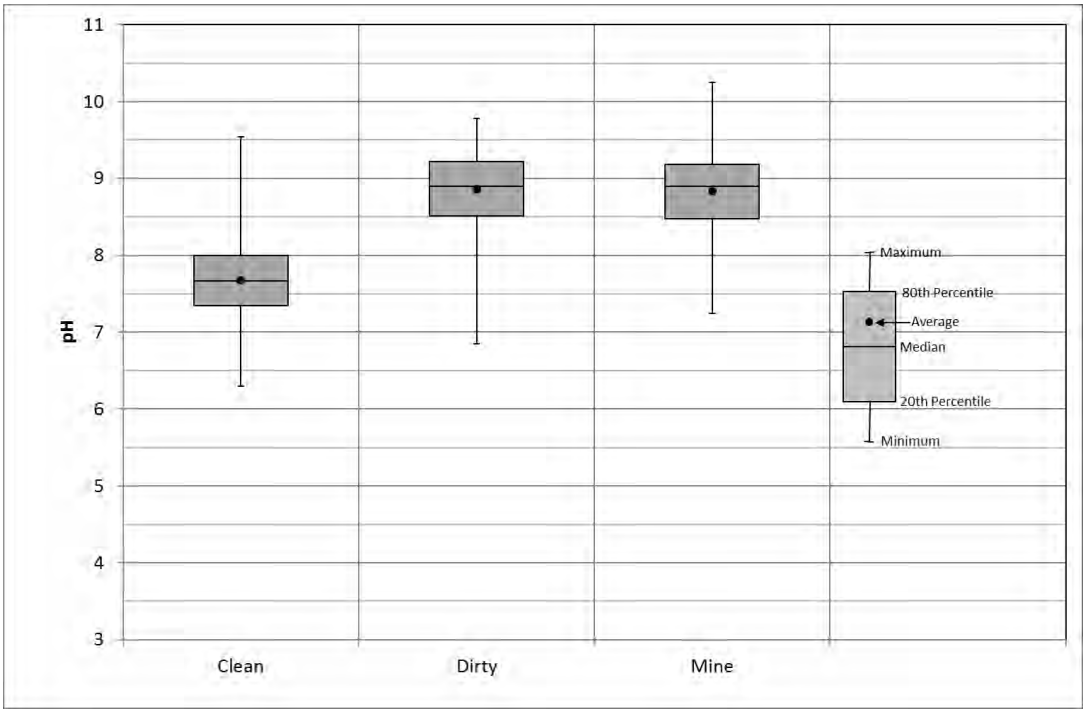


Figure A – pH

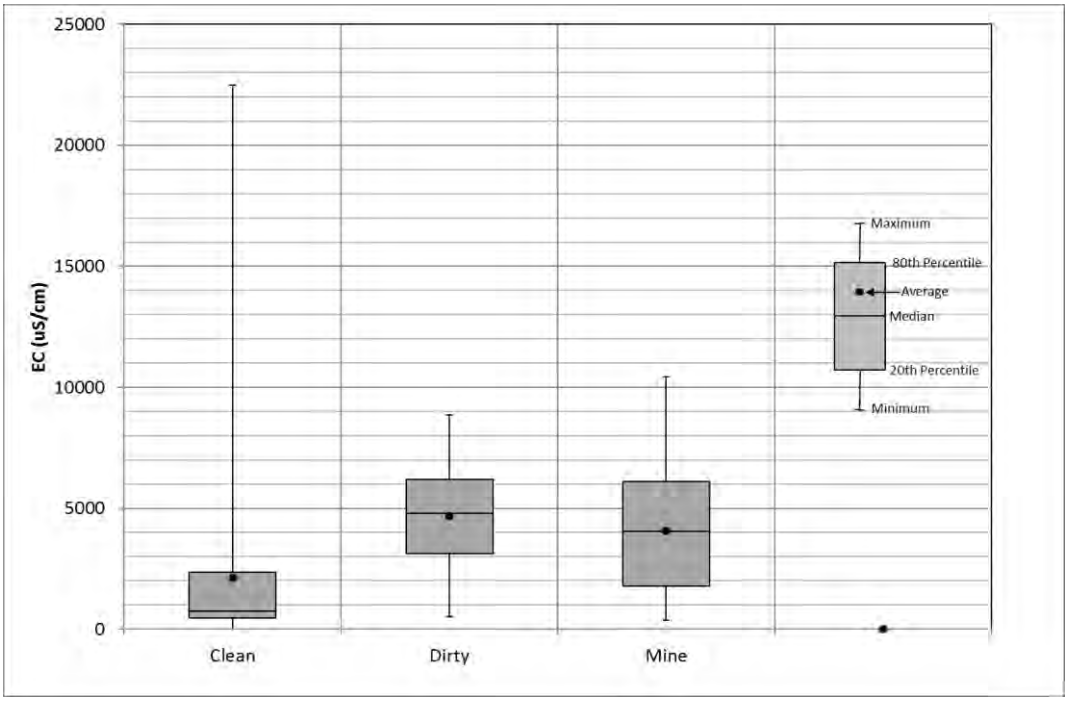


Figure B - EC

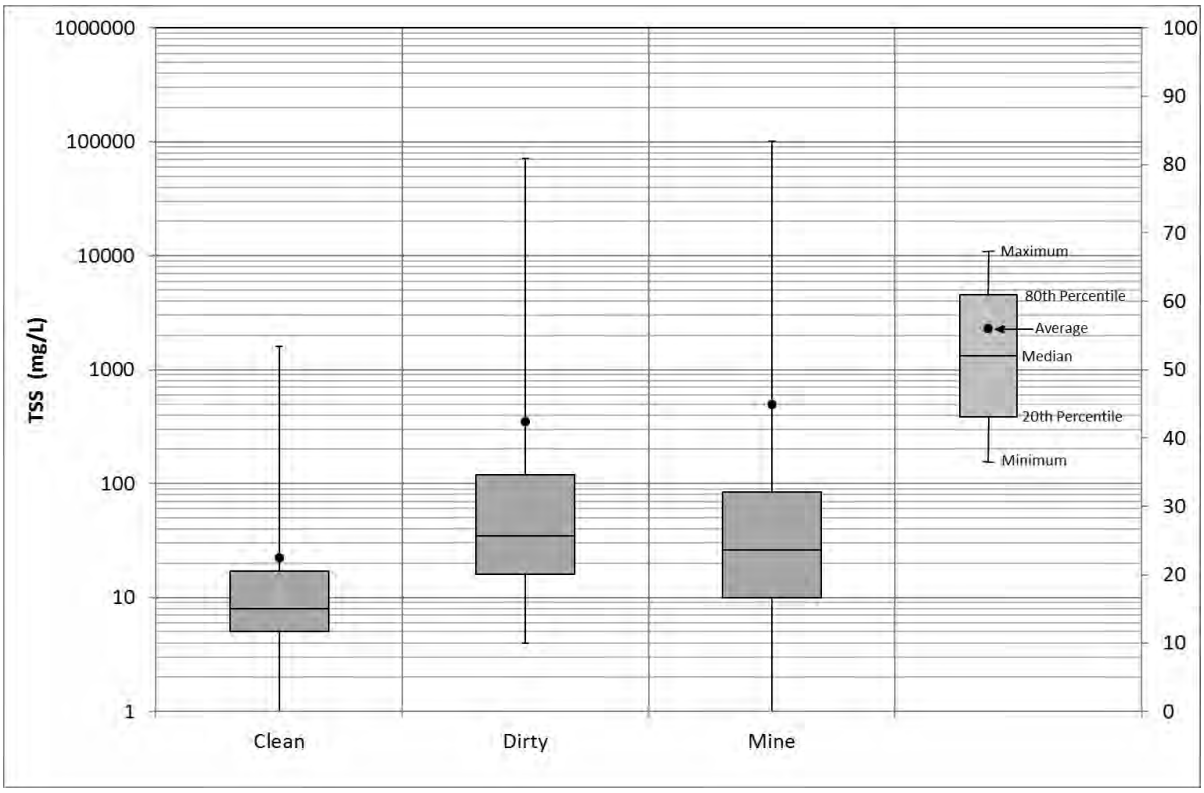


Figure C – TSS

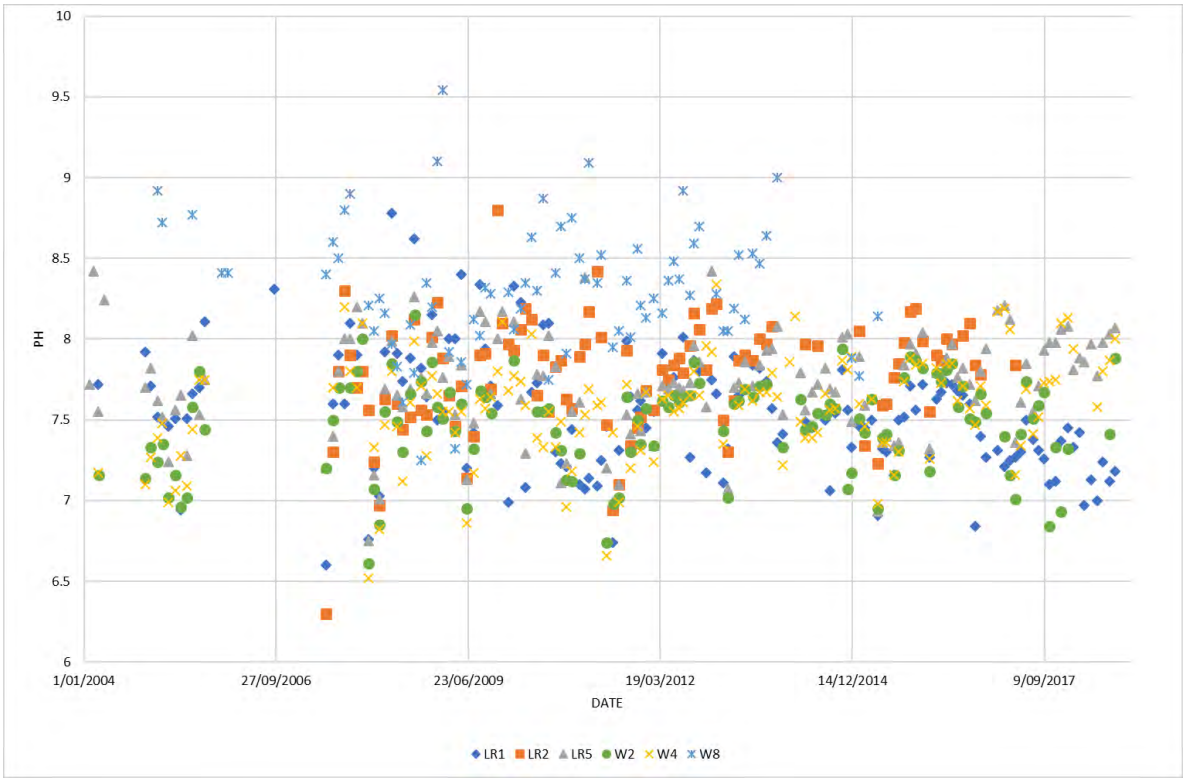


Figure D - Clean water system – pH

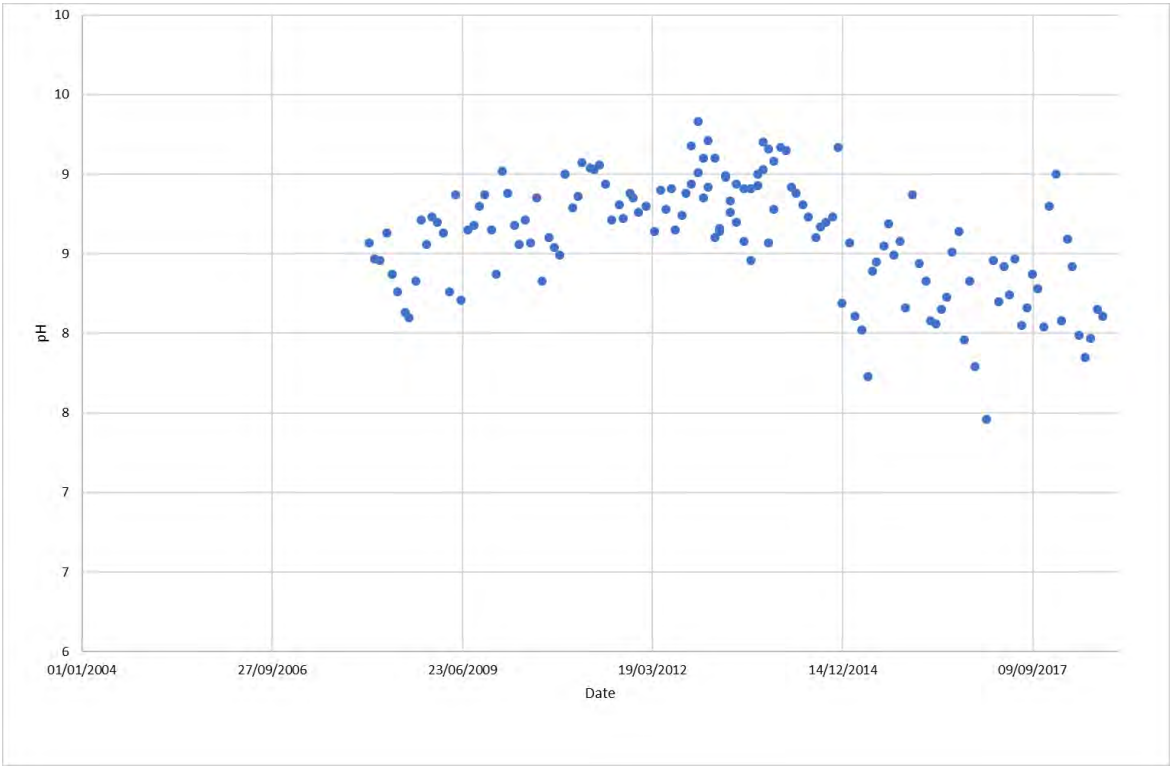


Figure E - Dirty water system – pH

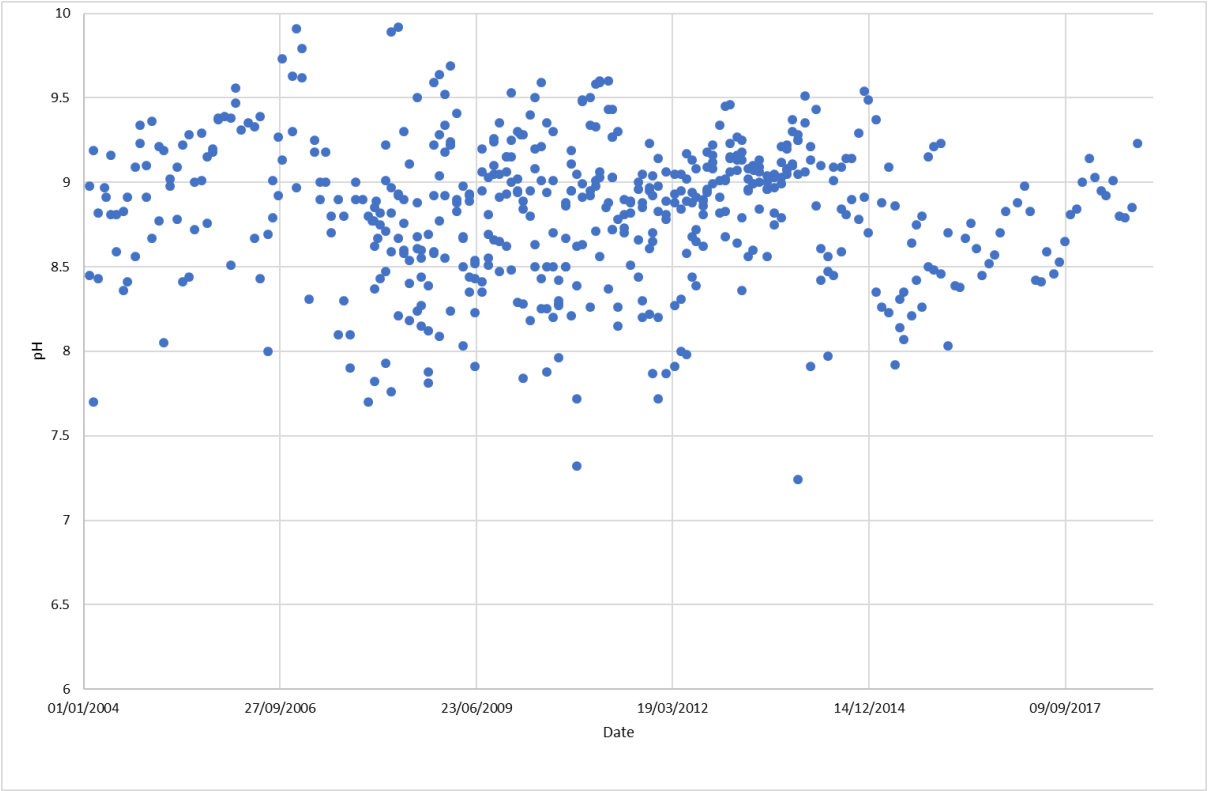


Figure F - Mine water system – pH

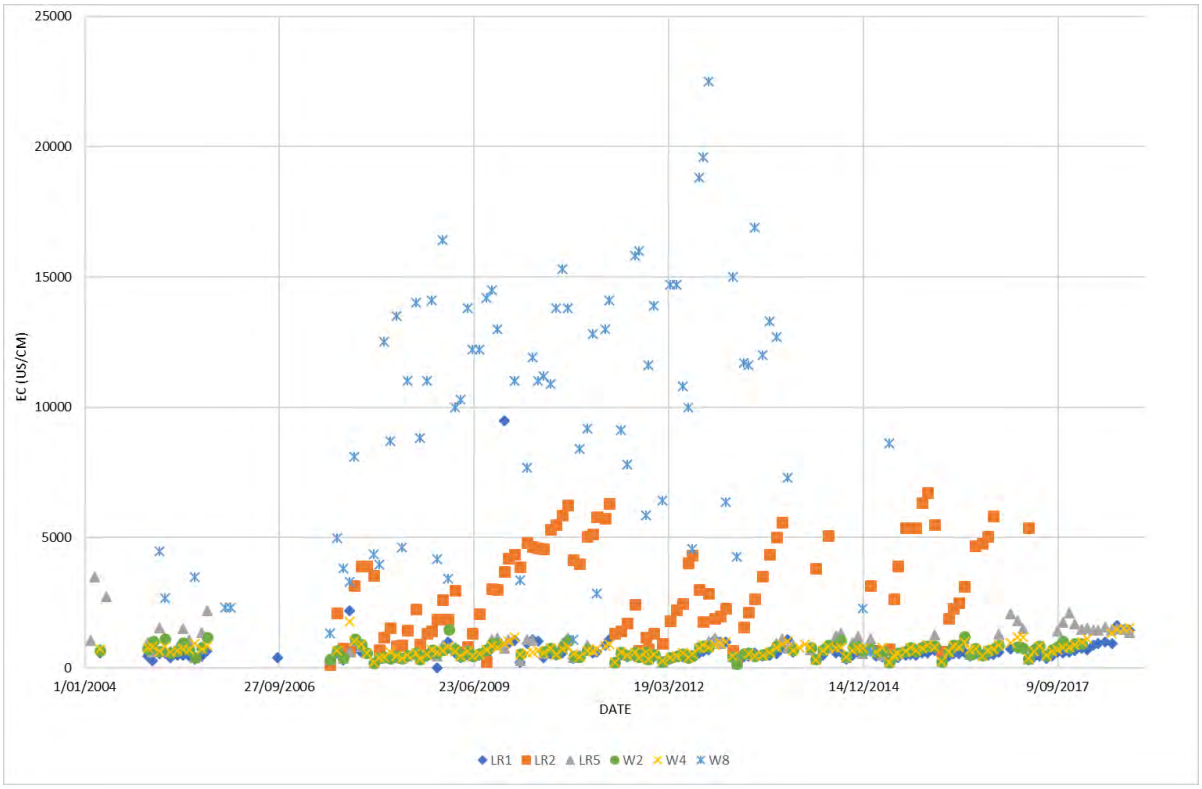


Figure G - Clean water system – EC

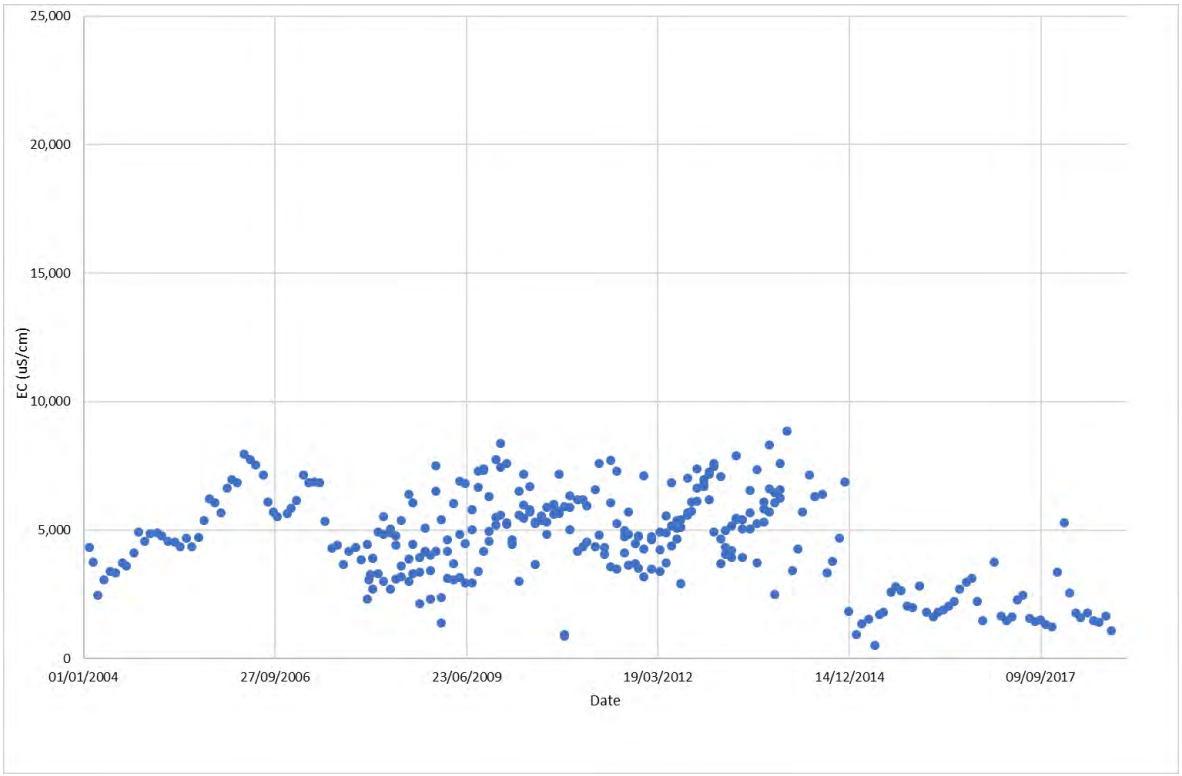


Figure H - Dirty water system – EC

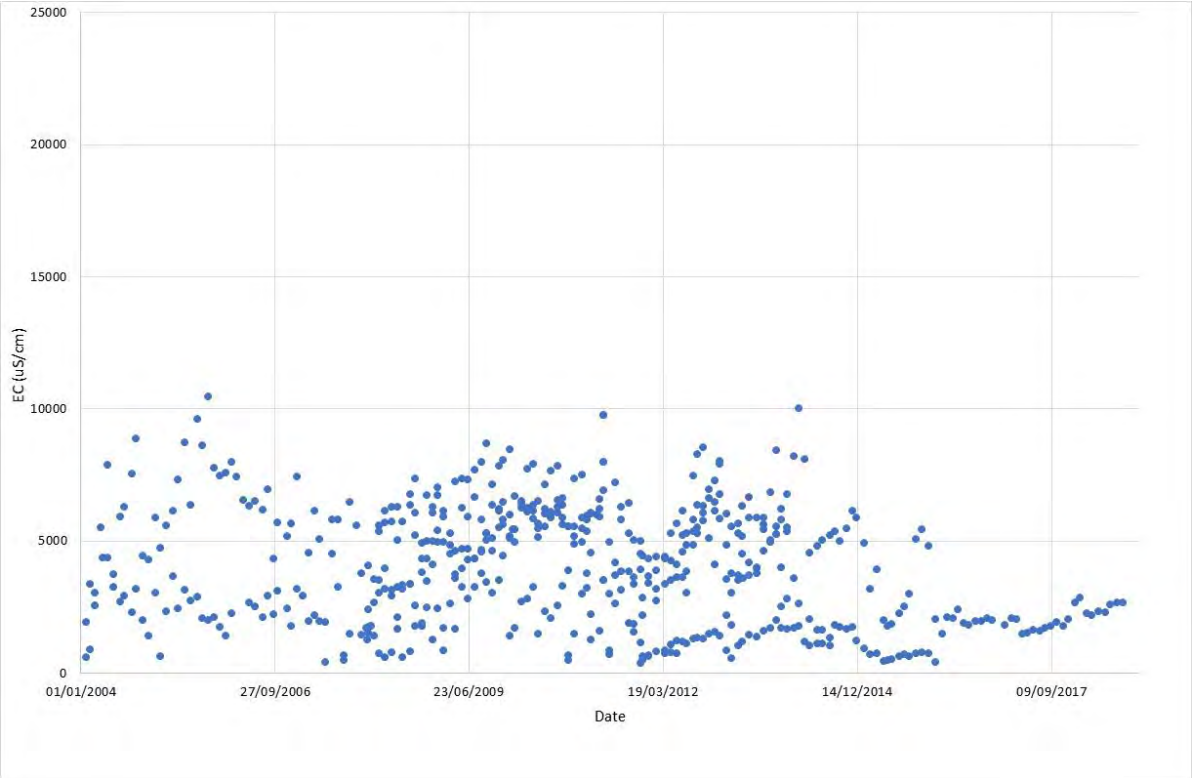


Figure I - Mine water system – EC

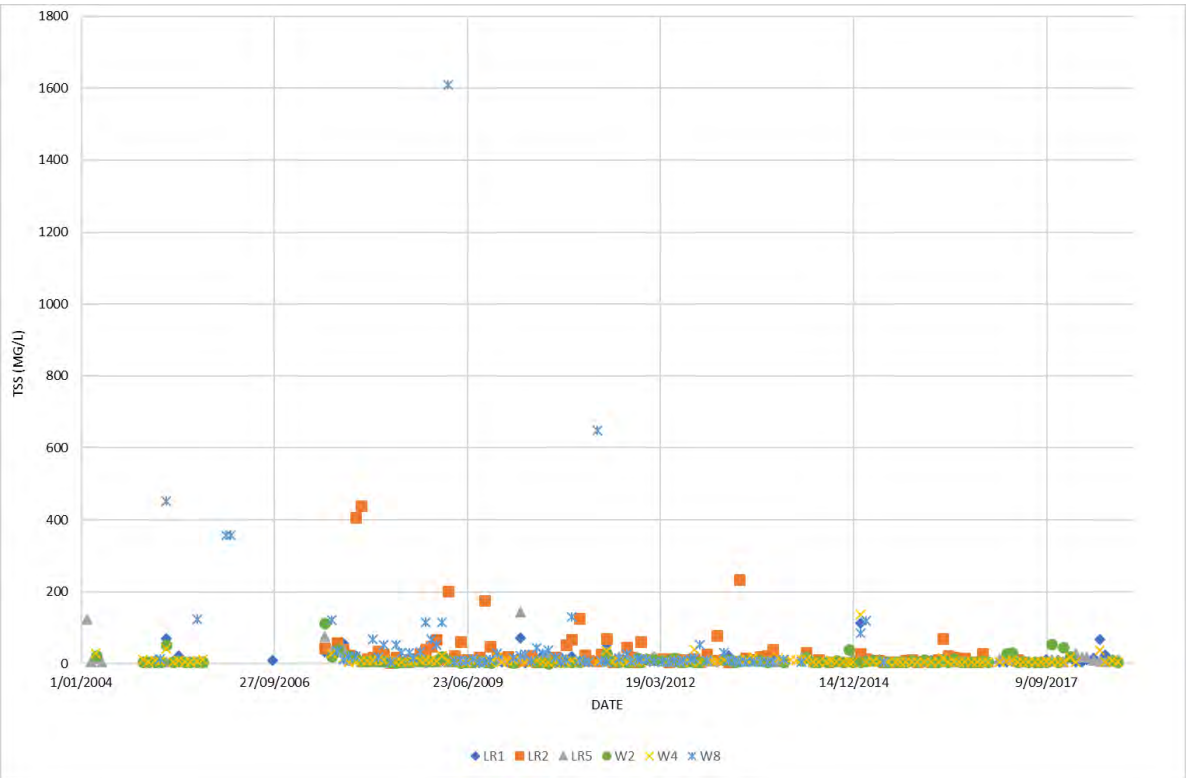


Figure J - Clean water system – TSS

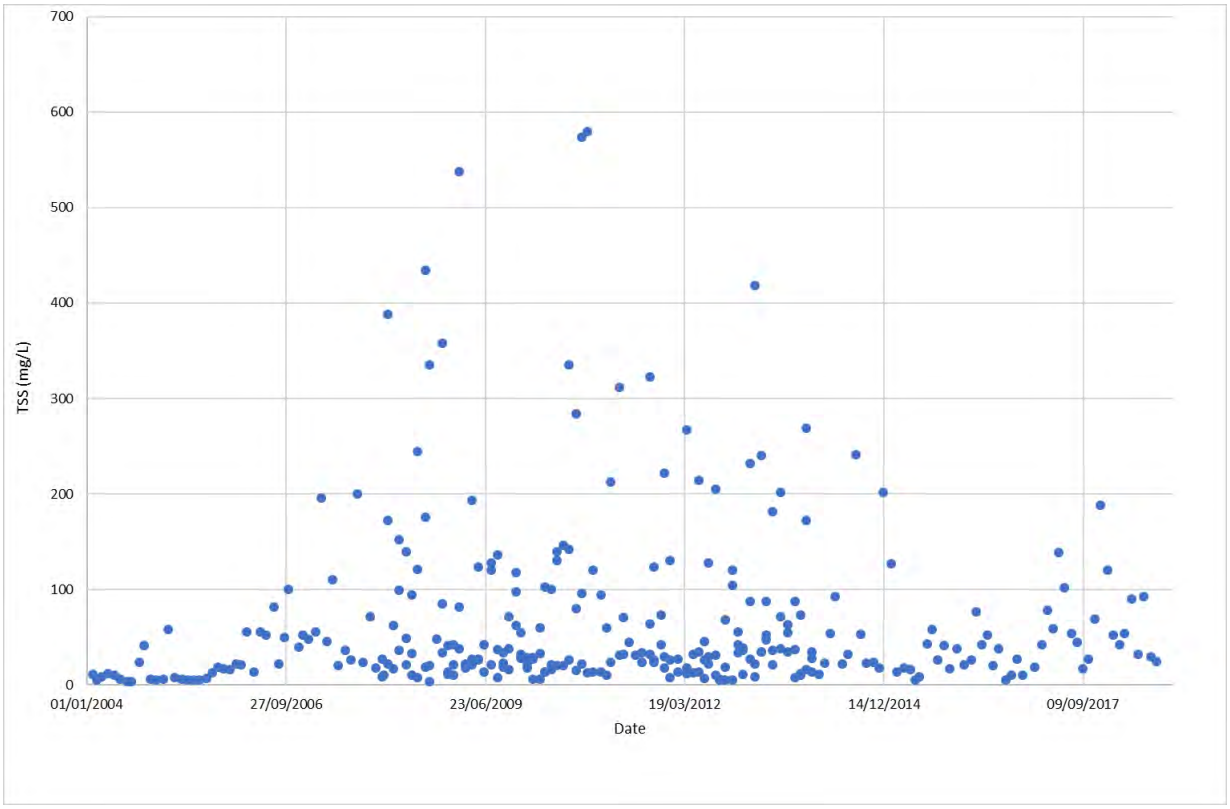


Figure K - Dirty water system – TSS

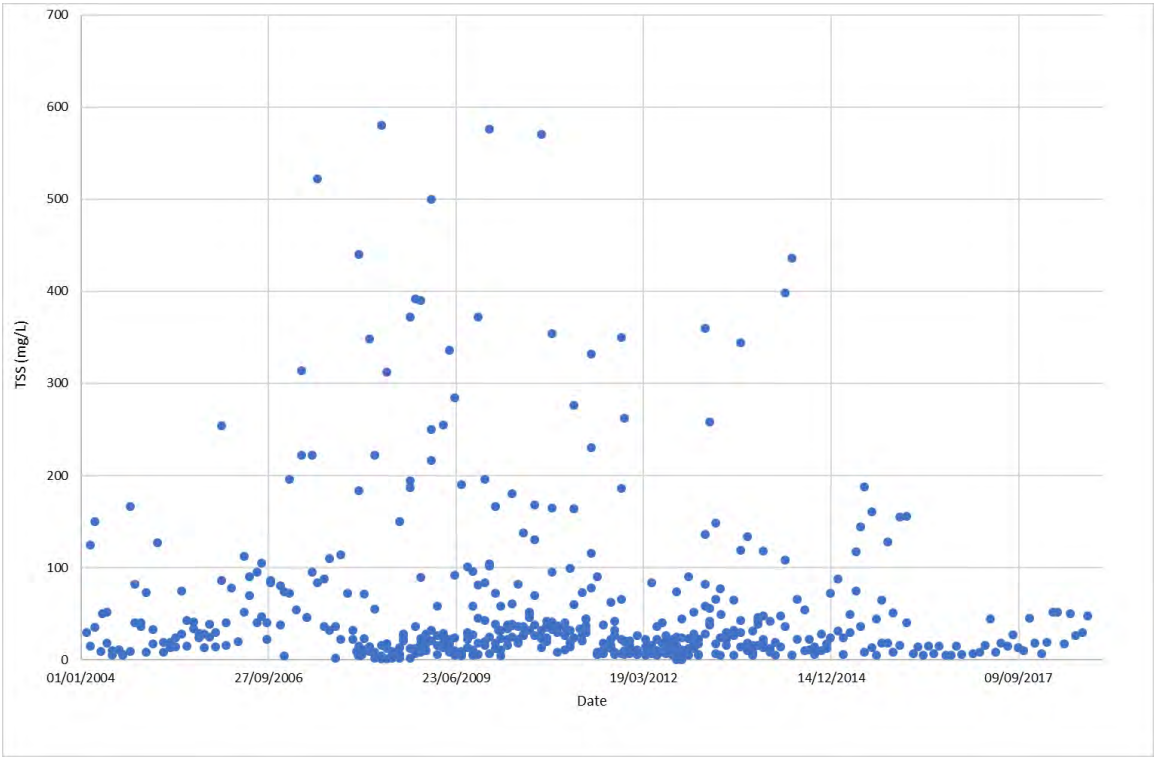
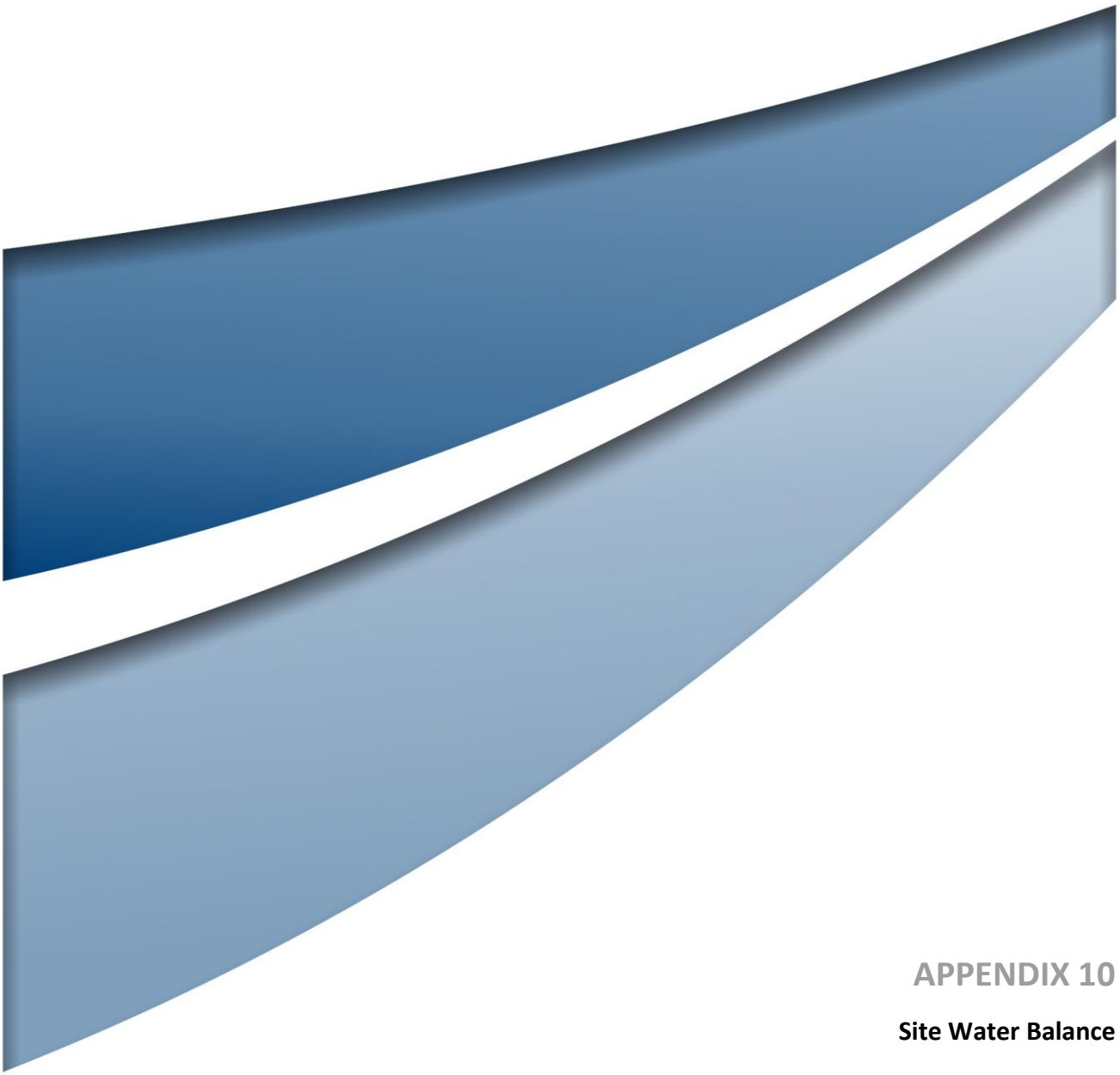


Figure L - Mine water system – TSS



APPENDIX 10

Site Water Balance

HYDRO ENGINEERING & CONSULTING PTY LTD

REPORT

Bulga Coal Complex

Bulga Optimisation Project

Modification 3

Site Water Balance

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b	Draft (Incomplete)	TSM	CW	TSM	7 Jun 2019
c	Draft (completed)	TSM	CW	TSM	12 Jun 2019
d	Revised Draft	TSM	CW	TSM	3 Jul 2019
e	Revised Draft	TSM	BCM/Umwelt	TSM	22 Jul 2019
f	Final	TSM	BCM	TSM	25 Jul 2019
g	Revised Final	TSM	Legal	TSM	6 Aug 2019

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1.0 INTRODUCTION

This report describes the water and salinity balance for the proposed Bulga Optimisation Project Modification 3 (Proposed Modification).

1.1 MODIFICATION DESCRIPTION

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located in the Hunter Valley, NSW. The BCC consists of two existing coal mining operations: the open cut operations (Bulga Open Cut) and the underground operations (Bulga Underground Operations) using shared coal washing and rail loading infrastructure. The BCC is located approximately 4 kilometres (km) to the south-east of Bulga village, approximately 4 km to the north of Broke village and approximately 12 km southwest of the township of Singleton.

Mining operations have been occurring at the site for over 30 years with Bulga Coal Management Pty Ltd (BCM) currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014, which allowed ongoing operation of the Bulga Open Cut until 31 December 2035. SSD 4960 was subsequently modified (SSD 4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailings management strategy. Modification 2, approved in August 2018, involved an extension to the period of construction for the outer face of the noise and visual bund. The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). BCM also operates the BCC in accordance with Environment Protection and Biodiversity Conservation (EPBC) Approval 2012/6637 (as modified).

BCM is proposing a modification to SSD 4960 and DA 376-8-2003 to maximise resource recovery within the approved Bulga Optimisation Project Area by a relatively small extension of the open cut operations to the south and west into a former open cut mining area occupied by the current Tailings Storage Facilities (TSFs) known as Deep Pit and Bayswater Pit (the Proposed Modification). The extension of the open cut also enables extraction of additional deeper resources below parts of the currently approved Bulga Open Cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 million tonnes per annum (Mtpa) run-of-mine (ROM) while enabling the extraction of approximately an additional 63 Mt of coal.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Open Cut will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- extension of mining areas to the south and west to access approximately 63 Mt of additional ROM coal by accessing deeper resources within the approved open cut pit and in the proposed extension area;
- realignment of the western highwall to improve long term stability and allow access to additional coal resources;
- an additional disturbance of 20.2 hectares (ha) to accommodate the proposed extension of the mining areas to the south and west;

- removal and relocation of the tailings material currently stored in the existing TSFs to the Main Pit TSF - the capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings;
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit TSFs and reprocessing infrastructure;
- relocation and removal of infrastructure servicing the open cut and Bulga Underground Operations including workshops, gas infrastructure and power station, fuel and oil storage;
- continued use of the temporary mine infrastructure area known as East Pit Muster Area;
- construction of new water management structures to manage changes to the site surface water catchments;
- the use of all existing or approved infrastructure and equipment with some additions to the existing mobile equipment fleet over the life of the Project; and
- reprocessing of tailings where practicable - any reprocessed coal from tailings would form part of the 20 Mt of product coal approved from the BCC and is not included in the Bulga Open Cut annual limit of ROM coal mined.

The key aspects of the Proposed Modification are shown on Figure 1.

A modification to the current Bulga Underground Operations consent (DA 376-8-2003) is also proposed for the relocation of infrastructure to allow for the extension of open cut mining. The Proposed Modification as it relates to DA 376-8-2003 includes:

- demolition and relocation of the Bulga Underground Operations mine infrastructure area;
- allowance for the relocation of underground mine ventilation, as required;
- relocation of the Gas Power Station and Waste Flare Station;
- relocation of the Bulga Underground Operations electrical substation; and
- upgrading, relocation, construction and decommissioning of several mine owned transmission lines and associated access tracks.

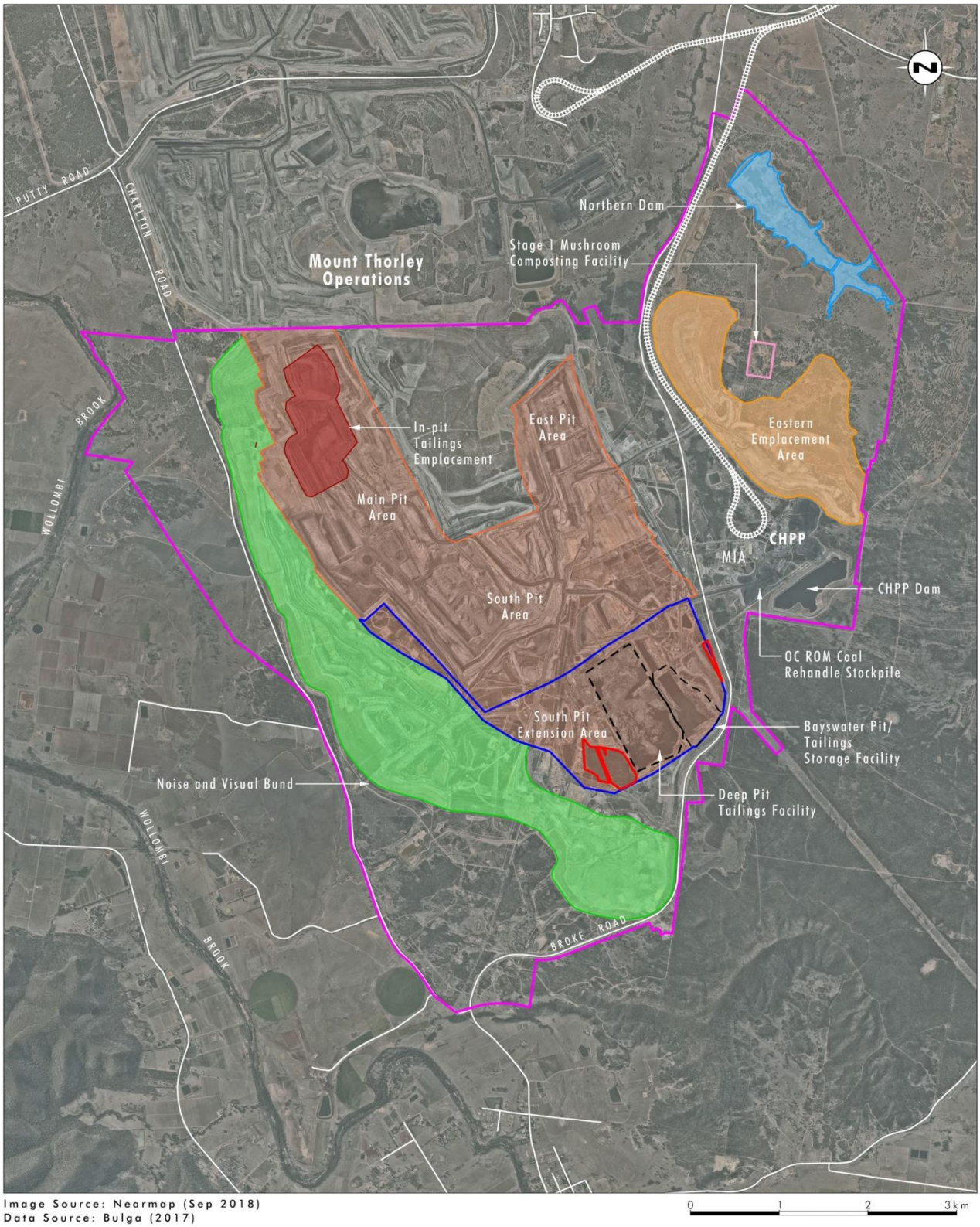

Figure 1 Project Layout

1.2 SCOPE OF WORK

Hydro Engineering & Consulting Pty Ltd (HEC) have been engaged by Umwelt (Australia) Pty Limited (Umwelt) (Proposed Modification environmental assessment lead consultants), to undertake the following work:

- Preparation of a detailed mine site water balance for the life of the Project including the following:
  - consideration of external water supply and discharge requirements;
  - accounting for available water sources and project water demands;
  - assessment of demand, supply and storage requirements under a range of climatic conditions including groundwater inflows and varying production rates;
  - identification of potential supply shortfalls and options for sourcing additional supply;
  - identification of the need for and frequency of controlled discharge via the Hunter River Salinity Trading Scheme (HRSTS); and
  - identification of the risk and likely quantities of designed outflows from water storages to the environment.
- Inclusion of a salt balance as part of the water balance.
- Preparation of a final void water and salt balance.

HEC (formerly Gilbert & Associates Pty Ltd – G&A) have previously developed an operational water and salinity balance model of the BCC, including for the Bulga Optimisation Project. The model has been modified to simulate the future predicted water balance for the proposed Project, using future water management system details provided by Umwelt. The operational model was developed with the aim of assessing future site water and salinity balance behaviour and water supply reliability using historical climatic data for the period of the Proposed Modification.

Key operational model outputs were as follows:

- Predicted water supply security for the BCC CHPP, for underground mining operations and for dust suppression use.
- Risk of spill occurring from BCC water storages to receiving creeks.
- Risk of accumulation of excess water in pits during Proposed Modification period and prediction of water volume variations in pits into the future.
- Evaluation of the relative proportions of:
  - water management system inflow obtained from different sources; and
  - system outflows to various demands/losses.

The model builds upon previous work undertaken by G&A (2013) for the BCC water balance model, with an additional or enlarged water management storages for Proposed Modification. A final void water and salt balance model has also been developed for the Proposed Modification. This report outlines model assumptions and describes results.

2.0 MINE AND WATER MANAGEMENT SYSTEM DESCRIPTION

2.1 SURFACE LAYOUT AND OPERATIONS

The existing (2018) site layout is shown in Figure 2. The site incorporates Bulga Underground Operations (with mining currently suspended) and the Bulga Open Cut. Mt Thorley Mine lies to the north with Wollombi Brook to the west. Nine Mile Creek flows northwards immediately west of the CHPP to Loders Creek. Loders Creek, which originally had its headwaters in the open cut area, drains northwards to the Hunter River.

Mining in the Beltana underground (Beltana Highwall) mine was completed in 2011, however the underground goaf remains as an important water storage for the BCC (refer Section 2.2). Open cut overburden and interburden is placed in a series of emplacement areas, including the EEA and an emplacement along the western perimeter of the BCC. ROM coal is transported by haul road or conveyor to the CHPP for crushing, screening and washing. Product coal is stockpiled on the north-east side of the CHPP prior to loading onto trains via a rail loop. A portion of the fine reject (tailings) from the CHPP is dewatered in a paste plant and is then co-disposed along with CHPP coarse rejects within the open cut overburden emplacements. The remaining tailings is pumped as slurry to the Main Pit TSF. Secondary flocculation of the tailings occurs at the discharge point to enhance settling of solids and improve water recovery. Water is recovered from the Main Pit TSF for re-use within the BCC water management system.

The future Project development of the BCC is shown as a series of stage plans in Figure 3 to Figure 6. It is important to note that the calendar years given in the stage plans (which have been adopted for water balance modelling) should be regarded as indicative only, being determined by construction and mining schedules. Open cut mining would extend southwards during the Proposed Modification. Overburden would continue to be placed within existing emplacement areas and as backfill within completed open cut areas. These areas would be progressively regraded and rehabilitated as indicated in Figure 3 to Figure 6.

An estimated 25.6 Mt of tailings are located in the path of the planned open cut in the Deep Pit and Bayswater TSFs. These tailings would be relocated over an approximate 6 year period, ahead of open cut mining of these areas, to the Main Pit TSF. Relocation would occur initially from the Bayswater TSF and then the Deep Pit TSF. Relocation is planned to be undertaken using dredging techniques, with the tailings pumped as a slurry (similar to existing CHPP tailings). Water would be recovered from the Main Pit TSF for re-use within the BCC water management system. The relocated tailings may be processed to recover additional coal prior to discharging to the Main Pit TSF. Following tailings relocation, open cut mining would proceed into the areas presently occupied by the Deep Pit and Bayswater TSFs.

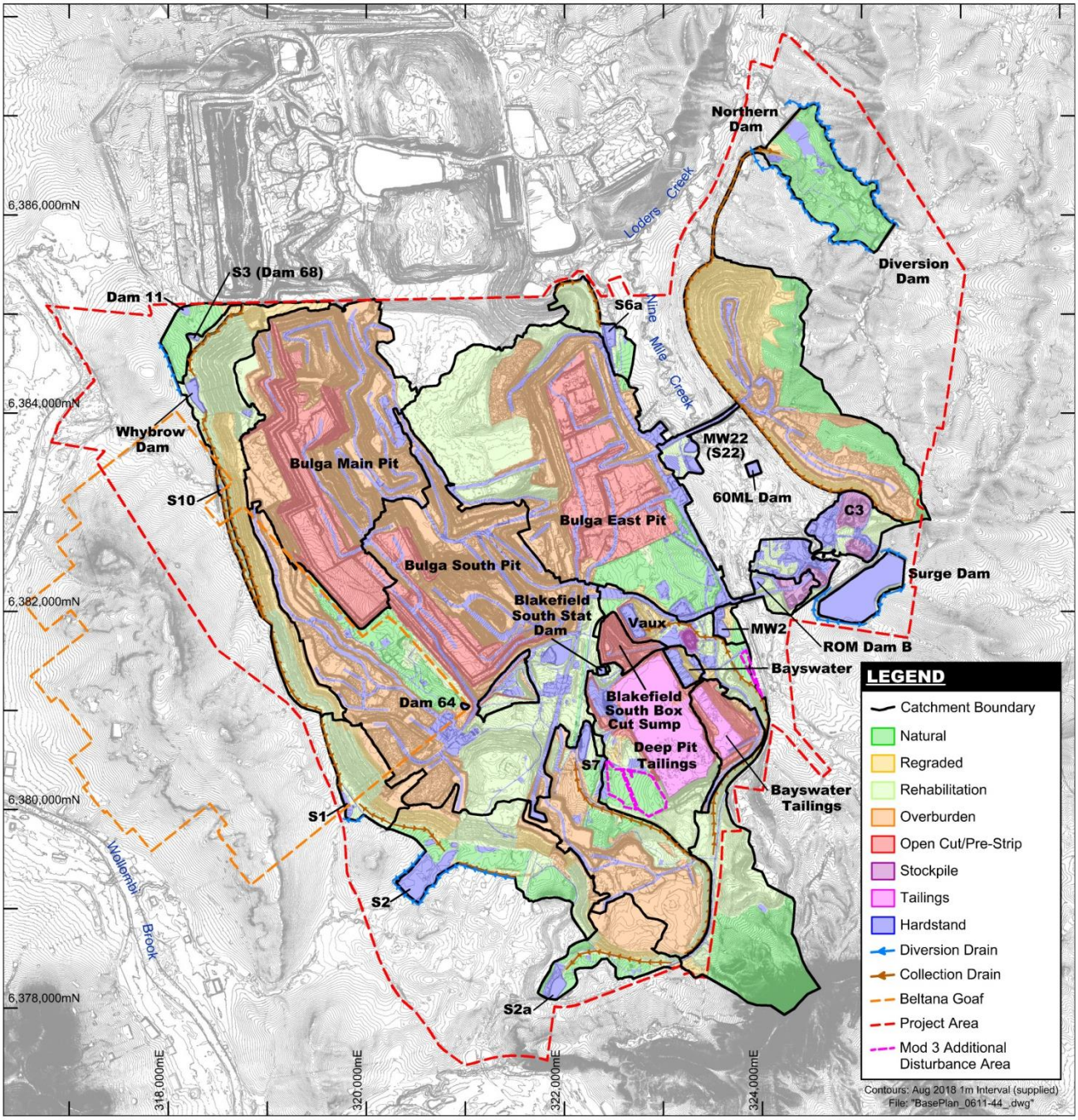

Figure 2 Existing BCC Layout and Catchments - 2018

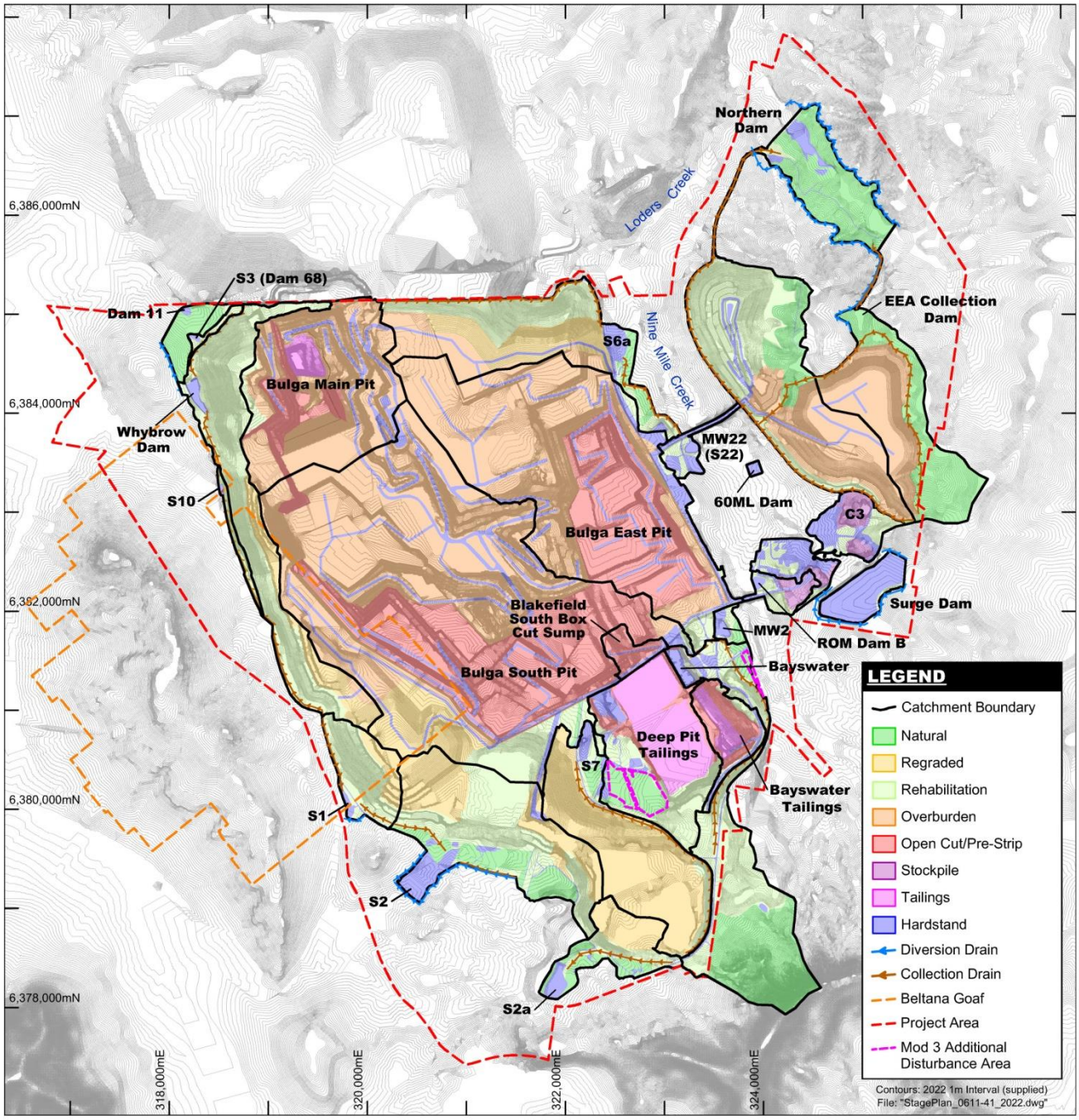

Figure 3 Project Layout and Catchments - 2022

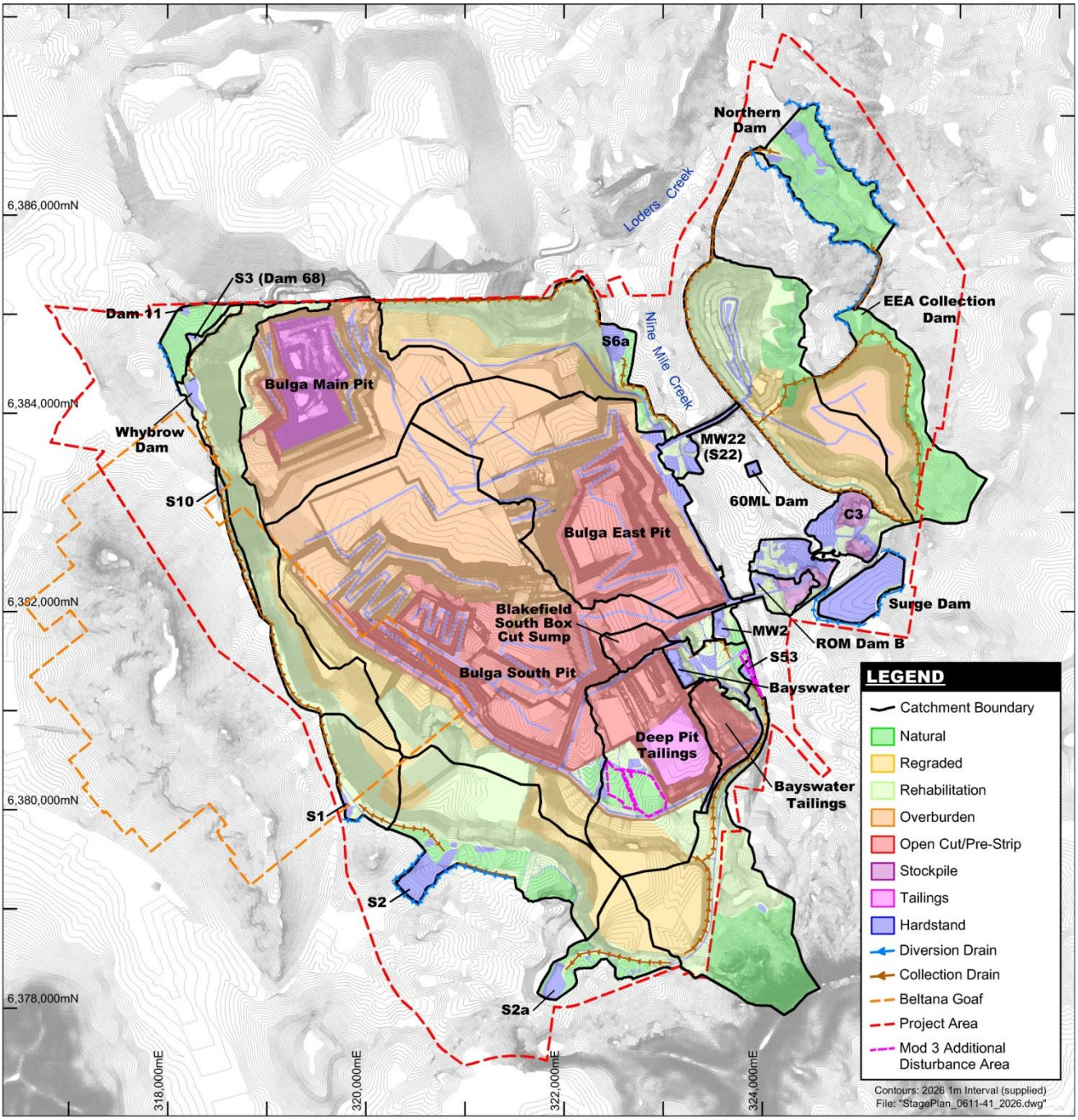

Figure 4 Project Layout and Catchments - 2026

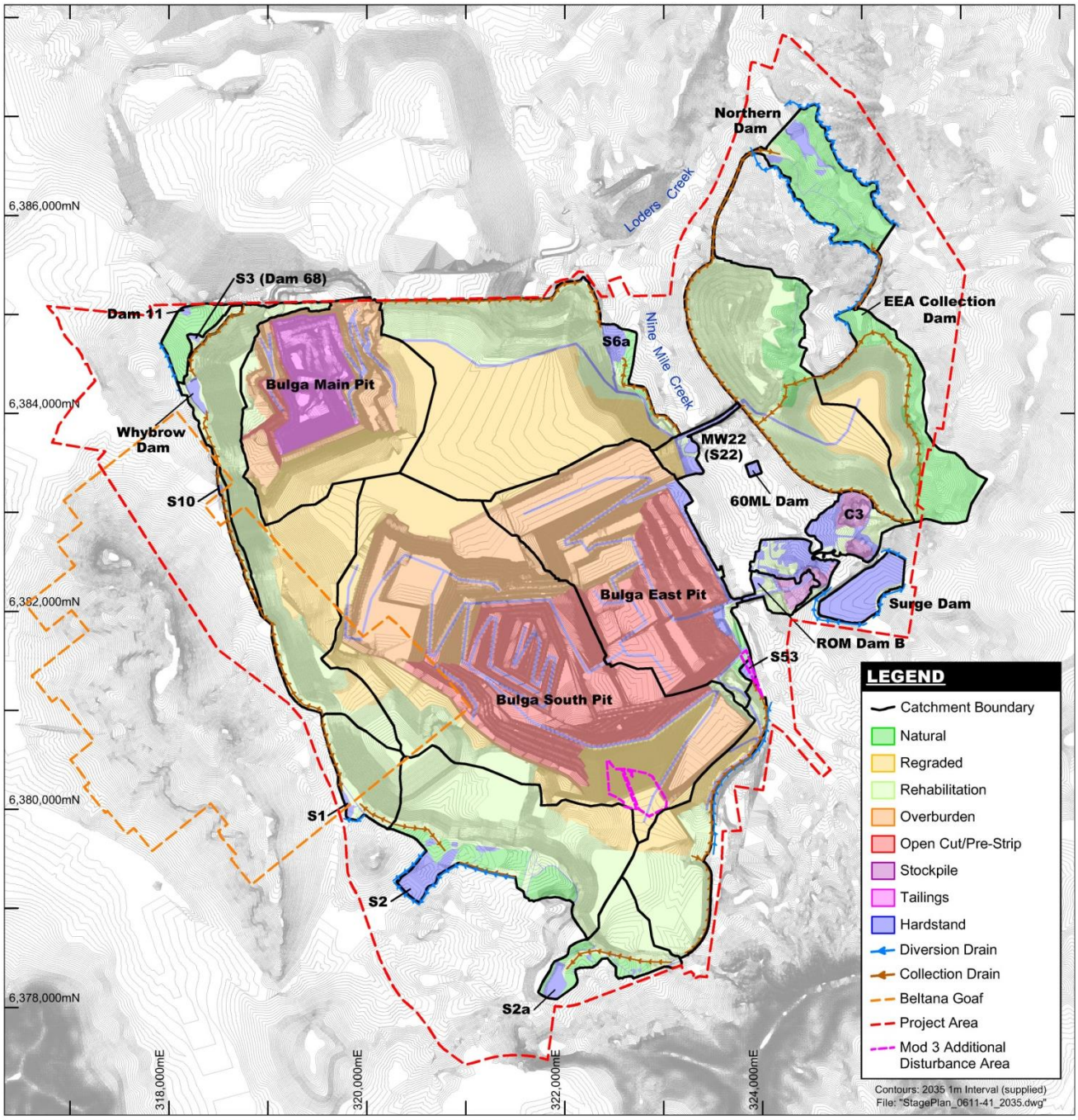

Figure 5 Project Layout and Catchments - 2035

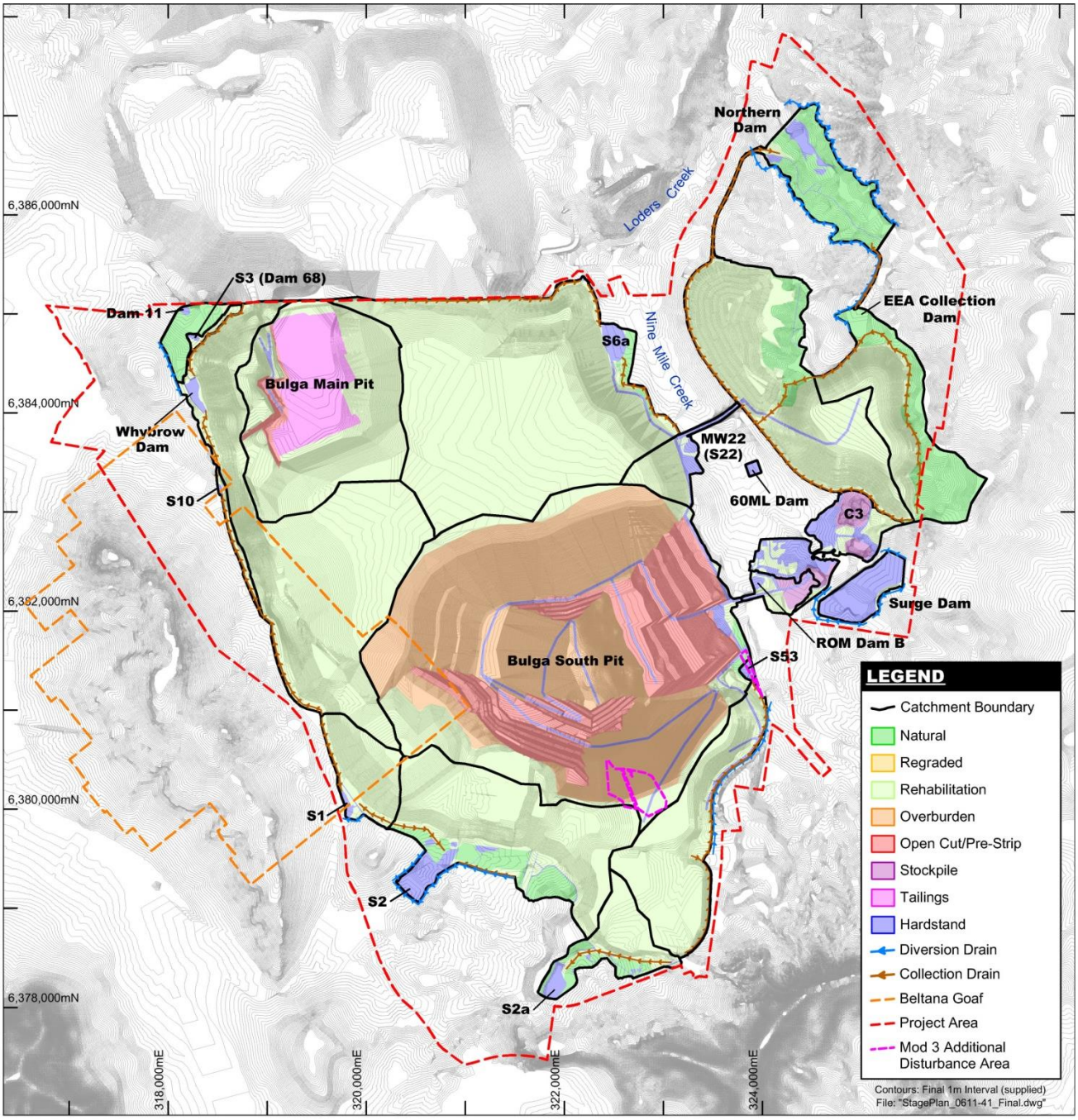

Figure 6 Project Layout and Catchments – 2039 (End of Mining)

2.2 WATER MANAGEMENT SYSTEM

2.2.1 Existing System

The surface water management system of the BCC involves a number of interlinked pits, voids, dams, ponds, the Main Pit TSF, their catchments, the former (Beltana) and suspended (Blakefield South) underground mining areas, the CHPP and water pumping systems. Figure 2 to Figure 6 show the location of existing and proposed storages and their surface catchments. A schematic representation of the current (2018) storages and their inter-linkages is shown in Figure 7.

The main system storages are as follows:

- Surge Dam: this is the main site surface water storage and is the principal supply for CHPP make-up water. It has limited catchment, other than its own surface area but receives water pumped from other storages. It has an estimated capacity of 3,140 ML.
- Northern Dam: this is a catchment dam located downslope of the EEA and is the main licensed discharge storage at the BCC. Its catchment is reduced by the use of upslope diversions but it receives pumped inflow from Dam S6a which in turn receives pumped inflow from other storages. It can also transfer water to and from the Surge Dam. The Northern Dam has an estimated capacity of 2,033 ML.
- Beltana Goaf Storage: this is the largest capacity storage at the BCC estimated[1] at 6,412 ML, located in the former underground workings to the west of the open cut pit area. Water can be transferred to the goaf from the Bulga South open cut and the Main Pit TSF. Transfer from the goaf occurs to Dam S7, with subsequent transfer to the Surge Dam. The current extraction pump rate (via a bore into the former workings) of 15 L/s will be increased to 85 L/s by approximately December 2019.
- Bayswater Pit: this is a pit void located near the Deep Pit and Bayswater TSFs and was used as the reclaim water storage for those TSFs. It can transfer water to and from the Surge Dam and other storages. It has an estimated capacity of approximately 1,680 ML but is not normally maintained with more than 1,088 ML for geotechnical stability reasons.
- Vaux Pit: this is a second pit void storage located north of the Bayswater Pit. Although it has an estimated capacity of approximately 1,900 ML, it is planned to be intercepted by open cut operations in early 2020 and is therefore of limited utility.

The majority of the BCC water supply is obtained from runoff captured from disturbed mine landforms and from water reclaimed from the TSF. Site (make-up) water supply is pumped from the Hunter River (licensed extraction) to the 60 ML Dam (a small 'turkey's nest' dam with no external catchment). BCM has access to high security water access licence (WALs) totalling 867 ML/year. Water accumulating in pit sumps is usually pumped via Dam S7 to the Surge Dam (the Bulga South open cut can also pump to the Beltana goaf storage).

A number of sediment dams are located along the western perimeter of the BCC, capturing runoff from the nearby emplacement area (noise and visual bund – refer Figure 1). Sediment dam capacities have been developed using Landcom (2004) and DECC (2008) guidelines. These are dewatered by pumping to either the Surge Dam via Dam S7 or the Northern Dam via Dam S6a. Additional sediment dams are located between the open cut areas and Nine Mile Creek and these are dewatered to the Surge Dam. Runoff from the EEA reports to the Northern Dam. Runoff from the CHPP area reports ultimately to C3 Dam which is dewatered directly to the CHPP or the Surge Dam.

[1] Based on a volume difference calculated from supplied underground floor and roof contours with an assumed porosity of 0.24.

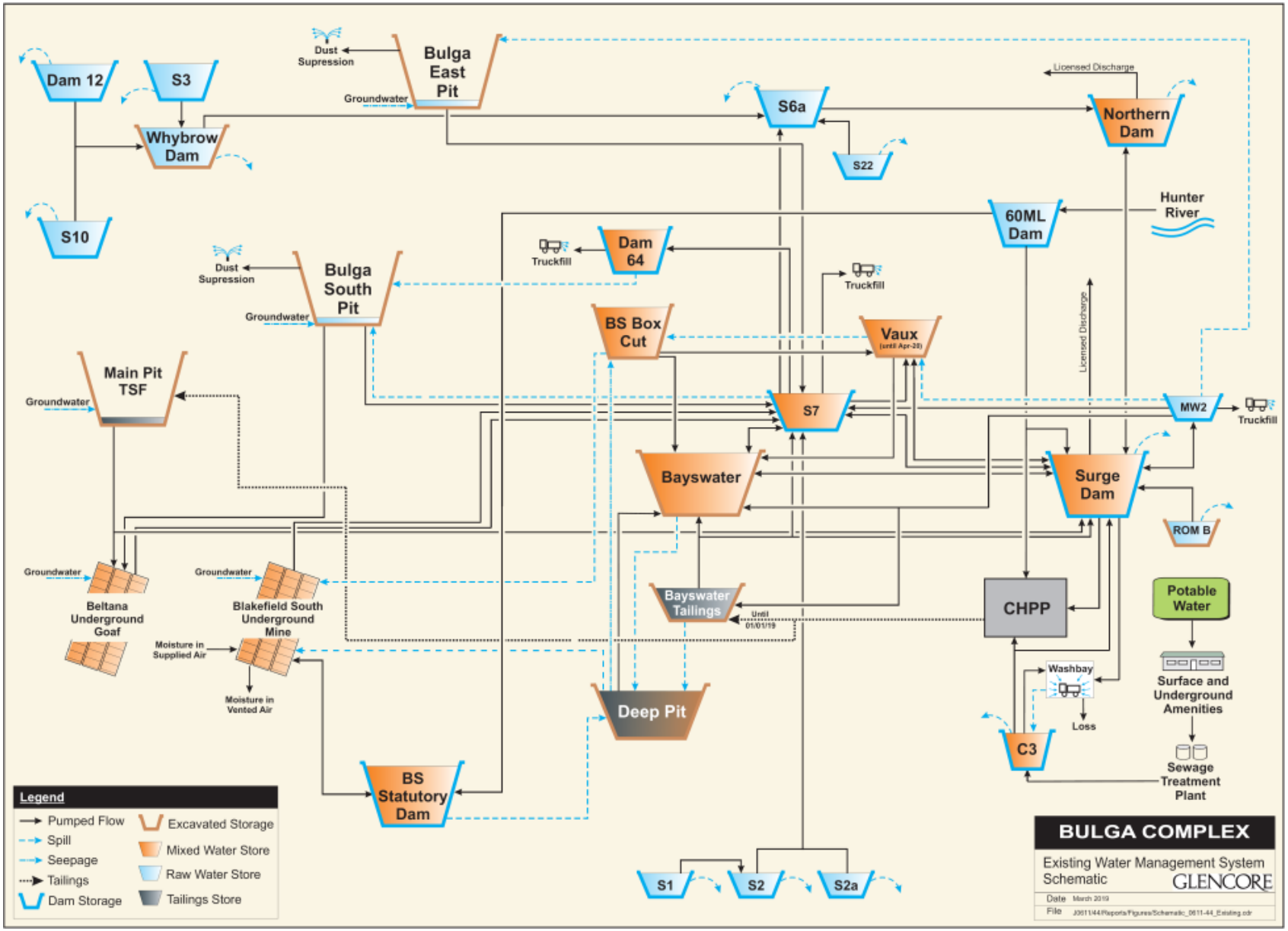

Figure 7 BCC 2018 Water Management System Schematic

Haul road dust suppression (truckfill) is provided by several small storages (Dam S7, Dam 64 and MW2). BCC also undertake dust suppression of overburden areas via a sprinkler system, supplied from in-pit sumps.

Licensed discharge (in accordance with the HRSTS) can occur from the Surge Dam and Northern Dam at release rates of up to 127 ML/d and 500 ML/d respectively. BCM currently hold 121 HRSTS credits – this may change into the future in line with credit auctions which occur every two years.

2.2.2 Proposed Modification System

A schematic representation of the Proposed Modification storages and their inter-linkages is shown in Figure 8. No new significant water storages are planned as part of the Proposed Modification and the existing system of water storages should be adequate for Project requirements with some modifications. Some storages are located within the path of planned open cut operations and would therefore only remain in place for a period of time. Some of these storages may need to be replaced in order to maintain system function – e.g. Dam S7, which is a transfer storage for water pumped from the open cut pits, would be replaced with a 'turkey's nest' storage with limited catchment area. Additional small, 'turkey's nest' storages may need to be constructed at various points in time to provide truckfill points for haul road dust suppression.

Supply for tailings dredging operations would be drawn from the Bayswater Pit water storage which in turn would be supplied by other storages (refer Figure 8). Truckfill supply would continue to be provided by several smaller storages (e.g. Dam S7 or its future replacement, Dam 64 and MW2). Dust suppression of overburden areas supplied from in-pit sumps, would continue for the duration of the Proposed Modification.

The Proposed Modification would continue to source site make-up water from Hunter River WALs and to discharge via the HRSTS as required. The future water volumes that may need to be sourced have been forecast as part of operational water balance modelling (refer Section 3.0).

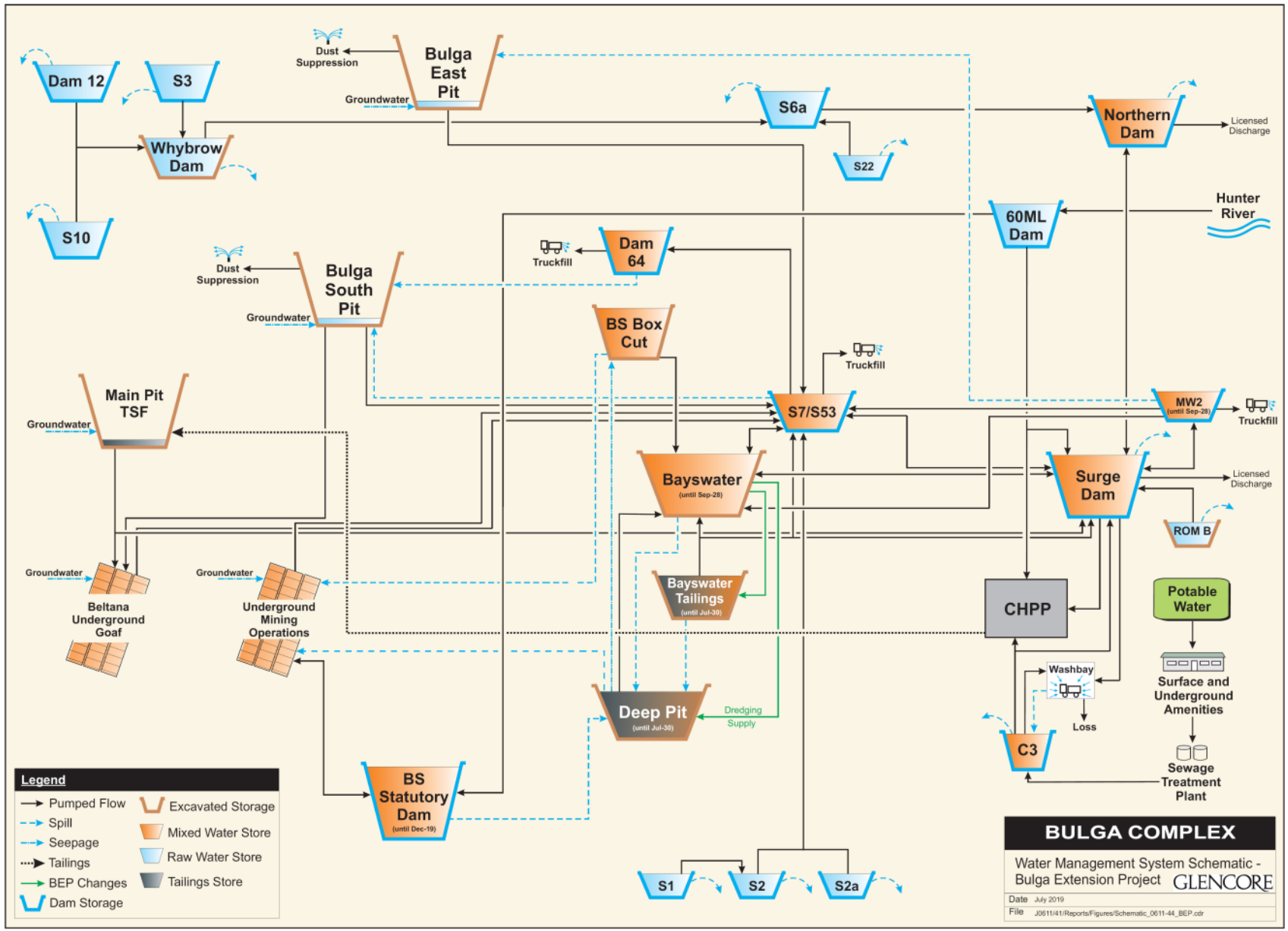

Figure 8 Proposed Modification Water Management System Schematic

3.0 OPERATIONAL WATER AND SALINITY BALANCE MODEL

3.1 MODEL DESCRIPTION

The water and salinity balance model has been developed to simulate the storages and linkages shown in schematic form in Figure 7 and Figure 8. The model has been developed using the GoldSim® simulation package. The model simulates the behaviour of water held in and pumped between all simulated water storages shown in Figure 7 and Figure 8. For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

Inflow includes rainfall runoff, groundwater inflow (for the Open Cut pits, goaf and underground mine), tailings 'bleed' water[2] (for the Main Pit TSF), water sourced from the Hunter River and all pumped inflows from other storages.

Outflow includes evaporation (surface storages), spill, licensed discharge to the Hunter River via the HRSTS (Surge Dam and Northern Dam) and all pumped outflows to other storages or to a demand sink (e.g. the CHPP).

The model operates on a ⅓ day time step. Model simulations commence on 8/5/2019 and simulate the period to the end of 2039. The model simulates 121 "realizations" derived using the historical daily climatic record[3] from 1892 to 2012. Realization 1 uses climatic data from 1892 to 1912, realization 2 uses data from 1893 to 1913, realization 3 uses data from 1894 to 1914 and so on. The results from all realizations are used to generate estimates of supply reliability, spill and stored water inventory. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods.

The model can also be used to 'hindcast' the past system performance using monitored site rainfall, production, transfers and other data. This method was used to calibrate the model water balance (refer Section 3.3).

Salinity (electrical conductivity – EC) values have been assigned to runoff (for each sub-catchment, refer Section 3.2.9), groundwater, rainfall, Hunter River water and tailings bleed water. A salinity balance is performed for each modelled storage assuming conservation of mass.

3.2 MODEL ASSUMPTIONS AND DATA

3.2.1 Rainfall Runoff Simulation and Catchment Areas

Rainfall runoff in the water balance model is simulated using the Australian Water Balance Model (AWBM) (Boughton, 2004). The AWBM is a nationally-recognised catchment-scale water balance model that estimates catchment yield (flow) from rainfall and evaporation.

AWBM simulation of runoff from six different sub-catchment types was undertaken, namely: undisturbed (natural) areas, hardstand (for example, roads and infrastructure areas), open cut pit, active spoil emplacements, regraded spoil emplacements, rehabilitated spoil, coal stockpiles and tailings. AWBM parameters for natural surface sub-catchments were taken from regional AWBM

[2] Tailings bleed water is water liberated from tailings slurry as it settles within a tailings storage. This water reports to the tailings surface, ponds and is available for reclaim pumping – otherwise known as 'supernatant'.

[3] Data was sourced from the SILO Data Drill generated climatic data for the mine location. The Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology (https://legacy.longpaddock.qld.gov.au/silo/). Both rainfall and pan evaporation data were obtained from this source.

calibrations undertaken using nearby streamflow gauging stations. Parameters for other sub-catchments were developed as part of calibration (refer Section 3.3).

For water surface areas, rainfall was assumed to add directly to the storage volume with no losses.

Each modelled storage catchment area was divided into sub-catchment areas corresponding with the above sub-catchment types. The stage plans in Figure 2 to Figure 6 were used to calculate catchment and sub-catchment areas for each surface storage.

The total catchment area reporting to the water management system over the simulation period is shown in Figure 9. The catchment area is calculated in the model by linearly interpolating in between the values derived from the above stage plans and assuming commissioning/decommissioning dates for storages as required. The total catchment area is forecast to reach a peak in early 2022 at just over 35 km^2 (note that this excludes the catchment of the diversion dam upslope of the Northern Dam – refer Figure 2).

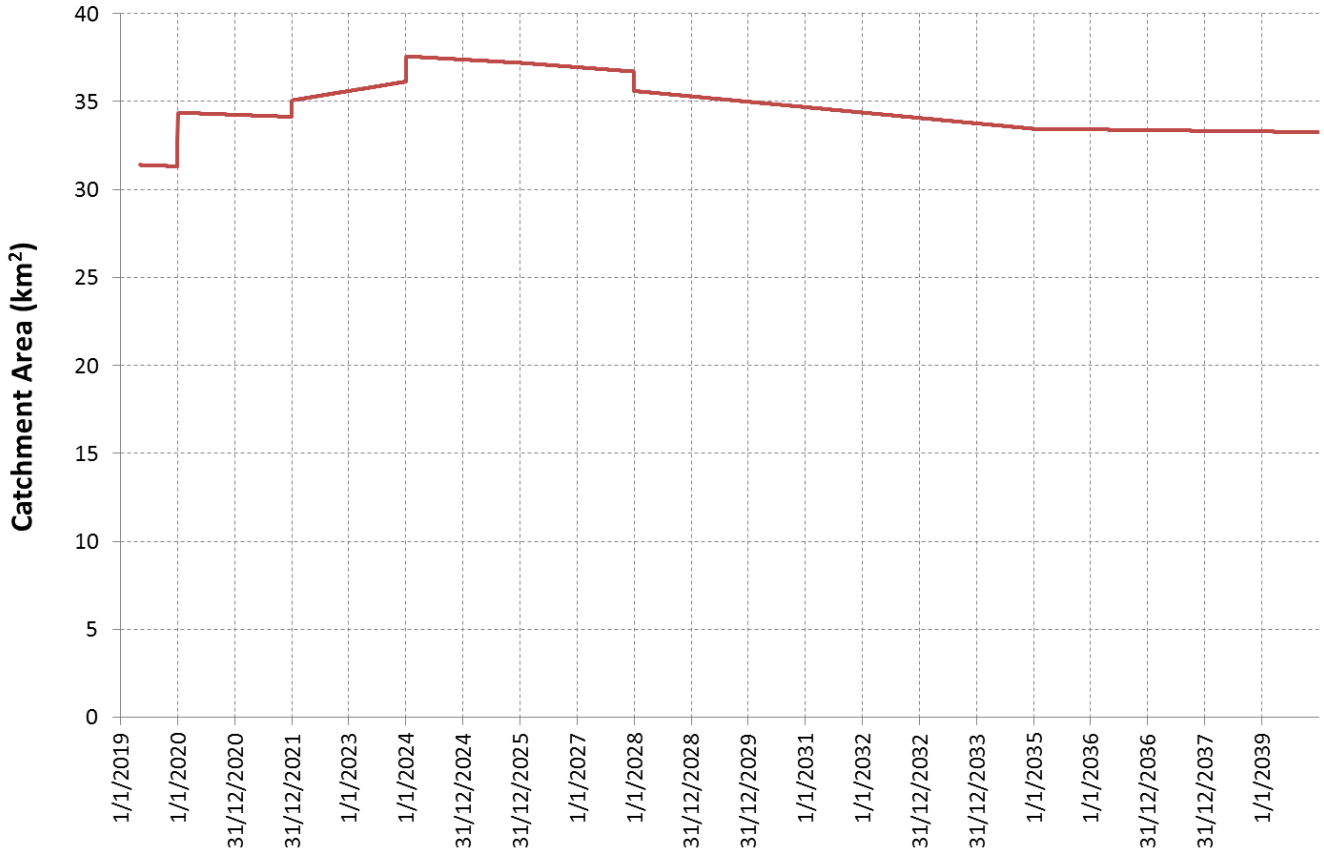

Figure 9 Modelled Total Catchment Area Versus Time

3.2.2 Evaporation from Storage Surfaces

Storage volumes simulated by the model are used to calculate storage surface area (i.e. water area) based on storage level-volume-area relationships for each water storage either based on data provided by BCM or derived from available site plans. Level-volume-area relationships for the Main Pit TSF were developed assuming a 1% gradient sloping tailings beach from discharge locations on the eastern side of each initial tailings storage cell.

The following pan factors were assumed in the estimation of evaporation from various water storage areas (as a multiplier on daily pan evaporation):

- Wet tailings beach = 1.1; due to the darker tailings surface;

- Open cut pits = 0.75; due to shading effects and lower wind speed at depth; and
- All other storages = monthly values varying from 0.84 to 0.95 on the basis of values in McMahon et al. (2013) for Scone.

3.2.3 CHPP Demand and CHPP Tailings

Planned annual CHPP tonnages (CHPP feed, product, rejects and tailings) as advised by BCM are summarised in Figure 10 and Figure 11. Reject and tailings tonnages are dry tonnes while feed and product are at the moistures given below. Mining at the Bulga Underground Operations is currently suspended. If underground mining were to resume immediately, it would continue until 2036. BCM have indicated that underground mining could be suspended (for assessment purposes until nominally 2029) or may not resume at all. Given the Bulga Underground Operations are currently suspended, the assessment has modelled three possible mining scenarios for completeness, being:

1. The Proposed Modification with the Bulga Underground Operations as approved
2. The Proposed Modification with the Bulga Underground Operations suspended until 2029
3. The Proposed Modification with the Bulga Underground Operations not operating.

This approach as allowed a range of outcomes to be assessed and considered. Therefore three possible mining scenarios have been simulated as shown in Figure 10, Figure 11 and Figure 12, with underground operations contributing up to 8.6 Mt/year ROM.

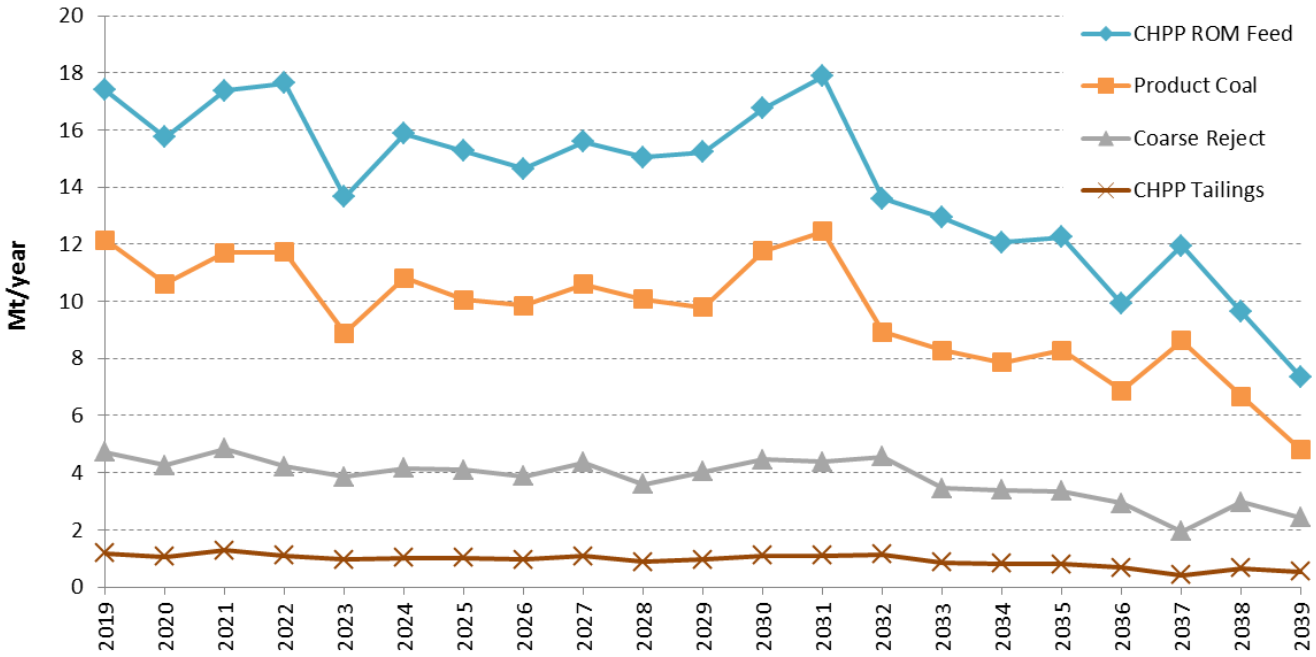

Figure 10 Planned CHPP Tonnage Rates – with Approved Underground Operations

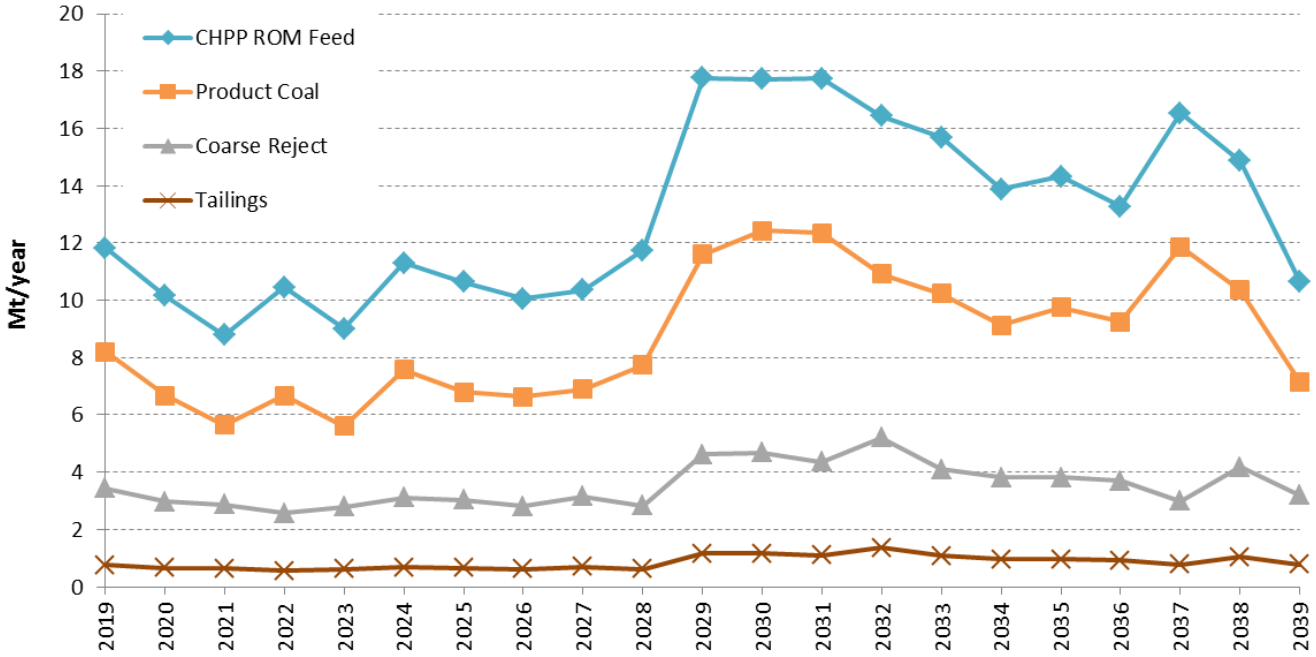

Figure 11 Planned CHPP Tonnage Rates – with Delayed Underground Operations

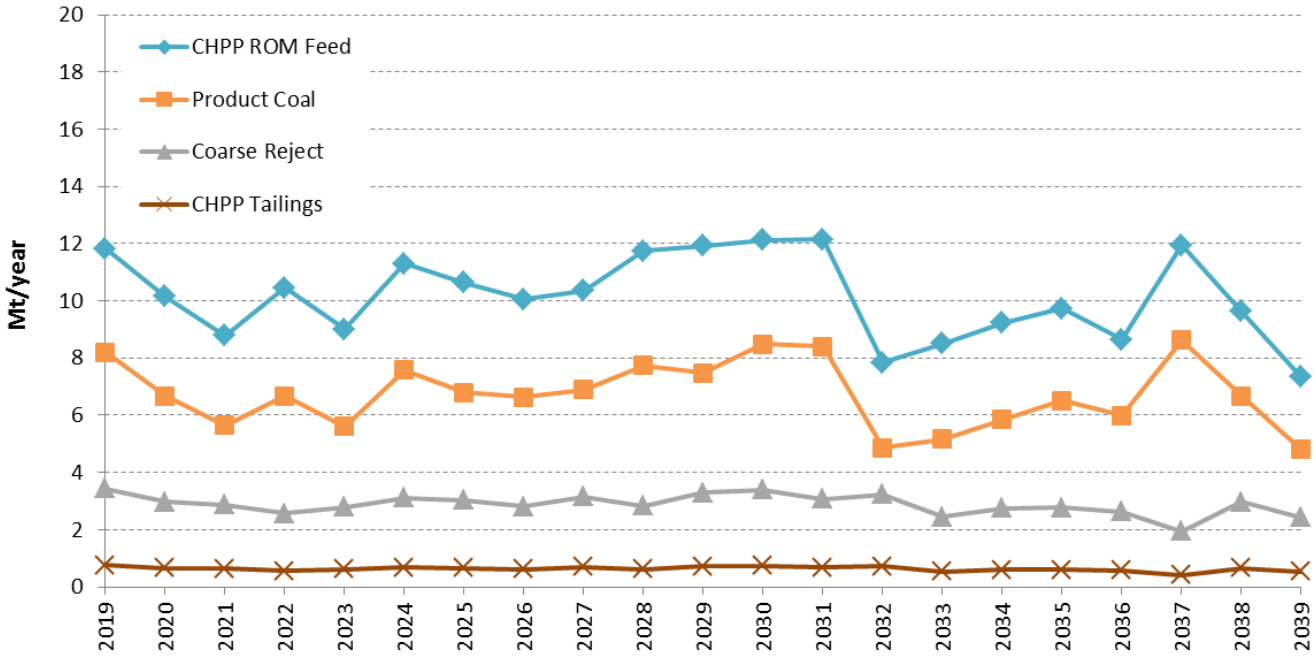

Figure 12 Planned CHPP Tonnage Rates – with No Further Underground Operations

CHPP make-up water demand has been calculated from the above and the following coal and reject properties:

- ROM coal moisture: 6%
- Product coal moisture: 10%
- Coarse reject moisture: 6%
- Conventional tailings solids content: 27%
- Paste tailings solid content: 54%
- Conventional tailings as proportion of all tailings: 0.67.

The calculated CHPP make-up demand based on the above information is shown in Figure 13 and averages 2,285 ML/year (6.3 ML/d) with the approved underground operations until the end of the Proposed Modification period. The demand pattern is a reflection of the CHPP tonnages shown in Figure 10 to Figure 12.

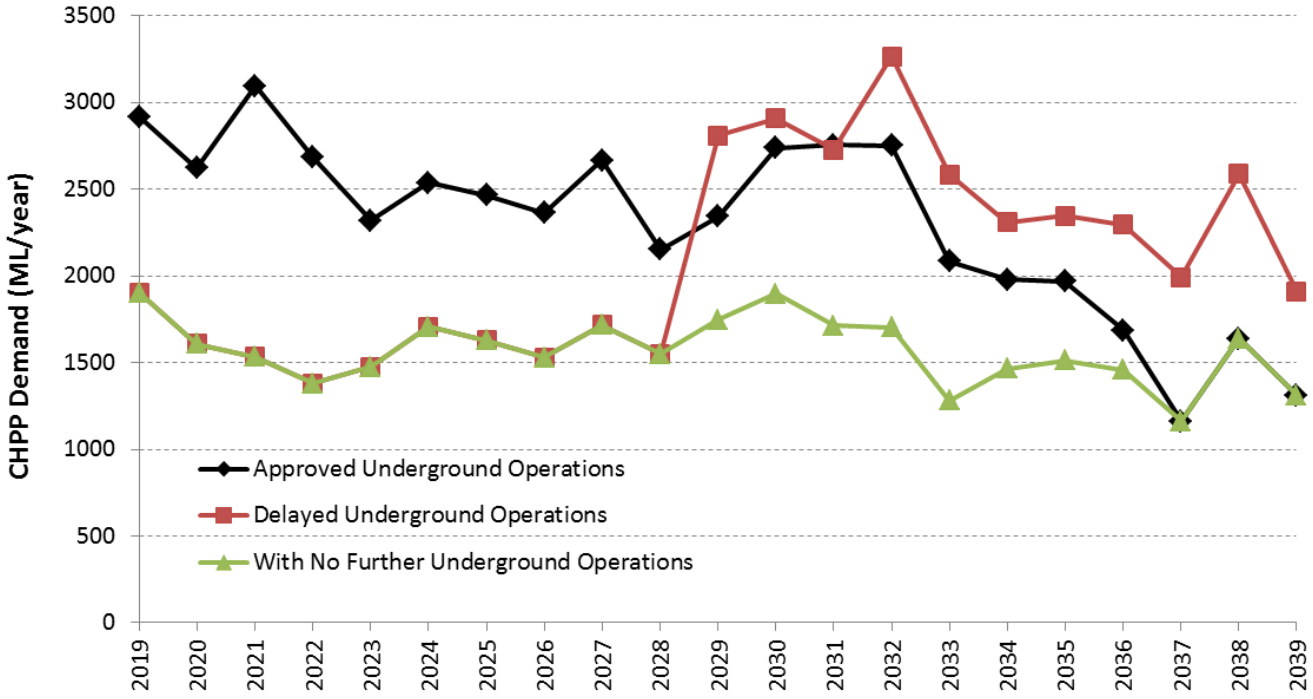

Figure 13 Calculated CHPP Make-Up Demand

No water is recovered from paste thickened tailings which are co-disposed with rejects in overburden emplacement areas. Conventional tailings are assumed to settle to 45% solids content in the Main Pit TSF, resulting in liberation of approximately 55% of the water pumped with the tailings as the tailings settle. Discharge of tailings to the Main Pit TSF was commenced in January 2019 and no tailings bleed has been included in the model for the initial 6 month period.

3.2.4 Tailings Relocation (Dredging)

Recovery and relocation of tailings by dredging from the Bayswater and Deep Pit TSFs is planned to occur from the start of 2022 for just less than six years at a rate of approximately 4.5 Mt/year (dry tonnes). The planned pumped tailings solids content is 25%. The existing tailings moisture content varies from 55% in the near surface portion of the Bayswater TSF to 26.1% in the deeper portions of the Deep Pit TSF. In calculating the water demand for dredging, the following existing tailings moisture content assumptions were made (based on data provided by BCM):

- Bayswater TSF: 41.6%
- Deep Pit 0 to 10.5 m depth (area overlying Deep Pit North and South): 42.9%
- Deep Pit North below 10.5 m depth: 34.1%
- Deep Pit South below 10.5 m depth: 33.5%

Dredging make-up demand was calculated as the water required to increase the moisture content of the tailings from the above values to 75% (25% solids content) at approximately 4.5 Mt/year. A dredge pond was assumed to be maintained in each active dredging area of between 3 to 5 m depth.

Relocated tailings were again assumed to settle to 45% solids content in the Main Pit TSF. Calculated dredging demand and the resulting bleed rate to the Main Pit TSF are shown in Figure 14,

based on the relocation schedule provided by BCM and the above data. The average demand during the period of dredging is 11,137 ML/year (30.5 ML/d). The difference between dredging demand and dredged tailings bleed averages 3,130 ML/year (8.6 ML/d) which would comprise water entrained in the relocated tailings.

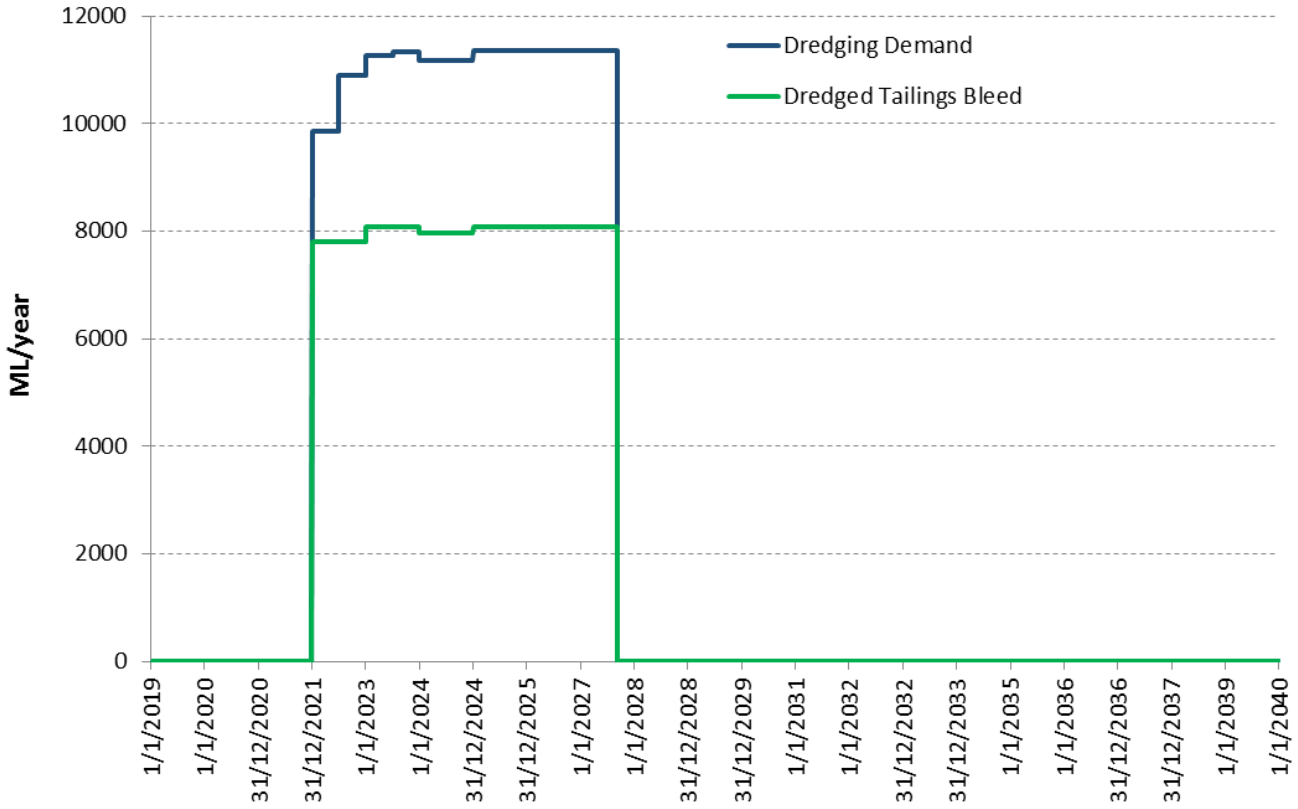

Figure 14 Calculated Tailings Dredging Demand and Bleed Rates

3.2.5 Dust Suppression Water Demand

Haul road dust suppression (truckfill) demand is calculated in the model by multiplying an estimated (time-varying) haul road length by a 35 m width multiplied by the pan evaporation excess over rainfall each day multiplied by a pan factor of 1.2. Haul road lengths (estimated from Figure 2 to Figure 6) varied from 35.4 km currently reducing to 10.4 km by the end of the Proposed Modification. An upper bound demand rate of 10 ML/d was set – reflecting the maximum rate that the water truck fleet is able to apply. The average daily rate calculated is summarised in Figure 15 and averages 1,158 ML/year (3.2 ML/d) over the simulation period.

In addition to truckfill, irrigation of overburden areas occurs using a system of sprinklers. BCM advise that this occurs for 10 days each month at a rate of 50 L/s on those days (i.e. 518 ML/year). Supply is drawn from in-pit sumps which receive inflow from runoff and groundwater (no supply from other water storages occurs).

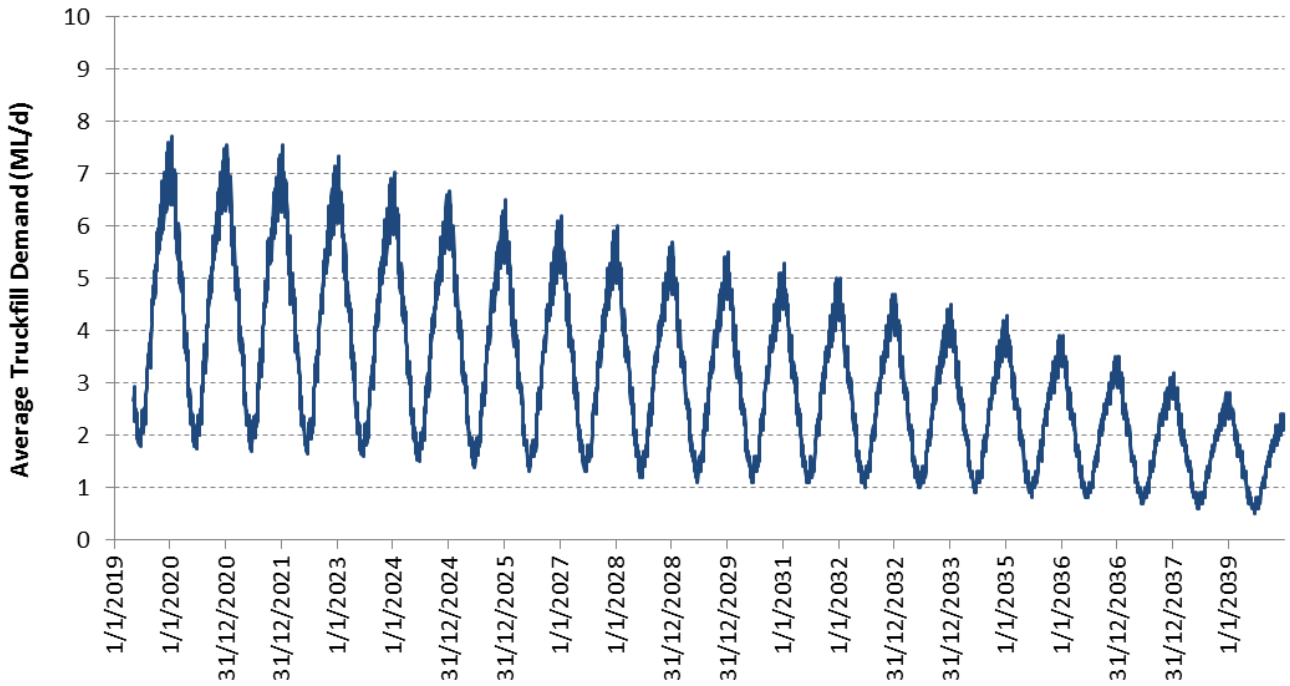

Figure 15 Calculated Truckfill Demand

3.2.6 Groundwater Inflow

Predicted groundwater inflow rates versus time for each pit and underground were obtained from groundwater modelling undertaken for the Proposed Modification by KCB[4]. Forecast rates are summarised in Figure 16 for the approved underground mining case. For the case of delayed underground mining, the underground groundwater inflows were 'shifted' to coincide with the start of mining of the Blakefield North seam at the start of 2029.

[4] Provided via email to HEC from Umwelt 4 June2019.

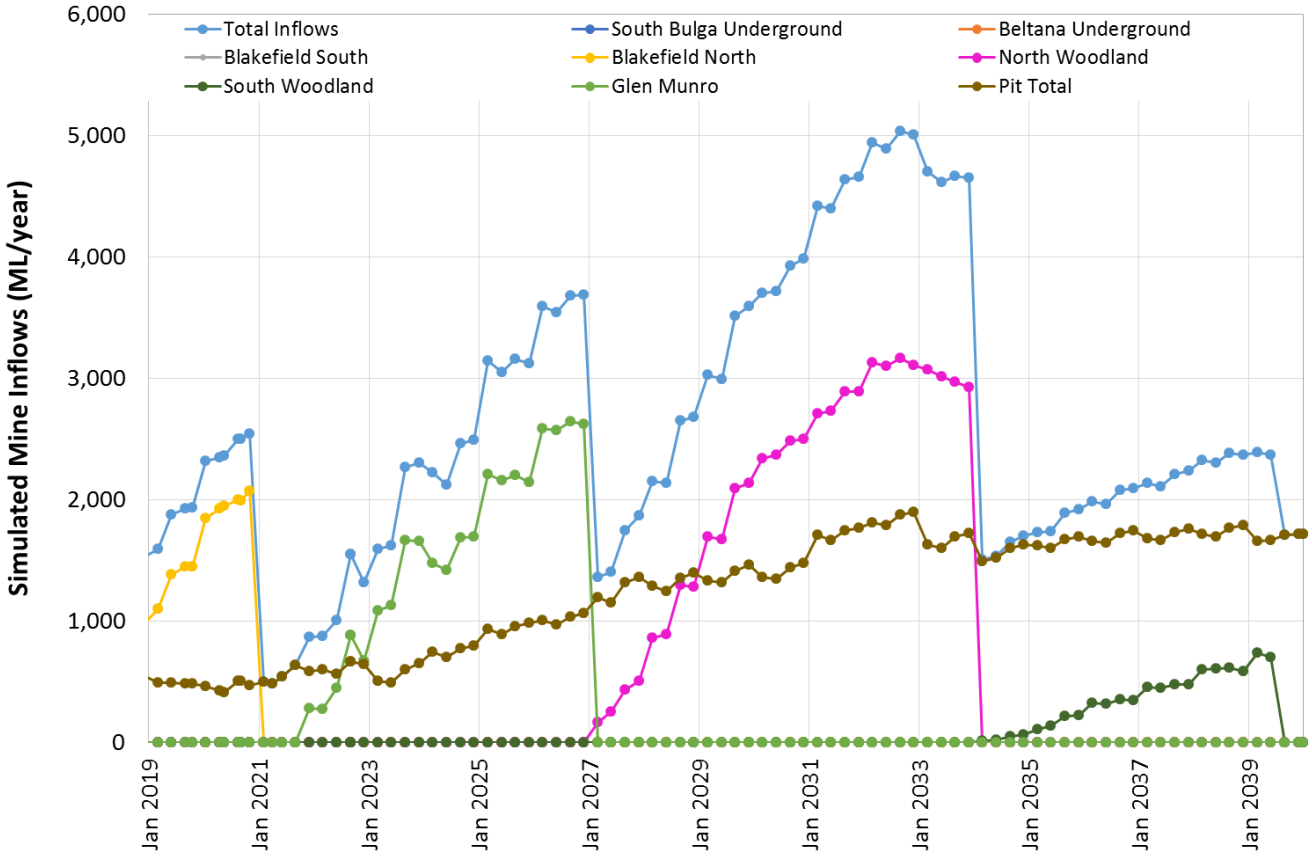

Figure 16 Predicted Groundwater Inflow Rates

The former South Bulga underground overlies the Blakefield South underground and therefore the inflows to both these were added and assumed to be dewatered from the Blakefield South underground until the planned end of mining in 2032. After 2032, it was assumed that groundwater inflows would only be dewatered if the site water inventory was low (refer Section 3.2.12).

For the case of no further underground mining, groundwater inflow rates to the Beltana goaf storage and Blakefield South underground were set at 379.6 ML/year (1.04 ML/d) and 155.7 ML/year (0.43 ML/d) respectively, based on rates calculated by BCM. Open cut pit groundwater inflow rates were as given in Figure 16 for all cases modelled.

3.2.7 Hunter River Supply

The water balance model has been linked to output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM has been the model used by the Department of Industry - Water (DI - Water) to set available water determinations (AWDs) in the Hunter Valley, in accordance and in conjunction with the *Water Sharing Plan for the Hunter Regulated River Water Source 2003* (the Water Sharing Plan). Hunter River IQQM simulations have previously been undertaken using climatic data from 1892 to 2012 (the same period of data as used in the water balance model) to generate predictions of AWD, periods of uncontrolled flow and volume of water stored in Glenbawn Dam and Glennies Creek Dam (the two Hunter River major regulating storages), used to estimate AWD for High Security WALs. In this way the simulation of water availability from WALs is modelled in parallel with variations in climate.

The IQQM does not explicitly determine AWDs for High Security WALs. Rather a volumetric "reserve" is set aside at the start of each water year in the two major regulating storages equal to the sum of 2 years' of High Security licences, local water utilities licences (town water), major utilities licences, stock and domestic licences and Environmental Contingency Allowance (ECA). Based on

the Water Sharing Plan, when General Security AWD is determined as being greater than 50 %, High Security AWD is set to 100 %. If General Security AWD is less than 50 %, High Security AWD is varied linearly in proportion to General Security AWD from 100% down to 75 % (i.e. 75% High Security AWD when General Security AWD equals zero). These rules were incorporated into the water balance model.

Model simulation of High Security AWD is undertaken to estimate reductions in AWD below 75% during drought periods, taking cognisance of simulated volumes in the two major regulating storages and their availability to satisfy the requirements of the ECA, stock and domestic licences, major utilities licences and town water. Modelling also includes simulation of uncontrolled flow access and allocation carry over.

BCM has access to 867 ML/year of High Security WALs. In addition, a further 1,560 ML of temporary transfer (allocation assignment) volume for the 2018/19 water year has been modelled. Model simulations have included acquisition of additional temporary transfer in subsequent water years in order to improve forecast supply reliability (assumed not subject to AWD). For modelling purposes, in order to improve forecast site water supply reliability, up to an additional 800 ML of temporary transfer was modelled available each year from the start of the 2019/20 water year until the end of dredging in 2027 for the case of the approved continued underground operations. For the case of delayed underground operations, up to an additional 1,800 ML of temporary transfer was modelled available each year from the start of the 2019/20 water year until the end of dredging in 2027. For the case of no further underground operations, up to an additional 900 ML of temporary transfer was modelled available each year from the start of the 2019/20 water year until the end of dredging in 2027. Actual water demand from the Hunter River is simulated subject to a site inventory trigger volume (refer Section 3.2.12). Water is modelled as imported to the 60 ML Dam at a maximum rate of 85 L/s (infrastructure limit).

3.2.8 Licensed HRSTS Discharge

Simulation of periods available for licensed discharge under the HRSTS was included in the model. Simulated or historically recorded flows in the Hunter River (refer Section 3.2.7) were used along with relationships between flow and EC developed from historical recorded data[5], to simulate EC in the river and to model allowable release according to the number of HRSTS credits modelled as held by BCM and predicted salinity in the Proposed Modification water storages. BCM currently holds 121 HRSTS credits but also has access to additional credits via trading – 200 credits has been adopted for forecast water balance simulations. Simulation of both “high” and “flood” flow events was undertaken.

Licensed discharge is simulated from the Surge Dam and Northern Dam at release rates of up to 127 ML/d and 500 ML/d respectively. Licensed discharge is simulated subject to a site trigger inventory volume (refer Section 3.2.12).

3.2.9 Salinity

Salinity (EC) values were assigned to runoff for each sub-catchment as well as to groundwater and tailings water based on monitoring data supplied by BCM. Values assigned are summarised in Table 1.

[5] Sourced from https://realtimedata.waternsw.com.au/

Table 1 Model Assigned Salinity (EC) Values

Sub-catchment Type or Water Source	Modelled EC (µS/cm)
Hardstand	5,100
Natural Surface	310
Open cut	5,500
Tailings	5,900
Active spoil	2,500 & 3,900 (surface runoff & baseflow [seepage])
Regraded spoil	2,600
Rehabilitated spoil	1,330
Coal stockpile	4,500
Tailings water	7,150
Groundwater	8,500
Hunter River	480
Rainfall	70

EC values were converted to equivalent estimated Total Dissolved Solids (TDS) values (in mg/L) by multiplying by 0.64. Simulated salinity values in the Surge Dam and Northern Dam were used in the modelling of allowable releases under the HRSTS.

3.2.10 Storage Capacities and Initial Volumes

Existing storage capacities were obtained from information supplied by BCM. As part of the Proposed Modification, runoff from additional catchment area will report to several sediment dams and these will need to be enlarged to ensure compliance with Landcom (2004) and DECC (2008) guidelines. The current and future proposed capacities[6] of storages are summarised in Table 2. Also given in Table 2 are initial simulated storage volumes as at 8/5/2019 from information provided by BCM.

[6] Future per design sizing by Engeny (2019)

Table 2 Modelled Storage Capacities and Initial Volumes

Storage	Current Capacity (ML)	Future Capacity (ML)	Initial Volume (ML)
Surge Dam	3,140	No change	2,486
Northern Dam	2,033	No change	139
Bayswater Pit	1,680	0 (Sep 2028)	286
Vaux Pit	1,944	0 (Apr 2020)	65
Beltana Goaf	6,412	No change	2,800
Dam S1	59.3	No change	18
Dam S2	156	No change	32
Dam S2a	39.8	No change	7.1
Dam S3	6.7	No change	2.4
Dam S7	76.6	No change	54.7
Dam S6a	84.6	404 (Jan 2022)	26.2
Dam S10	10.1	No change	2.9
Dam S22	17.7	40.1 (Jan 2020)	6.3
MW2 Dam	52.9	No change	24
ROM B Dam	27.7	No change	7.3
Dam 12	17	No change	0
Whybrow Dam	423	No change	151
Dam 64	70	No change	2
60 ML Dam	64.1	No change	42.4
C3 Dam	43.1	No change	7.7
Blakefield South Box Cut Sump	20.8	0 (Jan 2026)	0

3.2.11 Pumping Rates

Modelled pumped transfer rates between storages are summarised in Table 3.

Table 3 Modelled Pump Rates

Source	Destination	Pump Rate (L/s)
Bayswater Pit	S7; MW2	80
	Surge Dam	150
Bayswater Tailings	S7; MW2	80
	Surge Dam	80
	Bayswater Void	100
Beltana Goaf	S7 (current) via SP07	25
	S7 (new bore)	70
Blakefield South UG	S7	250*
Blakefield South Box Cut Sump	Bayswater Void; Vaux	100
Bulga Main/North Pit	Bulga South Pit	150
Main Pit TSF	Current	150
	During Dredging	1,000
Bulga South Pit	S7	80
Bulga East Pit	S7	80
Deep Pit	Bayswater Void	180
C3 Dam	Surge Dam	200
	CHPP	100
Dam 12	Whybrow Dam	50
MW2 Dam	S7; Bayswater Void	80
	Surge Dam	83
Northern Dam	Surge Dam	100
ROM B Dam	Surge Dam	45
Dam S1	S2	21
Dam S2	S7	295
Dam S2a	S7	62
Dam S3	Whybrow Dam	19
Dam S6a	Northern Dam	380
Dam S7	Bayswater Pit; Vaux Pit; Surge Dam	400
	Dam 64 (Fill Point 4)	100
Dam S10	Whybrow Dam	15
Dam S22	S6a	21
60 ML Dam	Surge Dam	90
	CHPP	200
Surge Dam	Northern Dam	280
	Bayswater (during dredging)	600
	CHPP	170
Vaux Pit	Bayswater Void; Surge Dam	80
Whybrow Dam	S6a	255

* Increased from existing 25 L/s to allow for forecast increased groundwater inflows (refer Section 3.2.6).

3.2.12 Operational Triggers

The model simulates pumping between storages, as well as into the system (from Hunter River supply) and licensed discharge according to a number of operating rules which relate to model storage trigger levels or volumes. Key main storage trigger volumes are as follows:

- Surge Dam maximum operating volume (MOV): 2,940 ML (200 ML below capacity, to avoid spill). No pumped inflow to the Surge Dam once it reaches this volume, except from Northern Dam (to 'equalize' remaining freeboard in these two large storages) and from C3 Dam (up to within 50 ML of capacity). A minimum volume of approximately 500 ML is reserved in the Surge Dam for CHPP supply. No transfer to other storages will occur from the Surge Dam below this volume.
- Northern Dam MOV: 1,500 ML (approximately 500 ML below capacity, to avoid spill). No pumped inflow to the Northern Dam once it reaches this volume, except from Surge Dam (to 'equalize' remaining freeboard in these two large storages).
- Bayswater Pit MOV: 1,088 ML (approximately 600 ML below capacity, geotechnical reasons). No pumped inflow to the Bayswater Pit once it reaches this volume. (Note: Bayswater Pit is to be decommissioned in September 2028 ahead of being intercepted by open cut mining).
- Beltana Goaf MOV: 5,912 ML (500 ML below capacity – as agreed with BCM). No pumped inflow to the Beltana Goaf once it reaches this volume.

If both the Surge Dam and Northern Dam are above their respective MOVs, water is transferred from one dam to the other depending on which has the lower freeboard, however the remaining freeboard of the Surge Dam is 'factored' by 3.33 for this comparison (because the Northern Dam has a greater catchment area than the Surge Dam and therefore has a higher risk of spill during high rainfall periods). This value was derived iteratively to avoid modelled spill.

In addition, 'total site' trigger volumes have been defined as follows:

- "High" volume:
    - Prior to the end of dredging = 90% of the sum of the three main surface storage MOVs = 4,990 ML.
    - Post dredging = 75% of the sum of the two remaining surface storage MOVs = 3,330 ML.
- "Low" volume:
    - Prior to the end of dredging = 88% of the sum of the three main surface storage MOVs = 4,880 ML.
    - Post dredging = 50% of the sum of the two remaining surface storage MOVs = 2,220 ML.

The adoption of these trigger volumes has the following effects:

- Licensed discharge can only occur if:
    - the sum of stored water volumes in the three main surface storages (or two storages post dredging) exceeds the "High" volume;

    AND EITHER
    - the Beltana Goaf is greater than its MOV (prior to end of dredging) or greater than 75% of its MOV (post dredging);

    OR
    - the Northern Dam is greater than its MOV + 50 ML AND the Surge Dam is greater than its MOV + 20ML (imminent risk of spill occurring);

- Sourcing of water from Hunter River allocation can only occur if:
    - the sum of stored water volumes in the three main surface storages (or two storages post dredging) drops below the “Low” volume;

    AND
    - the Beltana Goaf is less than its MOV.

In addition, licensed discharge will only occur in simulated “high” and “flood” flow events (refer Section 3.2.8).

3.3 WATER BALANCE MODEL CALIBRATION

Water balance model calibration was undertaken by comparing model estimates of total water volume stored in all monitored water storages against water volumes estimated from monitoring records for the period 1 January 2012 to 31 December 2017. Groundwater inflows and rainfall runoff model parameters were adjusted in order to match modelled water volumes to those estimated from monitored water levels. Storage catchment and sub-catchment areas for the calibration period were estimated from supplied site contour plans and aerial photographs. The following data records for the calibration period were provided by BCM for use in calibration:

- site daily rainfall data;
- recorded stored water volumes in the main above ground storages;
- CHPP tonnages (feed, product, tailings and coarse rejects) and estimates of moistures of these streams in order to estimate CHPP water demand;
- haul road dust suppression use and underground supply;
- licensed discharge volumes;
- Hunter River supply volumes; and
- pumping records from the undergrounds to the surface and for a campaign of pumping from the open cut to the Beltana goaf.

A comparison between estimated actual total stored water volume in the monitored storages and volumes generated by the model for the calibration period is shown in Figure 17.

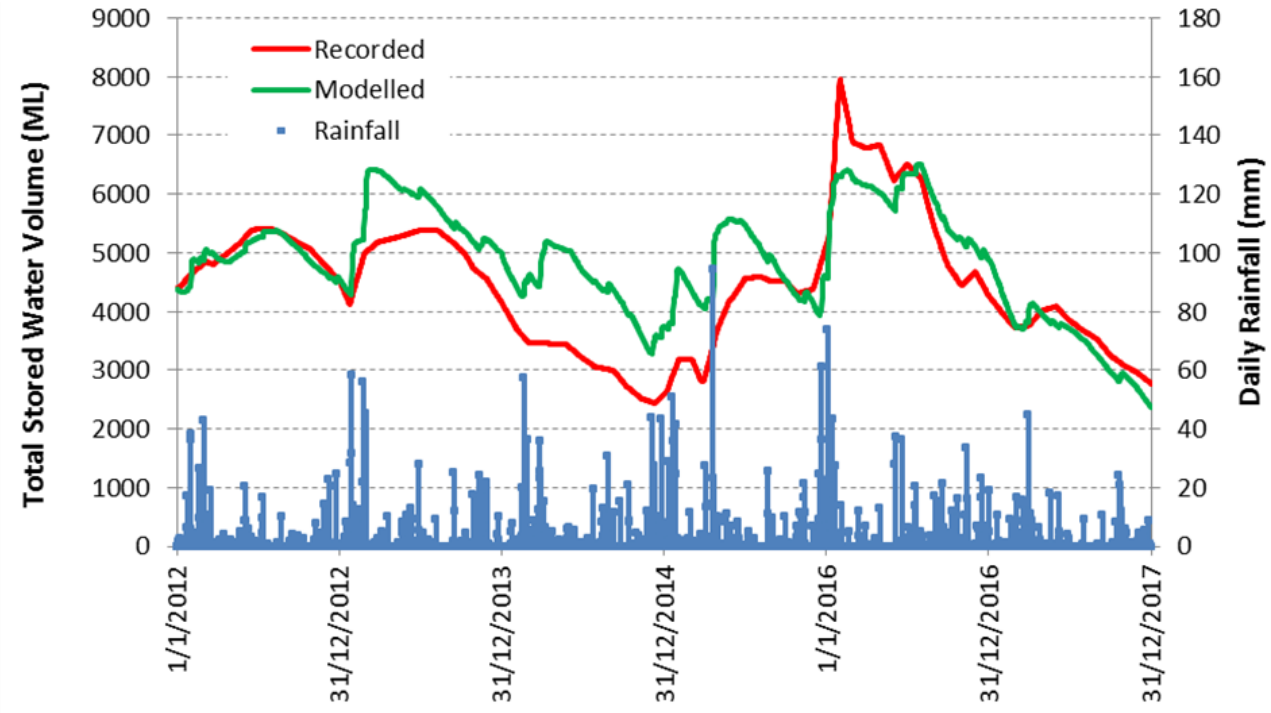

Figure 17 Calibrated Model and Estimated Actual Total Stored Water Volume

Figure 17 shows fair model replication of total water volume derived from records, with a linear correlation coefficient for the modelled to monitored total stored water volumes of 0.64. The model gives a good match in 2012 and from mid-2016 to the end of 2017. Note that any storage of water in storages where volumes were not monitored (e.g. open cut pits) or records were of poor quality could be a cause of model mismatch.

The sub-catchment AWBM parameters derived as part of the calibration are provided in Table 4.

Table 4 Calibrated AWBM Parameters

Parameter	Sub-catchment Type							
	Natural	Hardstand	Open Cut Pit	Stockpile	Overburden			Tailings
					Active	Regrade	Rehabilitated	
C_1 (mm)	11.5	5	5	5	5	5	11	0
C_2 (mm)	110	-	23	50	57	60	95	10
C_3 (mm)	234.7	-	-	-	-	-	190	-
A_1	0.134	1	0.2	0.1	0.1	0.1	0.1	0.3
A_2	0.6	-	0.8	0.9	0.9	0.9	0.3	0.7
A_3	0.266	-	-	-	-	-	0.6	-
K_s (d^{-1})	0.2	0	0.1	0	0.3	0.3	0.3	0
BFI	0.21	0	0.1	0.5	0.6	0.6	0.22	0
K_b (d^{-1})	0.953	-	0.96	0.98	0.98	0.98	0.953	-

3.4 MODEL FORECAST RESULTS

3.4.1 Overall Site Water Balance

Model predicted average inflows and outflows, averaged over all 121 realizations and the 21 year simulation period, are shown in Figure 18.

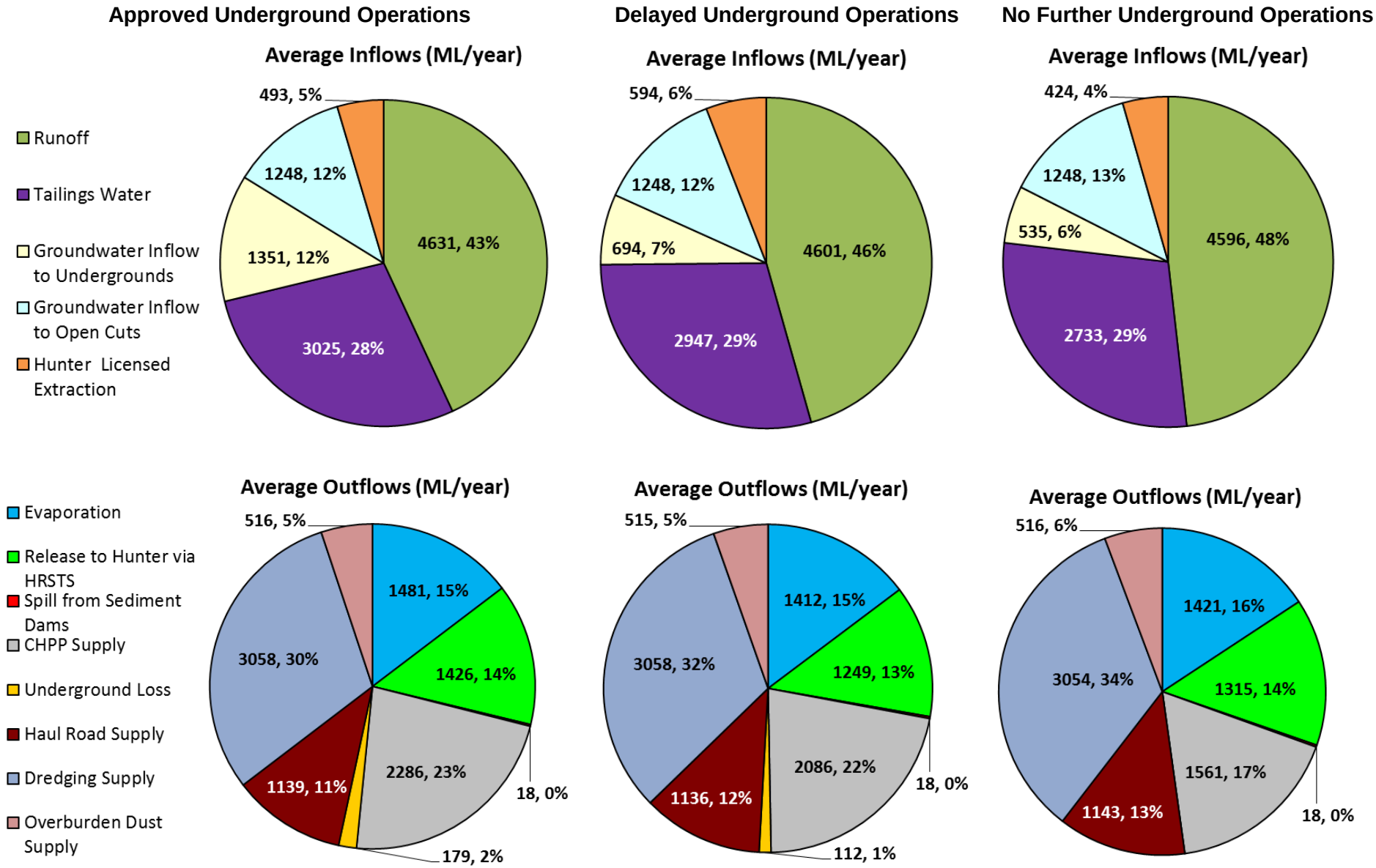

Figure 18 Average Modelled System Inflows and Outflows

From Figure 18 it may be seen that site rainfall runoff provides the greatest average modelled system inflow, accounting for just under approximately a half of total inflows, followed by water liberated from settling tailings (28-29%), while Hunter River Supply (WALs) accounts for only 4%-6% of inflows on average. The largest average outflow comprises supply to dredging which amounts to approximately one third of the total of all outflows over the simulation period. CHPP supply (17-23%) is the next largest outflow, followed by haul road and overburden dust suppression (16-19%) and then evaporation (15%-16%).

3.4.2 Stored Water Volumes

Predicted total stored water inventory is shown in Figure 19 to Figure 21 for the three modelled mining cases as probability plots over the simulation period. These probability plots show the range of likely total stored water volumes with the solid central plot representing the median volumes and the coloured upper and lower plots showing the 10th and 90th percentile volumes. There is a predicted 80% chance that the total water volume will fall in between the 10th/90th percentile volume plots. It is important to note that none of these plots represents a single climatic realization – these probability plots are compiled from all 121 realizations - e.g. the median volume plot does not represent model forecast volume for median climatic conditions.

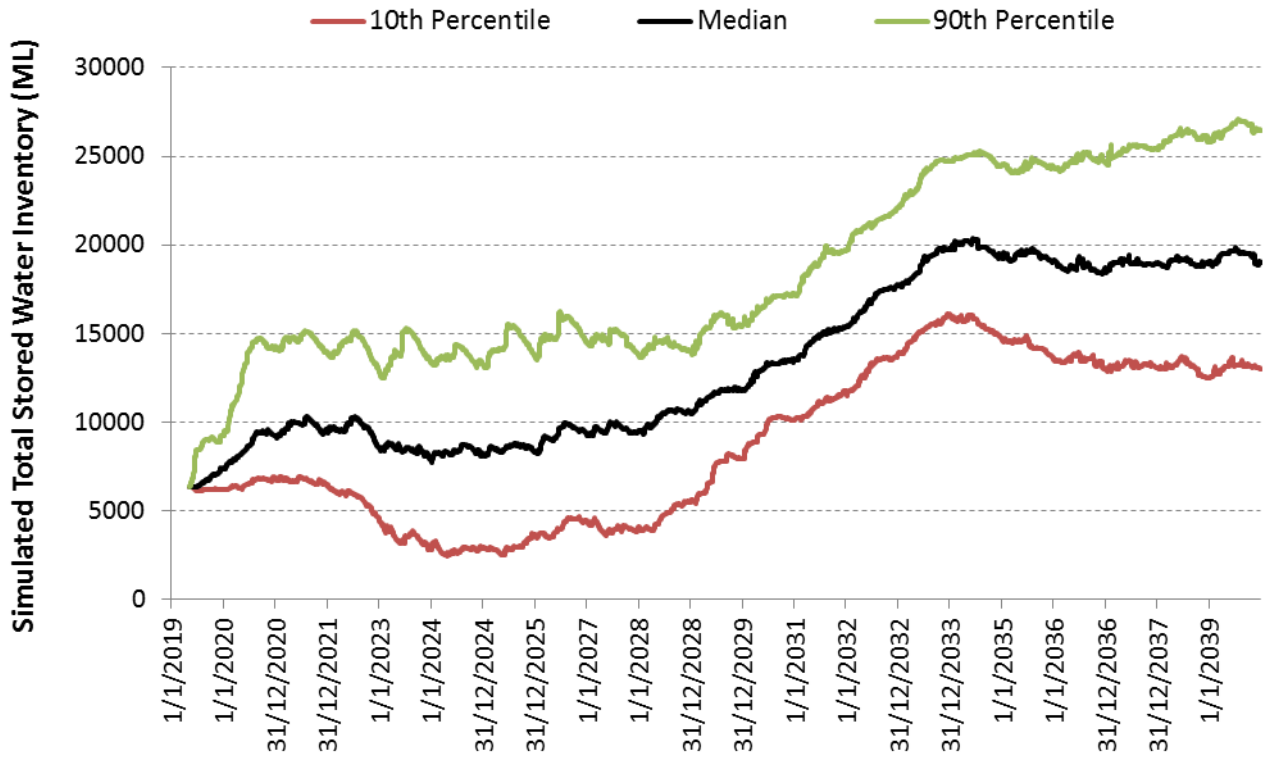

Figure 19 Simulated Total Stored Water Volume with Approved Underground Operations

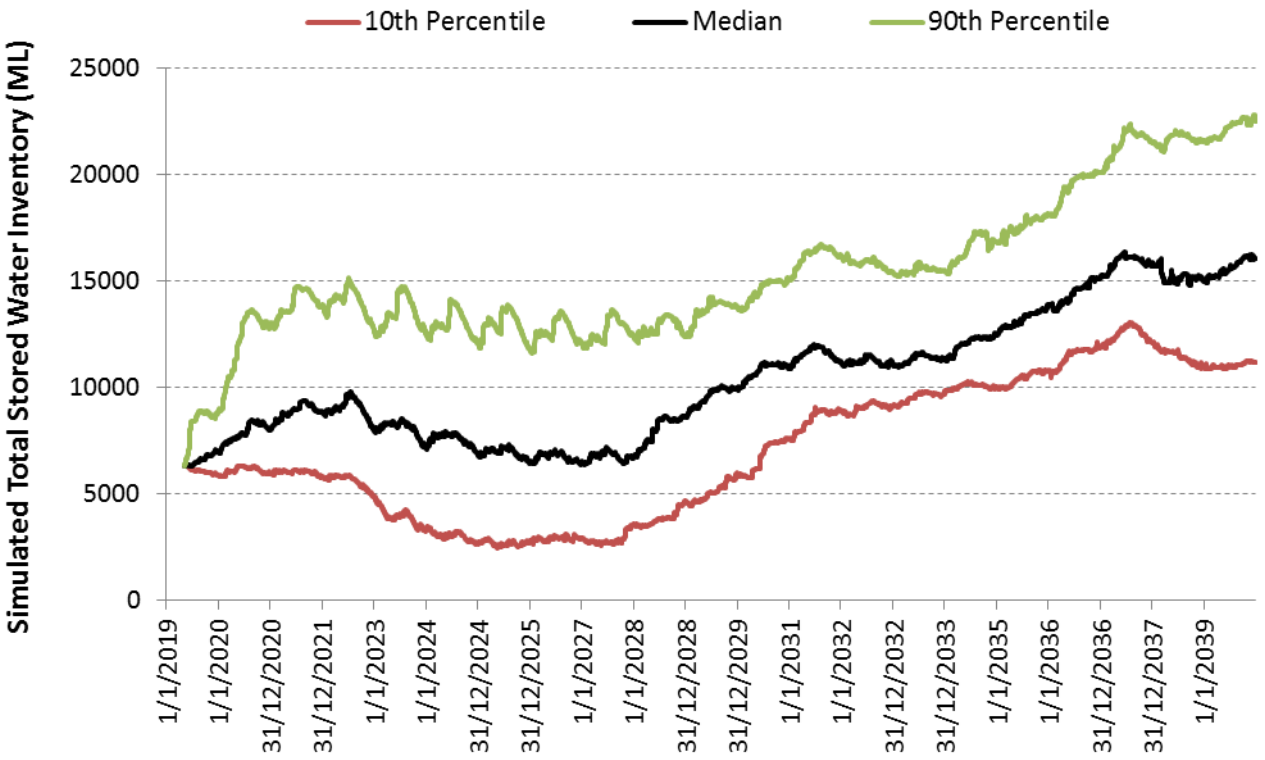

Figure 20 Simulated Total Stored Water Volume with Delayed Underground Operations

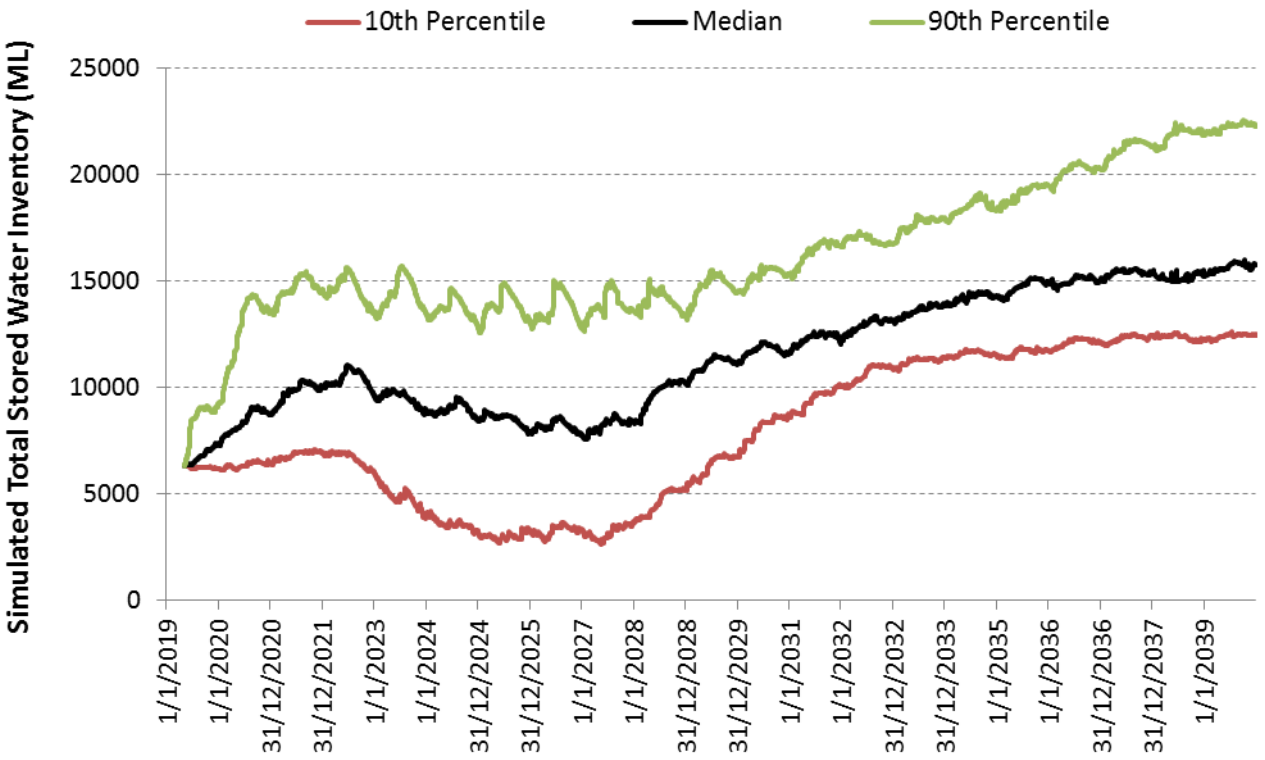

Figure 21 Simulated Total Stored Water Volume with No Further Underground Operations

The model results plotted in Figure 19 to Figure 21 indicate that median total stored water volume on site is predicted to increase somewhat in the period ahead of the start of dredging in 2022. The trigger volumes for sourcing water from the Hunter River (refer Section 3.2.12), which are quite high, result in a build-up of site inventory ahead of dredging. The significant increase in demand during dredging results in a drop in predicted inventory during this period, particularly for the lower percentile

result, followed by recovery post dredging. Lower total site demands coupled with higher forecast groundwater inflow rates result in a forecast increasing inventory in the latter half of the simulation.

The simulated stored water volume in the Surge Dam is given in Figure 22 to Figure 28.

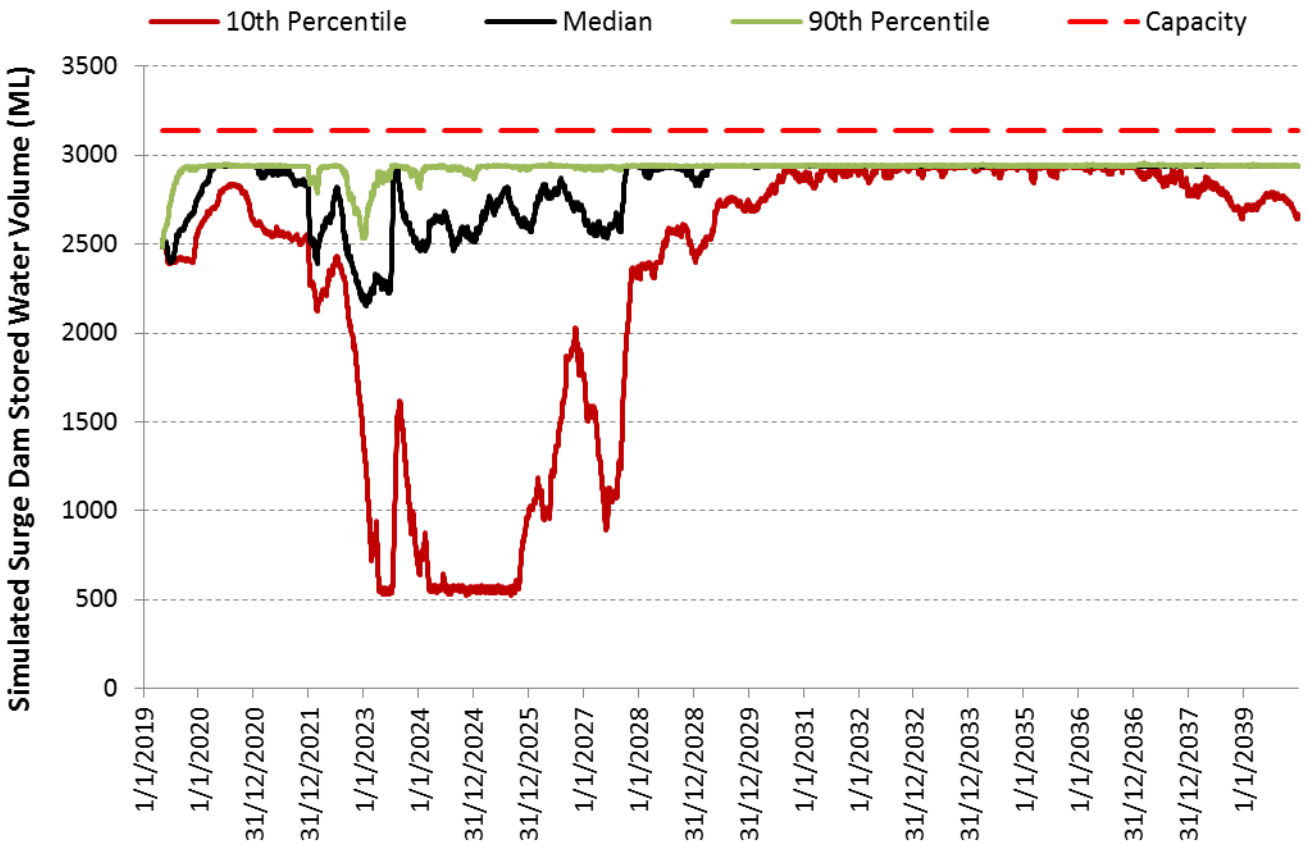

Figure 22 Simulated Surge Dam Stored Water Volume with Approved Underground Operations

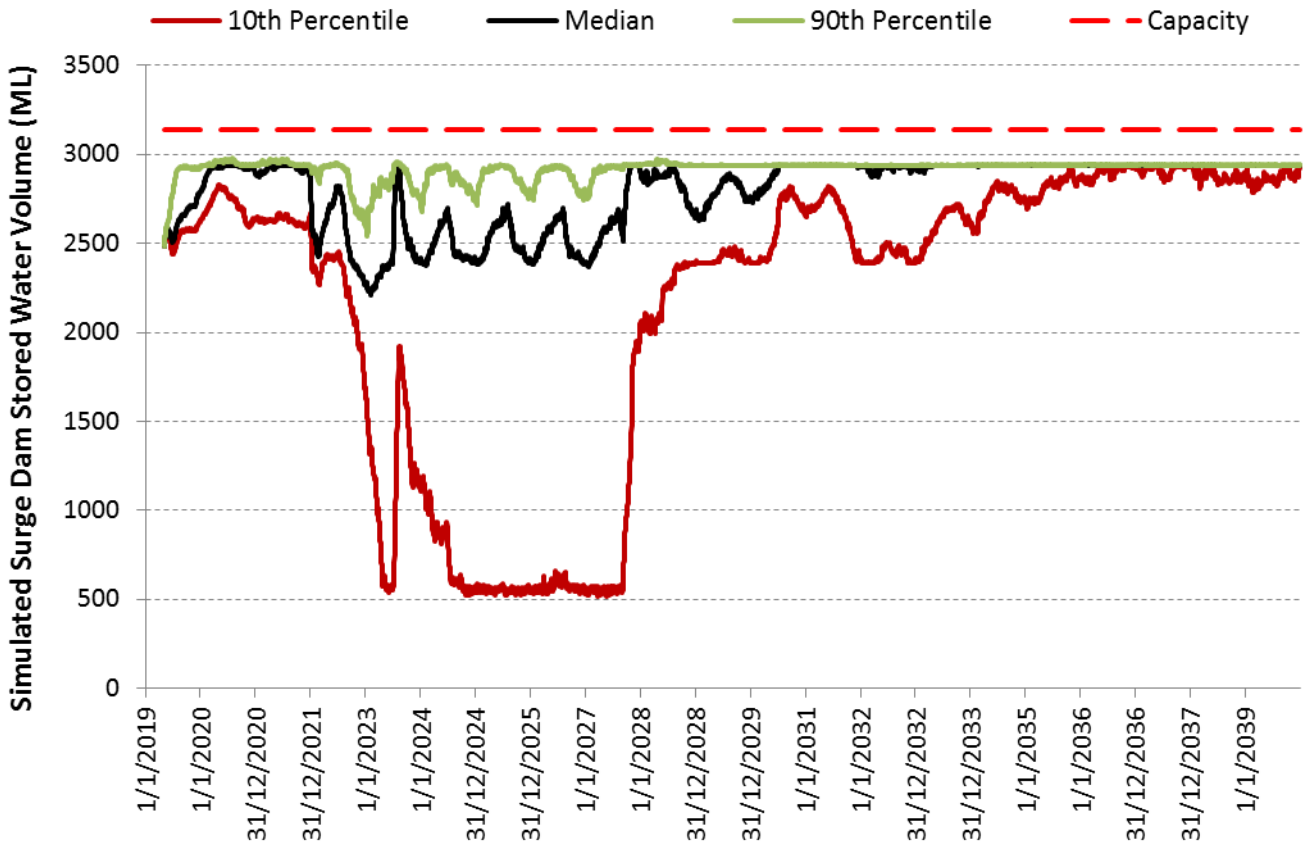

Figure 23 Simulated Surge Dam Stored Water Volume with Delayed Underground Operations

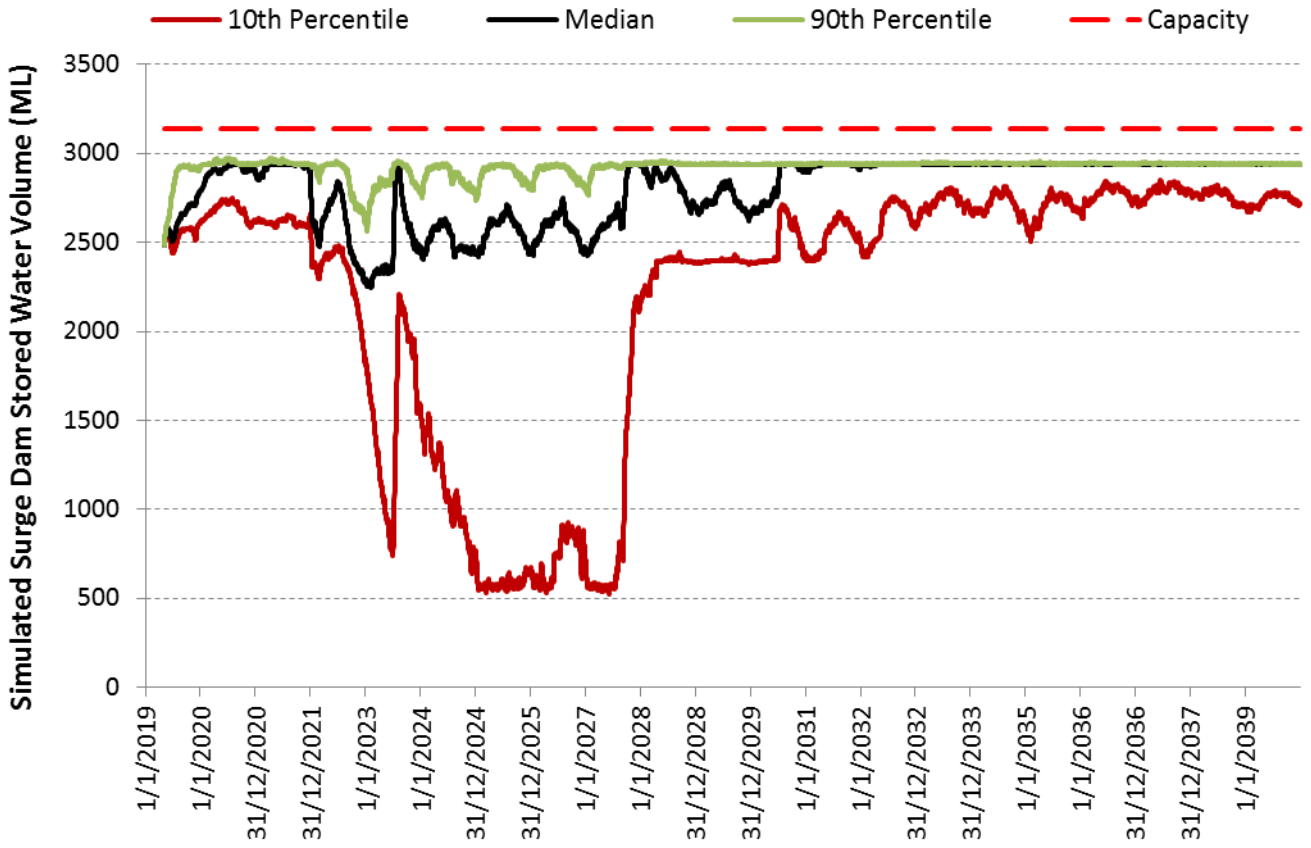

Figure 24 Simulated Surge Dam Stored Water Volume with No Further Underground Operations

The model results plotted in Figure 22 to Figure 28 indicate that the median stored water volume remains between the storage MOV and approximately 2,200 ML. However the 10th percentile plot indicates a depletion of the storage during the dredging operations down to the 500 ML reserved for CHPP supply.

An excessive volume of water stored in the open cuts has the potential to affect mining operations. The simulated stored water volume in the Bulga East open cut is shown in Figure 25 to Figure 27.

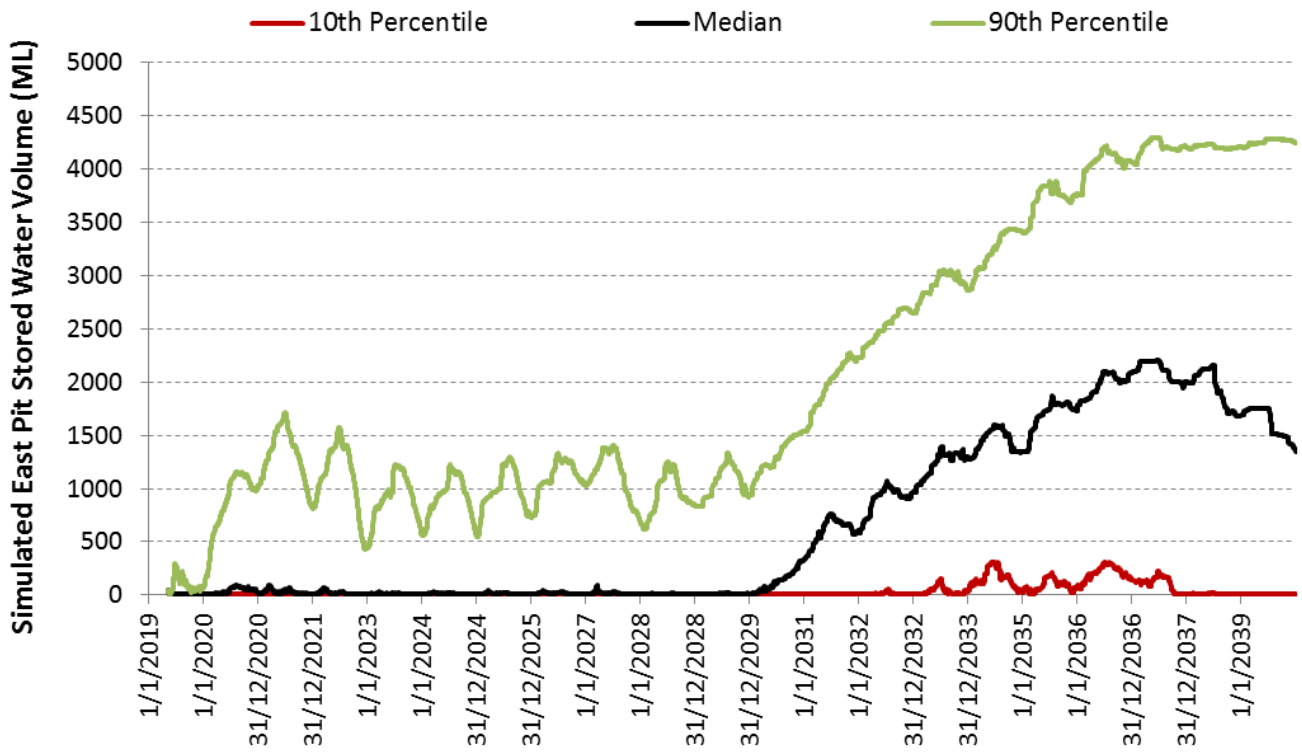

Figure 25 Simulated Bulga East Open Cut Stored Water Volume with Approved Underground Operations

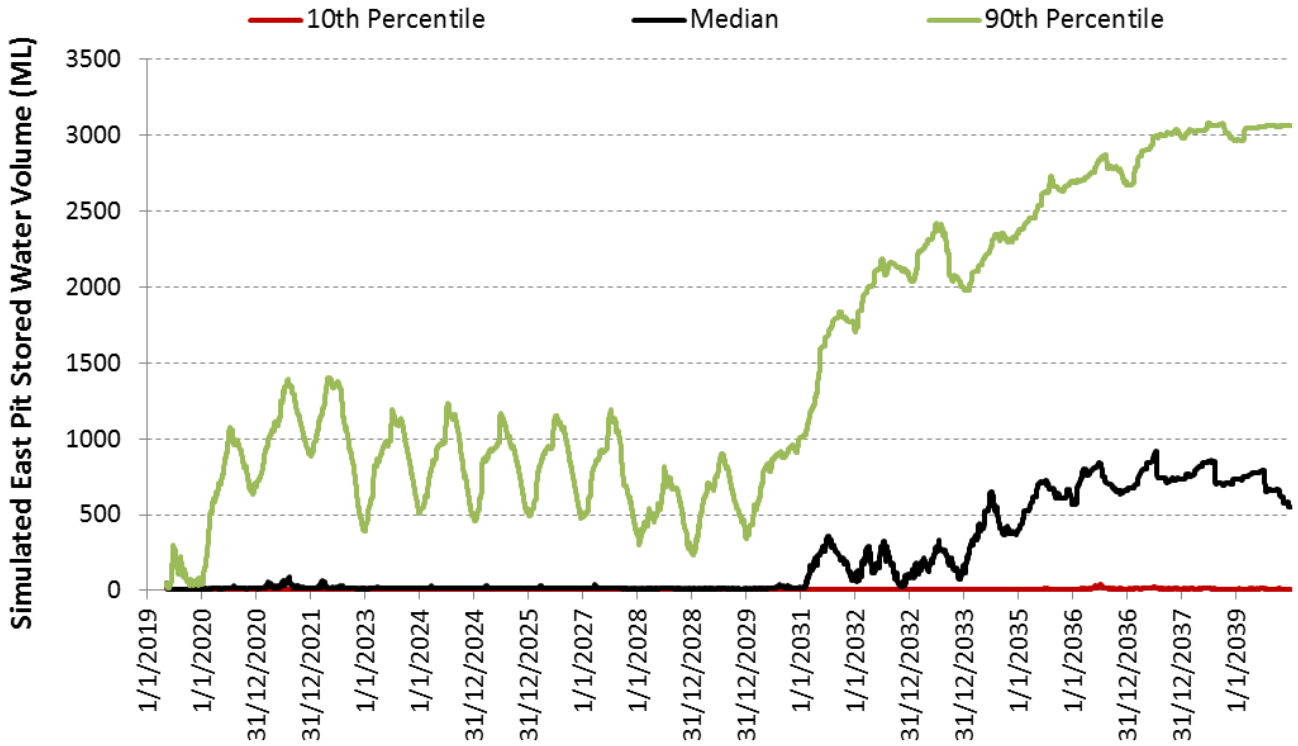

Figure 26 **Simulated Bulga East Open Cut Stored Water Volume with Delayed Underground Operations**

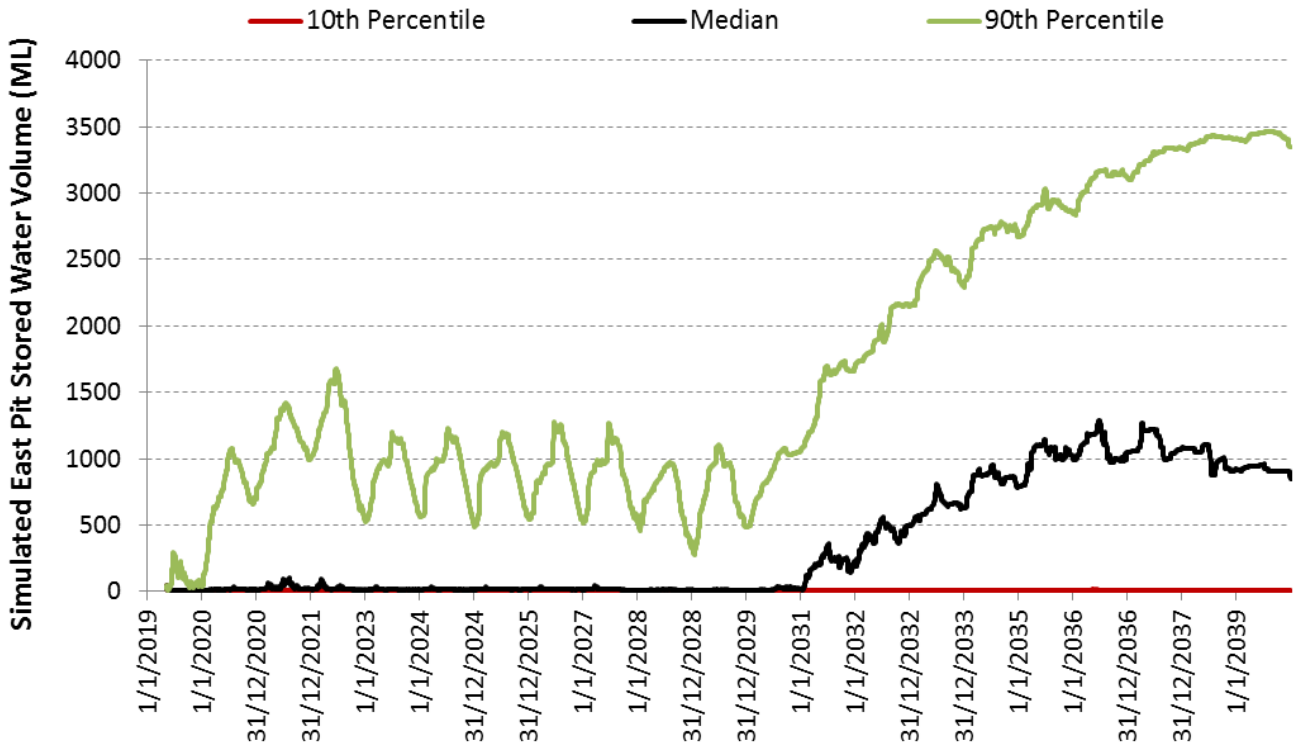

Figure 27 **Simulated Bulga East Open Cut Stored Water Volume with No Further Underground Operations**

The model results plotted in Figure 25 to Figure 27 indicate that there is a low risk of an accumulation of a substantial water volume within the open cut in the period up to the end of dredging. Lower total site demands coupled with higher forecast groundwater inflow rates result in a forecast increase in open cut stored water volumes in the latter half of the simulation.

An excessive volume of water stored in the open cuts has the potential to disrupt mining. The site's water storage strategy will be as follows:

- store 1 year of operational water demand in surface storages;
- discharge water in excess of this to underground goafs;
- discharge additional excess water via HRSTS (including the potential to increase credits via temporary trades); and
- retain excess water in the open cuts.

3.4.3 Water Supply Reliability

Predicted average supply reliability is expressed as total water supplied divided by total demand (i.e. a volumetric reliability) over the simulation period. Average supply reliability over all climatic realizations, as well as the lowest single realization reliability (representing a simulated 'worst case' simulation period), for CHPP supply, dredging supply, haul road dust suppression (truckfill) and overburden dust suppression are summarised in Table 5. There was negligible shortfall simulated for underground supply.

Table 5 Summary of Modelled Water Supply Reliability

Demand	Volumetric Supply Reliability					
	Average			Lowest		
	Approved Underground Operations	Delayed Underground Operations	No Further Underground Operations	Approved Underground Operations	Delayed Underground Operations	No Further Underground Operations
CHPP	99.9%	99.9%	99.9%	99.0%	98.8%	99.4%
Dredging	99.7%	99.7%	99.6%	94.5%	93.3%	91.0%
Haul Road Dust Suppression	98.4%	98.1%	98.7%	82.8%	82.6%	87.7%
Overburden Dust Suppression	99.5%	99.5%	99.5%	98.2%	98.1%	98.6%
Underground Operations	99.9%	99.9%	-	99.9%	99.9%	-

Of the 121 simulated realizations, 90% had a dredging shortfall of less than 150 ML over approximately 6 years (i.e. negligible), while 98.5% of realizations had a similar or lower predicted CHPP supply shortfall. This indicates a high predicted water supply reliability.

3.4.4 Hunter River Licensed Extraction

Supply drawn from Hunter River licensed extraction would vary through the Proposed Modification life. The predicted annual water year (July to June) extraction at different probabilities is shown in Figure 28 to Figure 35. The 90th percentile values are those that would be expected to have a 10% chance of being exceeded. Annual licensed extraction is predicted to peak during the dredging operation (i.e. 2023 to 2027). Modelling suggests low volumes would need to be supplied post dredging and in the year or two ahead of dredging, once inventory levels had been built up initially.

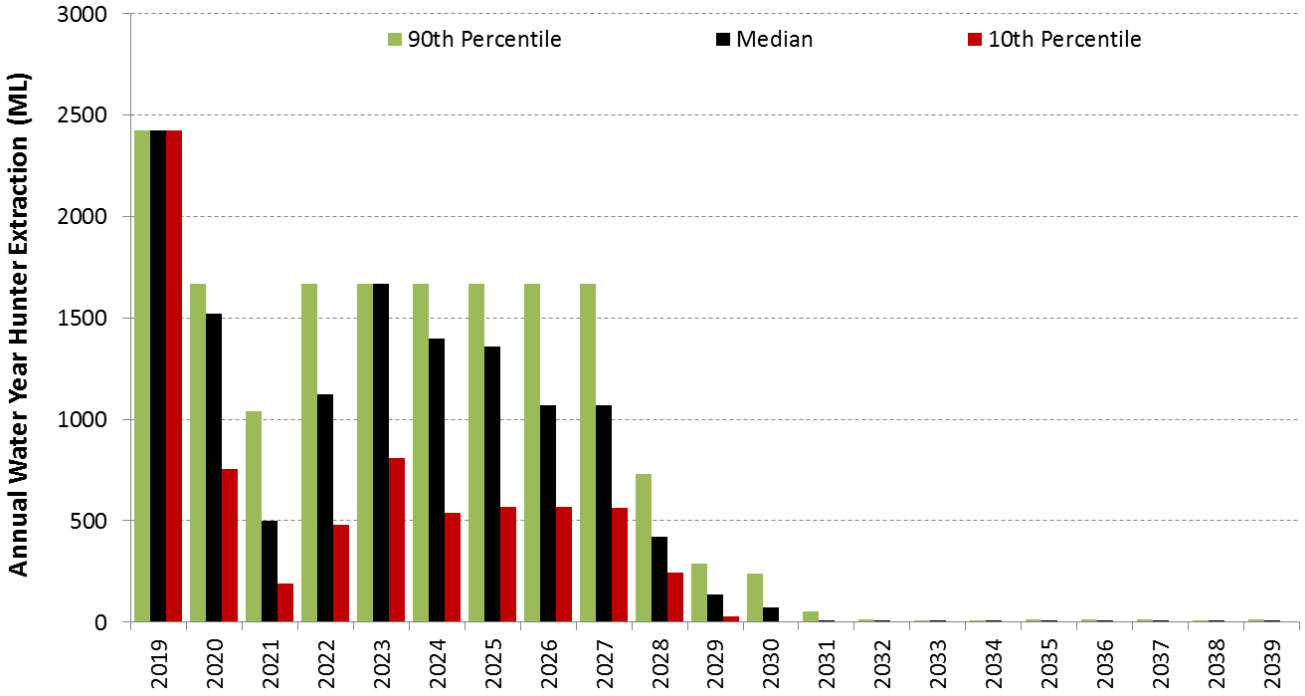

Figure 28 **Predicted Annual (Water Year) Hunter River (WAL) Extraction with Approved Underground Operations**

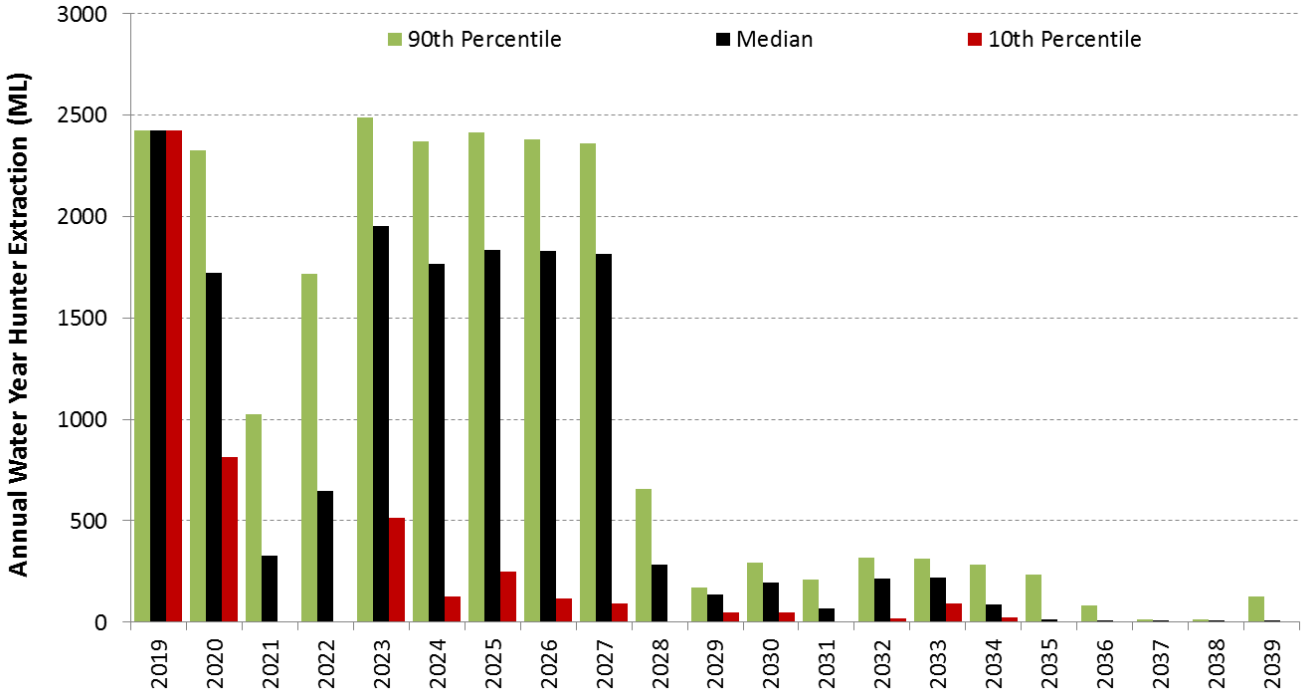

Figure 29 **Predicted Annual (Water Year) Hunter River (WAL) Extraction with Delayed Underground Operations**

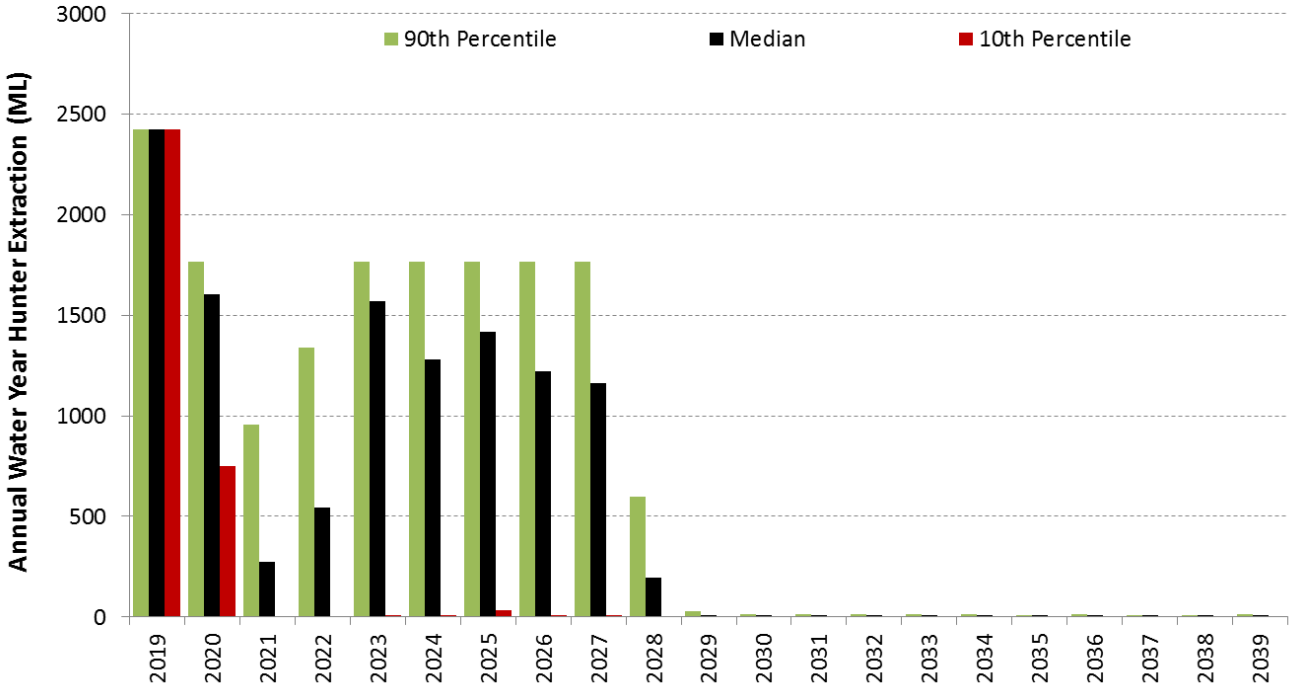

Figure 30 Predicted Annual (Water Year) Hunter River (WAL) Extraction with No Further Underground Operations

3.4.5 Licensed HRSTS Release

Model predicted annual (water year) licensed releases in accordance with the HRSTS from the Northern Dam and Surge Dam are summarised in Figure 31 to Figure 33 at different probabilities. Predicted median annual releases are low, while predicted 90th percentile release volume increases post dredging as site water demand falls. Some releases may still be required before and during dredging during high rainfall periods to mitigate the risk of spill from the Northern Dam and Surge Dam.

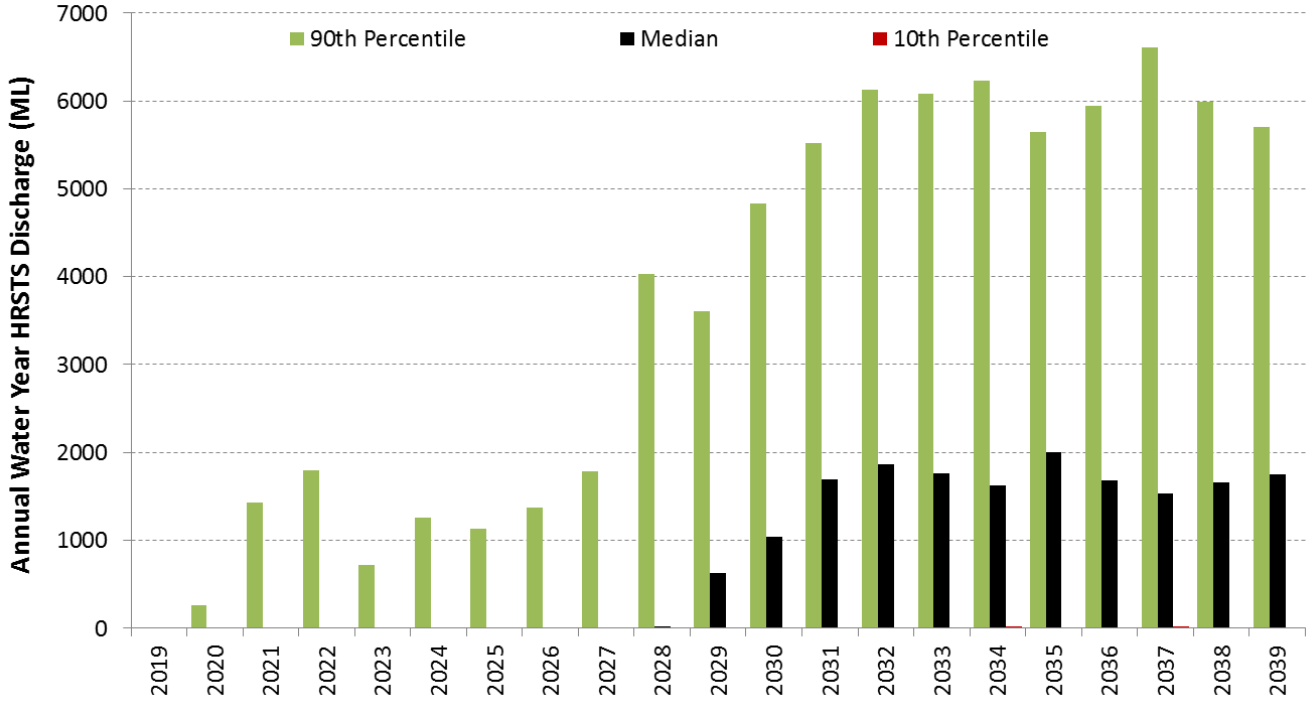

Figure 31 Predicted Annual (Water Year) HRSTS Licensed Discharge with Approved Underground Operations

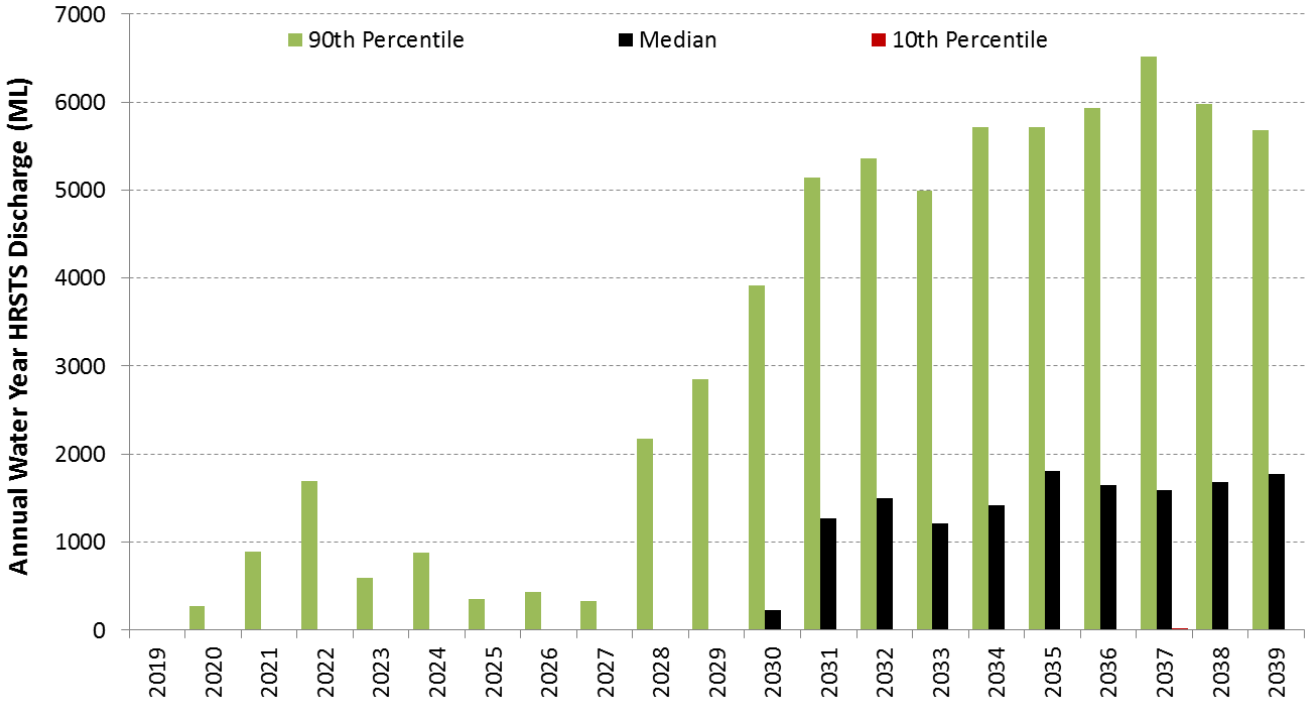

Figure 32 Predicted Annual (Water Year) HRSTS Licensed Discharge with Delayed Underground Operations

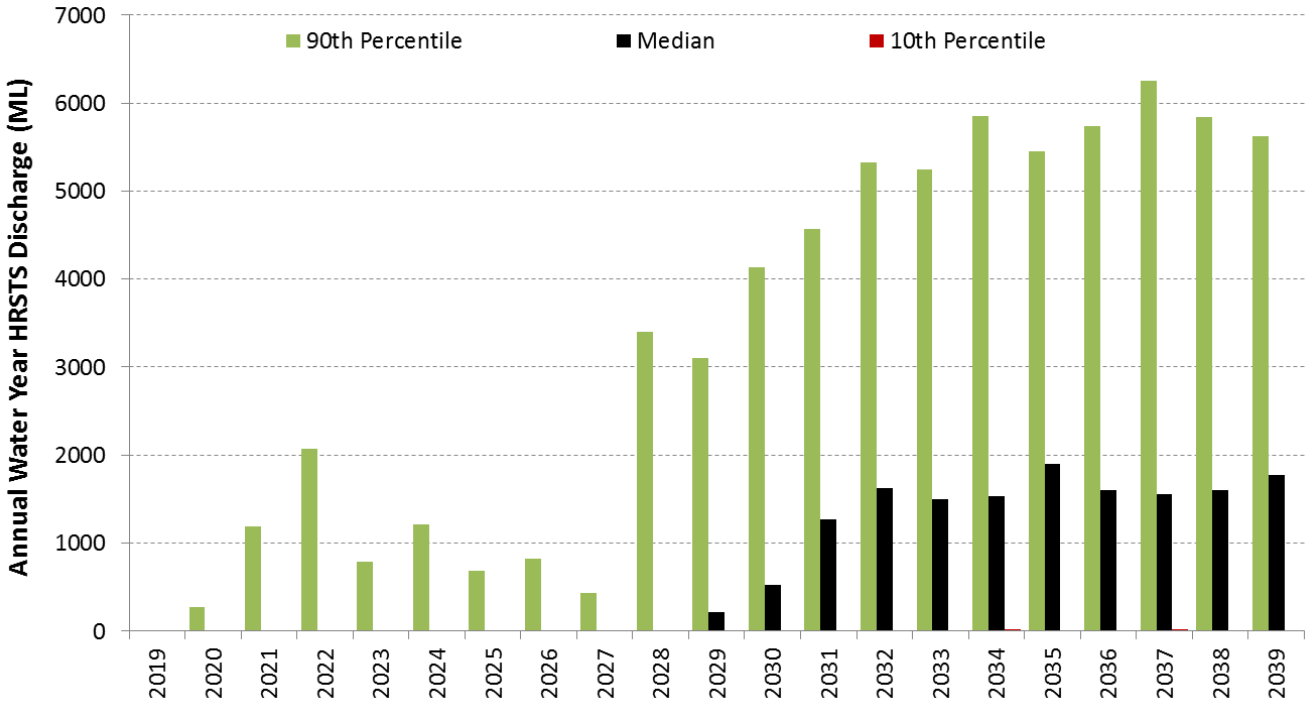

Figure 33 Predicted Annual (Water Year) HRSTS Licensed Discharge with No Further Underground Operations

3.4.6 Designed Outflows from Dams

Predicted outflow volumes from dams (other than HRSTS discharge) are shown in Figure 34 to Figure 36 at different probabilities. These are expressed in total megalitres over the approximately 21 year simulation period. Outflows at the risk levels given are only predicted from sediment dams, which are intended to spill periodically in accordance with Landcom (2004) during rainfall events that

exceed sediment dam design capacity. The magnitude of the predicted outflow volume is related to the capacity of the storage, the catchment area reporting to the storage, the pump capacity at the storage, the availability of the receiving storage to accept pumped inflow and the period for which the given storage will be in service.

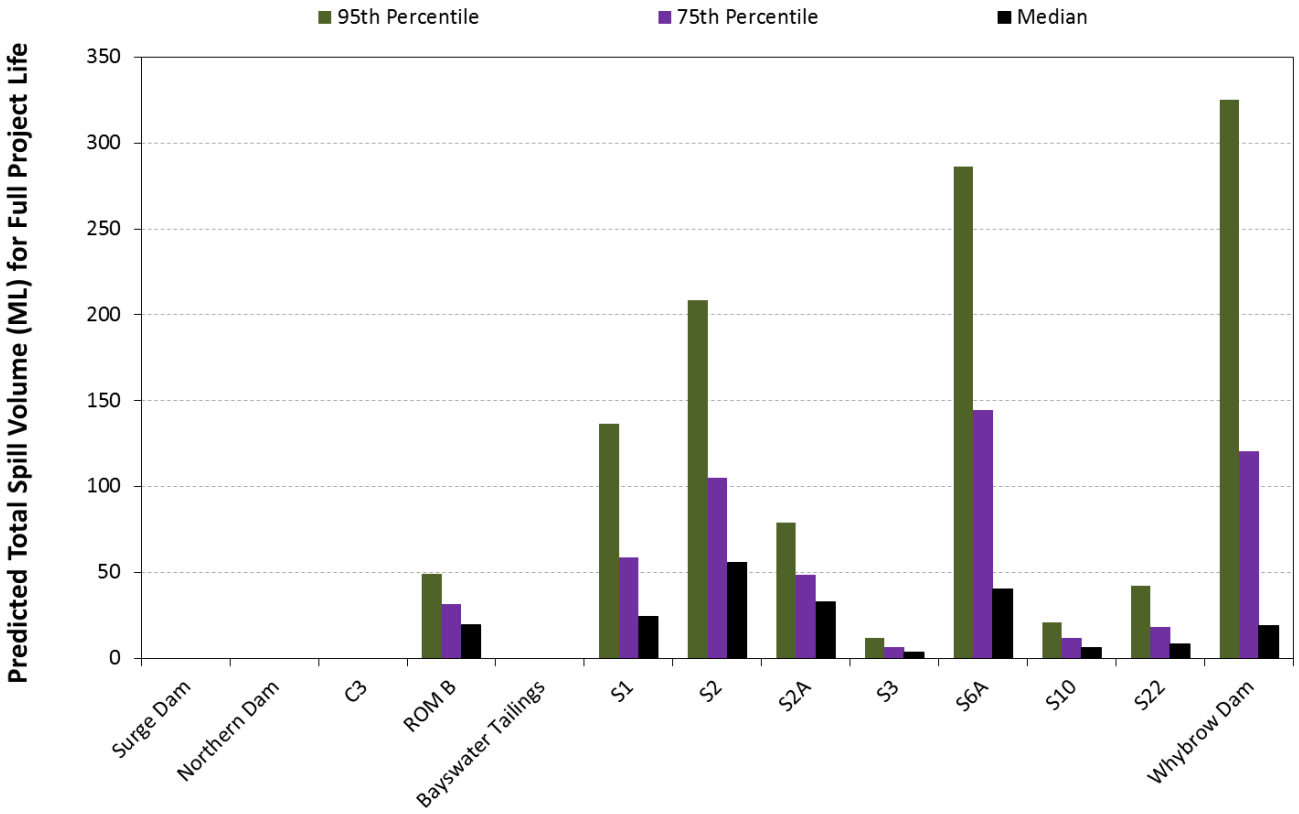

Figure 34 Predicted Total Outflow Volumes with Approved Underground Operations

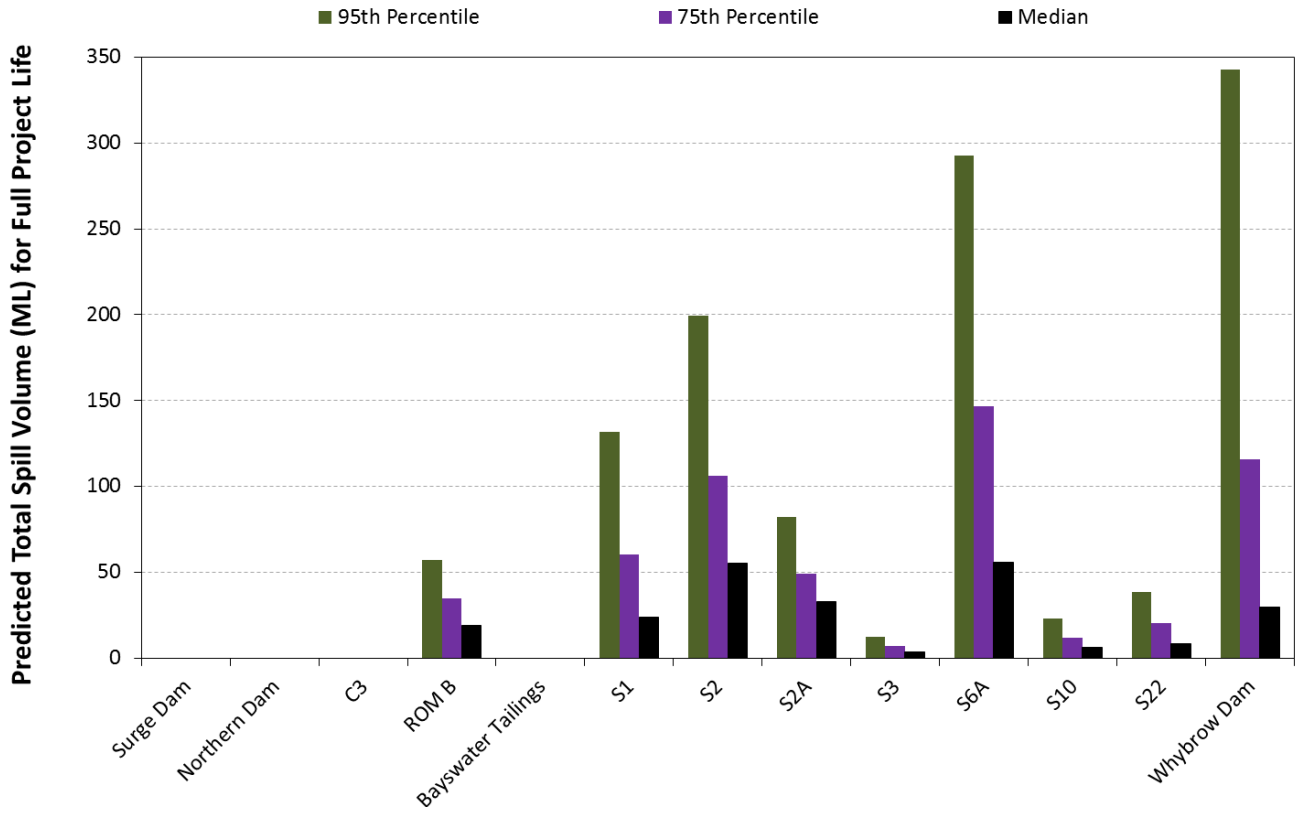

Figure 35 Predicted Total Outflow Volumes with Delayed Underground Operations

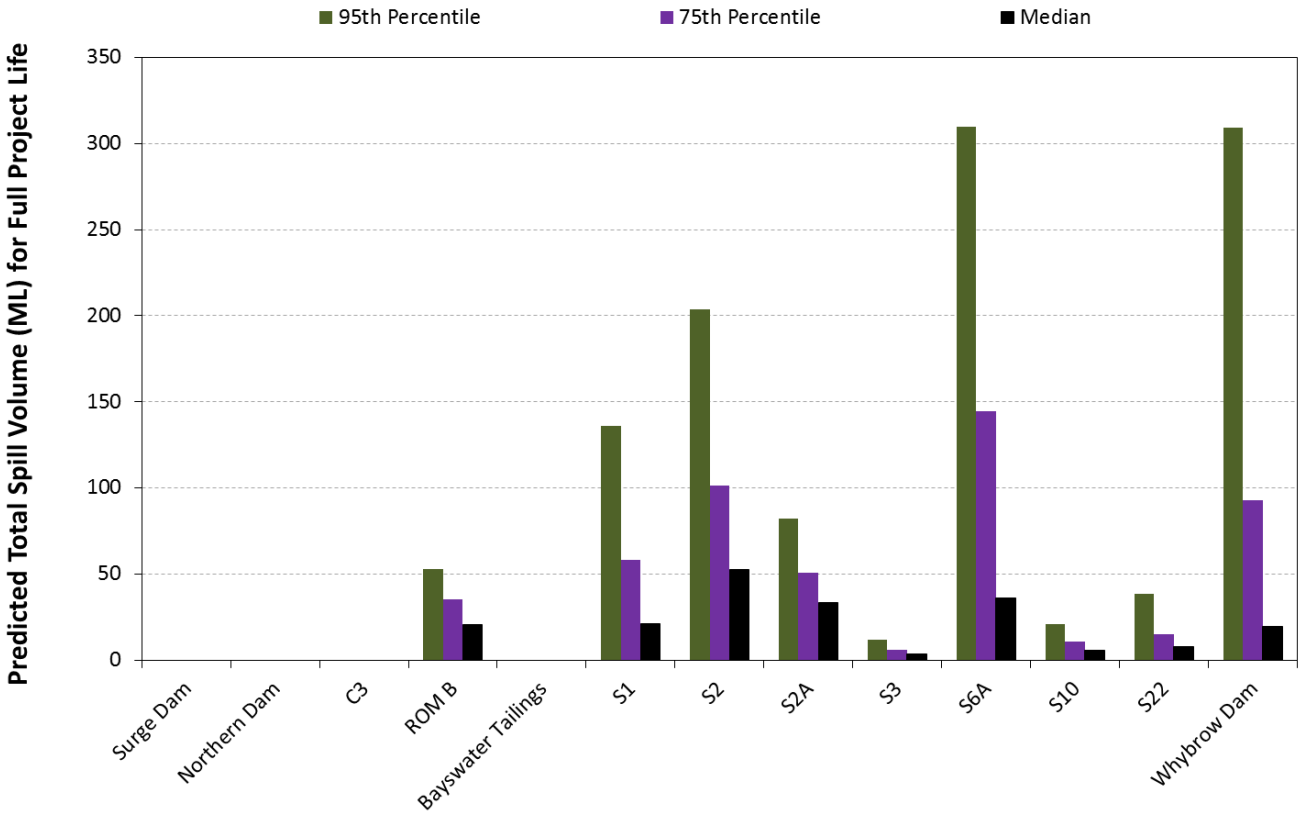

Figure 36 Predicted Total Outflow Volumes with No Further Underground Operations

3.4.7 Summary Outcomes

Operational water balance forecasts for the Proposed Modification may be summarised as follows:

1. Site rainfall runoff provides the greatest average modelled system inflow, while the largest average outflow comprises supply to dredging (tailings relocation). Dredging, which is planned to occur for a period of just under six years, is estimated to require an average 11,137 ML/year for this period.
2. Total site water inventory is predicted to increase ahead of the start of dredging in 2022 (with high site water inventory targets set to boost inventory prior to and during the high dredging demand), followed by a fall during the dredging period and then a recovery post dredging.
3. Modelling predicts a low risk of a substantial water volume within the open cut pits during the period up to the end of dredging while lower total site demands coupled with higher forecast groundwater inflow rates result in a forecast increase in open cut stored water volumes in the latter half of the simulation period. Supplementary surface water will be preferentially stored in the underground goafs and then open cut pits as necessary.
4. Average predicted supply reliability is high, with greater than 98.0% of all demands able to be supplied on average. Out of 121 simulated climate scenarios, the lowest reliability for supply to the CHPP was 98.8% and for dredging was 90.8%.
5. Predicted high reliability is contingent on adequate licensed extraction from Hunter River allocation. In addition to the existing 867 ML/year of High Security WALs, it has been assumed for modelling that up to an additional 800 ML (for the case of existing approved underground operations), 1,800 ML (for the case of underground operations restart delayed until 2029) or 900 ML (for no further underground operations) of temporary transfer will be able to be sourced each year from the 2019/20 water year until the end of dredging in 2027. Modelling indicates a median annual licensed Hunter River supply requirement of up to

1,670 ML/year (for the case of existing approved underground operations), 1,950 ML/year (for the case of underground operations restart delayed until 2029) or 1,570 ML/year (for no further underground operations) during the dredging period, falling to less than approximately 420 ML/year following the completion of dredging.

6. Licensed discharge (via the HRSTS) may be required at times of higher rainfall to mitigate spill risk and control high inventories. Modelling predicts zero median discharge volumes until well after the end of the dredging period, with up to approximately 2,000 ML/year median discharge in the last eight years of the Proposed Modification period.
7. Outflows will periodically occur from sediment dams, which are designed to outflow from time to time in accordance with Landcom (2004) during rainfall events that exceed their dam design capacity.

4.0 FINAL VOID WATER AND SALINITY BALANCE MODEL

The planned final landform is shown in Figure 37, with a single final void at the south-eastern end of the open cut pit area. A water and salt balance model has been set up to simulate the behaviour of the water body that would form in the final void.

The model simulates inflow from remnant final void catchment rainfall runoff (including direct rainfall), groundwater inflow/outflow from/to bedrock as well as outflow due to evaporation on a daily basis. Key model assumptions include the following.

1. A contributing surface catchment area of approximately 8.0 km^2 and a sub-surface (i.e. spoil seepage) catchment area of an additional 10.3 km^2.
2. Final void level-volume-area relationships derived from the final landform contour plan (Figure 37). The storage characteristics are for the empty void only – i.e. storage of water within the in-pit spoil is neglected. This will not affect the final long term water level in the void but should only affect the time taken to reach this equilibrium level (the time taken will be somewhat longer than model predictions).
3. A 129 year climatic data set (1889 to 2017 inclusive) obtained from the SILO Data Drill for the Project location (refer Section 3.1). The data set was repeated several times to generate an extended period of data to ensure equilibrium water levels were reached during the simulation period.
4. A constant pan factor of 0.75 for calculation of evaporation from the final void.
5. Rainfall runoff from the remnant rehabilitated overburden and open cut pit was estimated using the AWBM applied to the final void sub-catchments, as for the mine water balance model (refer Section 3.2.1). Seepage from rehabilitated overburden outside the immediate final void catchment area was simulated using the AWBM baseflow component for those areas overlying open cut pit shell areas (i.e. those areas of rehabilitated spoil within former open cut pit areas).
6. Groundwater inflow and outflow rates supplied by KCB (2019), varying with final void water level. Based on these predictions, groundwater outflow would occur above a void water level of -52.9 mAHD.

Catchment runoff and groundwater salinity values for void remnant rehabilitated overburden and rehabilitated catchment areas were assumed the same as for the operational water and salinity balance model (refer Table 1).

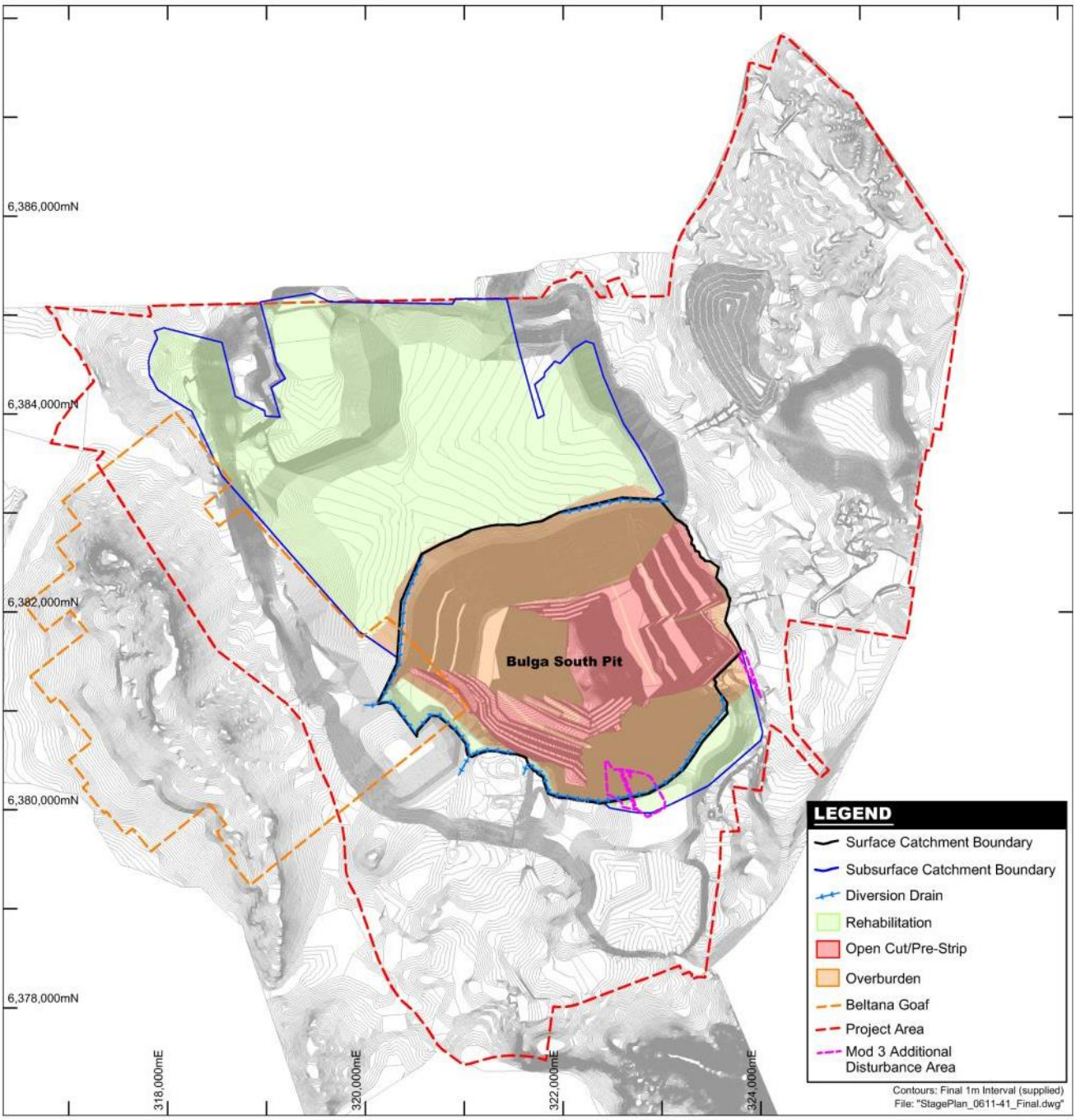

Figure 37 Proposed Final Landform

Model predicted final void water levels and EC values are shown in Figure 38.

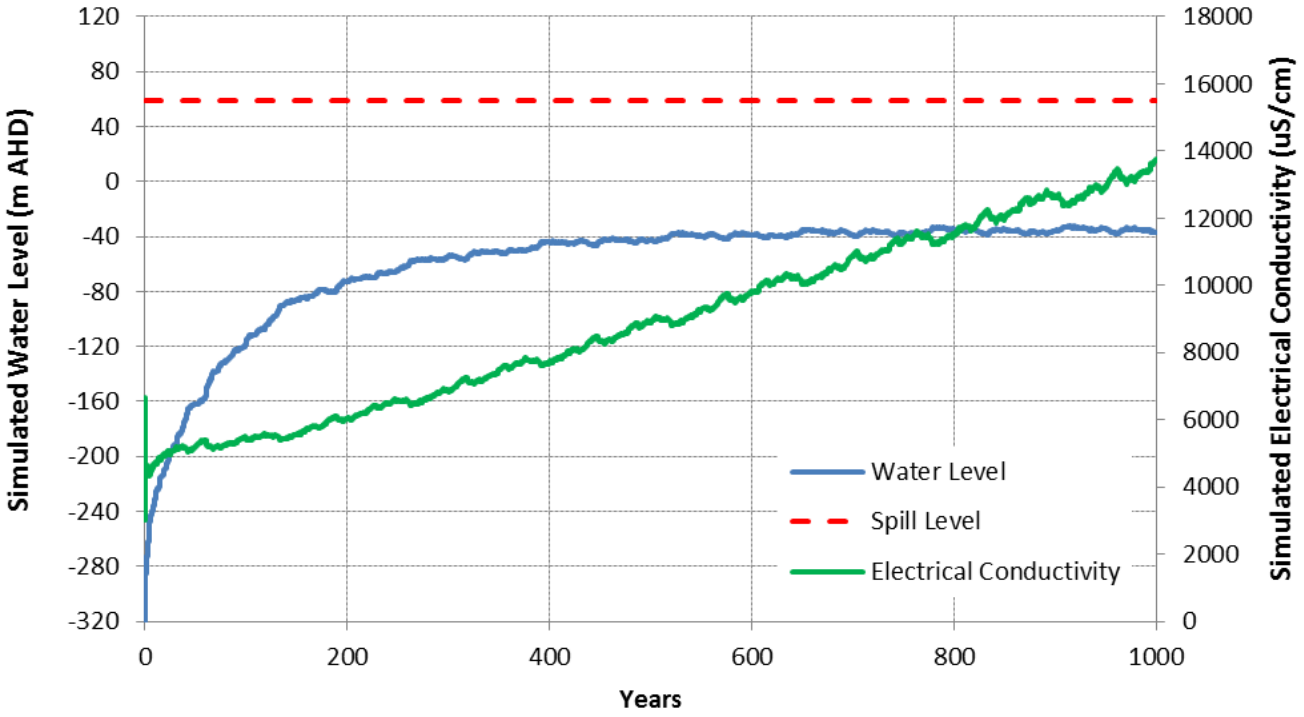

Figure 38 Predicted Final Void Water Levels and EC Values

Model results indicate that the final void water body would reach an equilibrium level approximately 120 m below spill level. The equilibrium level would be reached very slowly over a period of several hundred years. Groundwater outflow would occur in the longer term at a rate of up to 0.3 ML/d. Final void salinity levels would increase slowly as a result of evapo-concentration.

5.0 REFERENCES

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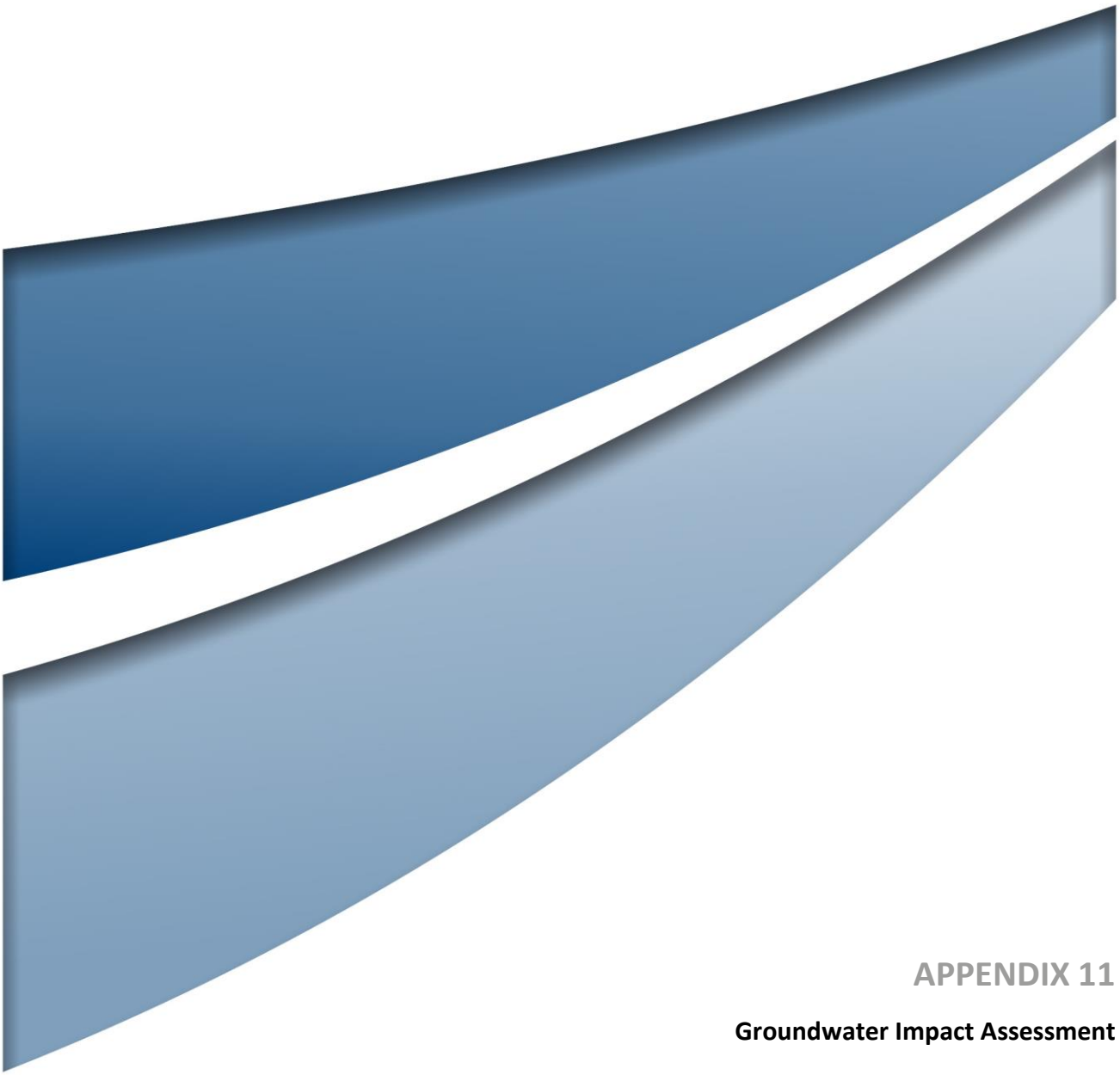


APPENDIX 11

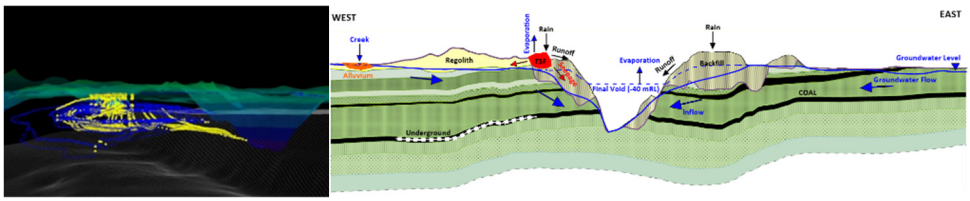
Groundwater Impact Assessment

Klohn Crippen Berger

Umwelt Australia Pty Ltd.

Environmental and Social Consultants

Bulga Optimisation Project Modification



Groundwater Impact Assessment

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August 2019

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd (KCB) was commissioned by Umwelt Environmental and Social Consultants (Umwelt), to undertake the Groundwater Impact Assessment (GIA) for the Bulga Optimisation Project Modification 3 (Proposed Modification). Umwelt has been appointed by Bulga Coal Management, a Glencore operation, to manage and prepare the Statement of Environmental Effects (SEE) for the Proposed Modification.

This assessment forms part of the overall SEE body of work, with a focus specifically on potential groundwater impacts associated with the Proposed Modification.

Description of the Proposed Modification

The Bulga Coal Complex (BCC) has both approved open cut and multiple underground longwall operations. The Bulga Optimisation Project was initiated as a continuation of the existing open cut operations, extending and deepening the mine pit. The Proposed Modification relates to the extension of the open cut operations to the south-east which will also allow for the extraction of resources below part of the currently approved pit. No additional underground operations form part of the Proposed Modification, but previously approved underground mining may continue coincident to the proposed extension of the open cut operations.

The Proposed Modification includes approximately 30 million cubic metres of tailings to be relocated from the current tailings storage facilities to the Main Pit TSF, which will consequently be expanded. The Proposed Modification will maintain the currently approved production rates of up to 12.2 Mtpa run of mine (ROM), extract an additional approximate 63 Mt of coal and extend the life of mine (LOM) by approximately 4 years (to 2039). Mining will be undertaken within the existing mining lease areas.

Summary of legislative requirements for groundwater impacts considered

Previous groundwater impact assessments have been completed to address the various Commonwealth and NSW State legislation applying to mine developments since the approval of the Bulga Underground mine in 2004. This includes the mine's current EPBC approvals 2002/773 and 2012/6637. The Proposed Modification was referred under the EPBC Act, and determined by the Commonwealth Minister for the Environment to be a controlled action in December 2018. This referral was made on the basis of the project being a large coal mining development and the potential of the project to impact a water resource.The aspects considered in this assessment include Significant Impact Guidelines 1.3 for Coal seam gas and large coal mining developments which include impacts on water resources, the potential for the project to be referred to the Independent Expert Scientific Committee (IESC) and consequently the 2018 IESC's guidelines.

To meet NSW government requirements, the groundwater assessment considers the requirement of the Environmental Planning and Assessment Act of 1979, the Water Act, Water Management Act of 2000 and the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources (updated in 2016). The requirements of the NSW Aquifer Interference Policy (AIP) have also been considered.

The Warkworth Sands Woodlands Ecological Community (WSWEC) was declared a critically endangered ecological community, under section 184 of the EPBC Act. The WSWEC falls within the area considered in this project's groundwater assessment.

The groundwater assessment updated the site's conceptual hydrogeological model, to reflect the Proposed Modification and used this update to inform and update the numerical groundwater models that have been used to obtain previous approvals (Mackie 2013 and AGE 2016). The three-dimensional groundwater model was updated, and a process of model re-calibration and uncertainty and sensitivity analysis was completed. Output from the uncertainty and sensitivity assessment was used to inform the final MODFLOW SURFACT model modification for the Proposed Modification application.

The model was peer-reviewed by Dr. Noel Merrick (HydroAlgorithmics).

Groundwater Modelling Results

The three-dimensional groundwater model includes both the Proposed Modification and the previously Approved mine plan. The previously Approved scenario includes both approved opencut and underground mines. Comparison of the results of modelling of the predicted water inflows and drawdown between the previously Approved scenario and Proposed Modification scenario allows the potential incremental1 impacts of the Proposed Modification to be identified. Whilst this modelling has not been undertaken to re-assess potential impacts of ongoing approved mining operations, it does provide a prediction of potential cumulative impacts from Bulga's approved open cut and underground operations, the Proposed Modification and the adjoining Mount Thorley open cut mine.

Predicted groundwater heads in the Wollombi Brook or Monkey Place Creek alluvials indicate a negligible difference between the Proposed Modification and the current Approved scenario. As a consequence, changes to stream baseflow are minimal (Table 1). The Proposed Modification case does not appreciably change groundwater conditions in any of the mapped alluvial areas. In the Permian strata, a strong drainage effect toward the main pit void, as would be expected, is noted in the Proposed Modification model predictions. This is also evident in the Approved scenario.

While the Warkworth Sands are assessed as disconnected to the modelled Permian layers, model results for the Proposed Modification suggest that no additional drawdown will occur in the Permian units immediately underlying these sands and that no additional incremental impacts are predicted on the associated Warkworth Sands Woodland vegetation communities resulting from groundwater changes resulting from the Proposed Modification.

Incremental impacts of the Proposed Modification on the Alluvial Water Source of Wollombi Brook, including nearby registered private bores, are not predicted to cause exceedances of the Minimal Impact Considerations of the NSW Aquifer Interference Policy.

[1] Incremental impacts are considered to be the impact of the Proposed Modification that occur in addition to those associated with the Approved mine plan

Table 1: Summary of Predicted Natural Drainage Impacts

Natural Drainage	Approved Project – Flow Rate @ 2039 (m^3/d)	Proposed Modification – Flow Rate @ 2039 (m^3/d)	Incremental Impact of Proposed Modification (m^3/d)	Assessment
Wollombi Brook (Beltana Reach)	1392	1380	-12	<1% baseflow take
Wollombi Brook (Bulga Reach)	528	528	-	Negligible impact
Lower Monkey Place Reach	389	382	-7	<1.7% baseflow take
Upper Monkey Place Reach	450	449	-1	Negligible impact
Loders Creek	31	31	-	Negligible impact
Nine Mile Creek	14	9	-5	~36% baseflow take in average conditions (~ 0.05 L/s)

Heads in the in-pit spoil dumps would increase to reach around 80 mAHD in the northern part of the mine but remain below the current ground level outside of the extent of the mining. This increase for the Proposed Modification results in a predicted hydraulic gradient developing towards the north in the direction of the Mount Thorley mine. Model predictions suggest that despite the development of this gradient, groundwater flow rates in the northern area will remain low (in the order of 1 L/s).

Predicted incremental changes in mine inflows, averaged over the respective mine period, from the Proposed Modification, are shown in Table 2.

Table 2: Summary of Mine Inflows

Mine	Seam	Model Layer	Start Year	End Year	Proposed Modification Incremental Impact (ML/a)
Bulga OC	Various	Down to 19	1982	2039	346
South Bulga UG	Lower Whybrow	8	1994	2002	-3
Beltana UG	Lower Whybrow	8	2003	2011	-7
Blakefield South	Blakefield	11	2010	2017	-1
Blakefield North	Blakefield	11	2018	2020	-4
Glen Munro	Glen Munro	13	2021	2026	-2
North Woodlands	Woodland Hill	15	2027	2033	138
South Woodlands	Woodland Hill	15	2033	2039	7

The open pit, in the Proposed Modification scenario, is expected to observe a largely static inflow until about 2023 due to inflows being diminished as underground operations dominate water make. After 2023, as the open cut deepens, inflows progressively increase to a peak of ~2,000 ML/annum, which then settles to about 1,700 ML/annum to end of mining.

Based on a total approved hard rock aquifer allocation of ~2,400 ML/a (Table 4-5) held by BCC, the predicted cumulative inflow volumes from approved open cut and underground mining operations along with the small incremental increase attributed to the Proposed Modification are predicted to exceed current hard-rock aquifer licence allocations held by BCC in 2016 to 2018 (Blakefield South operation), in 2020 (Blakefield North operation), in 2024 to 2026 (Glen Munro operation) and in 2028 to 2033 (North Woodland operations).

Operational practice at Bulga Underground Mine has been to dewater only to the extent necessary to maintain operations. The sequencing and timing of the underground mining is unlikely to be as aggressive as the schedule used in the model, and furthermore, due to the requirement to undertake pre-mining gas drainage, some groundwater will be removed ahead of mining to facilitate gas drainage, which is not reflected in the model. The overall water take due to underground mining in the Permian measures is therefore likely to be less than the conservative modelled inflows.

On average, cumulative water inflow production across the remainder of the mining life (Approved mines plus Proposed Modification impacts) is predicted to approximate to the amount of current approved hard rock allocation.

Glencore holds significant quantities of transferable hard rock aquifer allocations at other mining operations in the upper Hunter Valley which will be available to transfer to BCM if increased water extraction is required beyond current allocation volumes.

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1 INTRODUCTION

Klohn Crippen Berger Ltd (KCB) was commissioned by Umwelt Environmental and Social Consultants (Umwelt), to undertake the Groundwater Impact Assessment for the Bulga Optimisation Project Modification (Proposed Modification). Umwelt has been appointed by Bulga Coal Management, a Glencore operation, to manage and prepare the Statement of Environmental Effects (SEE) for the Proposed Modification.

This assessment forms part of the overall SEE body of work, with a focus specifically on potential groundwater impacts associated with the Proposed Modification.

1.1 Project Background

The Bulga Coal Complex (BCC) has both approved open cut (which includes a CHPP[2]) and multiple underground longwall operations. The mine is located 12 km southwest of Singleton and approximately 2 km from the townships of Broke and Bulga in the Upper Hunter Valley, NSW (Figure 1-1).

[2] CHPP – Coal Handling Preparation Plant

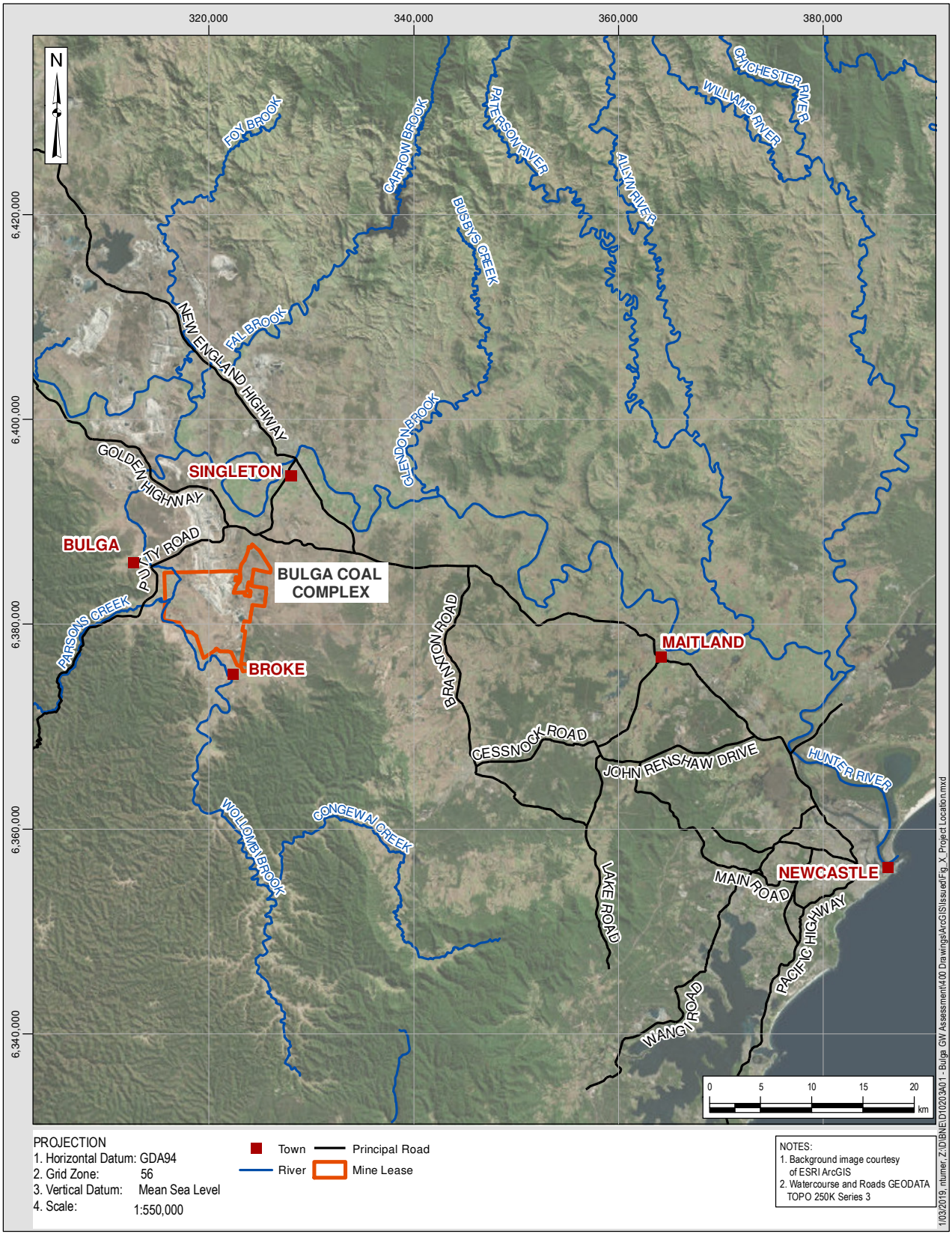


Figure 1-1: Location of the Bulga Coal Complex

The Bulga Optimisation Project (approved as SSD 4960, December 2014) was initiated as a continuation of the existing Bulga open cut operations commenced in 1981, extending and deepening the mine pit towards the south and east. The Proposed Modification relates to the extension of the open cut operations to the south-east which will also allow for the extraction of resources below parts of the currently approved pit. No additional underground operations form part of the Proposed Modification, but underground mining is approved to continue coincident to the extension of the open cut operations.

Whilst underground mining operations at Bulga are suspended at the time of this report, approval exists for ongoing underground mining at Bulga. Potential impacts from the ongoing approved Bulga underground mine, and the adjoining approved Mount Thorley open cut, are reflected in this assessment as components of the cumulative context, and are not included as components that will be assessed for approval.

To extract the additional resources, approximately 30 million cubic metres of tailings need to be relocated from the current tailings storage facilities (TSF), Deep Pit and Bayswater Pit, to the Main Pit TSF (Cell A is approved and in operation). This Main Pit TSF will consequently be expanded. The Proposed Modification will maintain the currently approved production rates of up to 12.2 Mtpa[3] run of mine (ROM), extract an additional approximate 63 Mt of coal and extend the life of mine (LOM) by approximately 4 years (to 2039). Mining will still be undertaken within the existing mining lease areas. An additional area of 20.2 ha will be disturbed.

Figure 1-2 shows the general (current) layout of the mine described above.

Access to approved underground resources to the south and west of the pit will not be affected. As such, the Proposed Modification represents an extension to open cut mining and modification of the management of tailings only. Figure 1-3 shows the layout of the proposed final mining void based on the proposed Modification.

[3] Mtpa – million tonnes per annum

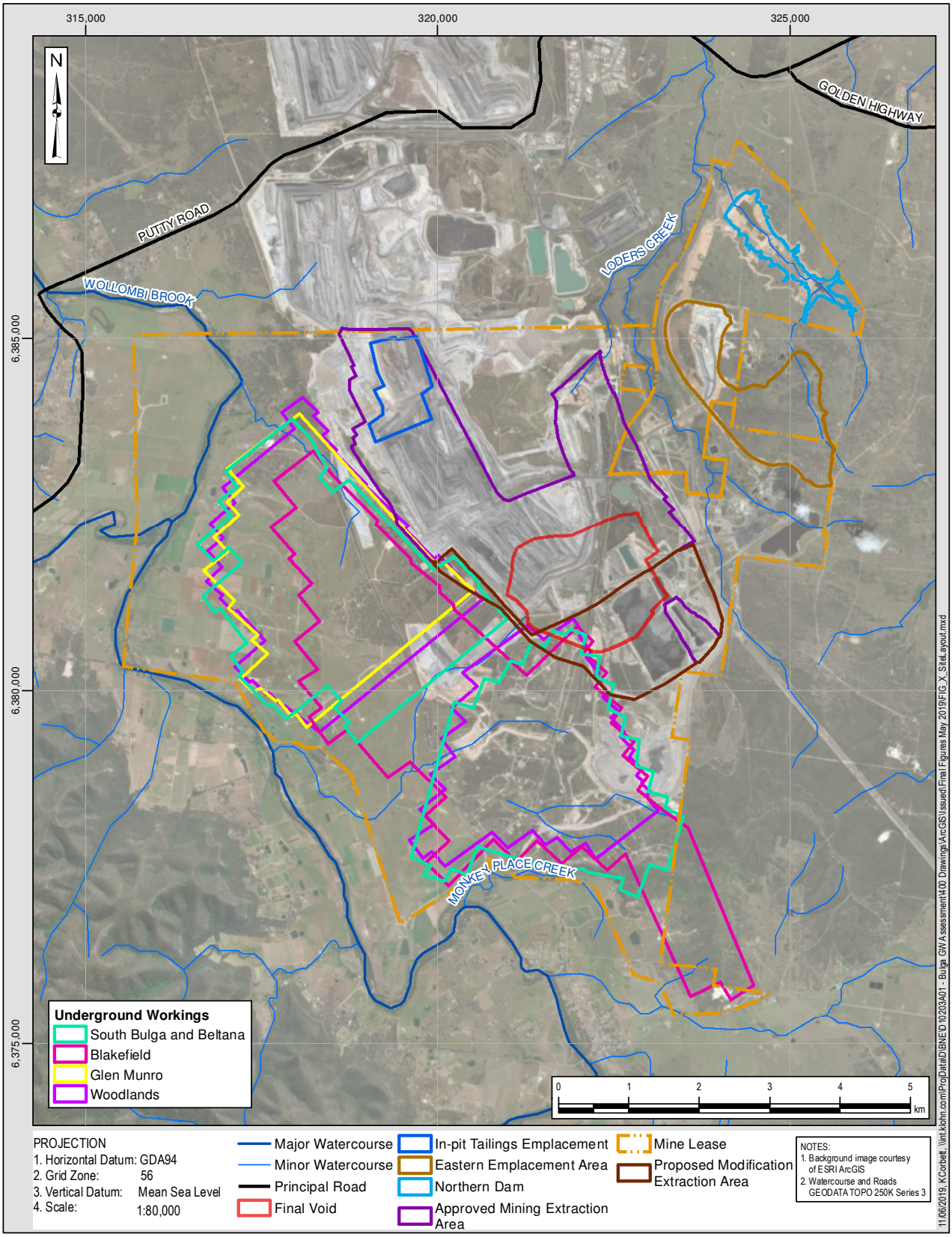


Figure 1-2: Currently Approved Mine Layout

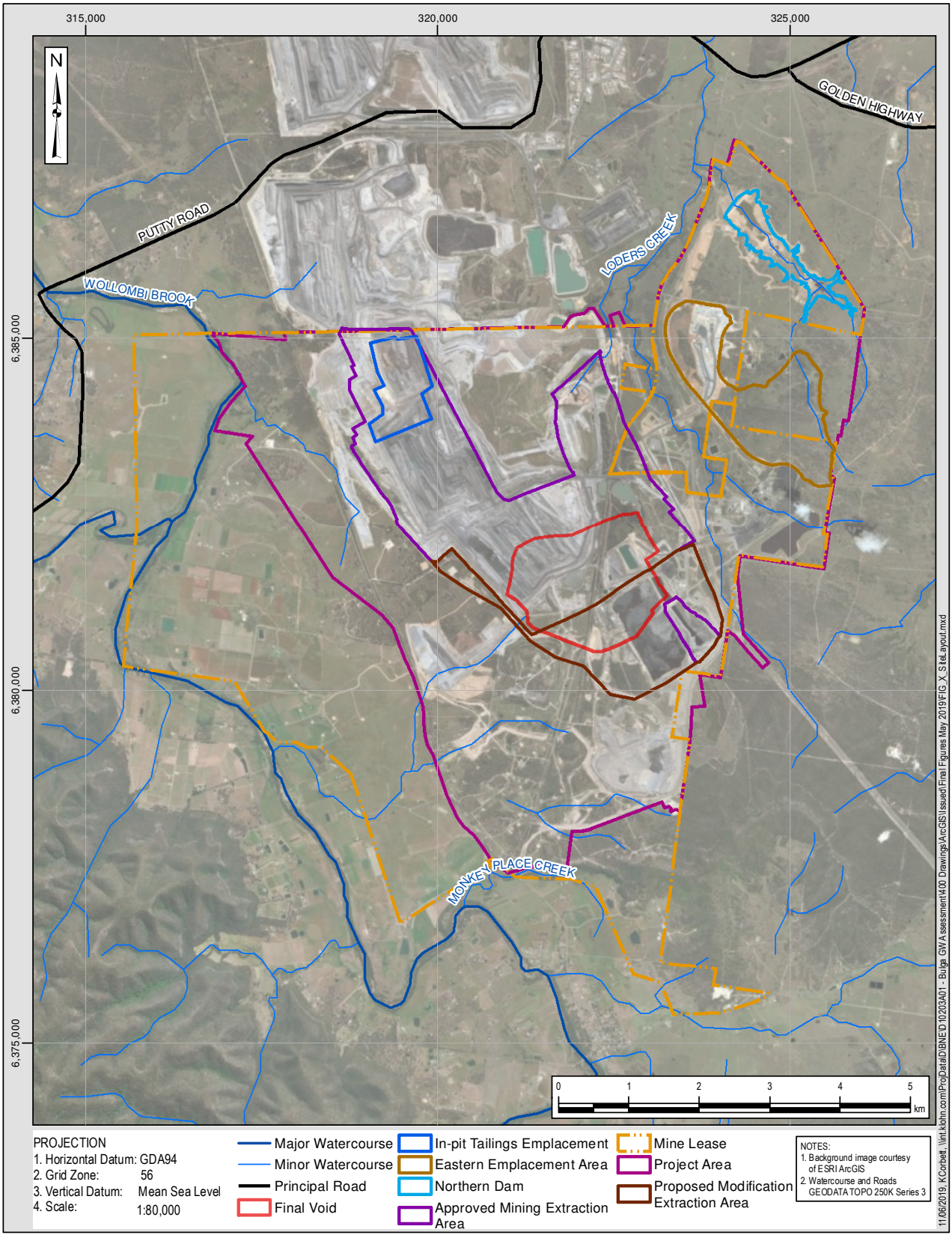


Figure 1-3: Mine Layout Forming Part of the Proposed Modification

1.2 Scope of Work

The scope of work for this Groundwater Impact Assessment (GIA) comprises:

- Updated summary position of relevant legislation and guidelines as they relate to the Proposed Modification.
- Updated Conceptual Hydrogeological Model (CHM) to inform the numerical groundwater flow modelling.
- Groundwater modelling of the proposed mine expansion and assessment of potential incremental impacts to groundwater that the Proposed Modification may impose, including the assessment of potential impacts on the Wollombi Brook Aquifer and the interface of groundwater with the surface drainage systems, local bores and groundwater-dependent ecosystems (springs).
- Associated reporting and forward planning including mitigation or monitoring strategies which may need to be adjusted or deployed.

This report includes ongoing approved underground mining to reflect the context of the assessment of the Proposed Modification; however, as indicated in Section 1.1, underground operations do not form part of this project (Proposed Modification) and are not assessed by this GIA, as these operations have previously been approved.

1.3 Previous Work

This assessment relies heavily on previous work, including updated application of the mine area groundwater flow model which was first constructed by Mackie Environmental Research (Mackie), and later updated by Australasian Groundwater & Environmental Consultants (AGE).

Chronologically, key previous hydrogeological work includes:

- Mackie Environmental Research (Mackie, 2013): Assessment of Groundwater Impacts Arising from the Proposed Bulga Optimisation Project. Report prepared in support of the project EIS reference 605-081507/Rev4, completed for Bulga Coal Management.
- Glencore (Glencore, 2016): Bulga Coal Water Management Plan. Report reference BUL SD PLN 0052.
- Australasian Groundwater & Environmental Consultants (AGE, 2016a): Model Handover. Report reference AMD/G1832A prepared for Mackie Environmental Research.
- Australasian Groundwater & Environmental Consultants (AGE, 2016b): Bulga Coal Complex Numerical Model Update 2016. Report reference G1832A prepared for Glencore.
- Australasian Groundwater & Environmental Consultants (AGE, 2016c): Bulga Coal Complex Deep Pit Expansion Model. Report reference G1832B prepared for Glencore.
- David, K (David, 2014): Groundwater Investigation into the Status of the Alluvium in the Area North of Beltana LW14. Report reference KD2014/01 prepared for Bulga Underground Operation Pty Ltd.
- David, K (David, 2017): Groundwater Assessment Report for Blakefield South Longwall Panel 8. Report reference KD2017/09 prepared for Bulga Underground Operation Pty Ltd.

Additional references used have been cited throughout this report and are summarised in the list of references at the end of this report.

2 REGULATORY AND POLICY FRAMEWORK

The Proposed Modification is subject to various pieces of both Commonwealth and NSW State legislation. An outline of the relevant legislation, policies and guidelines and how they affect the Proposed Modification is provided in the section below. An outline of the requirements, specifically in terms of the content of a SEE for both Commonwealth and NSW authorisation, is provided in Table 2-1.

2.1 Commonwealth Regulatory Framework and Guidelines

2.1.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)(Commonwealth of Australia 1999) is the Commonwealth Government's principal piece of environmental legislation. The EPBC Act aims, amongst others, to provide for the protection of the environment, especially matters of national environmental significance, provide a streamlined national environmental assessment and approvals process and promote ecologically sustainable development.

While the State government regulates activities to protect the environment, the Federal government specifically focusses on national environmental assets, known as Matters of National Environmental Significance (MNES).

Update on EPBC approvals

BCM currently operates under two EPBC approvals 2002/773 and 2012/6637 (most relevant to the Bulga Surface Operations). Aspects of the Proposed Modification that are not covered by these approvals are:

- Extension of mining areas to the south and east to access an additional 63 Mt of coal within the proposed extension area;
- Additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east within the proposed extension area; and
- Accessing deeper resources beneath part of the currently approved open cut.

On 17 December 2018 the Proposed Modification was determined to be a controlled action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on various MNES but specific to this report, an impact on a water resource, in relation to coal seam gas development and large coal mining development.

Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources

Following amendments to the EPBC Act in 2013, water resources, in relation to coal seam gas and large coal mining, are an MNES (Commonwealth of Australia 2013). This means that impacts of proposed large coal projects must be assessed at a national level should there be significant impacts on the water resources. These significant impacts include changes to the hydrology or

water quality of a water resource that will reduce the current or future use of the water resource to a third-party user. Following a self-assessment, the project may be referred to the Independent Expert Scientific Committee (IESC) who evaluate it based on the value, sensitivity and quality of the impacted environment and the intensity, duration and scale of the impacts.

IESC guidelines for coal seam gas developments and large coal mining developments

The information guidelines (IESC 2018) outline the information considered necessary to provide the advice and emphasise the need for the most comprehensive information possible, including historical data.

In the case of existing operations, this should also include current water-related environmental approval conditions and associated monitoring and management plans, clearly identifying existing impacts and outlying how current data has been used to assess impacts and verify models. At a minimum, the submission needs to include:

- Description of the proposed project;
- Risk Assessment;
- Description of impacts to water resources and water-dependent assets using conceptual models, analytical and numerical modelling and water and salt balances;
- Baseline data;
- Monitoring and Management; and
- Cumulative impacts.

2.1.2 Warkworth Sands Woodlands Ecological Community

The Warkworth Sands Woodlands Ecological Community (WSWEC) was declared a critically endangered ecological community, under section 184 of the EPBC Act, as well as being listed as threatened in New South Wales (Threatened Species Conservation Act 1995). These listings allow for the ecological community to be protected and restored by implementing priority conservation actions. The national listing forces protection of patches of this community that are functional with key diagnostics and condition thresholds applying in identifying a patch that may need to be referred under the EPBC Act.

Due to the remaining size of this community, no condition thresholds have been applied and instead a minimum patch size of 0.1 ha has been applied, meaning that patches less than 0.1 ha do not trigger any protection provision of the EPBC Act. Key diagnostics relate to the condition of the patches. As part of the listing, it is acknowledged that it is more practical and cost-effective to maintain existing high-quality remnants than to allow their degradation and to then attempt rehabilitation. For this reason, neighbouring mines and other properties have been encouraged to work together to reduce fragmentation and isolation.

The four main occurrences are Wallaby Scrub Road, Warkworth Village, Archerfield and Bulga within the Central Hunter region of the Hunter Valley. The WSWEC is typified by a mid to low woodland (occasionally forest), typically dominated by Angophora floribunda (rough-barked apple) in the canopy and Banksia integrifolia subsp. integrifolia (coast banksia) and/or Acacia filicifolia (fern-leaved wattle) in a sub-canopy; together with other small trees, shrubs and

groundcover species that are typical of sandy soils classified as part of the Warkworth Land System, but specifically on aeolian sands – on old dune formations and swales between dunes and on sand sheets.

It has been identified that the WSWEC are primarily threatened by clearing, mostly for open cut mining and the construction of associated infrastructure as well as land clearing for agricultural purposes, although invasive plants, altered fire regimes and climate change also have an effect.

As detailed in the submission by Umwelt, the WSWEC within the Bulga Referral area is adjacent to the existing operations and the Mount Thorley open cut mines.

2.2 NSW Regulatory Framework

This section has been compiled using Water Regulations Overview (NSW Government 2015b) document as a guide.

2.2.1 Environmental Planning and Assessment Act 1979

On 1 December 2014 BCM was granted approval for the Bulga Optimisation Project (SSD 4960), which related to the ongoing operation of the Bulga Surface Operations until 31 December 2035. The approval was granted by the Planning and Assessment Commission (under delegation from the Minister for Planning). SSD 4960 has been modified twice since it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

It is proposed to modify SSD 4960 and DA 376-8-2003 pursuant to Section 4.55(2) (previously Section 96(2)) of the Environmental Planning and Assessment Act 1979 (EP&A Act) (NSW Government 1979). As a State Significant Development, the Independent Planning Commission (IPC) will be the consent authority.

2.2.2 Environmental Assessment Requirements

The Department of Environment and Energy (DoEE) issues environmental assessment requirements (EARs) for the Proposed Modification. The EARs for the Proposed Modification as they relate to groundwater include:

- A description of relevant groundwater resources with details on variations;
- Identification of the relevant NSW Water Quality objectives for the groundwater;
- Identification and description of the relevant Water Sharing Plan (WSP);
- Assessment of the impacts on the quantity and quality of the regional groundwater including connectivity between water sources and water-dependent assets;
- A description of the proposed water use including water and salt balances, separation of clean and dirty water, storage facilities, dams and any discharges;
- Modelling of long-term impacts;
- A description of how the project will protect or contribute to the NSW Water Quality Objectives; and

- Development of a management and monitoring plan (NSW Government 2015a)

Secretary's Environmental Assessment Requirements (SEARs) were not issued for the Proposed Modification by DPE.

2.2.3 Water Act 1912

The *Water Act 1912* (NSW Government 1912) focuses on the licencing of water extracted from surface and groundwater resources including borehole water supply and groundwater seepage to open cut and underground operations. For the current project, the relevant parts of the act have been superseded by the *Water Management Act 2000* (WM Act).

2.2.4 Water Management Act 2000

The objective of the *Water Management Act 2000* (NSW Government 2000) is the sustainable and integrated management of NSW water resources. It is based on the concept of ecologically sustainable development and recognises that the fundamental health of water resources needs to be protected and managed with the consideration of environmental, social, economic and cultural and heritage aspects. The *Water Management Act* recognises the need to provide licence holders with secure access to water while providing water for the environmental health of water resources. This is achieved through Water Sharing Plans (WSP) which establish performance indicators and water rules.

The *Water Management Act* also identifies aquifer interference activities which fall under the ambit of the Aquifer Interference Policy (AIP)((NSW Government 2012).

Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

The Bulga project falls into the WSP for the Hunter Unregulated and Alluvial Water Sources (NSW Government 2016) and further into the Wollombi Brook Water Sources, in the southern part of the catchment, which includes the Wollombi Brook, Monkey Place Creek and any connected alluvium groundwater contained within the coal measures. This area is characterised by a relatively high value of economic dependence on the groundwater due to the irrigated agricultural production for vineyards with a number of identified threatened species. The Lower Wollombi is a highly connected water source: it is a groundwater-dominated system fed by an alluvial aquifer of good quality, underlain by saline water associated with Permian coal measure formations with limited surface flows (NSW Government 2009).

The environmental provisions in the groundwater sharing plans are aimed at protecting the long-term storage component of each aquifer. Based on infiltration and recharge and the proportion of water allocated to the environment, long-term average extraction limits or sustainable yields have been identified. These determine the amount of groundwater that can be extracted.

Although no water sharing rules (or Very Low Flow Classes) have been established, borehole monitoring to confirm groundwater behaviour, extraction limits and impacts on Groundwater Dependent Ecosystems (GDE)[4] is being undertaken to inform the rules. In the interim, the Lower Wollombi Brook source has medium instream values with a medium risk (NSW Government 2016)

[4] Although there may be some GDE's, there are no high value GDE in the project area.

with a total of 5,071 shares available for the alluvium aquifer in the Lower Wollombi Brook Water Source (NSW Government 2016).

Aquifer Interference Policy

Groundwater impacts for activities requiring approval under the EPA Act are assessed under the requirements of the Aquifer Interference Policy (AIP) (NSW Government 2012). The AIP describes the requirements and obligations for project proponents when planning to undertake aquifer interference activities. The framework provides guidance on what an aquifer interference activity is, the potential risks associated with the activity and design guidelines to minimise impacts. Aquifer interference activities relevant to Bulga include:

- Penetration of an aquifer;
- Interference with water in an aquifer;
- Obstruction of flow of water in an aquifer;
- Taking of water from an aquifer in the course of carrying out mining; and,
- Disposal of water taken from an aquifer in the course of carrying out mining.

Key considerations of the AIP are:

- Accounting for the amount of water taken to ensure the amount taken does not exceed the extraction limit in the WSP.
- Assessing the impacts on the aquifers, including modelling, seepage, water supply, dewatering and bore pumping and considers aquifer connectivity to account for leakage between water sources due to induced groundwater flow gradients. The assessment criteria are called minimal impact consideration and include impacts on:
    - Water table levels
    - Water pressure levels
    - Water quality; and
- Risk management – contingency plans for when impacts are greater than predicted.

An important aspect of the AIP is the initial assessment of impacts in relation to minimum harm criteria for highly productive and less productive waters.

The waters of the Wollombi Creek and Monkey Place Creek are considered less productive due to the variable, and sometimes poor, groundwater quality (TDS>1,500mg/L) and are unlikely to support a sustained yield of more than 5L/s (NSW Government 2012). Constraints associated with less productive waters are detailed in the Minimal Impact Considerations in Table 1 of the AIP and fall into three impact categories:

- Water table – drawdown impacts must be less than or equal to 10% of the cumulative variation in the water table and at least 40m from high priority GDE's or high priority culturally significant sites with a maximum of a 2m decline. If it is more than 10% or 2m or closer than 40m, the long-term viability of a high priority GDE or significant site must be demonstrated. If the drawdown impacts are more than 2 m at any water supply works, appropriate make-good provisions should apply.

- Water pressure -cumulative pressure head decline of less than 40% of the prescribed pressure head to a maximum of 2m at any water supply work. Should the decline be greater than 40% or 2m, the decline cannot affect the long-term viability of the water supply works unless make-good provisions apply; and
- Water quality – there are three conditions:
    - No decrease of water quality lower than the beneficial use category beyond a 40m buffer zone around the mining activity,
    - No increase of more than 1% per activity in the long-term average salinity in highly connect surface water sources, and
    - No mining below natural ground surface within 200m laterally or 100m vertically of a connected (alluvial) water source.

Should any of these conditions not be met, it needs to be demonstrated that there will not be any decrease in the River Condition Index and that there are minimal instability and flooding risks.

2.2.5 Water Management (General) Regulation

The Water Management (General) Regulation 2011 (NSW Government 2011) lapsed in September 2018 and is replaced by the Water Management (General) Regulation 2017 (NSW Government Draft). Key amendments to the 2011 regulation include clarification on licensing and approval and the functions and powers of the authorities and creating new exemptions for approvals. Relevant to the Bulga project, the Water Management (General) Regulation makes provision for water access license and water use approvals and management plans.

2.2.6 Natural Resources Access Regulator Act 2017

The independent Natural Resources Access Regulator (NRAR) was established under the *Natural Resources Access Regulator Act 2017* (NSW Government 2017). It combines the functions previously split between the NSW Government and Water NSW. The NRAR will be responsible for enforcing compliance and enforcement of NSW water law. Specifically, the NRAR is responsible for water access licences and associated approvals required by mining companies.

2.2.7 Other Policies and Guidelines

The NSW State Groundwater Policy (NSW Government 1997) aims to manage the NSW groundwater resource in order to sustain environmental, social and economic uses for the people of NSW and was a precursor to the Water Management Act. It is supported by the NSW Groundwater Quality Protection Policy (NSW Government 1998)and the NSW State Groundwater Dependent Ecosystems Policy (NSW Government 2002), for which there are detailed risk assessment guidelines.

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012) promote a consistent approach to the development of groundwater flow models.

Mining activities taking place under the Mining Act 1992 (NSW Government 1992) require Groundwater Monitoring and Modeling Plans that incorporate the requirements of the AIP.

2.3 Summary of Requirements

Table 2-1 summarises the requirements of the legislation discussed, specifically in terms of the content of an EIS, and details where in this report the relevant information can be found.

Table 2-1: Summary of Legislative Requirements

Aspect	Required by:			Relevant section of this report
	Federal Legislation	NSW Legislation	DoEE Original Assessment	
	EPBC requirements with reference to IESC guidelines	AIP		
Description of the proposed project including status, background, location and design parameters	✓ Specifically, how these may affect any MNES		✓[1] Specifically, the water resources potentially affected	Section 3
Risk Assessment	✓	✓		In Progress
Description of impacts to water resources and water-dependent assets	✓ Specifically, making use of conceptual models, analytical and numerical modelling and water and salt balances and existing data, describing and assessing direct and indirect impacts and the likelihood and reversibility of impacts	✓ Specifically, considering supply and dewatering, aquifer connectivity and impacts on water table and water pressure levels and water quality	✓[1] Specifically, considering other water users and groundwater and surface water quality and quantity with a focus on Wollombi Brook, Loders Creek and the Hunter River	Section 4.6 Section 5
Baseline data	✓		✓[1]	Section 3
Monitoring and Management	✓		✓[1]	Section 5.5
Avoidance and mitigation measures	✓ Specifically for the MNES including expected effectiveness, statutory basis and name of agency responsible for approving, cost of measures and an Environmental plan with the framework for management of measures		✓[1]	Section 5.5
Offset strategies if applicable	✓		✓[1]	N/A
Cumulative impacts, including how exiting impacts will be affected	✓		✓[1]	Section 5

Current water-related environmental approvals and conditions	✓		✓[1]	Section 4.6.2
Identification of the relevant NSW Water Quality objectives for the groundwater and how the project will protect or contribute to these				Section 2
Identification and description of the relevant WSP				Section 2.2.4
Groundwater Monitoring and Modelling Plans		✓ In conjunction with the Mining Act 1992		Section 5.5
Account for quantity of water taken in relation to the relevant WSP.		✓		Section 4.6 Section 5
Any interference with an aquifer caused by the development does not affect the water table, water pressure or water quality[2]		✓ N/A for Water Table		Section 5
Detailed groundwater modelling to allow a detailed assessment of the potential impacts on the proposed action on groundwater			✓	This updated report
EIS must detail the changes to the hydrological regime (quality and quantity) and how this may affect dependent fauna and flora			✓	Section 5

Notes:
1 Required to be compliant with the IESC requirements, a requirement of the assessment
2 Any interference with an aquifer caused by the development does not
- Exceed < 10% of the cumulative variation in the water table 40m from a high priority GDE or culturally-significant site or 2m cumulatively from a water supply works
- Cause a cumulative pressure head decline of < 40% to a maximum of 2m near any water supply work
- Lower the beneficial use groundwater quality beyond 40m
- Increase the salinity by more than 1%/activity at the nearest connected surface water source.

Additionally, there should be no mining below natural ground surface within 200 m laterally or 100 m vertically of a connected (alluvial) water source.
Should any of these conditions be exceeded, appropriate studies to demonstrate that the activity will not affect the long-term viability of the water resource are required.

3 CONCEPTUAL HYDROGEOLOGICAL MODEL (CHM)

3.1 Physical Setting

3.1.1 Topography and Drainage

The BCC lies in the Upper Hunter Coalfields and straddles a gentle topographic high between Wollombi Brook and Loders Creek. This feature strikes roughly south-east to north-west, coincident with the Jerrys Plain Subgroup outcrop (Figure 3-1). Underground mine development is to the west and south of the open cut mine.

A north-west south-east trending ridge between the open cut mine and Wollombi Brook is the geomorphological expression of a Jurassic Basalt outcrop, and remnants of Narabeen Group sandstone. Topography increases significantly west of Wollombi Brook.

The site is bounded by Monkey Place Creek to the south-south west and Wollombi Brook to the west (David 2017). Drainage toward the east and away from the mining area flows into the Hunter River via Loders Creek (Figure 3-2). Characteristics of these three drainage systems are:

- **Wollombi Brook:** This is the most dominant drainage feature, and is largely perennial, located to the west and south-west of the mine. It flows to the north turning eastward, before merging with the Hunter River. This system receives inflows from the Monkey Place Creek and Loders Creek.
- **Monkey Place Creek:** This is a relatively small yet important tributary of the Wollombi Brook. Monkey Place Creek flows westerly into Wollombi Brook to the south of the BCC. The drainage is ephemeral in nature.
- **Loders Creek:** Is an ephemeral system which flows south-east to north-west along the eastern perimeter of the BCC tenement, flowing northward before merging with the Hunter River. The headwaters for this drainage commence within the BCC tenement.

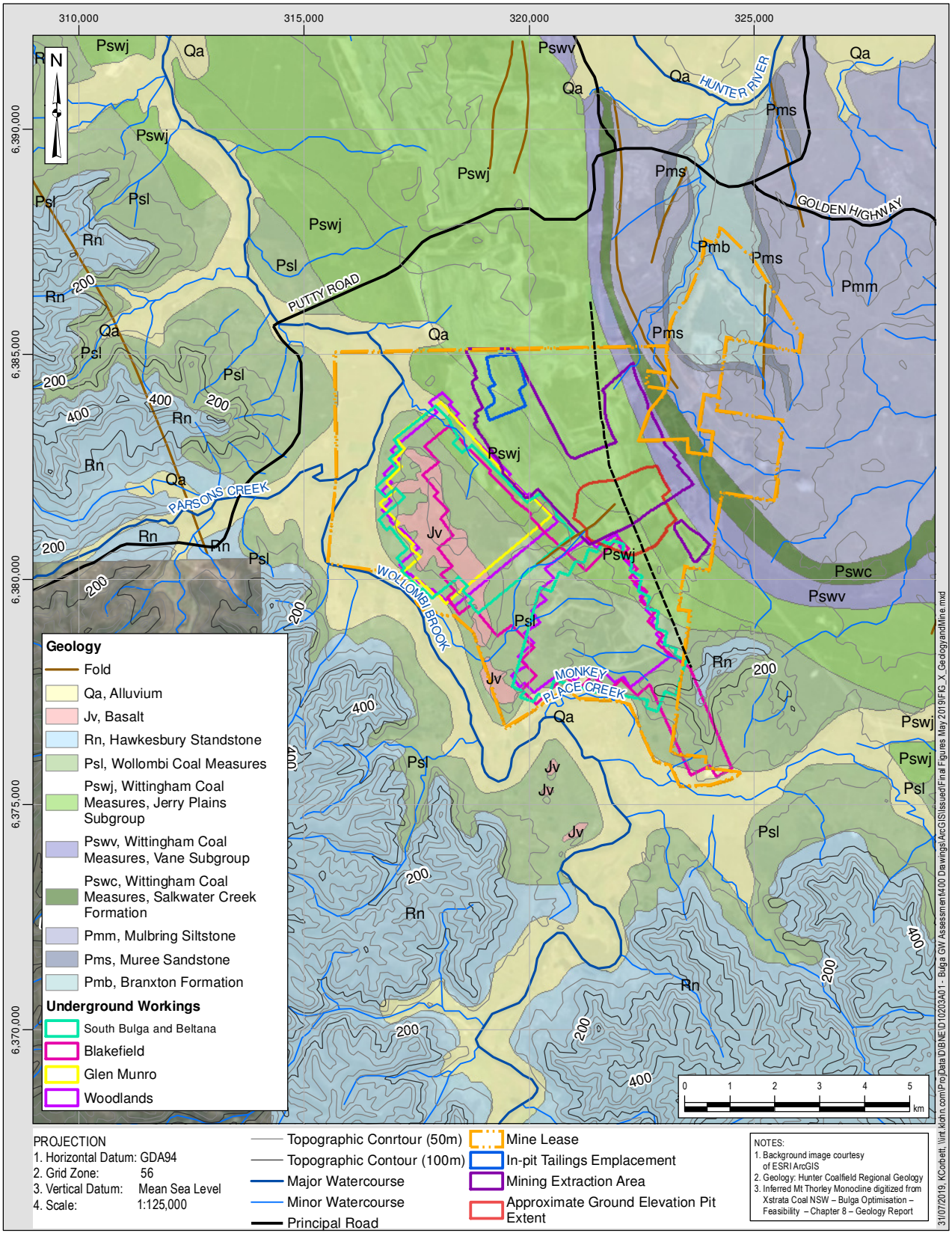


Figure 3-1: Local Mine Topography, Surficial Geology and Approved and Proposed Elements of the Bulga Coal Complex

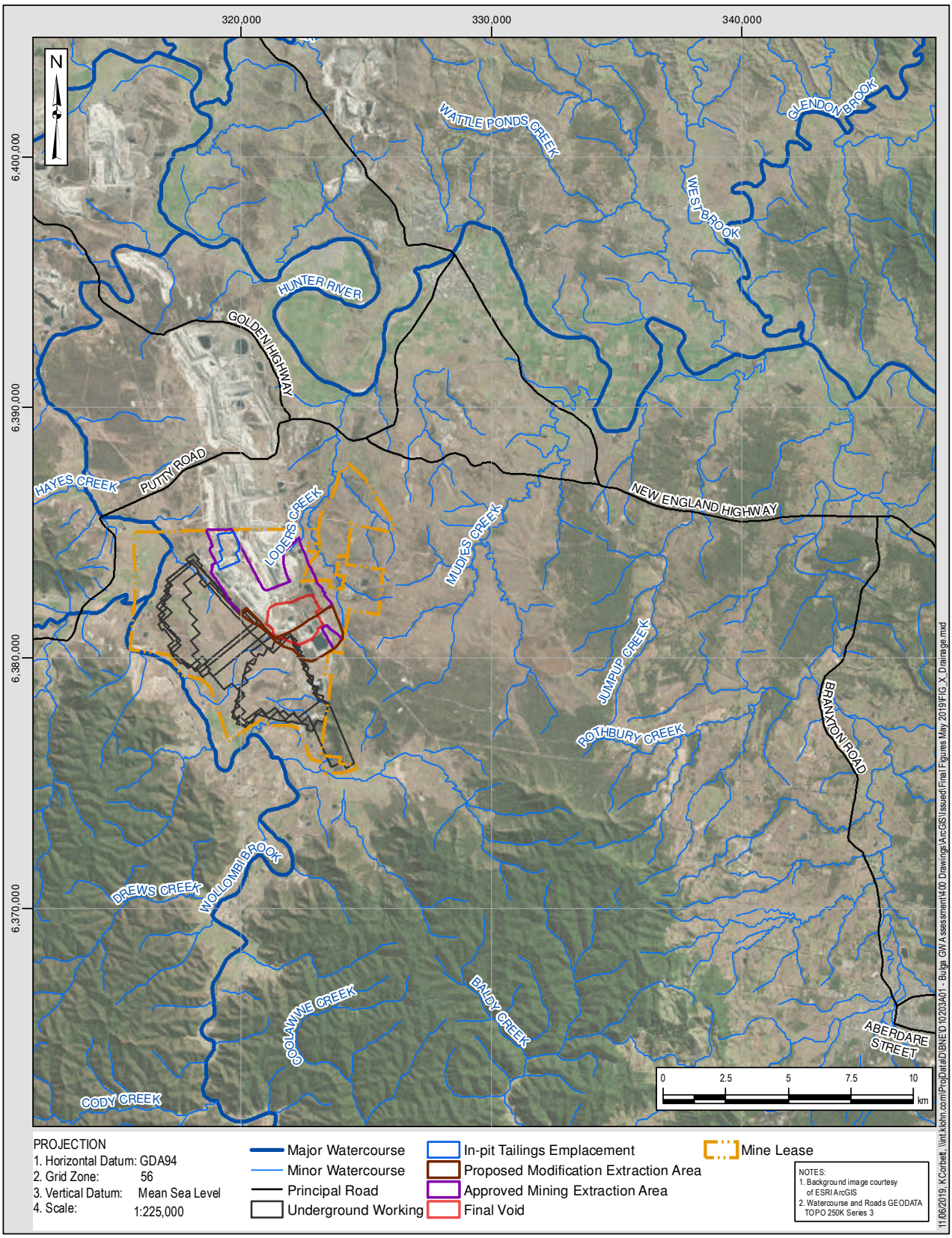


Figure 3-2: Mine Area and Major Regional Drainage

Creek flow (gauge height and flow rate) is provided in Figure 3-3 for the Wollombi Brook station #210028 over the period 2000 to 2019. This station is located to the northwest downstream of the mine, with the following key statistics:

- The creek has a median daily flow of 0.124 m^3/sec (~10.7 ML/d);
- Average daily flow exceeding 10 m^3/sec has occurred on 199 days (~3% of the time);
- Average daily flow exceeding 100 m^3/sec has occurred on 18 days (~0.3% of the time);
- Gauge height indicates most flow occurs between 0.5 m and 1.5 m; and
- Reduction in flow following major events can take weeks to months to abate, with several periods of prolonged flow height above 1 m.

Creek flow and gauge height data is important in understanding alluvial hydrogeological processes, with gauge height data shown in the below figure applied where appropriate to do so to piezometer hydrographs presented later in this report.

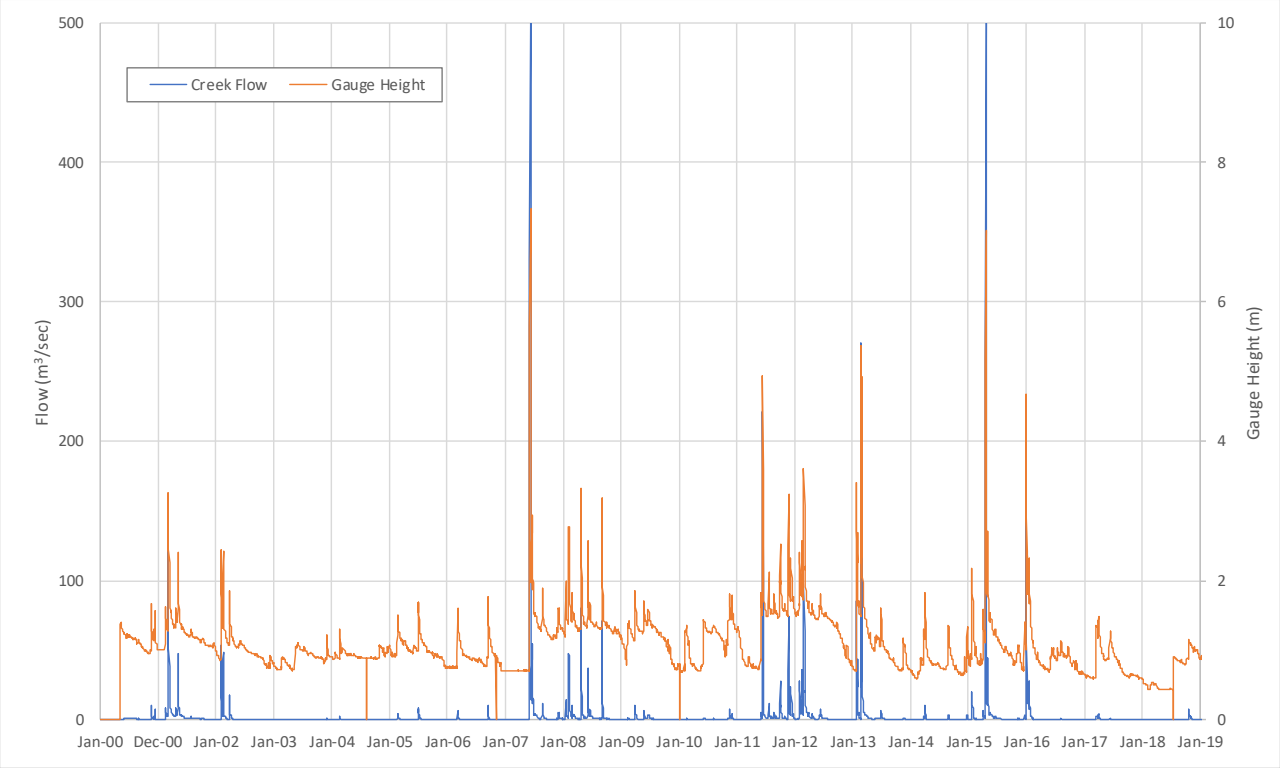


Figure 3-3: Wollombi Brook, Station 210028, Flow and Creek Height Records (2000-2019)

3.1.2 Climate

The project area experiences a climate of hot summers and cool winters, with rainfall distributed relatively evenly throughout the year and with highest falls generally in the summer months.

Climate statistics were sourced from the nearest Bureau of Meteorology (BoM) weather stations. The Jerrys Plains Post Office (Station 061086) collected a range of data for a significant period of time (1884-2014), although this station is now decommissioned. This station is located approximately 30 km north of the project area (Mackie Environmental Research 2013) and has been used as a guide for longer-term trends.

Local station(s) more proximal to the mine have been used (Bulga_South_W) to provide a rainfall record and cumulative rainfall departure (CRD) trend, up to the period of this current assessment.

A summary of average temperatures, rainfall and evaporation from Jerrys Plains weather station is presented in Table 3-1. Daily evaporation exceeds mean daily rainfall for all months of the year.

Table 3-1: Climate Averages from Jerrys Plains - Station 061086 (Australian Government Bureau of Meteorology 2018)

Site	Jerrys Plains Post Office			
Statistic Element	Mean Monthly Maximum Temperature (°C)	Mean Monthly Minimum Temperature (°C)	Mean Daily Pan Evaporation (mm)	Mean Monthly Rainfall (mm)
Period of Record	1907 to 2014	1907 to 2014	1957 to 1972	1884 to 2014
January	31.8	17.2	7.1	77.1
February	30.9	17.1	6.0	73.1
March	28.9	15.0	5.0	59.7
April	25.3	11.0	4.0	44.0
May	21.3	7.4	2.9	40.7
June	18.0	5.3	2.0	48.1
July	17.4	3.8	2.3	43.4
August	19.4	4.4	2.6	36.1
September	22.9	7.0	3.7	41.7
October	26.3	10.3	5.3	51.9
November	29.1	13.2	6.5	61.9
December	31.2	15.7	6.6	67.5
Annual	**25.2**	**10.6**	**4.5**	**53.8**

The CRD trend for Bulga_South_W is provided in Figure 3-4. This shows data from the 1960's; and shows approximately 2 years of below average rainfall most recent in the record, with around 10 years of above average rainfall resulting in an annual gain of about 120 mm/year preceding this period.

Modelled data was based on actual evapotranspiration (450 mm/a), adopted from BOM 2008.

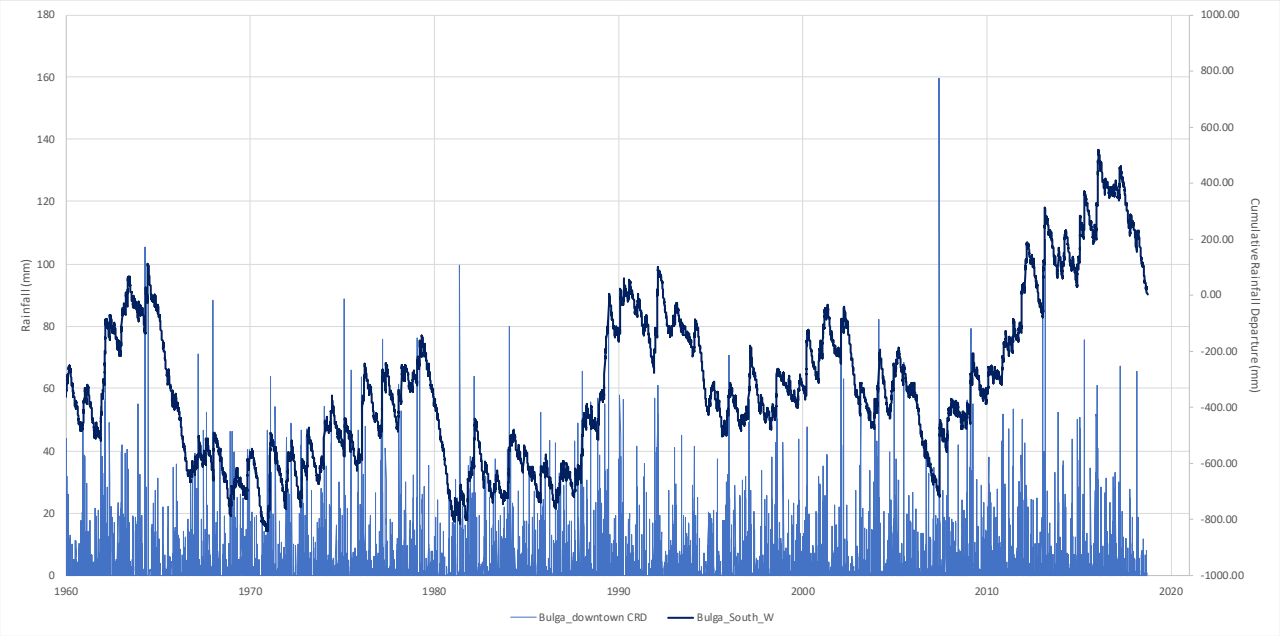


Figure 3-4: Daily Rainfall and Cumulative Rainfall Departure Trend (mm), Bulga_South_W

3.2 Regional Geology

A summary of the regional and local geology has been compiled from previous reports on the area by Mackie (2013) and AGE (2016), with earlier geological information from Glenn and Becket (1993), Jones and Rust (1983) and Moloney (1990) used to contextualise the information.

The BCC is located within the Hunter Coalfield, in the northern part of the Sydney Basin, approximately 70 km north-west of Newcastle. The mine accesses coal from Permian strata from surface. These coal measures are of Permian age (290 – 240 million years) and are similar to the coal measures extracted in the Newcastle and Hunter Valley area (Xstata Coal). Locally these seams dip to the south-west beneath the alluvium of the Wollombi Brook and outcropping Triassic sandstone of the Narrabeen Group and the Hawkesbury Sandstone (Figure 3-5). Local remnants of Jurassic basalt flank the eastern side of the Wollombi Brook.

Local geological outcrop on BCC (after the Hunter Coalfield Regional 1:100 000 Geology map ref.9033) is provided in Figure 3-6, with an accompanying modified stratigraphic summary provided in Table 3-2.

A noted structural feature is the Mount Thorley monocline, which lies to the east of BCC and is represented by north-westerly trending strata (Mackie Environmental Research 2013). The effect of this monocline is accounted for in the local to regional distribution of the respective units in modelling (Section 4). No significant faulting is noted to occur local to the mine area.

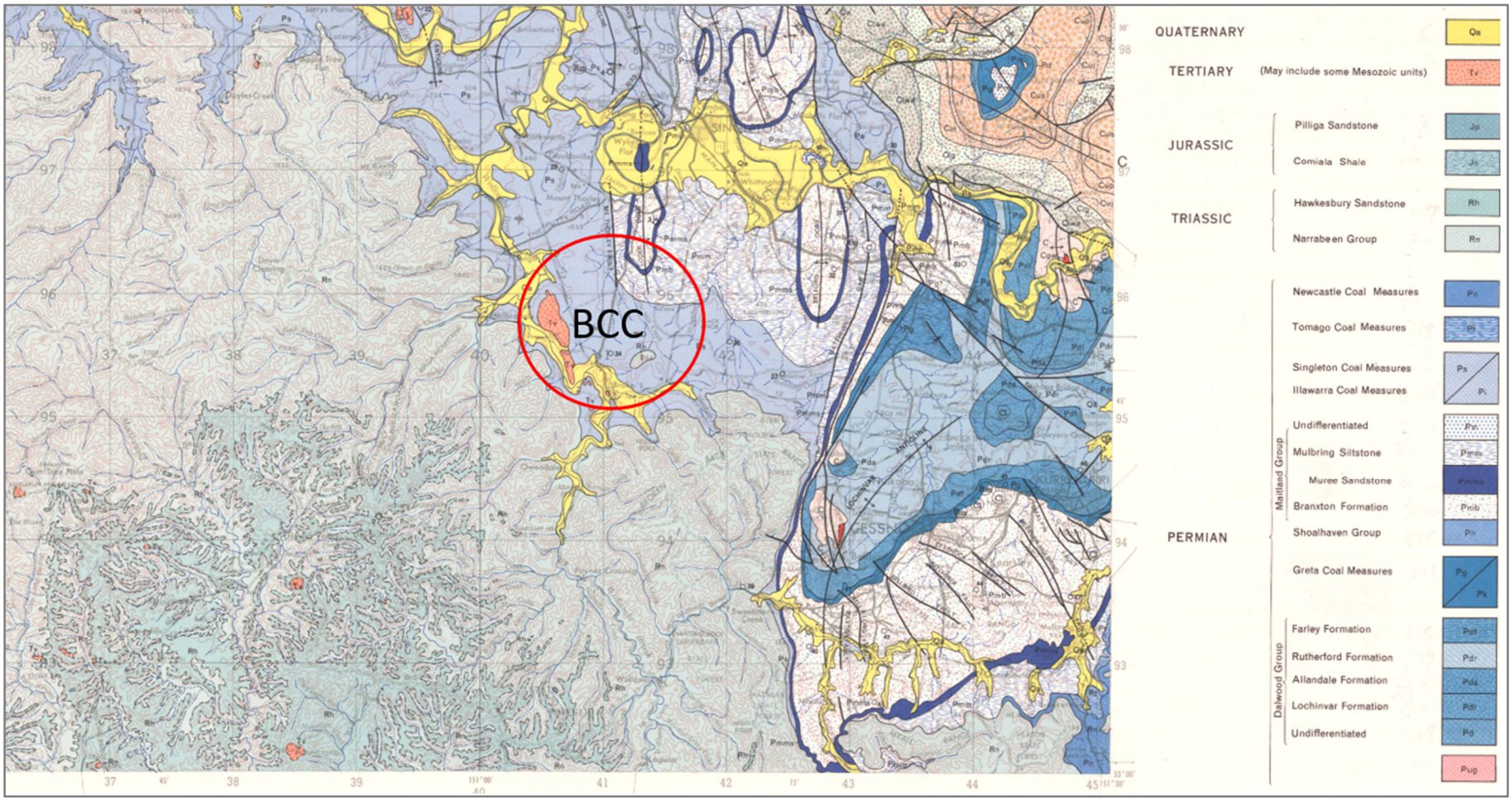


Figure 3-5: Regional Geology, Singleton 1:250,000 Geology Sheet

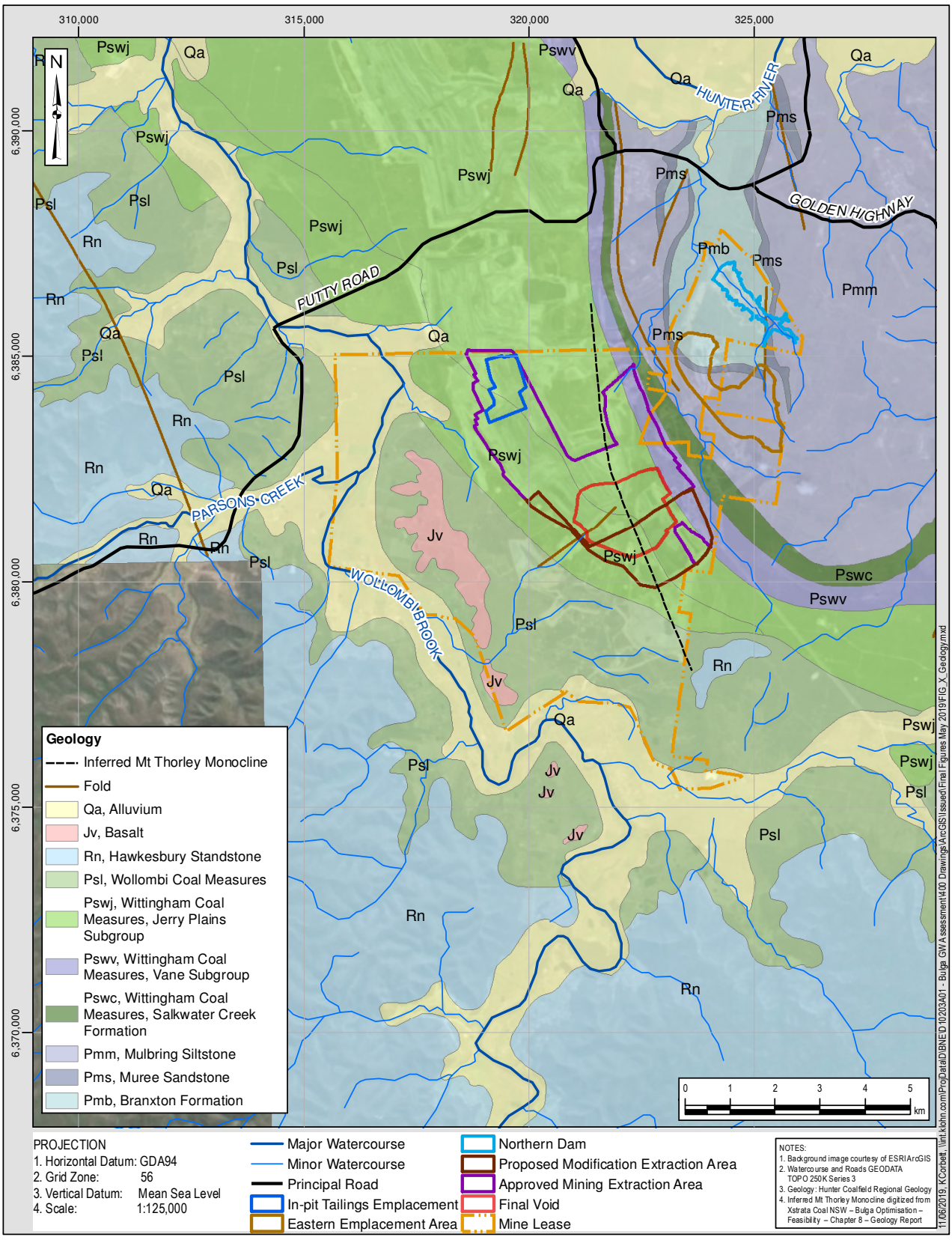


Figure 3-6: Local Geology (after Glen and Beckett 1993)

Table 3-2: Modified Stratigraphy of the BCC area (after Glenn & Beckett, 1993)

Period	Unit		Stratigraphy		Lithology
Quaternary		Qa	undifferentiated alluvium		Alluvial terrace deposits, lay, silt, sand and gravel -
Jurassic		Jv	unnamed Basalt		Basalt, flows, sills and dykes
Triassic		Rn	Hawkesbury Sandstone		Massive bedded, cross-bedded and horizontally bedded quartz sandstone and minor siltstone
	Narrabeen Group		Terrigal Formation		Sandstone, interbedded sandstone, siltstone and claystone
			Clifton Subgroup	Patonga Sandstone	
				Tuggerah Formation	
				Widden Brook Conglomerate	Sandstone and conglomerate
Upper Permian	Singleton Super Group	Psl	Wollombi Coal Measures	Glenn Gallic Subgroup	Conglomerate, sandstone, siltstone, claystone, tuff and coal
				Doyles Creek Subgroup	
				Horseshow Creek Subgroup	
				Apple Tree Flat Subgroup	
				Watts Sandstone	Sandstone & minor conglomerate
		Pswj	Wittingham Coal Measures	Denman Formation	Sandstone-siltstone laminite and siltstone
				Jerrys Plains Subgroup [1]	Conglomerate, lithic sandstone, siltstone, coal and minor claystone
		Pswv		Archerfield Sandstone	Quartz-lithic sandstone
				Vane Subgroup	Conglomerate, lithic sandstone, siltstone, coal and conglomerate
		Pswc		Saltwater Creek Formation	Sandstone-siltstone laminite and minor coal bands

Note: [1] includes Whybrow, Wambo, Blakefield, Warkworth and Piercefield coal seams.

3.3 BCC Local Geology & Hydrogeology

The local geology in the vicinity of the project area includes (from youngest to oldest):

- Quaternary alluvium;
- Tertiary/Jurassic basalt;
- Triassic sandstone
- Permian Coal Measures

3.3.1 Quaternary Alluvium

Figure 3-6 shows the spatial distribution of regionally mapped Quaternary alluvium, which is limited to the channels and floodplains of the Hunter River and Wollombi Brook. These deposits can reach thicknesses of ~20 m in some areas (such as flood plains) but are highly variable, averaging ~5 m.

Monkey Place Creek and Wollombi Brook, that host these deposits, flow along the southern and western limits of the project area. The alluvium associated with Monkey Place Creek and Wollombi Brook is characterised as intercalated packages of undifferentiated silt, sand and gravel; typical of mixed load meandering fluvial systems. Alluvial sands and gravels will typically settle

from the water column over short-distances and will be redeposited on the creek bed, while alluvial silts and clays are typically transported significant distances in the water column.

An alluvium study was conducted (Katarina David 2014) to assess the properties of the materials along the Beltana Reach. This work indicates that the extent and distribution of alluvium at the Beltana Reach should be truncated compared to the regionally-mapped extent. This truncation is illustrated in Figure 3-7. Based on the geological logs and supported by the water quality data from piezometers installed in this area, David (2014) concluded that the Northern Drainage Line (NDL) alluvium is a localised groundwater system, recharged by rainfall, with discharge to the Wollombi alluvium (Katarina David 2014). The extent of the NDL alluvial is limited, and generally comprises clay and silty clay about 4-5 m in thickness, with a low hydraulic conductivity (0.02 to 0.01 m/d). This classifies the NDL alluvium as a poor aquifer to aquitard, which supports the truncation of the Wollombi alluvial at the junction with the NDL.

3.3.2 Tertiary / Jurassic Volcanics

Figure 3-5 and Figure 3-6 shows the location of Tertiary to Jurassic-aged volcanics, occurring as elongated and irregularly shaped discrete packages. Sub-regionally, these deposits are located to the south-west and north-west of the project area. A north-west to south-east long-axis orientation of the volcanic packages parallels the eastern side of the Wollombi Brook, with the volcanics overlying the Wollombi Coal Measures at El.100m+.

The Tertiary / Jurassic Volcanics within the project area measure no greater than 200 m in thickness, though regionally they may reach up to 500 m thickness. Lithological data shows that these volcanic deposits present as a combination of flows, sills and dykes, and are dominantly comprised of olivine basalts, with lesser instances of dolerite, trachyte and microsyenite.

Occasional interbedded sedimentary units are noted within these packages; these represent periods in volcanic quiescence.

3.3.3 Triassic Sandstone

Figure 3-6 shows the presence of several Triassic sedimentary units (Rn) within the project site and its surrounds, including the Hawkesbury Sandstone and the Narrabeen Group. These units lie west of Wollombi Brook and south of Monkey Place Creek; and are prominent features of the landscape due to their steep terrain and high elevation (El.200m+).

Published geological mapping indicates that the Triassic sandstones represent a transition from a regional scale large braided river system (the Hawkesbury Sandstone), to a mixed load meandering fluvial system (the Terrigal Formation and Clifton Subgroup) to, finally, an alluvial fan (primarily the Clifton Subgroup).

Hawkesbury Sandstone

The Hawkesbury Sandstone comprises medium to coarse-grained cross-, planar-and massive-bedded quartzose sandstone, intercalated with finer-grained sandstone, siltstone and rare clast-supported conglomerate. The unit is regionally extensive and of variable thickness ranging between 40 m to 100 m locally, although can extend to >500 m regionally. This unit does not outcrop inside the area of the project, but is a significant stratigraphic unit forming the surrounding foothills to the west and southwest.

Narrabeen Group

The Narrabeen Group (further subdivided into the Terrigal Formation and Clifton Subgroup) comprises interbedded units of sandstone, siltstone and claystone with a significant portion of pebble sized polymict clast-supported conglomerate with a coarse to granule-sized sandstone matrix. The Narrabeen Group has been eroded from the majority of the project area, except for a small outcropping ~1 km east of the Tertiary/Jurassic Volcanics adjacent to Wollombi Brook. Regionally, this stratigraphic unit reaches ~40 m in thickness.

3.3.4 Permian Coal Measures

Two stratigraphically significant geological groups comprise the Permian Coal Measures:

- The Wollombi Coal Measures (Psl), which can be subdivided into:
  - *the Glen Gallic Subgroup* *(~50 m thickness);*
  - *Doyles Creek Subgroup* *(~17 m thickness);*
  - *Horseshow Creek Subgroup* *(~136 m thickness);*
  - *Apple Tree Flat Subgroup* *(~12 m thickness); and,*
  - *Watts Sandstone* *(~20 m thickness).*

- The Wittingham Coal Measures (Pswj, Pswv and Pswc), subdivided into:
  - *the Denman Formation (Pswj)* *(~20 m thickness);*
  - *Jerry's Plains Subgroup (Pswj) inclusive of the Whybrow, Wambo, Blakefield, Warkworth, Piercefield, Woodland Hills, Vaux and Bayswater coal seams; (combined, ~435 m thickness);*
  - *Archerfield Sandstone (Pswv)* *(~2 m thickness);*
  - *Vane Subgroup (Pswv)* *(~266 m thickness); and*
  - *the Saltwater Creek Formation (Pswc)* *(lowest formation in this project site).*

A general description of each of these coal measures is provided in the following.

Wollombi Coal Measures

The Wollombi Coal Measures generally strike north-northwest to south-southeast with a 2-5° dip toward the west, and measure a combined thickness of about 230 m. They were deposited in a range of environments including alluvial plain, upper and lower delta plain to delta front, and operated as a volcanic ash catchment for locally erupting volcanic centres.

The Wollombi Coal Measures comprise:

i. pebble to cobble-sized, clast-supported conglomerate that fine upward into pebble-sized, matrix-supported conglomerate;

ii. Coarse to medium grained, planar- and ripple-cross bedded sandstone with carbonate fragments;

iii. Grey laminated siltstone with interstitial laminations of coal and disseminated siderite;

iv. Coal of variable grade, including some fracturing; and

v. Lenticular to massive, non- to moderately-welded tuff.

Wittingham Coal Measures

The Wittingham Coal Measures, similar to the Wollombi Coal Measures, generally strike north-northwest to south-southeast with a 2-5° dip, and measure over 700 m in overall thickness. They were deposited in various environments ranging from upper and lower delta plains, marine shelf to delta front and operated as a volcanic ash catchment for locally erupting volcanic centres, though to a lesser degree than the Wollombi Coal Measures.

The Wittingham Coal Measures comprise:

i. Quartz-rich to lithic-rich, fine to medium grained (with occasional coarse-grained lenses) sandstones with weak bioturbation;

ii. Dark grey, laminated siltstone with bands of siderite and tuff, increasing in bioturbation with depth;

iii. Pebble to cobble-sized polymict matrix-supported conglomerate, predominantly associated with sandstone units; and,

iv. Coal of variable grade; occasionally fractured.

Warkworth Sands

There are four known main occurrences of Warkworth Sands Woodlands (WSW): Wallaby Scrub Road, Warkworth village, Archerfield and Bulga. The ecological community is only known to occur on aeolian sands (sand transported by wind) – on old dune formations and swales between the dunes and on sand sheets. WSW mostly occupies linear sand dunes, which are between one and six metres high, typically resting on a river terrace, on the undulating valley floor (EPBC_s266B, 2016).

Figure 3-7 shows the WSW to lie entirely over weathered Permian, straddled between two westerly flowing tributaries. These aeolian sands are assumed to locally hold moisture and may present as locally perched groundwater systems. They lie on lower permeability Permian material (weathered or fresh material), and are of local extent with likely discontinuous distribution due to their very thin nature. They are probably recharged only by rainfall and have negligible to no hydraulic connection with the deeper saturated Permian system.

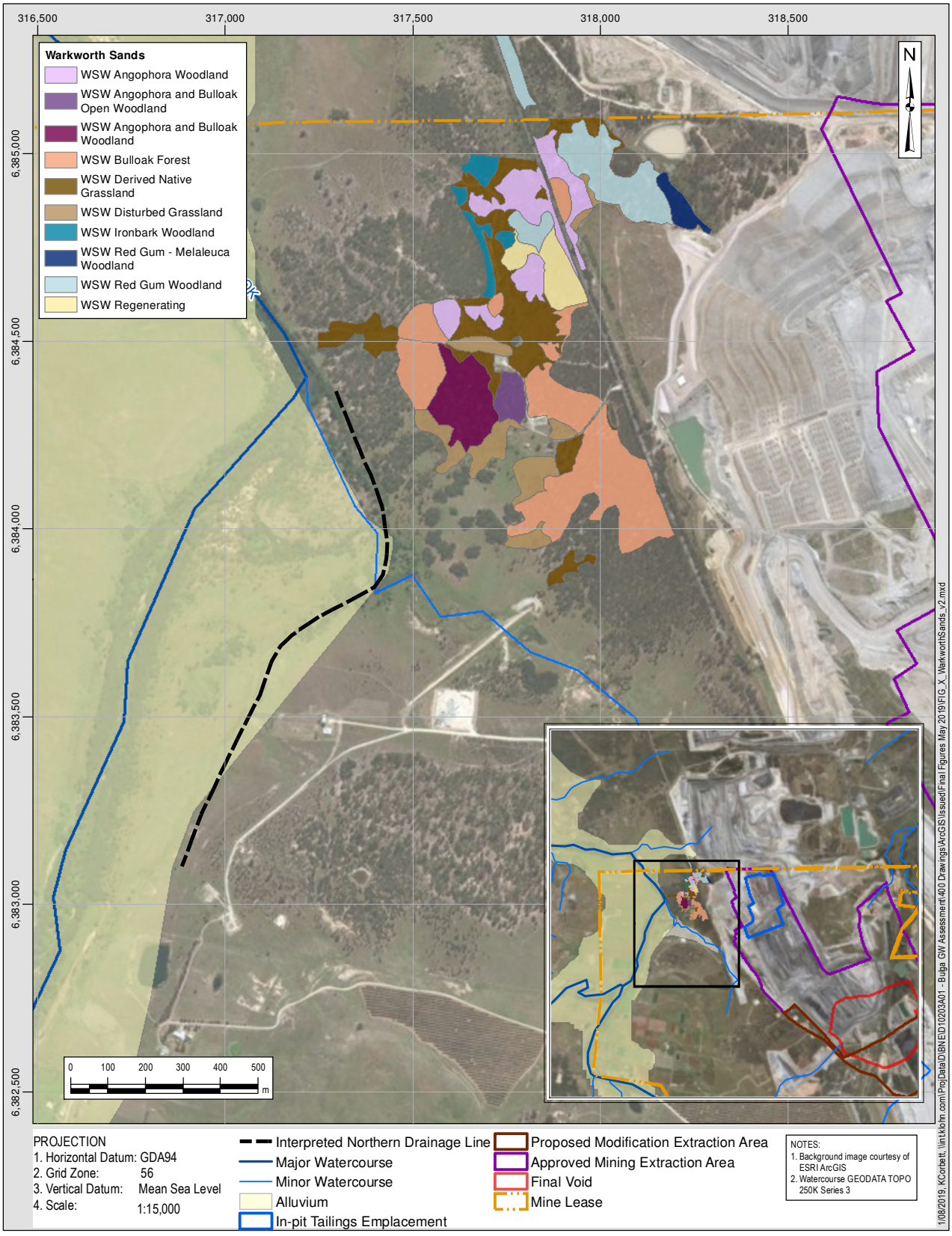


Figure 3-7: Location of the Warkworth Sands Woodland of the Hunter Valley Ecological Community

3.3.5 Structural Features

The project site is located within the Hunter Thrust System, which formed in response to east-west compression; the same force responsible for deforming the New England Orogen to the east.

A major structural feature within the Hunter Thrust System is the Redmanvale Fault Zone; a northwest-trending fault zone that controlled the local fault scarp development exposing the sediments of the Narrabeen Group.

The Project area is located to the east of the Redmanvale Fault Zone, within a region of north-west-trending, north-east-dipping thrust faults with a cumulative throw of ~120 m (identified from seismic reflection data by Moloney (1990). Faults in this area tend not to be transmissive and may compartmentalise the groundwater flow system.

The Mt Thorley Monocline is located to the north-east of the project site and forms the western limb of the Loder Anticline (within the Wittingham Anticlinorium). The western shallowing of the Mt Thorley Monocline is attributed to the west-south-west thickening of the Jerrys Plains Subgroup and the Wollombi Coal Measures fluvial package.

The degree of faulting over the BCC area is not considered to be a significant feature of the deposit. Most faults have displacements of less than 1 m with some showing displacements of up to 10 m. Jointing is found throughout the project area, with a dominant north-east and north-west orientation which is common throughout the Upper Hunter region. Joint formation lessens with depth; and are observed to occur sparsely in underground operations. As such, their influence on deeper groundwater flows is assumed to be minimal and deeper groundwater flow is consistent with matrix-dominated permeability, and the most significant influence on deeper groundwater flows is mining-associated processes.

3.4 Hydrogeological Setting

A summary of the hydrogeological conceptualisation is provided and schematically represented for the end of mine life (maximum drawdown) and post-closure recovered case in Figure 3-12:

- There are three general hydrogeological systems across the BCC area:
    - Alluvial aquifers associated with the Monkey Place Creek and Wollombi Brook which overlie Permian strata and wrap around the south and west of the main mining area.;
    - Warkworth Sands Woodlands (WSW), adjacent to the west of the existing operations and the Mount Thorley open cut mines. This system is interpreted as perched, positioned over lower permeable Permian and not in hydraulic connectivity with the underlying groundwater system; and
    - the Permian coal measures of the Singleton Super Group which host the mined resource and represent outcrop in all areas where regionally mapped alluvium is absent (low yielding, confined aquifers).
- Loders Creek and its tributary (Nine Mile Creek), northeast and north of the open cut operations drain to the Hunter River approximately 5.5 km north of the BCM operations.

The system is ephemeral and known for increased salinity as flow recedes (Mackie, 2013), and does not include regionally mapped alluvium.

- The Jurassic basalt has in some instance provided localised low yielding good quality water supplies but like the Triassic sandstones of the Narrabeen Group and the Hawkesbury Sandstone are not aquifers of relevance to local mining conditions.
- Although the mining area straddles a local topographic high, all perimeter drainage ultimately reports to the Hunter River.
- Longwall mining operations are mature and approved, and lie west of the central topographic high, while open cut mining, spoil placement / management and tailings storage straddles and lies to the east of the high.

3.4.1 Groundwater Levels and Flow Directions

The mine has a substantial monitoring network which has developed and evolved throughout the operations' life. Observations from this monitoring network are briefly described in the following sections, and a more detailed analysis completed and reported separately is reproduced in Appendix I. The groundwater monitoring system has evolved with the mining, with focus on the historical underground workings and the potential for impact on the alluvial aquifers.

Groundwater monitoring data is consistent with the composite hydrographs of Mackie (2013). Sites which have been destroyed or decommissioned have been included although their records are not current, while new sites more recently added to the program are also provided. The location of monitoring sites is shown in Figure 3-8.

Further monitoring is undertaken by the DPI at Bulga, Fordwich and Monkey Place Creek. These data are not included below but can be accessed via the NSW government website. In summary ten (10) bores are located within the alluvium of the study area, five (5) of which have a recorded water level measured during May or August 2018.

Hydrograph Records

Piezometer hydrographs[5] are presented with the Wollombi Brook creek level and a corresponding EC[6] record from the piezometer where available. VWP sites are shown with vertical reference to the respective tip location and aligned with groundwater model layers as they currently exist, and as reported in Mackie (2013).

The data are appended, in the following order, with each bullet point representing a composite hydrograph. Sites which have recent (2018) records are bolded in the below lists.

Piezometer Plots - 10 Hydrograph sets, 52 sites, 33 with 2018 data

- **Dwyers, Fernance, F1, F2, V1, V2**
- **WBR15,** HofH**, McG1, White1,** P9

[5] Note that data have been reduced to a 'monthly average record' for each site. This is to overcome practicality issues associated with the huge volume of information these sites have compiled. This also permits more meaningful vertical comparison of data between sites and instrumentation types.

[6] EC – Electrical Conductivity, uS/cm.

- **WBR50A, WBR50**, WBD55A, WBD55, WBD65
- **WBD62A**, WBD62, WBD57A, WBD57
- NPZ3-A, **NPZ3-B, NPZ4-A, NPZ4-B, NPZ5-A, NPZ5-B**
- **NPZ7-1, NPZ7-2A, NPZ7-2B, NPZ7-3A, NPZ7-3B**
- **WBD160, WBR180, WBR181, WBR182, WBR183**
- **V3, GW7, GW8**, GW9, **GW10**
- P1, **P2**, P3, P4A, P4B
- **P5A,** P5B**, P6A, P6B**, P7A, P7B

VWP Plots - 17 Hydrographs, 18 sites, 108 sensors, 54 with 2018[7] data

WBD210	1, 2, 3, 4, 5, 6, 7, 8
WBD207	1, 2, 3, 4, 5, 6, 7, 8
WBD170	**1, 2, 3, 4**
WBD171	**1, 2, 3, 4**
EBD004	1, 2, 3, 4, 5
EBD008	**1, 2, 3, 4, 5, 6, 7, 8**
EBD009	**1, 2, 3, 4, 5, 6, 7**
SBD194	**1, 2, 3, 4, 5, 6, 7, 8, 9**
EBR18 and **19**	1, 2 and **1, 2**
SBFOW…	01, 03, 05A, 07
SBF0W04A	1, 2, 3, 4, 5, 6, 7
SBFOW06	1, 2
SBFOW09	**1, 2, 3, 4, 5, 6**
SBF0W…	10, 11, 13, 16, 17, 18, 19
SBF0W15	**1, 2, 3, 4, 5, 6**
WBR177	2, 3, 4, 5, 6, 7, 8
WBR206	**1, 2, 3, 4, 5, 6, 7, 8**

[7] SBFOW09 includes data to late 2017, and has been included in the list of sites with recent / current data

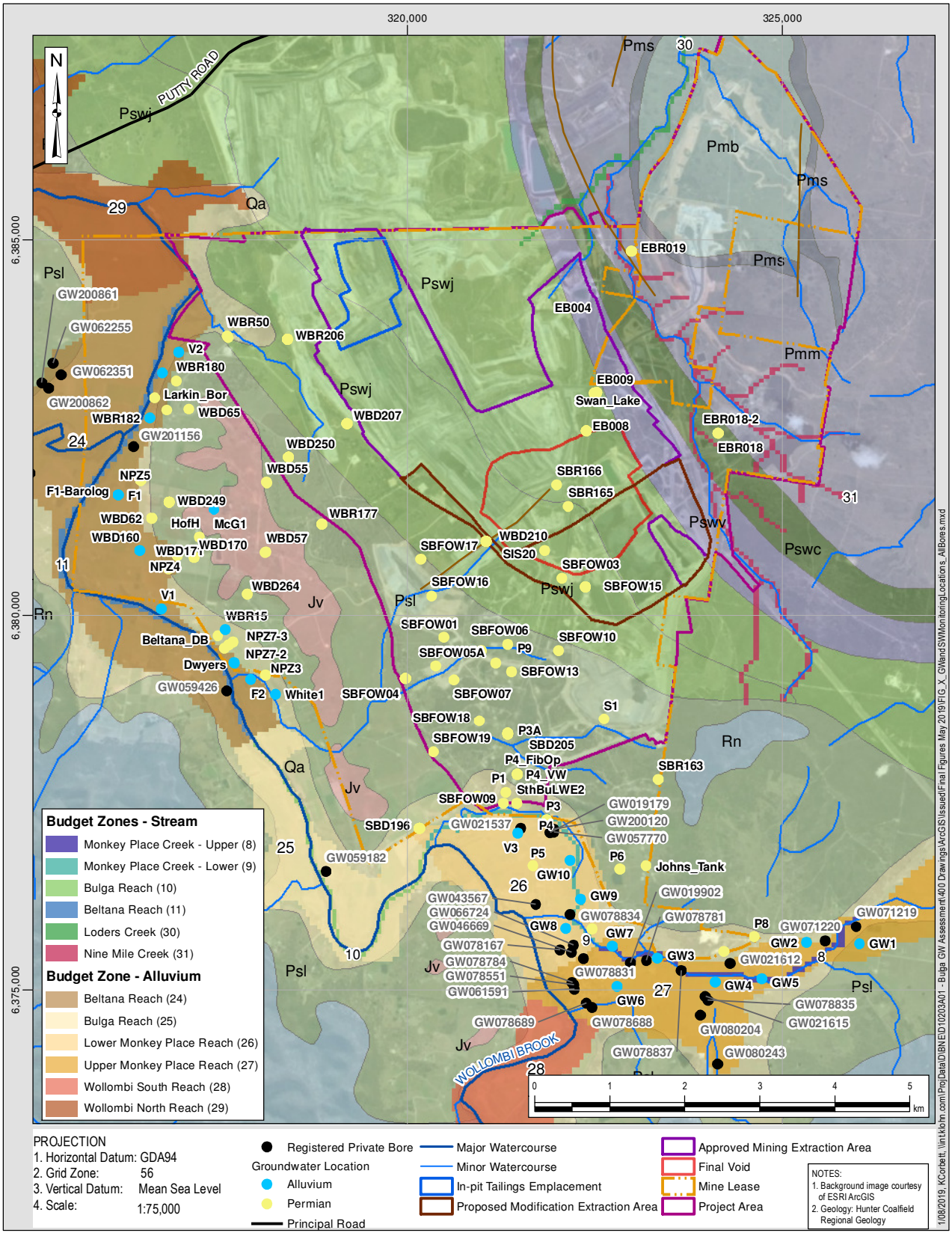


Figure 3-8: Bulga Mine Piezometer, VWP Monitoring and Private Bore Locations (Regional Geology shown)

Quaternary Alluvium

The alluvium of the Wollombi Brook and Monkey Place Creek are well instrumented, with 11 and 5 piezometers in each aquifer respectively, all with relatively intact records which show good correlation to Wollombi Brook flow elevation. In the Beltana mining area, coverage is relatively dense along the western margin of the mine footprint where it spatially approaches the edge of the alluvium. Distribution in the area of drainage mergence from Monkey Place Creek to Wollombi Brook is also well instrumented.

Alluvium response shows metre to sub metre scale vertical change to significant creek flow events. Hydrographs of sites Dwyers, Fernance, F1, F2, V1 and V2 are good examples of this, showing a moderate to strong response to creek flow particularly for events in 2007, 2011 and 2015. Regression of increased levels typically takes months to occur. Periods of increased creek flow appear to be the main driver of longer-term response in the system. Groundwater levels across these sites generally lie within a 5 m elevation band of ~60 m to 65 m.

Permian Coal Measures

Monitoring of Permian coal measures is extensive, particularly across the underground operations. Instrumentation is established along the longwall panels and at their extents, permitting data review within the seams being mined and above / below. This monitoring is established for mining purposes, however, the data (and in particular the long term and mining-induced trends) are important in characterising the Permian hydrogeology.

A map of the distribution of Wittingham Coal Measure monitoring locations (which includes the Jerrys Plains Group) is provided in Appendix I.

There are a number of Permian locations in the east and south that can be approximately ‘paired’ with alluvium monitoring sites to assess the strength and consistency of hydraulic gradients between the two systems. As an example, sites V2 and WBR180 in the northern area of the Beltana area are about 400 m apart. Site V2 is screened in Wollombi Brook alluvium to ~70 m depth, site WBR180 is screened to a similar depth in shallow coal seams, however, the latter has shown a moderately strong response to mining with about 18 m of drawdown occurring in 2009 to 2011. Hydraulic (vertical) gradients between these systems indicate a 25 m head differential. This gradient can consequently be used to assess potential vertical leakage or to assess for hydraulic disconnection between the systems. The response in WBR180 is not reflected in the alluvium hydrograph of V2, which over the same approximate period of mining stress observed approximately 1 m of variation, with levels at the start and end of the period roughly the same.

The VWP records in Appendix I show the nature of multiple level monitoring available for the site[8]. A good example of this is SBF09, reproduced below, which monitors confined strata between the Lower Whybrow Seam and the Vaux Seam (Figure 3-9). This shows two periods of mining impact: the first is from about 2010 to 2013 and has a similar effect on the four shallower seams. The second period is from 2014 to 2018; and shows a variable impact to each of these layers, although all respond to the mining activity. Data from V3, located in alluvium in close proximity, was included to demonstrate that the two systems (alluvium and Permian) behave independently.

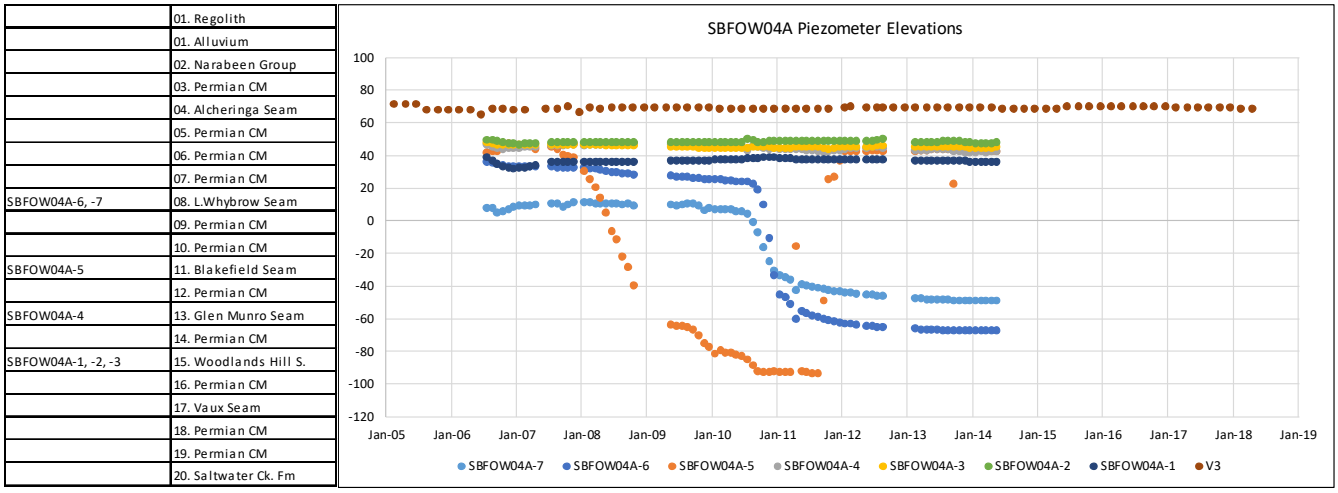


Figure 3-9: Example Vertical VWP Data, SBFOW09 1-6

A map showing the spatial distribution of these vertical arrays is provided in Figure 3-10. This network is extensive and is considered adequate for verification of hydrogeological concepts and model calibration purposes.

Depending on the location and depth of monitoring, and the timing of data collection, Permian strata have observed significant response to mining development, of the scale of 10's to 100's of metres. This is in contrast to the response of the alluvium which is more strongly aligned with creek flow (and possibly local alluvial abstraction), which only observe metre to sub-metre scale vertical variations of groundwater level.

Data from the monitoring records suggest that regionally there are strong drawdown responses associated with mining activities noted in the many Permian holes. In contrast, the alluvial systems more closely follow the stream flow data, and where decreases in alluvial water levels are noted, these water level changes are limited to generally less than 1 m. The two systems are therefore assessed as having limited connectivity.

[8] These data help to establish vertical mining impact progression and are a surrogate to assess vertical translation of fracture development. They are not however directly translatable into the numerical modelling environment because the cell sizing and time discretisation in the model is not able to represent all of the finite changes to the system that mining presents, and which generate the detail in the VWP records. Bulk mining changes only, eg longwall operation, are therefore modelled and hence, longer scale trends in the monitoring data are more relevant.

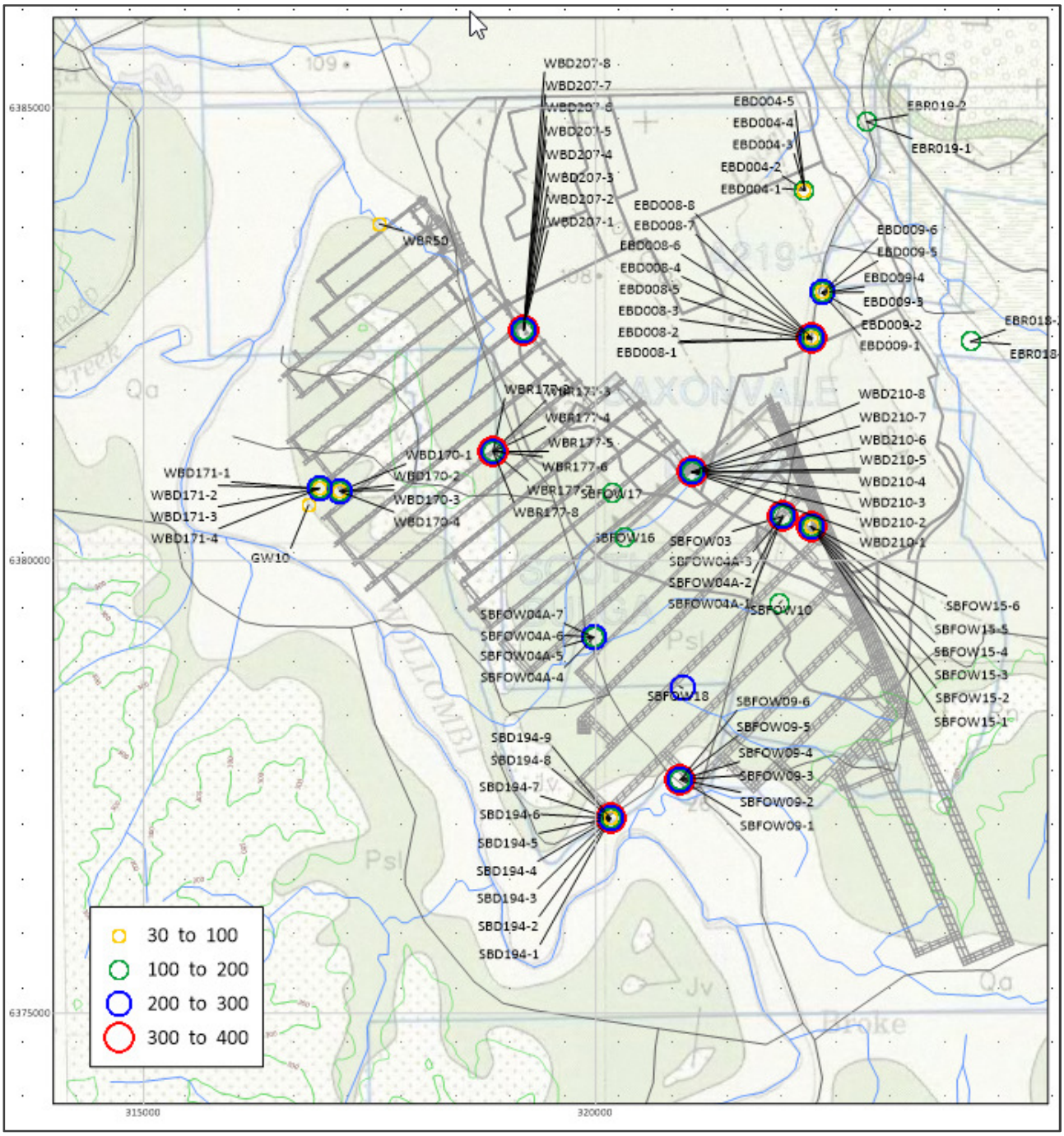


Figure 3-10: Spatial Distribution and General Depth Profile of VWP Arrays, all Data

3.4.2 Aquifer Interaction / Vertical Gradients

Groundwater level monitoring indicates a strong difference in long-term trends between alluvium and Permian sequences, suggesting that these systems are largely independent or only weakly-connected.

Alluvium exhibits a small seasonal vertical variability (generally sub-metre scale) and a strong relationship (recharge response) to large flow events in the main creek systems. The response of these flow events is observable in a number of hydrographs – both in terms of their physical head or pressure response and in several sites, a noted reduction post-flow in EC level (dilutional

effects). Any possible aquifer responses from mine depressurisation of the underlying Permian strata, are either too small to discern, or are masked by the stronger recharge events which drive the shallow alluvium water balance.

The confined Permian strata show strong response to coal seam depressurisation, consistent with similar mining operations in the area and coal mining elsewhere; and a very weak to absent (particularly for deeper conditions) response to surficial recharge processes. Depressurisation can occur very quickly – 10's to 100's of metres over months to quarters, and often shows a relatively fast re-equilibration to the mining stresses at or near the elevation of the mined seam. Propagation of vertical hydraulic stress across the direction of bedding appears to be limited, as is evident in nest SBFOW4A which shows mining drawdown in the Lower Whybrow Seam of the order of 100 m magnitude over a 1-2 year period, with no expression of this impact in deeper strata. Upward vertical leakage, in this case, is negligible and affirms the assumption of strong contrasts in horizontal to vertical permeability in the Permian units. This observation is also consistent with the interpretation that surficial recharge plays a minimal, if not negligible, role in deeper recharge, most likely due to the very low vertical permeability of these units

Interconnectivity between the Permian and the alluvium appears negligible. Transient head trends between the two systems are contrasting, and as long as a sustained depressurisation exists in the Permian, the direction of gradients across the two systems will be from the alluvium downward. Impacts of local abstraction for water supply or irrigation have not been included or considered.

3.4.3 Recharge and Discharge Mechanisms

Some general observations with respect to recharge and discharge mechanisms, is provided.

Alluvium:

- Creek flow (elevation) dominates recharge in periods of high flow. Recharge to the alluvium is likely dominated by losses from the creek during these high flow events, augmented with incident recharge where rain falls on exposed permeable alluvium;
- Flushing effects of large recharge events based on recorded EC levels appears strong;
- While a downward gradient to dewatered underground mining operations in underlying Permian strata is evident, this does not appear to be creating adverse effects in the alluvium, indicating that leakage to deeper strata is a minor to negligible process in the alluvium water balance
- Recharge from rainfall and creek flow occur seasonally and water levels correspond strongly to periods of higher surface water flow. Data records suggest that recharge is greater in magnitude and frequency than losses to Permian formations from the mining-induced coal seam depressurisation. This indicates a strong degree of disconnection between the alluvium and the Permian sequences;
- The main discharge component of the alluvium is expected to be pumping withdrawal during periods of higher groundwater demand (dry spells, irrigation periods, etc).

Permian:

- The contrast between horizontal (bedding direction) permeability and vertical (cross-bedding) permeability appears strong and is likely several orders of magnitude. Cross-

bedding recharge / discharge from model layer to model layer is likely negligible although will locally be enhanced as a result of mining modified permeability above longwall operations;

- Natural recharge is therefore likely to occur by recharge where units sub-crop and may have locally enhanced permeability due to weathering, alteration and surface reduction in litho-stratigraphic stress. Deeper sequences do not show evidence of such processes
- Recharge is therefore expected to be low to negligible, local higher recharge areas may exist where for example a creek and its alluvium lie over Permian aquifer sub-crop.
- Mining-induced discharge reports as mine water inflows to the operations, either underground or open cut.

3.5 Overview of Mining

A schematic description of the Proposed Modified landform is provided in Figure 3-11 for years 2022, 2026, 2031, 2035 and 2037 (to 2039). An estimate of the final mining plan is also provided for Mount Thorley to the north of Bulga, based on that mine's currently documented and publicly available EIS information with respect to final landform conditions in that area.

Key attributes to the Proposed Modified plan are:

- Progressive deepening of the final pit, most prominent in the 2037 image (representative of proposed conditions to 2039);
- Ongoing emplacement of spoil around and within the final pit;
- Relocation of the tailings to the north of the Bulga tenement near to the boundary with Mount Thorley;
- Continuation of underground mining operations in accord with previously-approved development; and
- Retention of a final in-pit void.

A simplified conceptual model indicating the expected hydrogeological aspects during mining and after closure is provided on Figure 3-12.

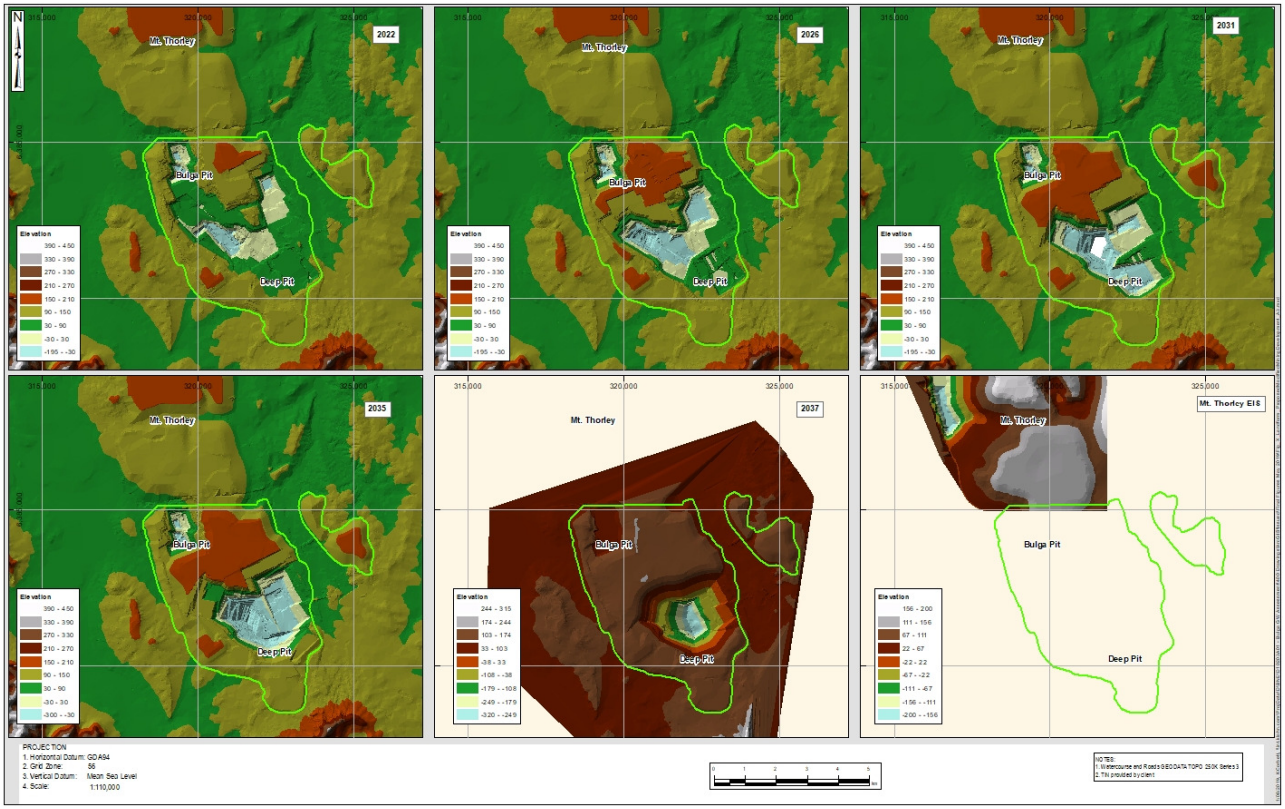


Figure 3-11: Landform Evolution of the Proposed Modified Mining Development

The tailings re-placement was included as part of the hydrogeology of the open pit and modelled using the following broad approach:

- The footprint and schedule were obtained from the data provided by Glencore and included in WSP's assessment of the tailings (WSP, 2018).
- Since the facility is dynamic, the schedule defined by WSP was used to alter the properties of the model to reflect the inclusion of tailings over the period of tailings deposition.
- Tailings are assumed to be spiggotted as a slurry with a change in footprint and an increase in elevation of the TSF over time. These changes have been based on the provided schedule.
- To account for the changing hydraulic properties of the tailings associated with ongoing settlement, parameters from the SRK tailings consolidation assessment (SRK, 2019) and reported by WSP were used to define the hydraulic conductivity of the tailings as a function of tailings elevation (or depth of tailings). The TSF takes on values of K_h = 0.1 m/d, and K_v = 0.02 m/d.
- A general head boundary condition has been used to define the elevation of the saturated portion of the tailings over the period of placement. The general head boundary elevation has been set to match the scheduled rate of tailings rise, and assumes a constant supply of water to maintain 'wet' conditions in the tailings consistent with operational techniques of deposition (slurry pumping).

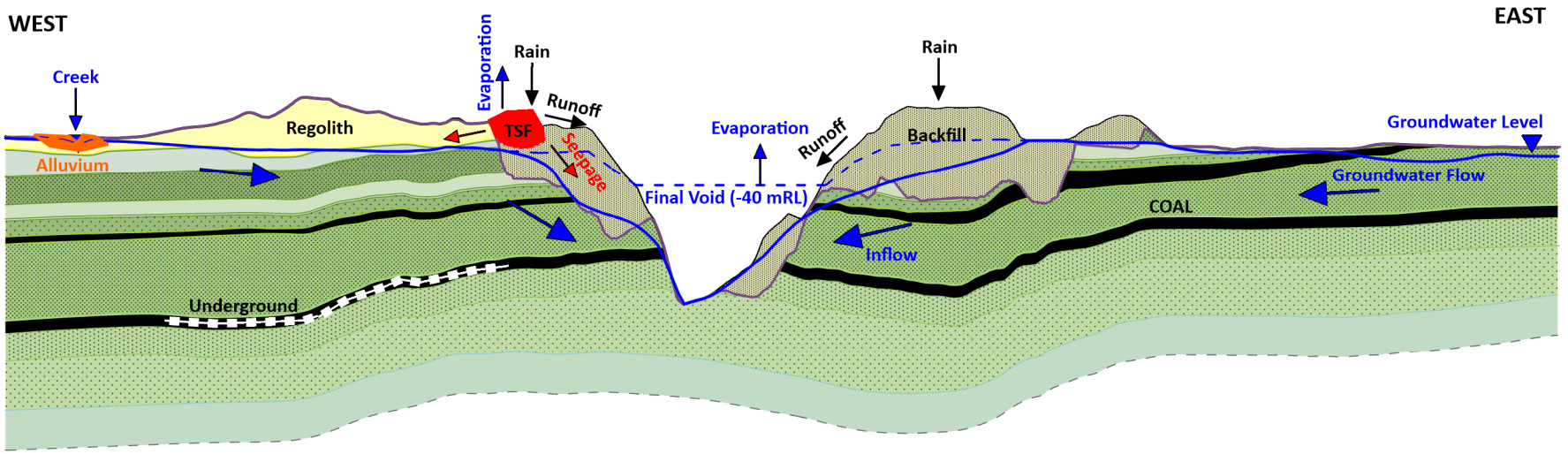


Figure 3-12: Conceptual Hydrogeological Model (CHM) for 2039 and post-closure conditions. Key components include neglible interconnectivity between Permian and alluvial units as well as the influence of mining alteration (changing hydraulic properties, effects of goafing from long-wall panels, re-placement of tailings providing transient elevated heads)

3.6 Groundwater Users

3.6.1 GDEs

There is only one recorded Groundwater-Dependent Ecosystem (Parnell Spring at ~15 km) within a 25 km radial zone surrounding the project area (Figure 5-2).

Mapped surface expressions of GDEs and subsurface GDEs, described by McVicar et al. (2015), are present within the Hunter sub-region of the Northern Sydney Basin. Many of the rivers in this sub-region have riparian vegetation along the banks, which provide habitat for a variety of species (McVicar et al., 2015).

The nearest mapped wetlands are approximately 40 km east of the mining area.

3.6.2 Warkworth Sand Woodland

The Warkworth Sands Woodland (WSW) of the Hunter Valley (located ~3.5 km from the Proposed Modified pit), is a mid to low woodland (occasionally forest), typically dominated by rough-barked apple trees in the canopy; together with other small trees, shrubs and groundcover species. It occurs in the Hunter Valley IBRA1 subregion (SYB02), in the north of the Sydney Basin Bioregion (SYB), as stated in the Approved Conservation Advice of the Warkworth Sand Woodlands of the Hunter Valley ecological community (EPBC_s266B, 2016).

3.6.3 Third-Party Groundwater Users

Bores listed with the New South Wales Department of Primary Industries Water (DPIW; 2016) database located within the model domain area are shown in Figure 3-13 and represent privately-owned bores in use for various purposes. The closed bore (GW200120) is located approximately 3.42 km to the south of the Proposed Modified pit.

A selection of bores is provided in Table 3-3 , showing the available information from the bore cards. Due to the variability of the data in terms of lithological information and frequency of measurement/monitoring (the DPI bore water levels in this areas are measured infrequently, mostly on an annual basis), the more detailed groundwater monitoring network that Bulga maintains has been used as the primary source of hydrogeological information and for calibration data.

Table 3-3: Summary of available data for public domain bores

Bore	Depth	Screened Lithology (Bore Card)	Screens	Recorded Use
GW078704	10	none recorded	none recorded	Household
GW064014	61	Sandstone Permian Mudstone	43-61m	Household
GW078550	9	none recorded	none recorded	Household
GW078787	8	none recorded	none recorded	Household
GW200930	7.4	none recorded	Cased, no screen record	Household
GW065611	61	none recorded	no screens installed	Household
GW078827	10	none recorded	none recorded	Irrigation
GW201204	9	none recorded	lined 0-9	Irrigation
GW019107	6.1	Clay	none recorded	Irrigation
GW080771	unknown	none recorded	none recorded	Monitoring

Bore	Depth	Screened Lithology (Bore Card)	Screens	Recorded Use
GW080769	unknown	none recorded	none recorded	Monitoring
GW079060	12	Gravel	8-12m	Monitoring
GW079062	50	sandstone	41-44m	Monitoring
GW203108	8.3	Clay	2.3-8.3m	Monitoring
GW203107	8.56	Sandstone; grey, fine-grained	5-8m	Monitoring
GW203109	10.95	Siltstone / tuff	4.95-10.95m	Monitoring
GW203128	11.6	Clay/ siltstone	5.7-11	Monitoring
GW201488	30.8	None recorded	no screen	Monitoring
GW080686	unknown	none recorded	none recorded	Monitoring
GW080690	unknown	none recorded	none recorded	Monitoring
GW079054	30	recorded, no screens	no screen	Monitoring
GW201485	46.5	none recorded	none recorded	Monitoring
GW202311	19	Tuff / coal	13-19	Monitoring
GW202312	460	recorded, no screens	no screen	Monitoring
GW200395	20	Sandstone	18-20	Monitoring
GW200396	5	Shale	3-5m	Monitoring
GW200394	20	Siltstone	18-20	Monitoring
GW200391	20	Siltstone (carbonaceous)	18-20	Monitoring
GW200393	20	Siltstone	18-20	Monitoring
GW200392	5	Siltstone (medium brown)	3-5m	Monitoring
GW080689	unknown	none recorded	no screens installed	Monitoring
GW080770	unknown	none recorded	none recorded	Test Bore
GW080244	60	none recorded	none recorded	Unknown
GW019108	10.4	Alluvium Clay / Water-bearing clay	Unknown	Unknown
GW200119	unknown	none recorded	none recorded	Unknown

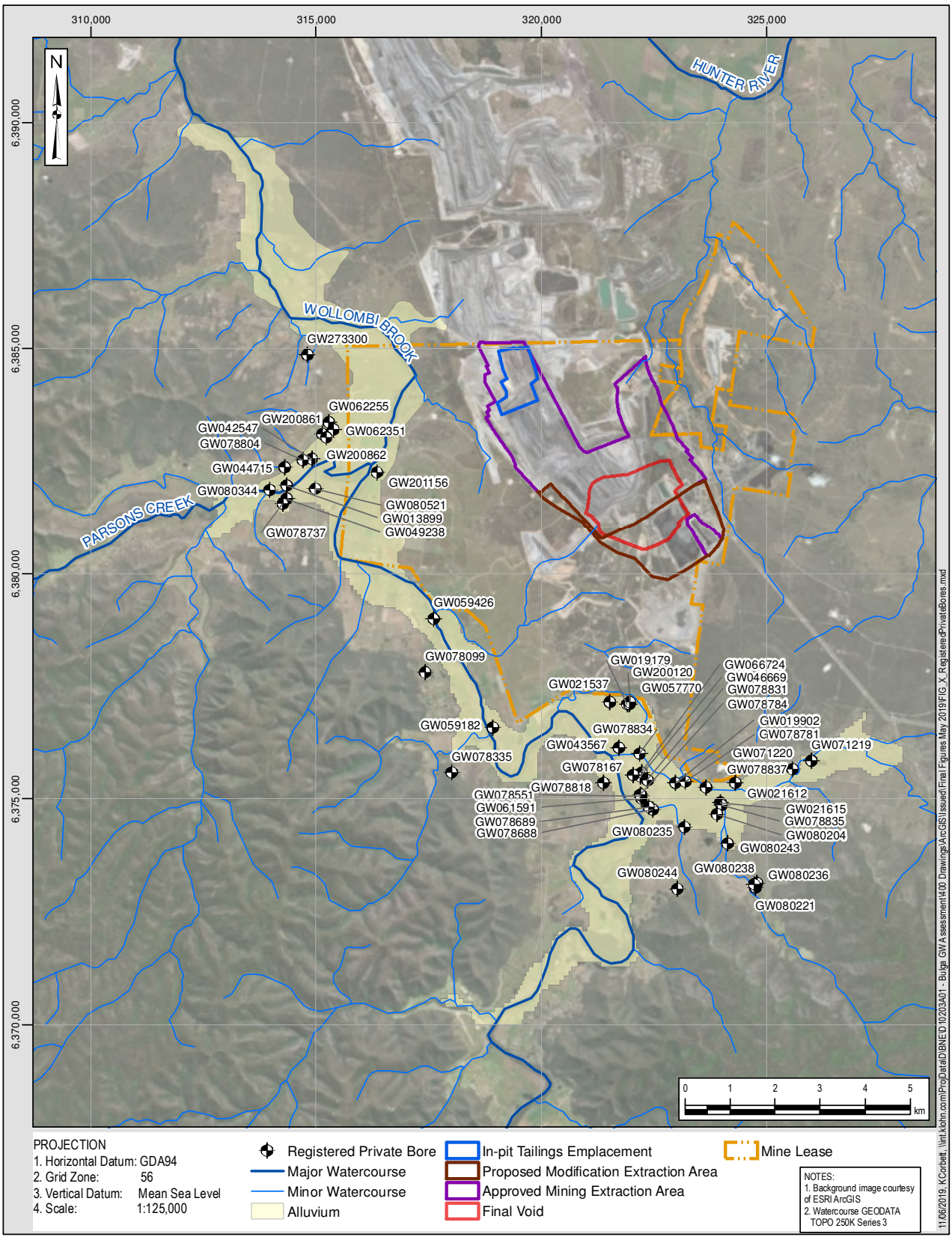


Figure 3-13: Location of NSW Registered Groundwater Bores relative to Model Domain

4 GROUNDWATER FLOW MODELLING

4.1 Preamble

The groundwater model used in this study is an update to previous work completed initially by Mackie (2013), and then by AGE (2016a and 2016b). The model was updated for this project to assess the potential impact of the Proposed Modification.

The model has been substantially updated to:

- Include the changes associated with the Proposed Modification to the mining plan;
- Assess changes to local and regional groundwater flow patterns due to the Proposed Modification (i.e. as a result of the expansion of the open cut and tailings relocation);
- Assess incremental and cumulative changes to potential impacts on groundwater resources, to other users, and to the environment resulting from the Proposed Modification;
- Estimate mine inflows to inform the ongoing mine water balance and future mine water demand;
- Predict the incremental impacts on the water resources of the immediate mine area from the Project Modification; and,
- Assess the condition of groundwater systems at, or following cessation of mining, in Year 2039.

The groundwater model is a single-phase saturated system simulator; the model was peer-reviewed by Dr. Noel Merrick (refer to Section 4.4).

4.2 Model Design & Construction

4.2.1 Model Code Selection

MODFLOW-SURFACT has been used as the numerical simulation code. MODFLOW-SURFACT is a commercial version of MODFLOW that has improved solution techniques for the handling of desaturation/re-wetting conditions. Specifically, it can use a Newton-Raphson formulation of the solution to the groundwater flow equations, which allows the water level within a model cell to fall below the bottom of the cell, without removing the cell from the model domain. This capability is essential for the simulation of mining-related operations.

MODFLOW-SURFACT also has the ability to vary hydraulic properties within the model, over discrete time periods. This allows for the simulation of the progressive material changes representing the progression of mining operations, within a single model simulation.

4.2.2 Model Units and Datum

The time unit for the model is days and the length unit is metres. In the horizontal direction, the model uses the MGA Zone 56 projection, while the vertical datum is the Australian Height Datum (AHD), in metres.

4.2.3 Model Domain & Extent

Spatial Model Extent

Figure 4-1 and Figure 4-2 shows the spatial extent and grid discretisation of the Bulga groundwater flow model. The model domain has been carried forward from previous modelling and comprises 263 columns in an unrotated East-West direction (17.9 km length), and 299 rows in the North-South direction (20.0 km length). Grid size varies from a maximum of 100 m x 100 m with refinement to a 50 m x 50 m grid in the main area of mining focus. The domain captures the main Permian sequences being mined as they dip and deepen toward the south-west, as well as the major alluvium of Wollombi Brook and Monkey Place Creek.

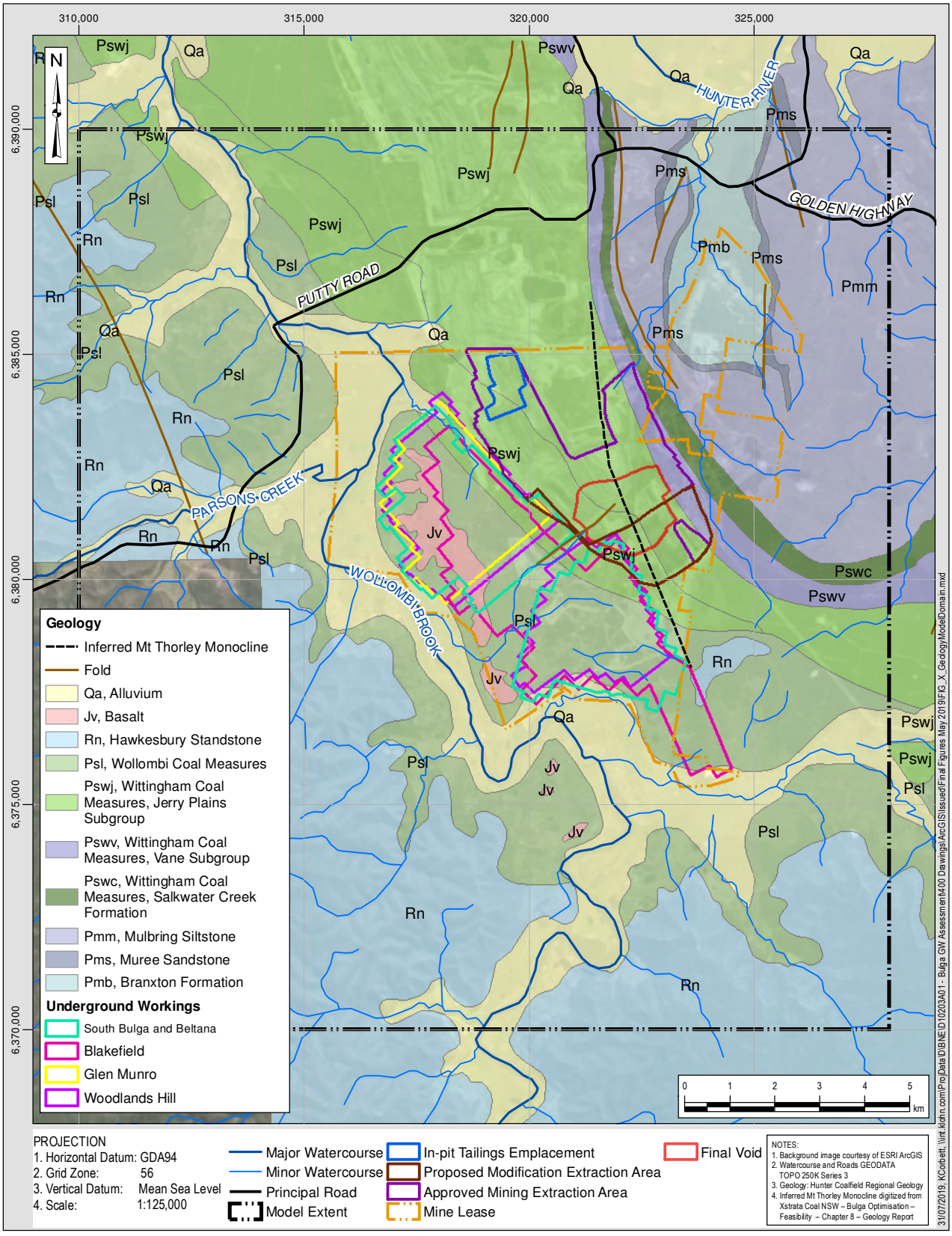


Figure 4-1: Groundwater Model Extent over Geological mapping

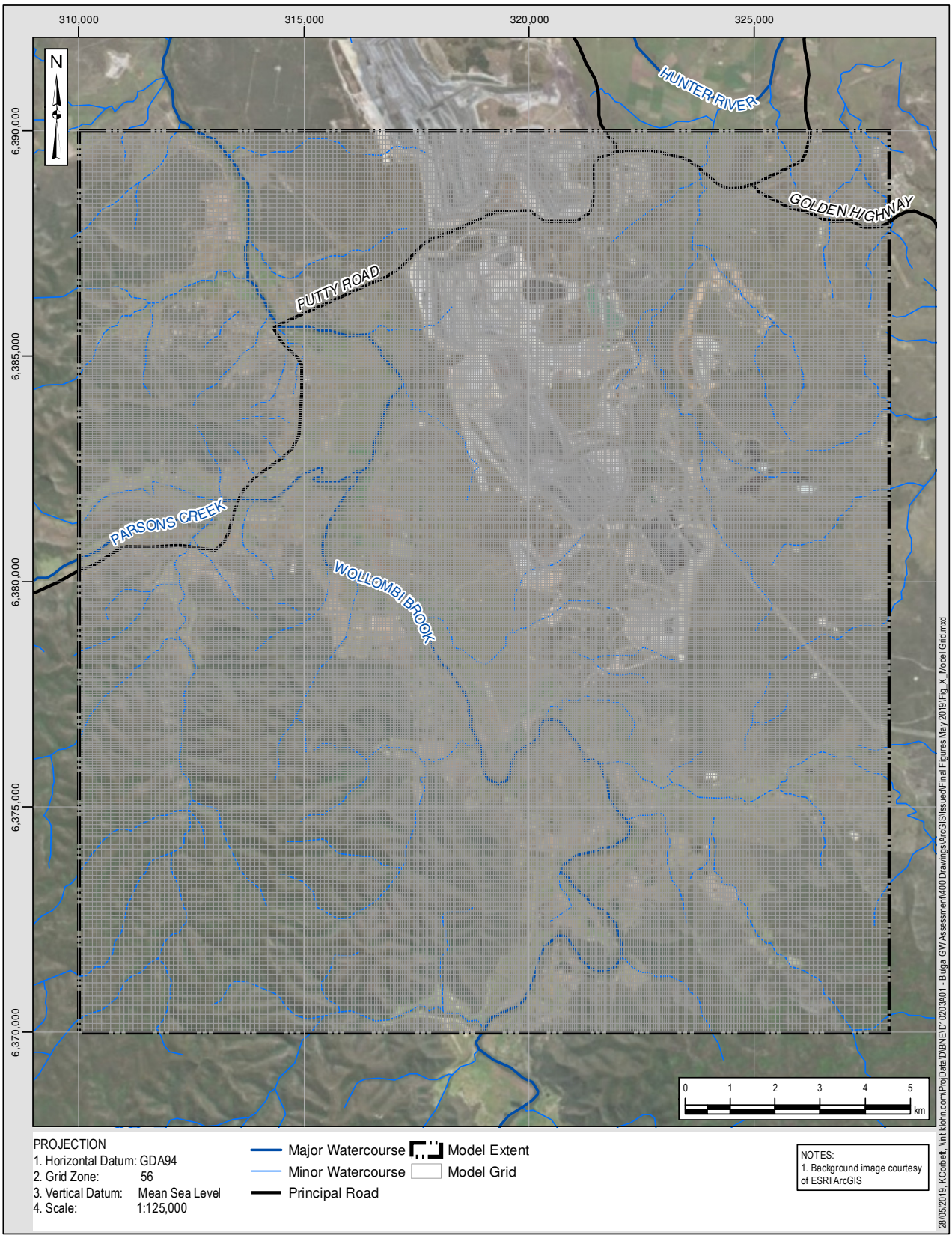


Figure 4-2: Groundwater Model Grid

Model Depth and Layering

The hydrostratigraphy of the study area is represented using 20 model layers that are mainly discontinuous across the model domain. Discontinuity of the hydrostratigraphic units is accommodated by applying hydraulic parameters representative of the underlying units where appropriate. The elevations of the layers, as well as the surface elevations, have been taken from earlier modelling of the mining area. Glencore has confirmed that underground mining activity remains unchanged from the work of AGE (2016a and 2016b), and as such geometric and timing details of the Permian strata did not require modification. The changes to the model and the focus of the impact assessment are consequently focused on the Proposed Modification (i.e. the proposed changes to the open cut and the tailings placement into the open cut void).

Table 4-1 presents the model layers and the primary geological units that are represented by each, noting where possible multiple layering of Permian coal measure (seam inter-burden) to provide flexibility in the application of goafing-modified permeability over mined seams.

Table 4-1: Summary of Model Layers and Starting Hydraulic Properties (AGE, 2016)

Layer	Hydrogeological Unit	Strat Column XRef	Horisontal Conductivity K_h (m/day)	Vertical Conductivity K_v (m/day)	Specific Storage S_s	Specific Yield S_y
1	Regolith	Qa	1.00E-02	1.00E-02	1.00E-05	5.00E-03
1	Alluvium		5.00E+00	5.00E+00	1.00E-05	3.00E-01
1	Spoil	Spoil	1.00E-01	1.00E-01	1.00E-05	2.00E-01
2	Narrabeen Group	Triassic Rn	4.00E-03	4.00E-05	3.00E-06	5.00E-03
3	Permian coal measures	Wollombi Coal Measures	4.00E-03	2.20E-05	1.00E-06	2.00E-03
4	Alcheringa Seam		8.00E-03	8.00E-03	6.00E-06	6.00E-03
5	Permian coal measures		3.00E-04	5.00E-06	8.00E-07	1.10E-03
6	Permian coal measures	Wittingham Coal Measures	1.00E-04	3.50E-06	7.00E-07	1.40E-03
7	Permian coal measures		6.00E-05	2.00E-06	6.00E-07	1.20E-03
8	Lower Whybrow Seam		9.00E-02	9.00E-02	1.00E-05	3.10E-03
9	Permian coal measures		4.00E-05	5.00E-07	9.00E-07	2.30E-03
10	Permian coal measures		3.00E-05	5.00E-07	9.00E-07	2.00E-03
11	Blakefield Seam		1.00E-01	1.00E-01	1.00E-05	8.00E-03
12	Permian coal measures		4.00E-05	5.00E-07	8.00E-07	2.10E-03
13	Glen Munro Seam		7.00E-02	7.00E-02	1.00E-05	9.00E-03
14	Permian coal measures		4.00E-05	6.00E-07	8.00E-07	2.00E-03
15	Woodlands Hill Seam		6.00E-02	6.00E-02	1.00E-05	7.00E-03
16	PCM / Piercefield Seam		5.00E-05	8.00E-07	8.00E-07	2.00E-03
17	Vaux Seam		5.00E-05	8.00E-07	8.00E-07	2.00E-03
18	PCM / Broonie Seam		1.00E-05	3.00E-07	1.00E-07	2.00E-03
19	Bayswater Seam		1.00E-04	9.00E-07	4.20E-06	2.00E-03
20	Saltwater Creek Fm		3.00E-06	7.00E-08	1.00E-05	1.00E-02

NOTE: KCB have used the packer test results (Mackie, 2013), to estimate depth-dependent hydraulic conductivities of coal seams.

4.2.4 Boundary Conditions

Boundary conditions provide a means by which auxiliary groundwater fluxes and stresses can be specified within the model. The following boundary conditions have been adopted in the model:

General Head Boundary

General Head Boundary cells (GHB package) were implemented around the active perimeter of the model domain and are applied to all layers of the model. Use of this boundary type allows for the regional groundwater flow system to be better replicated in the semi-regional model.

Conductance values applied to the GHB cells were calculated to be consistent with hydraulic conductivity values for each hydrostratigraphic unit they represent considering the dimensions of the boundary cells. During calibration, these conductances are recalculated each time the model is run to accommodate changes in hydraulic conductivities.

A reference head for these cells was obtained from steady state model heads in a pre-development scenario. Previous modelling efforts treated this boundary as a “no-flow” boundary, and the inclusion of GHB boundaries represents a more conservative and hydrogeologically-justified approach to the model.

Rainfall Recharge & Evapotranspiration

Rainfall recharge was applied in zones based on the surface extent of geological units present in the top layer, by using the RCH package of MODFLOW. For modelling purposes, recharge is regarded as the fraction of rainfall that passes through the unsaturated zone and reaches the groundwater system. In the model, recharge has been calculated as a percentage of rainfall.

Several recharge zones have been defined, and each of these has a unique recharge rate that reflects the strata through which it infiltrates. The percentage of rainfall that enters the model as recharge in each zone was adjusted during calibration. The zones are defined by the extents of mining, alluvium, spoil and the regolith sediments.

Evapotranspiration is implemented in the model using the EVT package. A uniform extinction depth has been applied across the domain and set at 1.5 m below the natural surface, a depth below which evaporative losses from the groundwater surface are deemed to be zero. Modelled data was based on actual evapotranspiration (450 mm/a), adopted from BOM 2008.

Watercourses

Minor watercourses in the model domain are represented using the MODFLOW Drains package (DRN). In these minor water courses, the reference head was specified as the model top and the conductance of these boundaries was set at a nominal value of 10 m^2/day, which is consistent with a small planar area of stream segment and moderately conductive stream bed interface.

The Wollombi Brook and Monkey Creek are the major water courses in the study area. These have been represented in the model with the use of River Package cells. The river stage has been set at 0.10 m above the river bottom elevation over the length of the stream. A nominally high value of 100 m^2/day has been applied as the conductance of these cell boundaries.

Mining Stresses

The progression of the approved and proposed mining operations are simulated using "Drain" cells which are activated in accordance with the mining schedule (Table 4-2) to reflect the progression of mining in both the underground and open cut operations.

In the case of underground mining operations, the drains have been specified as a reference head, set at the elevation of the bottom of the layer being mined. A nominally high conductance of 10 m^2/day is specified for these cell boundaries, which allows water to be removed by these cells. Once activated, underground mining drain cells remain active for the active mining simulation and are de-activated for the period post-mining which allows for recharge into the mined layer and the overlying layers to naturally occur.

For open-cut mining areas, the reference head of the drain cells follows the layer bottom elevations during progressive excavation (mine deepening). The drain cells control the elevation of the changing mine from which water is removed and also provide the flux removed which represents the rate of inflow predicted.

When a cell is re-filled (for example representing placement of overburden into mined voids) the reference heads are re-determined by a series of surfaces developed from the proposed mining plan to the final landform. The conductance of open-cut drains cells during excavation is set nominally high at 100 m^2/day. Re-filled overburden emplacement areas are assigned a horizontal hydraulic conductivity (K_h) of 0.1 m/day.

Table 4-2: Summary of Mine Schedule

Mine	Mining Type	Seam	Model Layer	Start Year	End Year	Duration
Bulga OC	Open Cut	Bayswater	1 to 19	1982	2039	58
South Bulga UG	Underground	Lower Whybrow	8	1994	2002	8
Beltana UG	Underground	Lower Whybrow	8	2003	2011	8
Blakefield South	Underground	Blakefield	11	2010	2017	7
Blakefield North	Underground	Blakefield	11	2018	2020	2
Glen Munro	Underground	Glen Munro	13	2021	2026	5
North Woodlands	Underground	Woodland Hill	15	2027	2033	6
South Woodlands	Underground	Woodland Hill	15	2033	2039	6

Other Boundary Conditions or Stresses

Drain conditions are applied to the upper surface of spoil piles to permit the model to remove water from these features. This process replicates discharge at the spoil pile toe, which is collected in a series of drains and sumps and pumped into the mine water management system, consistent with site observations of these features. The degree of saturation the stockpiles achieve is ultimately controlled by their internal material properties and their ability to shed water unimpeded.

There are no extraction bores operating in this model.

The default, no-flow boundary condition is applied to the base of the model. The thickness of the lowest model layer (layer 20) is a uniform 100 m.

Modelling of the open cut final void and TSF is presented in Section 5.4 and Section 4.6.5 of this report respectively.

Design of the tailings placement is being undertaken by others and the results of more detailed numerical models used to aid the design have been compared for consistency. The area of the tailings placement takes on values of 0.1 m/d K_h and K_v of 0.02 m/d, S_s of $1e^{-5}$ and S_y of 0.05.

When mining takes place in the void, cells adopt spoil parameters, with enhanced hydraulic conductivity, but with limited alteration to storage parameters. Evapotranspiration is applied to the highest active cell at a maximum rate of 1.2 mm/d.

4.2.5 Application and Variance of Hydraulic Properties

Assignment of hydraulic properties in the model has mostly been applied on a zonal basis and has been adopted and carried forward from previous modelling as appropriate. These zones delineate changes in geological units in each model layer. To provide a more consistent approach and to improve the numerical stability of the model, a continuous function approach was used post-calibration to parameterise the coal seam layers[9].

For the prediction run, and for calibration performance reporting, hydraulic conductivities have been assigned to the six major coal seams, in a continuous fashion through the application of an analytical relationship that has been used in many groundwater assessments for deeper Australian coal mining projects. Conceptually, the horizontal hydraulic conductivity (K_h) of the Permian coal seams reduces with increasing depth of overburden material. This is the result of closure of cleats and joints within the seam from increased lithostatic pressure, due to the increasing thickness of overlying material. The equation that has been used to express this variability in coal seam horizontal hydraulic conductivity is:

$$Kh_{coal} = Kh_0 \times depth^{(slope)}$$

Where:
- Kh_0 is horizontal hydraulic conductivity of material at depth of 0 metres;
- *slope* is a term representing steepness of the curve;
- *depth* is the depth to the mid-point of the cell at that location.

Values of Kh_0 and *slope* were adopted that allow a close replication of the observed hydraulic conductivities presented by Mackie (2013) from analysis of packer test data.

Figure 4-3 illustrates the depth-dependent relationships adopted in this model for the four target seams. Note the use of log scale for conductivity in this figure. Mackie (2013) provides limited packer test data for depths greater than 400 m, so a limiting value was applied to each seam to prevent unreasonably small values being generated.

[9] This approach was suggested by the external model reviewer.

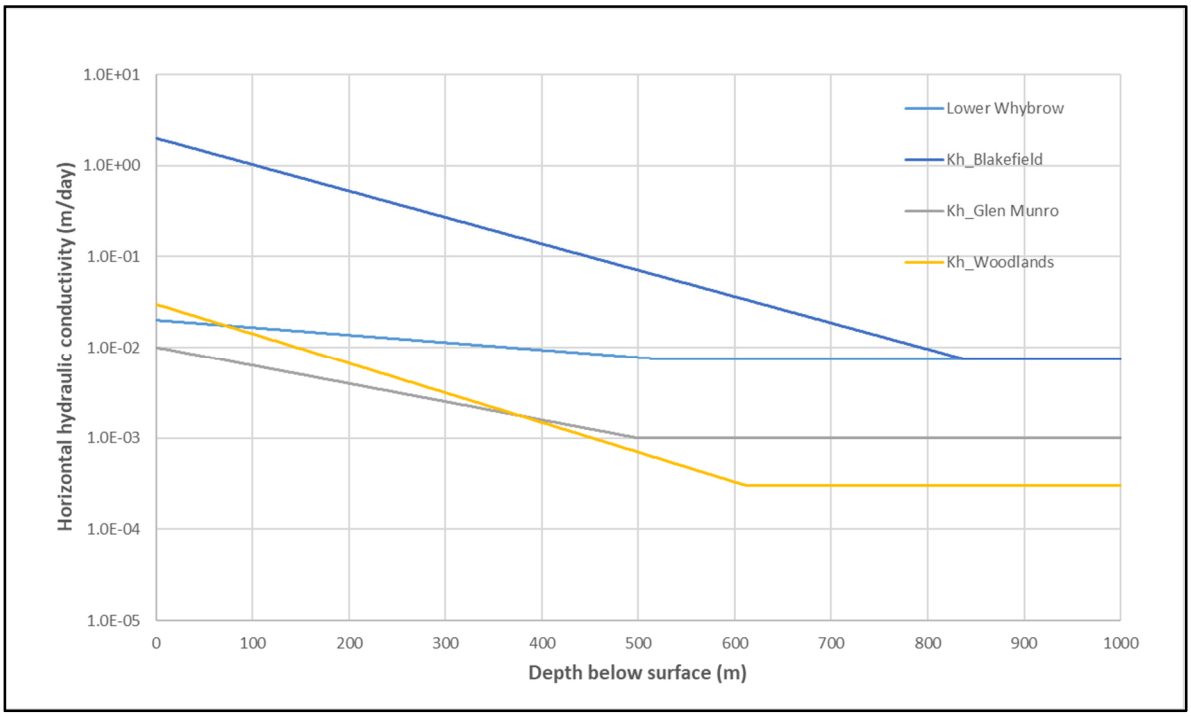


Figure 4-3: Example Depth Relationships Used in Assignment of Coal Seam Hydraulic Conductivity

The vertical hydraulic conductivity (K_v) was applied as a factor of horizontal hydraulic conductivity in each zone. These factors were adjusted during calibration. The original zonation was also used to delineate regions of changes in specific storage and specific yield within the model. These parameters were adjusted based on this zonation during calibration.

The conceptual model assumes no depth relation in the horizontal hydraulic conductivity (K_h) of the interburden material.

Goaf / Fracture Modified Hydraulic Properties

Despite the focus of this model on assessing potential impacts from the Proposed Modification only, the process of fracture development or goafing over mined longwall panels needed to be amended to accommodate the interactions with the deepening open cut.

Fracture development from goafing changes the hydrogeological conditioning of the Permian rock and is therefore important to calibration processes, and predictive simulations. This process was also complicated by the overlapping of, and interaction between, multiple approved longwall mining operations, as schematically shown in Figure 4-4. The stacked model layering on the left of this image (red representing mining, and yellow and orange representing varying degrees of fracturing), needed to account for the various underground operations (panels shown on the right of the image); and their scheduling and interaction with the expanding and deepening open cut void.

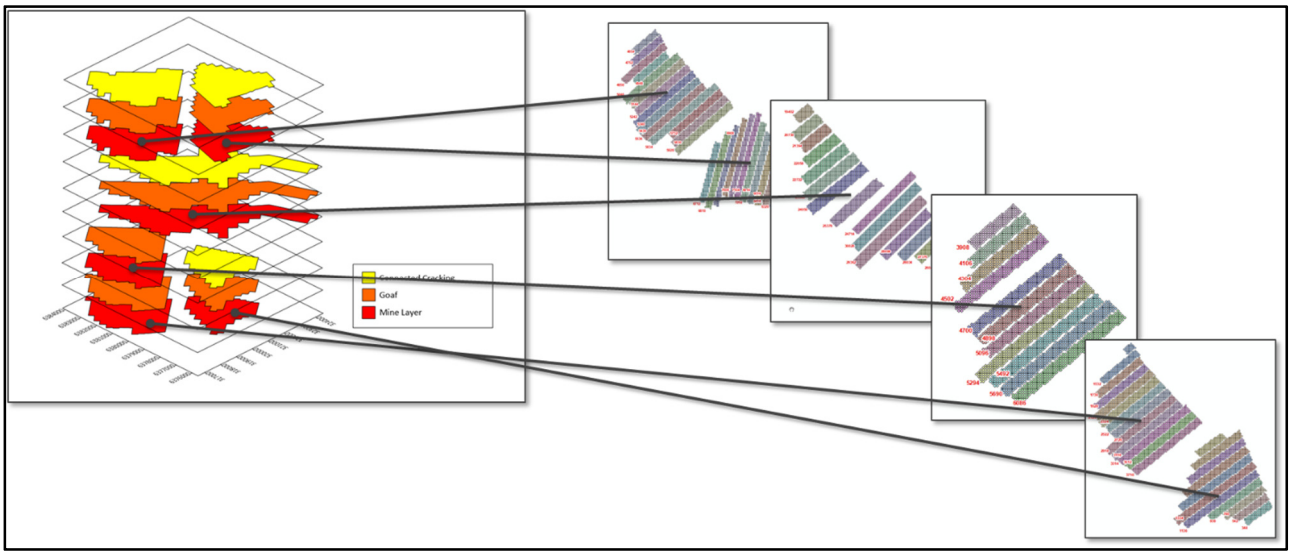


Figure 4-4: Schematic Stacked Longwall Mining Operations of Bulga

Representation of this process within the model was accommodated by the use of the "Time-Varying Material Property" (TMP) package. Multiplying factors provided in the TMP package input file were provided to specify a K_v value of 1 m/day and K_h of 0.1 m/day in directly-impacted cells, with a reduction in values as the height above the mined area increases, consistent with Tammeta, 2014 and Younger and Adams, 1999.

Initial calibration attempts applied this process to a number of layers overlying the mined seams. These calibration attempts failed to significantly reduce model-to-measurement disparity, so a more sophisticated approach which better represented the layer geometry variability was employed.

Ditton and Merrick (2014), provide guidance on predicting the height of continuous vertical fracturing induced by mining goaf development. The "Geometry Model" of that paper was applied to determine a height of approximately 75 m. In the predictive model, the area in which continuous vertical fracturing (enhanced permeability) occurs was limited to the area of an overlying layer where the cumulative thickness of layers overlying the longwall was less than 75 m[10]. In the fractured zones K_h and K_v is set to 0.001 m/d, S_s to $1e^{-5}$ m^{-1} and S_y to 0.15.

4.3 Model Calibration

4.3.1 Calibration Approach

An initial manual calibration was undertaken after updating the base data. This was then followed with an automated parameter estimation process using PEST. Calibration efforts for the Proposed Modification model targeted to achieving or, where possible, improving the calibration of the model compared to the models used for BCM's existing approvals. Stress periods, during transient calibration, varied with the rate of mining, from 60 to 90 days etc.

[10] It is noted that, implicitly in the model, this enhancement of K_v extends further than this height because of application of a weighted harmonic mean in calculating vertical conductance between adjacent cells, as is done with appropriate settings in MODFLOW-SURFACT.

In summarising the calibration of the model, the following is noted:

- Only a normalised RMS has been presented for the steady state calibration of the Mackie (2013) model, presenting an undefined subset of bores from the broader database – it is uncertain as to how many of the bores used by this previous study were alluvium or Permian in nature;
- Only manual calibration has been previously undertaken. There has been no previous steady state or transient automation of the calibration process;
- Although the AGE work (2016a and 2016b) is not relevant in considering the calibration status of the model, this work did provide raw transient prediction data against which this calibration performance could be compared.

The results of the calibration process are presented in the following section, while details of the calibration results and performance of the model used for the Proposed Modification are provided in Appendix II.

4.3.2 Model Calibration Results

Improved calibration was achieved for this GIA model compared to previous models (Appendix II). This included addressing the challenge for the calibration of the Proposed Modification model, regarding much of the data available for calibration being specific to the earlier underground mining aspects. As indicated in Section 3.4, the longer-running groundwater monitoring datasets for BCM are focussed on the deeper Permian responses and on the alluvial aquifers, leaving a more limited data set from which to infer the potential impact of deeper open cut development or in-pit tailings placement.

The normalised RMS achieved using all transient calibration data points is 10%. Calculation of the normalised RMS using a condensed 2018 data set indicates a value of 8.7%, which suggests that the model better replicates late-time observations which are the starting point to Project Modification simulations.

Key mining area inflow predictions from the calibrated model, as compared with previous predictions of water production include (Figure 4-5 provides a time series of inflows for the calibration period. This has been compared for agreement with Mackie, 2013. Mackie's inflows have been reported to be consistent with mine records and anecdotal observations):

- South Bulga Underground: good correlation in terms of volume of water produced and the period over which production occurs. Peak production occurs at about year 2001 in both simulations, with the Mackie (2013) model predicting about 850 m^3/day, and the KCB model predicting about 950 m^3/day.
- Beltana Underground: good correlation is achieved in terms of the volume of water produced and the period over which production occurs. Peak production occurs at about year 2006 in the KCB model, and about 2008 in the Mackie (2013) model, with the Mackie (2013) model predicting about 1,250 m^3/day, and the KCB model predicting about 1,350 m^3/day.
- Blakefield South Underground: good correlation in terms of peak water production dates, and good correlation in the amount of water produced and the period over which

production occurs. Peak production occurs in both models at about year 2016/17, with the Mackie (2013) model predicting about 2,400 m^3/day, and the KCB model predicting about 1,800 m^3/day.

- Other mining areas predict low and steady production in both cases.
- Total water produced varies slightly compared to the previous modelling, and the comparison at key dates is as follows:

1995	Mackie (2013) ~750 m^3/day	KCB ~800 m^3/day
2000	Mackie (2013) ~1,000 m^3/day	KCB ~1,050 m^3/day
2005	Mackie (2013) ~1,500 m^3/day	KCB ~1,300 m^3/day
2010	Mackie (2013) ~1,500 m^3/day	KCB ~1,600 m^3/day
2016	Mackie (2013) ~2,900 m^3/day	KCB ~2,400 m^3/day

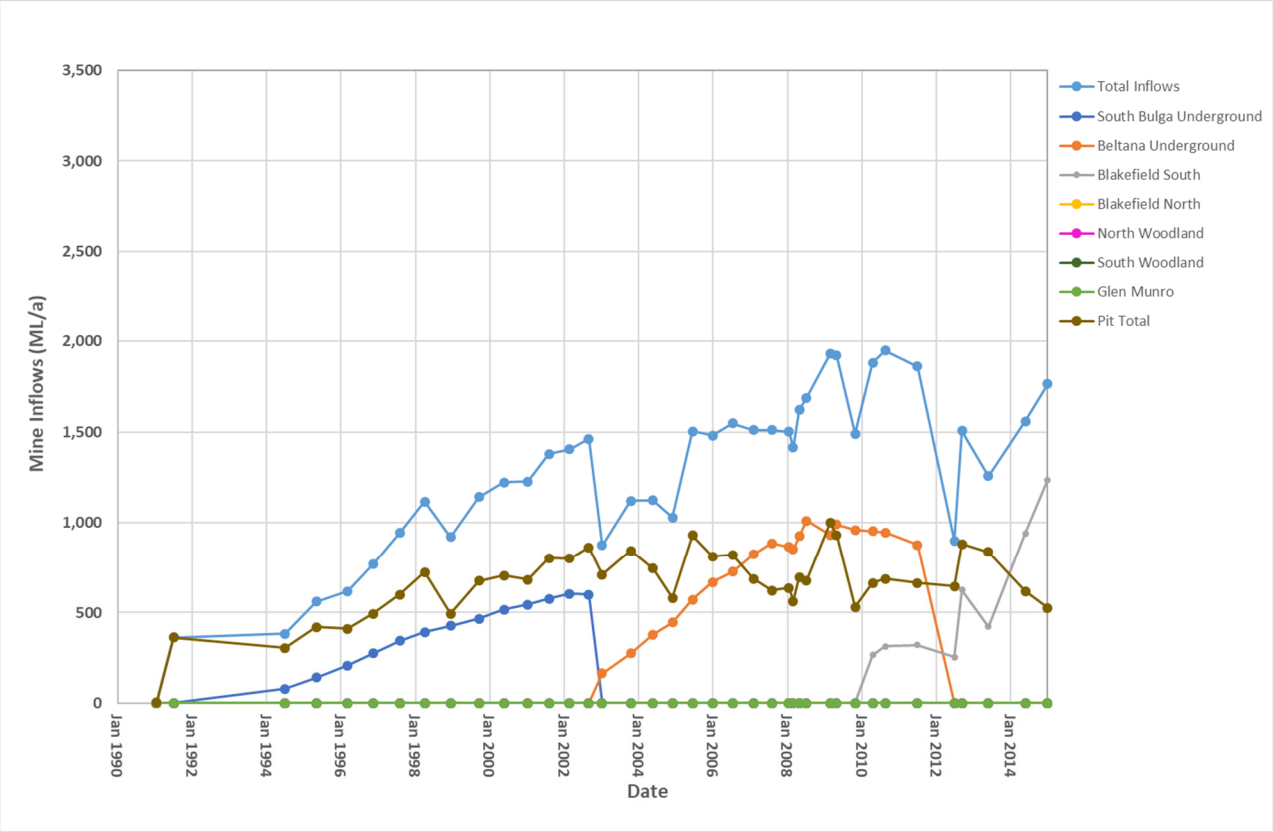


Figure 4-5: Mine Inflows for calibration period (cf Mackie, 2013 comparison provided in Appendix II)

A review of predicted versus measured drawdown is made through visual comparison of plotted data in the Mackie (2013) report, reproduced in this document compared with results extracted from the KCB model for the same approximate date in Appendix II. Consistent with inflow estimates, visual effects of mining across the layers presented are similar from both models.

4.3.3 Model Calibration Discussion

The process of automated calibration has resulted in the estimation of all parameters in an unbiased sense; importantly this includes storage parameters. Visual comparison of previous models can be used as a general indicator of the changes made to the simulation. These show:

- Improved RMS of the KCB model over that of the previous models for the approved cases (AGE/Mackie models);
- Similar overall mine production rates;
- Head predictions are similar for the calibration period for the models used for previous approvals and for the Proposed Modification model.
- Late calibration time (2018) which represents starting conditions for the transient model observed improved calibration performance statistics of less than 23.5 m RMS error and 8.7% normalised RMS.

4.4 Model Peer Review

The model was peer-reviewed by Dr. Noel Merrick (HydroAlgorithmics). A copy of Dr. Merrick's review is appended in Appendix VI.

4.5 Groundwater Modelling Scenarios

The model scenarios considered are presented in Table 4-3. In the results, the project-only impacts (i.e. only as a result of the Proposed Modification) have been defined through a process of differentiation of impact from the previously- Approved Mining scenario. This was undertaken to permit review of the potential impacts of the Proposed Modification as they relate to this assessment. Parallel simulations of the Approved Mining scenario were completed, the results from which were compared to the Proposed Modification scenario with the difference between the two being "the project-only impact". Cumulative impacts of the Proposed Modification scenario (i.e. Approved Mining case with the Proposed Modification case added) are presented for clarity of additional anticipated mining impacts for the Proposed Modification scenario.

Recharge applied was calculated based on the length of the stress period (days), the associated rainfall (from historical measurements) for that period; and the recharge factor which was estimated during calibration.

Table 4-3: Summary of Modelled Scenarios

Scenario	Description	Reason	Period
1	Approved Mining (Calibration)	Develop pre-conditions using the updated model domain in order to assess Approved Mining only impacts	1990-2018
2	Approved Mining (Calibration and Simulation)	Predictive simulation for the Approved Mining case and including the approved ongoing open cut and underground mining impacts through to 2039	2009-2039
3	Proposed Modification	Predictive simulation for the Proposed Modification which includes the elements of the Proposed Modification and the ongoing approved open cut and underground operations.	2018-2039
4	Post Closure	To assess post-closure pit water balance at the completion of both underground mining and the Proposed Modifictaion.	2039-3539

4.6 Groundwater Modelling Predictions

Final predictive modelling was conducted following the analysis of predictive uncertainty (Appendix III), with results of the uncertainty analyses used to improve the model for predictive purposes.

Other updates to the modelling predictions, apart from the mining changes associated with the Proposed Modification, include decreasing the sensitivity of the Mt Thorley monocline and incorporating the differences in the geometry between the Approved and Proposed Modification scenarios.

The monocline is a tilted structure where the K_v exceeds the K_h and was originally too strongly represented in the model and as a result, produced excessively high inflows to the underground workings. When the structure was mined through, the mine reported a brief period of increased flow, however, high flows were not sustained in the longer-term. As a consequence of these observations, the hydrogeological effect (i.e., the ability of the structure to release water in the longer term) was dampened by reducing the assumed difference between the K_v and K_h. The impact of this feature is still visible in the predictive results, however, the water produced is more consistent with that reported by the mine.

The Approved Mining scenario (including approved open cut and underground mines) was updated, based on the incorporation of the Mackie and AGE models. The reconstructed model was provided to Glencore and stakeholders so that changes in landform, mining schedule and other infrastructure development, such as spoils and tailings could be verified as representative of the current understanding of each of these aspects (Figure 4-6).

The predicted impacts of the Proposed Modification are derived from the difference between the Approved Mining scenario and the Proposed Modification scenario.

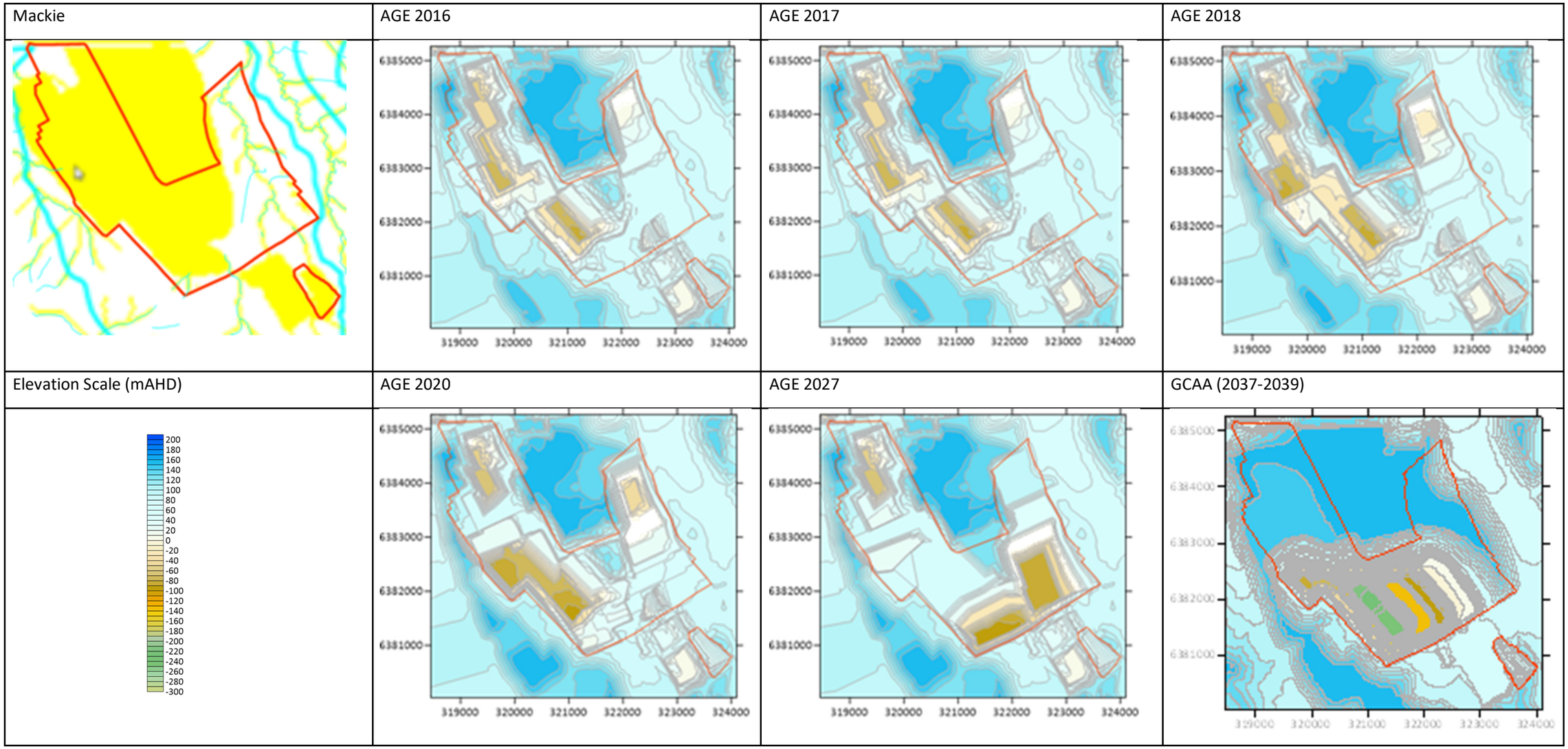


Figure 4-6: Approved Mining Schedule (with an indication of what each represents)

4.6.1 Predicted Groundwater Levels

Model-predicted groundwater levels for the alluvium are shown in Figure 4-7, and the main coal seams of interest are shown in Figure 4-8 to Figure 4-10. The 2039 predictions represent cessation of mining before closure, and before the development of pit lake conditions, therefore representing maximum impact during the period of mining conditions. In each of the cross-sections between Figure 4-8 to Figure 4-10, the following is shown (i) the cumulative or largest impact of the Proposed Modification scenario, being a representation of what future conditions are predicted to occur (upper left), (ii) a project only or Proposed Modification case impact, which is the difference between the Approved scenario, and the Proposed Modification scenario in this report, noting green shading is drawdown, and purple shading is head increase (upper right), and (iii) a cross-section (with alignment shown) depicting the Proposed Modification scenario and Approved scenario operation predictions across the mining domain, intended to show where differences may occur between the system and why sharp variations (which are a function of mining geometry change) occur. The top layer (Layer 1) is representing either alluvium or regolith, underlain by host material.

Alluvium

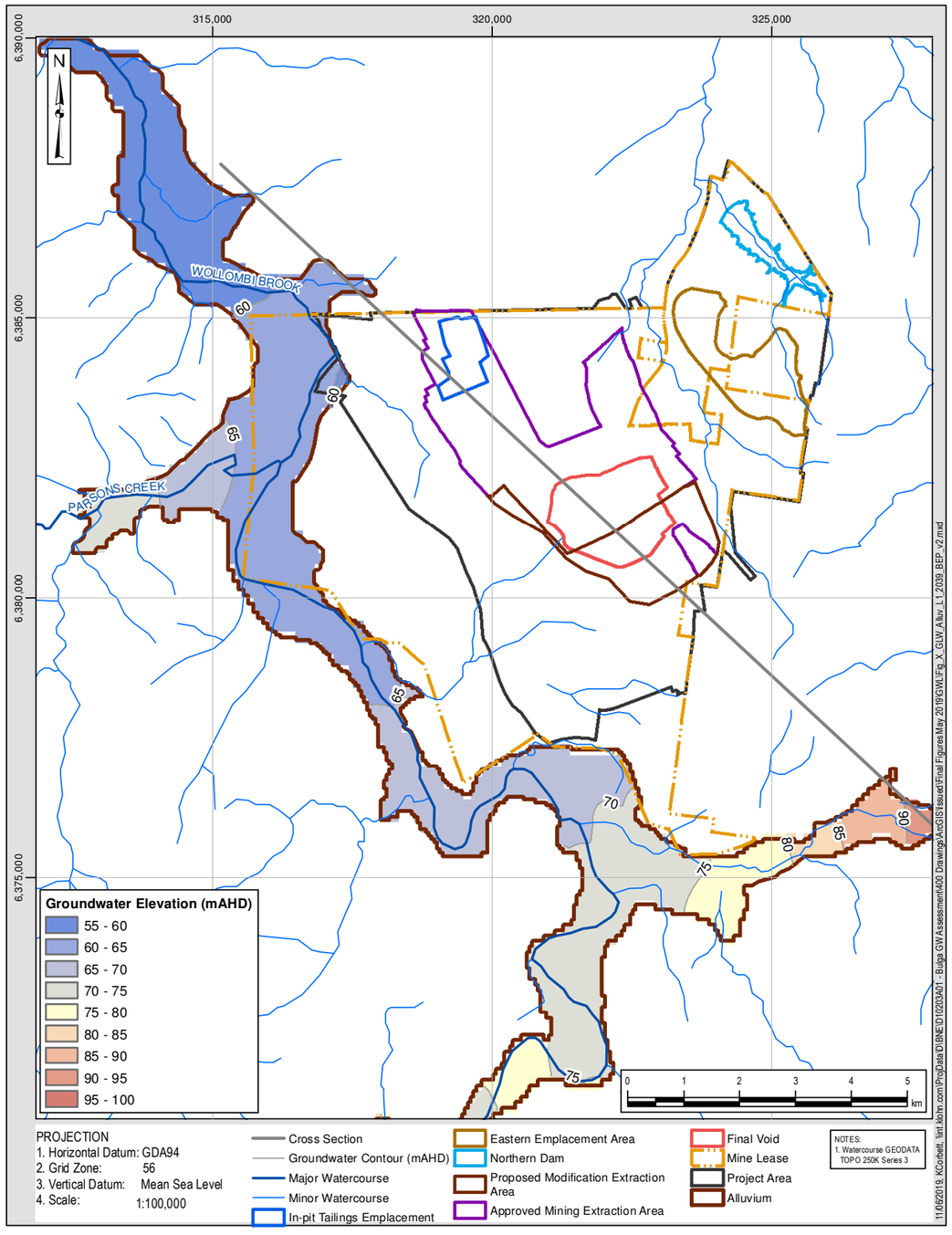
Head predictions in the alluvium (Figure 4-7) indicate no visual difference between the Proposed Modification and the Approved Mining scenario. Mining impacts that appear in localised alluvium are the consequence of the Approved Mining scenario. The Proposed Modification case does not appreciably change groundwater conditions in the mapped alluvial areas, compared to the Approved Mining scenario.

Permian Strata

For the water table predictions (combined, uppermost active, saturated, layer in the model) for non-alluvium strata, three observations are made:

- Heads in the spoil stockpile increase to reach around 80 mAHD in the northern part of the mine, however, these remain below the current ground level, consistent with the expectation that this spoil will act as a free-draining system, draining towards the open-cut void;
- Heads in the Permian outcrop areas where there is no alluvium, show a strong drainage effect toward the main pit void, as would be expected;
- There is a predicted hydraulic gradient developed towards the north and in the direction of Mt Thorley. This is a function of the head maintained by the TSF which then creates localised drainage away from the TSF. Predicted baseflow impacts show a minor (5 m^3/day or 0.05 L/s) increase in discharge and negligible changes associated to and from those natural drainage systems.
- The sharp contrast in predicted heads in the spoil / Permian / alluvium in the water table layer becomes muted with increasing depth, and Permian dewatering impacts become stronger as the lower permeability strata in deeper sections of the model become more dominant in the nature and distribution of mine dewatering impacts.

Predictions of drawdown in the Permian are of the order of 100's of metres, which are consistent with observed VWP records in previously mined areas of the operation. The effect of underground mining conditions skews the nature of the drawdown extents as the respective mined coal seams are shown with increasing depth.



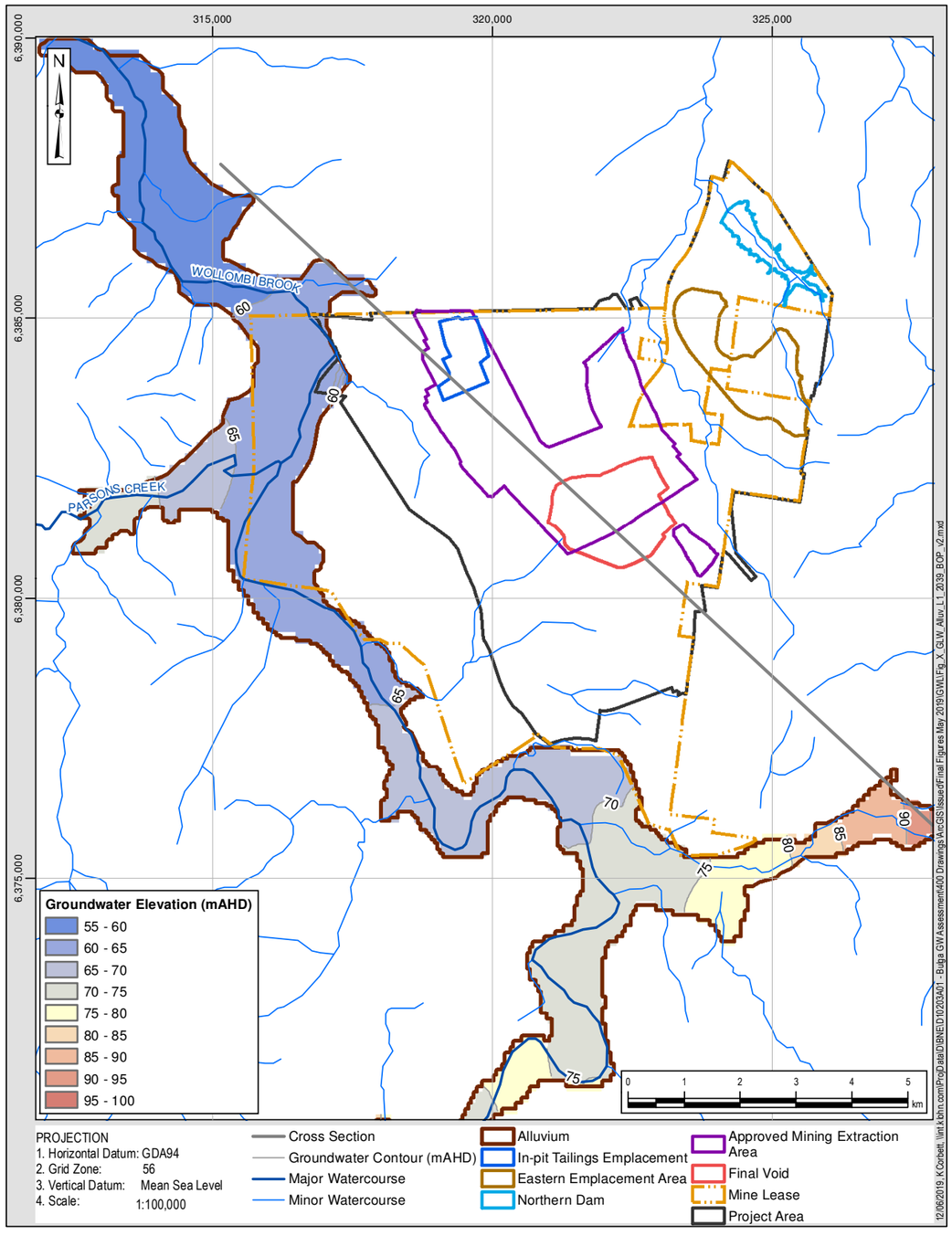


Figure 4-7: Predicted Groundwater Elevation in Alluvium – Largest Impact (Year 2039), Proposed Modification (L) and Approved Operation (R)

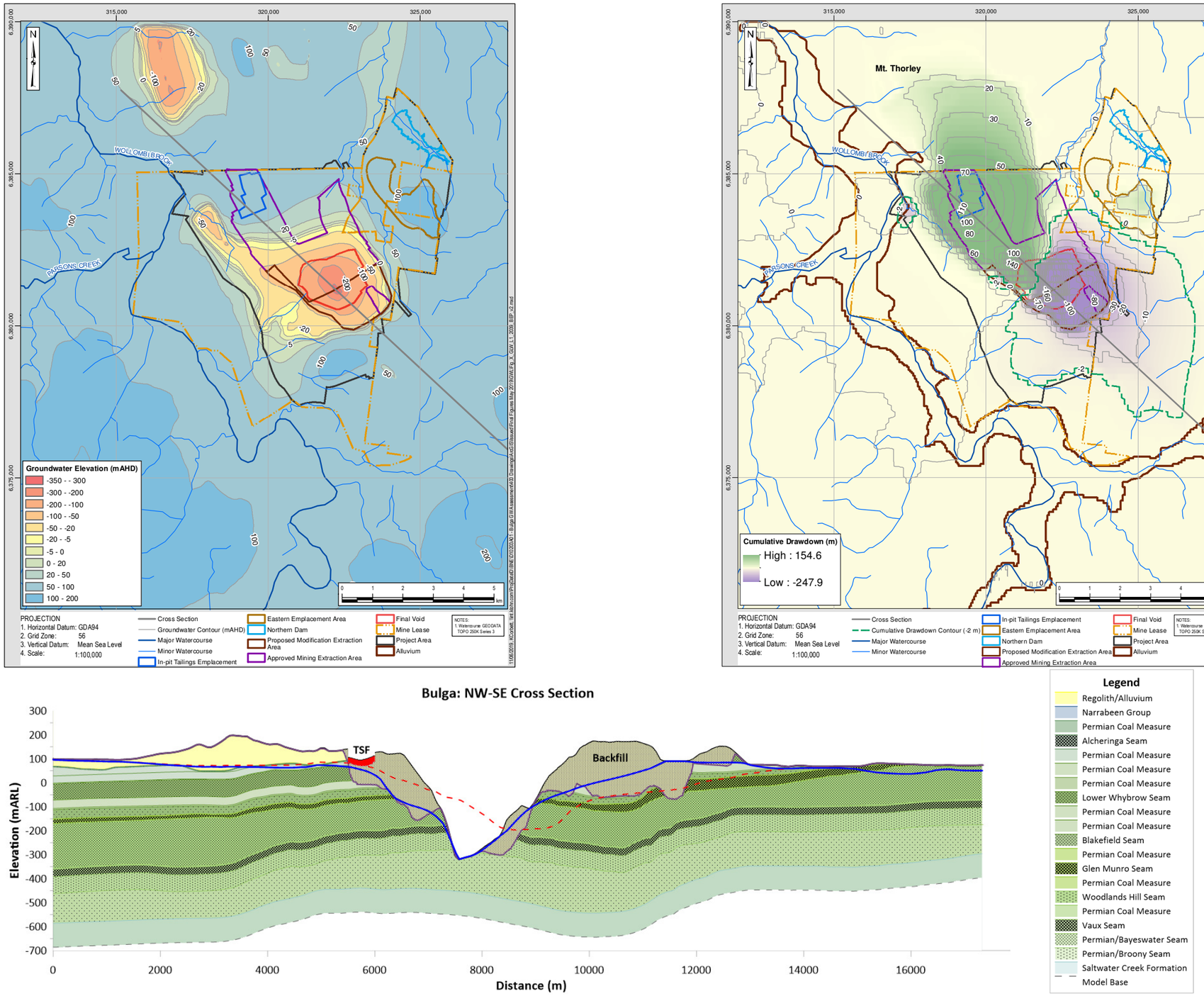


Figure 4-8: Predicted Groundwater Levels Water Table and Cross Section (Proposed Modification in Blue and Approved in dashed-Red) – Largest Impact (Year 2039), Proposed Modification (L) and Project Only (R)

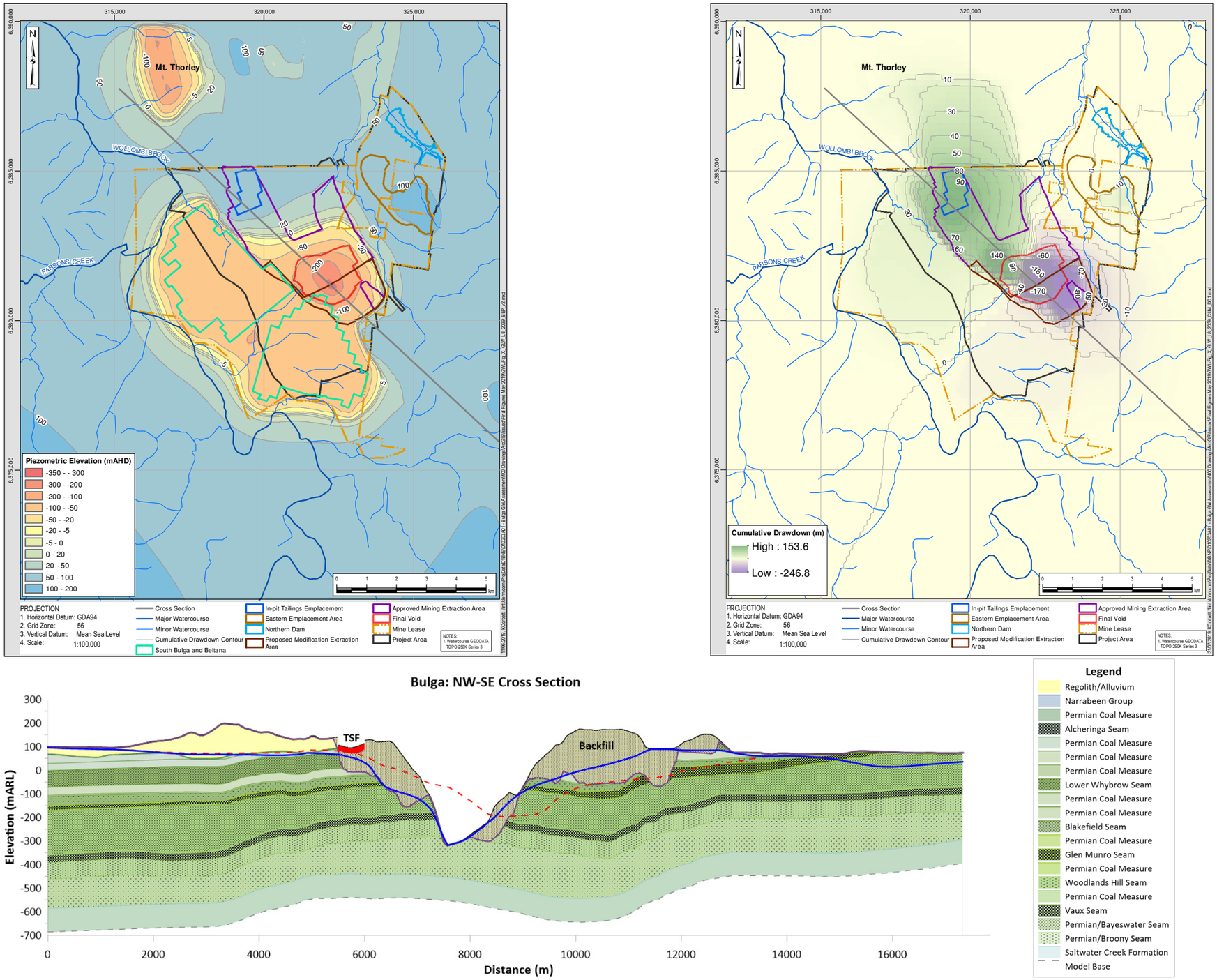


Figure 4-9: Predicted Groundwater Levels and Cross Sections for the Whybrow Seam (Proposed Modification in Blue and Approved in dashed-Red) – Largest Impact (Year 2039), Proposed Modification (L) and Project Only (R)

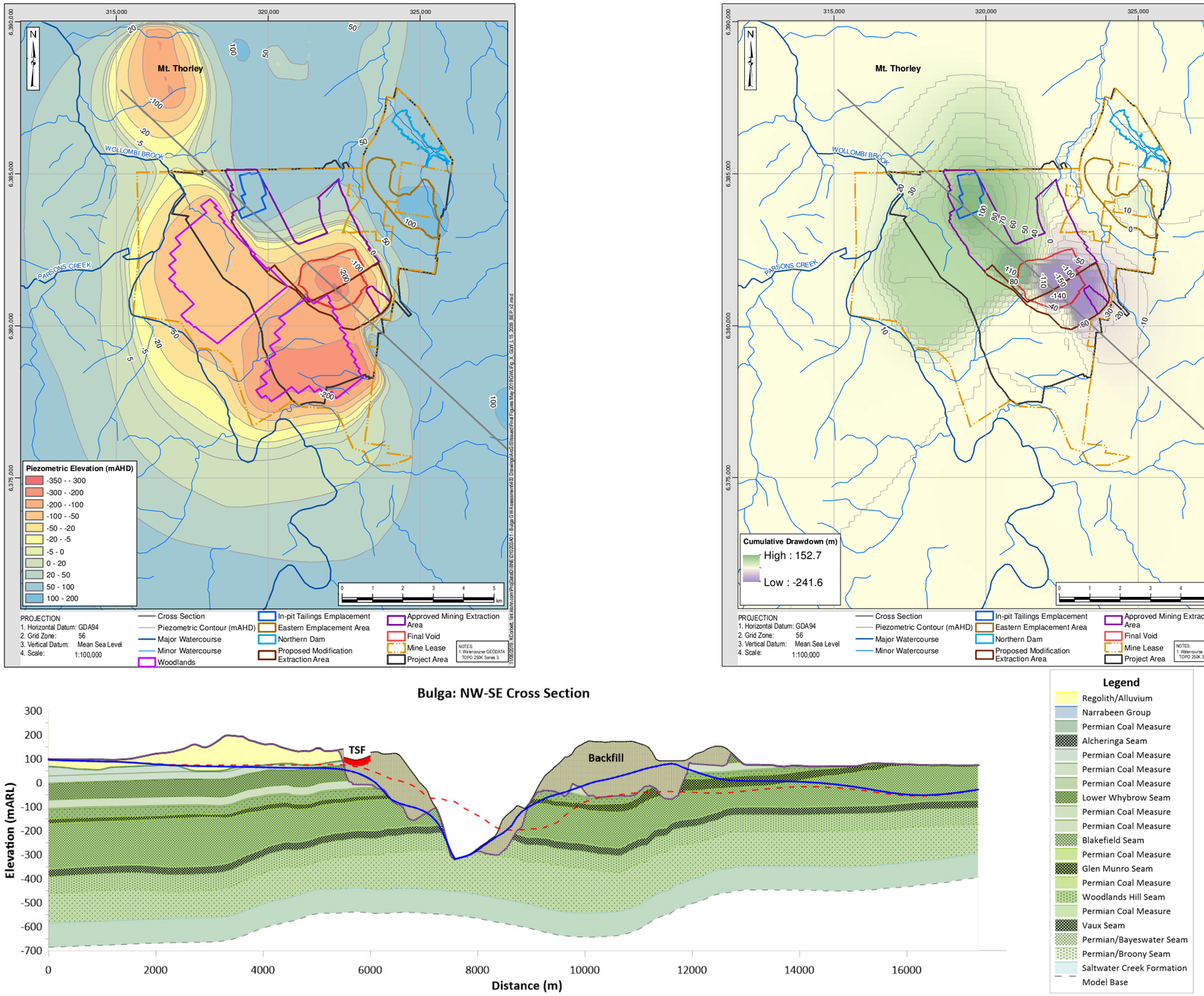


Figure 4-10: Predicted Groundwater Levels and Cross Sections for the Woodlands Hill Seam (Proposed Modification in Blue and Approved in dashed-Red) – Largest Impact (Year 2039), Proposed Modification (L) and Project Only (R)

Warkworth Sands

The Warkworth Sands are a perched groundwater system overlying low permeable weathered Permian and recharged by rainfall. While the Warkworth Sands are assessed as disconnected to the modelled Permian layers, model results for the Proposed Modification suggest that no additional drawdown will occur in the Permian units immediately underlying these sands, as a result of the Proposed Modification. The model results (Figure 5-3), as well as the probable long-term presence of perched conditions, suggest that it is unlikely that ongoing mining under the Proposed Modification scenario will negatively impact on groundwater conditions in the Warkworth Sands.

4.6.2 Predicted Changes to Mining Area Inflows

Predicted changes to mine inflows from the transient groundwater model resulting from the Proposed Modification are shown in Table 4-4.

Table 4-4: Summary of Mine Inflows

Mine	Seam	Model Layer	Start Year	End Year	Proposed Modification Peak Inflow (ML/a)	Proposed Modification Mean Inflow (ML/a)	Proposed Modification Incremental Impact (ML/a)
Bulga OC	Bayswater	1 to 19	1982	2039	1206	1024	346
South Bulga UG	Lower Whybrow	8	1994	2002	605	395	-3
Beltana UG	Lower Whybrow	8	2003	2011	1012	743	-7
Blakefield South	Blakefield	11	2010	2017	2291	1120	-1
Blakefield North	Blakefield	11	2018	2020	2089	1517	-4
Glen Munro	Glen Munro	13	2021	2026	2536	1565	-2
North Woodlands	Woodland Hill	15	2027	2033	2898	2097	138
South Woodlands	Woodland Hill	15	2033	2039	737	329	7

One of the primary drivers on the water make in the underground mines, because of the poor (limited) recharge of the Permian, is the release of water from storage as mining operations evolve. This is further complicated in the longwall mining areas, as overlap and timing differences in development of fractured goafs develops across the operations.

The open pit is expected to observe a largely static inflow until about 2023 due to inflows being diminished as underground operations dominate water make. After 2023, as the open cut deepens, inflows progressively increase to a peak of ~2,000 ML/annum, which then settles to about 1,700 ML/annum to end of mining.

Based on a total approved hard rock aquifer allocation of ~2,400 ML/a (Table 4-5) held by BCC, the predicted cumulative inflow volumes from approved open cut and underground mining operations along with the small incremental increase attributed to the Proposed Modification are predicted to exceed current hard-rock aquifer licence allocations during 2016 to 2018 (Blakefield South operation), in 2020 (Blakefield North operation), in 2024 to 2026 (Glen Munro operation) and in 2028 to 2033 (North Woodland operations).

Operational practice at Bulga Underground Mine has been to dewater only to the extent necessary to maintain operations. The sequencing and timing of the underground mining is unlikely to be as aggressive as the schedule used in the model, and furthermore, due to the requirement to undertake pre-mining gas drainage, some groundwater will be removed ahead of mining which is not reflected in the current model construction. The overall water take due to underground mining in the Permian measures is therefore likely to be less than the modelled predictions.

On average, cumulative water inflow production across the remainder of the mining life (Approved mines plus Proposed Modification impacts) is predicted to average approximately the amount of current approved hard rock allocation.

Glencore holds significant quantities of transferable hard rock aquifer allocations at other mining operations in the upper Hunter Valley which will be available to transfer to BCM if increased water extraction is required.

Table 4-5: Approved Groundwater Licence Volumes (Glencore)

License No.	Volume limit	Purpose
Bulga Coal Complex	**(ML/a)**	
20BL169347	365	Mining: Underground workings
20BL168475	500	Dewatering (mining): Beltana Longwall 1 Borehole
20BL169514 (WAL415543)	500	Dewatering (mining): Beltana MG4
20BL172658 (WAL41544)	500	Dewatering (mining): South Bulga MGE1
20BL172673 (WAL41545)	500	Dewatering (mining): South Bulga MGE4
Other Glencore Operations		
Glendell	550	Mining
HVO	5560	Mining
Integra	950	Mining
Liddell	15500	Mining
Mangoola	700	Mining
Ravensworth	4096	Mining

4.6.3 Predicted Changes in Alluvial system flows

Predicted flows for various reaches of the Wollombi Brook and Monkey Place Creek are shown in Table 4-6. The flow rate across the alluvium and base rock is presented. The location of the zones used in this analysis is shown in Figure 4-11.

Table 4-6: Predicted Alluvial Impact Summary

Alluvial Zone	Approved Project – Flow Rate @ 2039 (m^3/d)		Proposed Modification – Flow Rate @ 2039 (m^3/d)		Incremental Impact of Proposed Modification (m^3/d)		Assessment
	IN	OUT	IN	OUT	IN	OUT	
Wollombi Brook (Beltana Reach)	299	272	301	274	2	2	Negligible impact
Wollombi Brook (Bulga Reach)	101	47	101	47	0	0	Negligible impact
Lower Monkey Place Reach	87	43	81	45	-6	2	8 m^3/d out; small change (9%)
Upper Monkey Place Reach	416	329	415	343	-1	14	15 m^3/d out; less than 4% change in flows
Wollombi Brook (North Reach)	187	90	189	88	2	-2	4 m^3/d in; very small change (2%)
Wollombi Brook (South Reach)	281	149	281	149	0	0	Negligible impact

The results and the development of water take to each of these indicates that the Proposed Modification will have a small to negligible incremental impact on the alluvial take to each of these reaches. Further detail is provided in Appendix V. The results summarised in Table 4-6 support the groundwater contour plots to indicate that the changes to the groundwater system are largely restricted to the mining area.

The Upper and Lower Monkey Reach is losing water and therefore no change in the quality is expected. The small additional flow into the Wollombi Brook (North Reach) alluvium, as a result of the Proposed Modification, is expected to have an insignificant impact on the water quality.

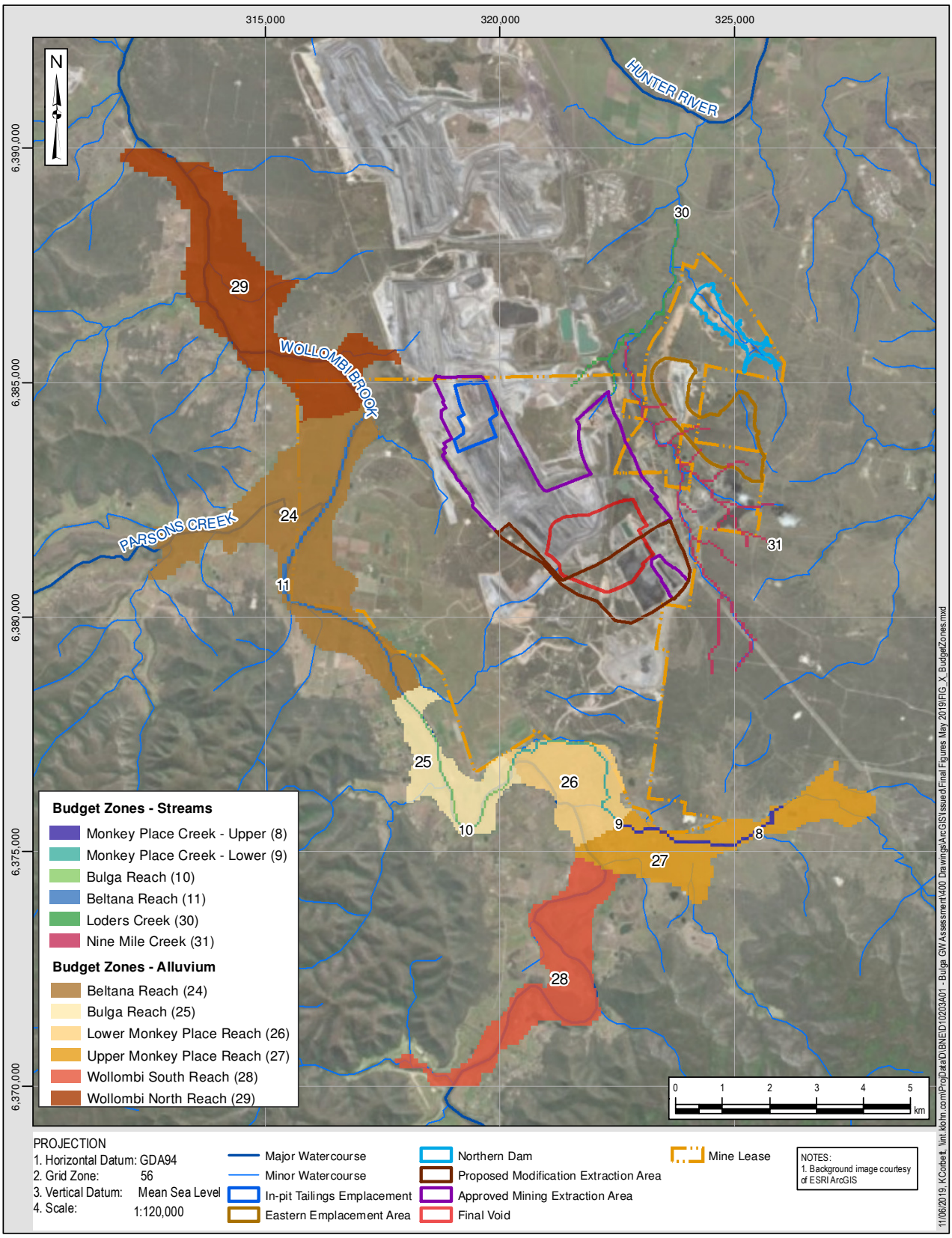


Figure 4-11: Zones Used in Determining Alluvium Losses or Gains; and Stream Water Transfer (in/out)

4.6.4 Predicted Discharge to Natural Drainages

The model has been used to extract predicted discharge to natural drainages (surface baseflows) based on the zonation shown in Figure 4-11. Detailed results are provided in Appendix V. A summary of these estimates is provided in Table 4-7.

Table 4-7: Predicted Natural Drainage Impact Summary

Natural Drainage	Approved Project – Flow Rate @ 2039 (m^3/d)	Proposed Modification – Flow Rate @ 2039 (m^3/d)	Incremental Impact of Proposed Modification (m^3/d)	Assessment
Wollombi Brook (Beltana Reach)	1392	1380	-12	<1% baseflow take
Wollombi Brook (Bulga Reach)	528	528	-	Negligible impact
Lower Monkey Place Reach	389	382	-7	<1.7% baseflow take
Upper Monkey Place Reach	450	449	-1	Negligible impact
Loders Creek	31	31	-	Negligible impact
Nine Mile Creek	14	9	-5	~36% baseflow take in average conditions (~ 0.05 L/s)

When assessing these impacts limitations to the approach are noted:

- The model is calibrated to and intended for Permian coal mining impact prediction. The alluvium is included in the model as an important receptor to these potential impacts, however, no detailed representation of conditions inside the alluvium is considered;
- Local impacts likely to affect discharge rates to surface drainage (such as irrigation activity from the alluvium, or high rainfall events) are not accounted for in the model;
- The boundary conditions influencing the ability of the model to produce creek discharge are limited in that they only consider the head of the creek versus the head of the adjacent alluvium, and that local alluvium is not uniquely represented – local conditions are likely to be more complicated and would be expected to vary along the reach of the creek alignments.

Monitoring data presented from piezometer records shows a very strong linkage between alluvial aquifer response and creek elevation – the amount of water passing from the groundwater system to the surface drainage is, therefore, more strongly influenced by rainfall and consequent creek flow, than changes that may occur in the underlying Permian units. Since averaged rainfall conditions have been applied in model predictions, the predictions shown should be considered representative of consistent average conditions of the bulked aquifer system only.

For the reaches of alluvium with higher baseflow rates (>100 m^3/day), the period of maximum baseflow prediction for the Proposed Modification and Approved cases are generally the same. Some settling of rates early in the transient simulation is apparent, however, these become

relatively stable without long term change (Appendix V). Greater variability in their range would be expected as a result of high or episodic rainfall and creek baseflow periods, however, these are not predicted in current simulations. Further, such conditions would be expected to exhibit a broader increase in saturated aquifer conditions across the alluvium, which would also likely result in more prolonged periods of higher discharge:

- Only results for Nine Mile Creek indicate small incremental water take as a result of the Proposed Modification case. The predicted changes are attributed to the presence of the developing spoil pile and the deeper open pit excavation and the hydraulic influence this imposes locally to these systems at surface. Baseflow into Nine Mile Creek decreases from 14 m^3/day to 9 m^3/day(~36%), or a reduction of 0.05 L/s for the Proposed Modification case. This water take is not considered significant, and it is also noted that alluvium is not regionally mapped in this system, and neither is it represented in this creek alignment. The prediction of flux is, therefore, representative of a small drainage over weathered Permian strata. It is noted that baseflows in Nine Mile Creek are typically ephemeral, and it is not considered a reliable water source.
- The apparent hydraulic disconnection between the alluvium and the Permian strata is consistent with the conceptual understanding of the area.
- There is a minor water take; and is not expected to have a meaningful impact on water quality in the natural surface water drainages (receptors).

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4.6.5 Post Closure Groundwater Recovery

To assess post-closure pit water balance at the completion of both underground mining and the Proposed Modification, the model was run for a period of 1,500 years past the time when mining operations are due to be complete (2039). In this simulation, drain cells were disabled from all underground and open cut mining areas to allow the system to recover (underground mines, goafed areas, the open cut void and spoil) under transient normal rainfall recharge. Only drains representing the minor surface drainage system remained in the model. Evapotranspiration (1.2 mm/d) is applied at the level of the final landform. The final elevation of the void water is controlled by the balance between the inflows and losses (largely evaporation), and while the rate of recovery is also influenced by enhanced hydraulic conductivity and increased Sy of the void.

From the groundwater model alone, the water level within the pit stabilises at approximately -53 mAHD after more than 500 years (Figure 4-12). In reality, it is likely the final pit lake level will be reached earlier, and will probably be higher, as high rainfall period contributions (not modelled) are likely to contribute to the filling rate faster. A more representative rate of recovery and final void water elevation has been determined by the integration of the groundwater flows and the surface water balance prepared concurrently by HEC. An iterative process of assessing likely groundwater contributions to the void at various elevations and understanding the water balance of the void was followed to provide an integrated assessment of the final post-closure void recovery; these aspects are reported in the surface water components rather than in this groundwater report.

Initially, the inflow rates as indicated in Figure 4-13 are estimated from the groundwater model to understand the variance in inflow rates as the groundwater levels recover.
Inflow rates to the post-mining void are about 700 m^3/day at the first modelled timestep of 90 days after closure, and abate to less than 3 m^3/day as the pit lake nears final elevation, and hydraulic gradients around the periphery of the void flatten or achieve a quasi-steady state condition. This initial inflow rate is consistent with end of mining inflow estimates, around 1,700 m^3/day, noting the first of the recovery predictions is around 3 months after cessation of mining.

The final void water level assessment from the surface water balance (once the system reaches an equilibrated level), indicates that the final open cut void will be ~ -40m RL. At this elevation, the void will remain a perennial sink to groundwater flow (Figure 4-14). Groundwater will not flow away from the final void under these conditions (apart from short-periods of very high rainfall when the void water level may show short-lived increases) with the gradients to toward the void, and no additional groundwater quality impacts from the mining operations to the alluvium or creeks are expected in the long-term after closure.

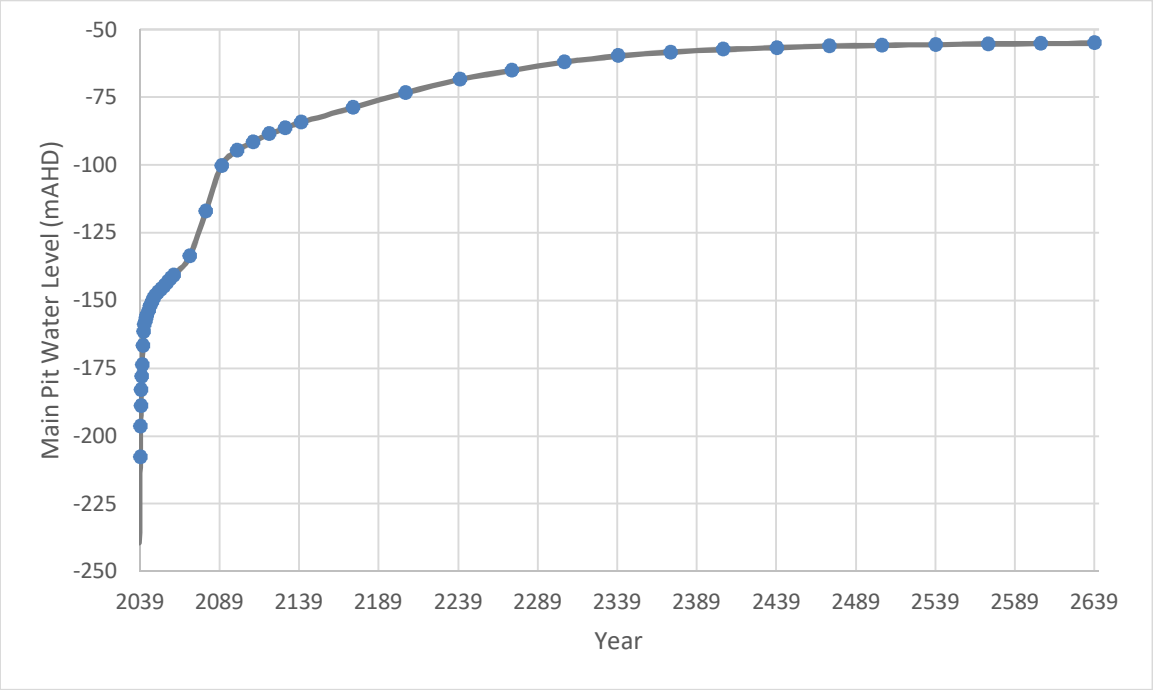


Figure 4-12: Predicted Final Void water level recovery Post-Closure under Natural Groundwater Recharge Conditions only

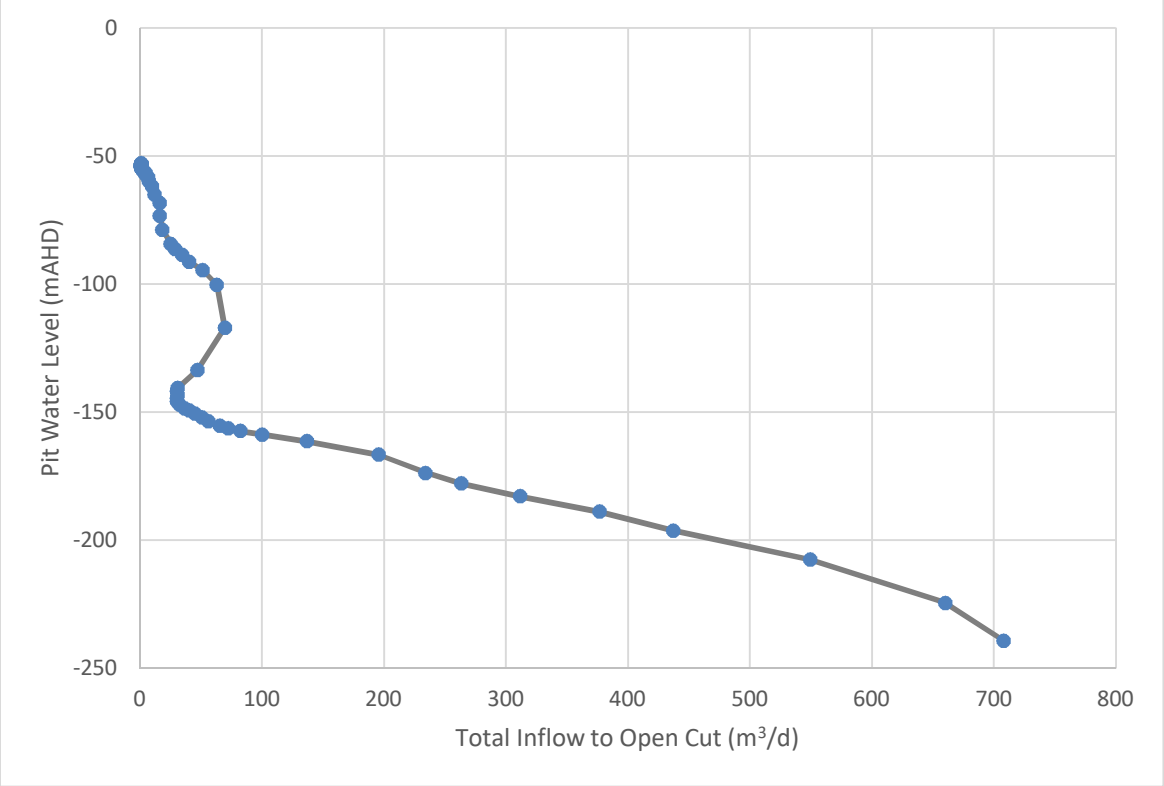


Figure 4-13: Predicted Open-cut Inflows during Recovery

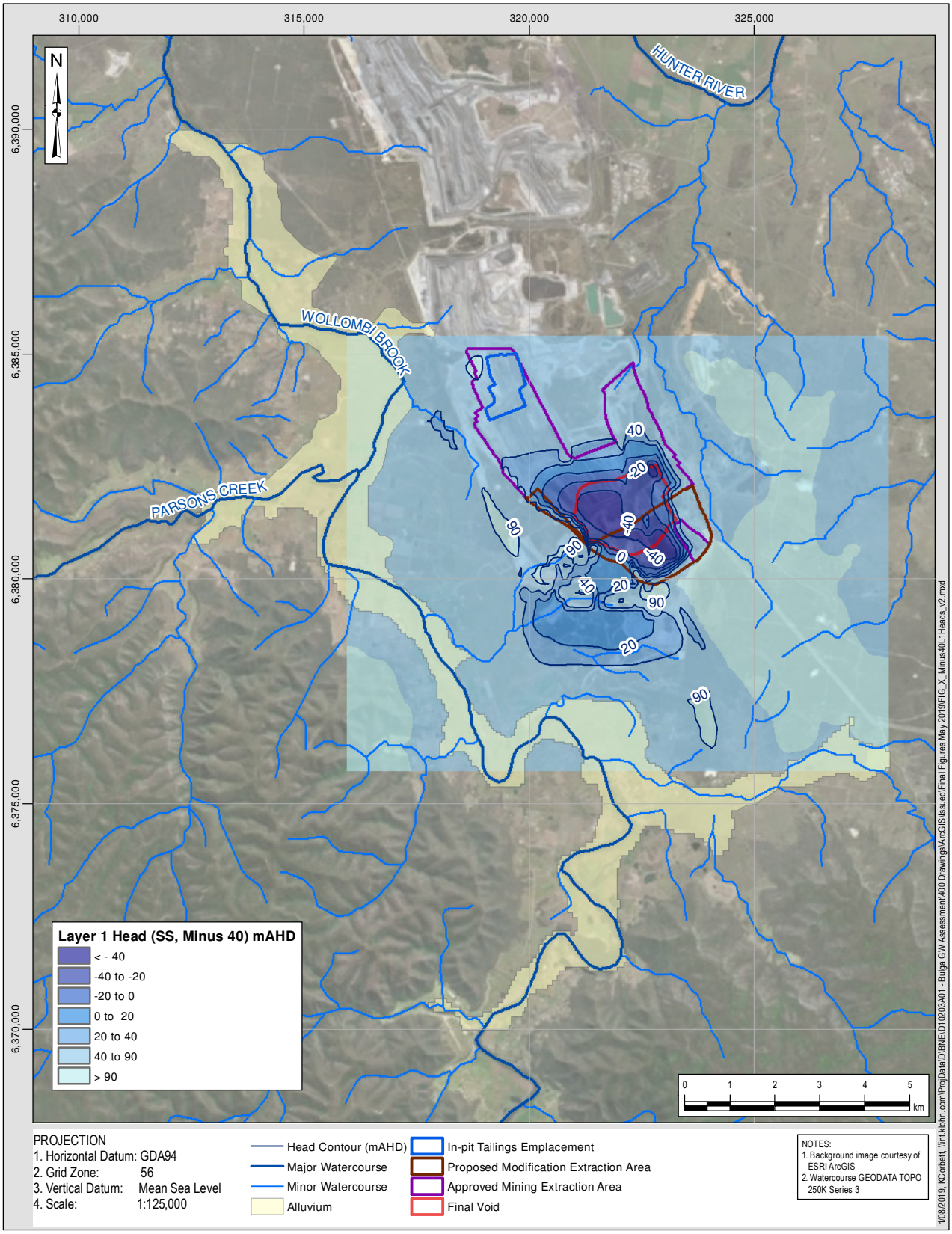


Figure 4-14: Steady State Head Conditions (Final Void at -40 mAHD, as determined by integration with surface water modelling)

4.7 Sensitivity and Uncertainty Analysis

As part of the model construction, and calibration process, sensitivity and uncertainty analyses were completed for the model (Appendix III). Since this process included aspects of the mine plan that were not consistent with the most recent iteration, the results cannot be directly used to quantify the sensitivity of the Proposed Modification. The uncertainty analysis approach broadly followed the Explanatory Note, Uncertainty Analysis in Groundwater Modelling from the IESC (Middelmis and Peeters 2018), with the approach used for Bulga consistent with the more advanced "stochastic modelling with Bayesian probability" approach outlined by the IESC note. The modeling also considered uncertainty as an integral part of the model development and assessment of results, and included the input of the external model peer-reviewer to assist in framing the approach.

For the penultimate model configuration, a suite of sensitivity analysis was completed for three specific runs, being variants of spoil recharge and spoil hydrogeological conditions, aimed at understanding the potential changes these may have on prediction of interactions between alluvium and Permian strata; and on potential groundwater derived baseflow discharge in mine proximal creeks.

In addition, a non-linear, Monte-Carlo methodology was applied for the uncertainty analysis. This methodology allows a suite of models, which collectively include the plausible range in key input parameters, to be run so that the range of outcomes can be obtained from the suite of models. A total of 360 model runs were completed.

Output from the uncertainty and sensitivity assessment was used to inform final model modification for the Proposed Modification application, however, the re-running of these data was not considered necessary for this report. The results are presented in Appendix III for discussion of the key areas of uncertainty from the conceptual understanding as it translates to the numerical simulation environment.

In general, the uncertainty analysis has shown that there is the potential for slight groundwater level drawdowns in the alluvium segments of the Wollombi Brook (Bulga Reach). The range of predicted drawdowns in these segments is localised and indicates a relatively high level of confidence with similar predictions made by the cumulative case predictive model.

In the case of Nine Mile and Loders Creeks, uncertainty analysis shows that there is generally potential for groundwater levels to decrease or rise at nearby points that potentially translate as decreased or increased baseflows.

The potential range of maximum groundwater level change over the life of mine for the range of parameters applied in the uncertainty analysis is quite large and indicates a reduced level of confidence in the prediction made by the cumulative case predictive model.

5 GROUNDWATER IMPACT ASSESSMENT

5.1 Project Only and Cumulative Impacts

General comments on model-predicted impacts of the Proposed Modification are provided:

- The majority of the groundwater drawdown impacts arise from the already-approved mining operations. The incremental change in drawdown resulting from the Proposed Modification (compared to the Approved Case) is small and almost entirely constrained to weathered or deeper Permian strata.
- Predicted mining impacts from underground operations represent the Approved mining case and are not modified for the Proposed Modification. Model predictions are generally consistent with observed monitoring to date, with predicted drawdown in the Permian strata of the order of 10's to 100's of metres restricted to areas adjacent to the mine void and above underground mined coal seams;
- Mining impacts from the approved open cut predict the development of a substantial groundwater sink, although mine inflow rates into the void are generally low due to the parallel depressurisation effects from underground operations to the west and south-west, as well as due to the low permeability of strata being mined through. This cone of depression has a negligible impact on the alluvial flows and water levels (Section 4 and Appendix V) but does appear to slightly decrease estimates of groundwater flow towards the easterly-draining Nine Mile Creek. These groundwater flow conditions, imposed by the sink, suggest that no additional water quality impacts are expected to the receiving groundwater environment, as a result of the Proposed Modification.
- Increased recharge in the spoil (0.1% to 6% - compared to the adjacent unmined strata) means that some local mounds of groundwater are expected in the spoils. The location of these mounds is expected to vary as tailings and spoil placement change over the Proposed Modification mine life, and results suggest that vertical losses from spoils to the Permian are not expected to be high due to the low K_v of the Permian strata and the very strong bedding-dominated direction of preferred groundwater movement.
- The addition of spoils and a TSF in the north of the mining area result in groundwater elevations for the Proposed Modification being higher in this area than for the Approved case, as could be expected from the increased inflows associated with these changes. While these changes are largely limited to the backfilled open cut, results indicate that this mounding creates a small component of groundwater flow towards Mt Thorley;
- Seepage from the relocated tailings is predicted to be strongly influenced by the sub-regional Permian gradients beneath the tailings, with flows during mining and post-mining predicted to fall under the deeper regional flow of the Permian units toward this sink that is formed by the open-cut void. This is consistent with spoil being a free draining unit.;
- Transition of mining impacts – underground or open cut – to alluvium is generally small, which reflects the strong permeability contrasts between these systems, and the dominance of surface recharge features (rainfall and creek flow) in maintaining conditions

in the alluvium. This is also consistent with most of the recorded monitoring observations for the Wollombi Brook and Monkey Place Creek alluvium; and

- Groundwater baseflow from alluvium to Permian from the Wollombi Brook (Beltana Reach) is predicted to be locally amplified, slightly decreasing under the application conditions of the Proposed Modification scenario.

5.2 Impacts on Groundwater Resources

5.2.1 Other Groundwater Users

Details of registered groundwater bores located within the project modelling domain were extracted from the BOM repository. Based on the results of the modelling, there are no registered bores included in the area where greater than 2 m drawdown would occur due to the Proposed Modification.

Broadly, there are observations in this spatial data that frame the interpretation of the impact from the Proposed Modification scenario:

- The alluvium impacts are consistently small to moderate due to the strong hydrogeological isolation of this system from the Permian. This is consistent with current monitoring records and supported by model predictions inclusive of sensitivity and uncertainty analysis results;
- The areas of greater than 2 m predicted drawdown are in weathered Permian and alluvium (Beltana Reach), however not near other sensitive users or receptors and do not have any externally registered bores included in the greater than 2 m drawdown (Figure 5-1);
- Mining induced drawdown impacts in the Permian strata are obvious and prominent between the lateral edge of the alluvium and the eastern extent of longwall mining operations, consistent with previous monitoring data; and
- A moderate to high reduction in head is noted in areas of spoil pile development to the east of the longwall operational extents, consistent with the expectation that spoil will be free draining and heads in the Permian outcrop areas where there is no alluvium, will show a strong drainage effect towards the open-cut void. Outside of the mining voids the drawdown impacts are limited and generally considerably less than ~ 2 m (Figure 5-1).

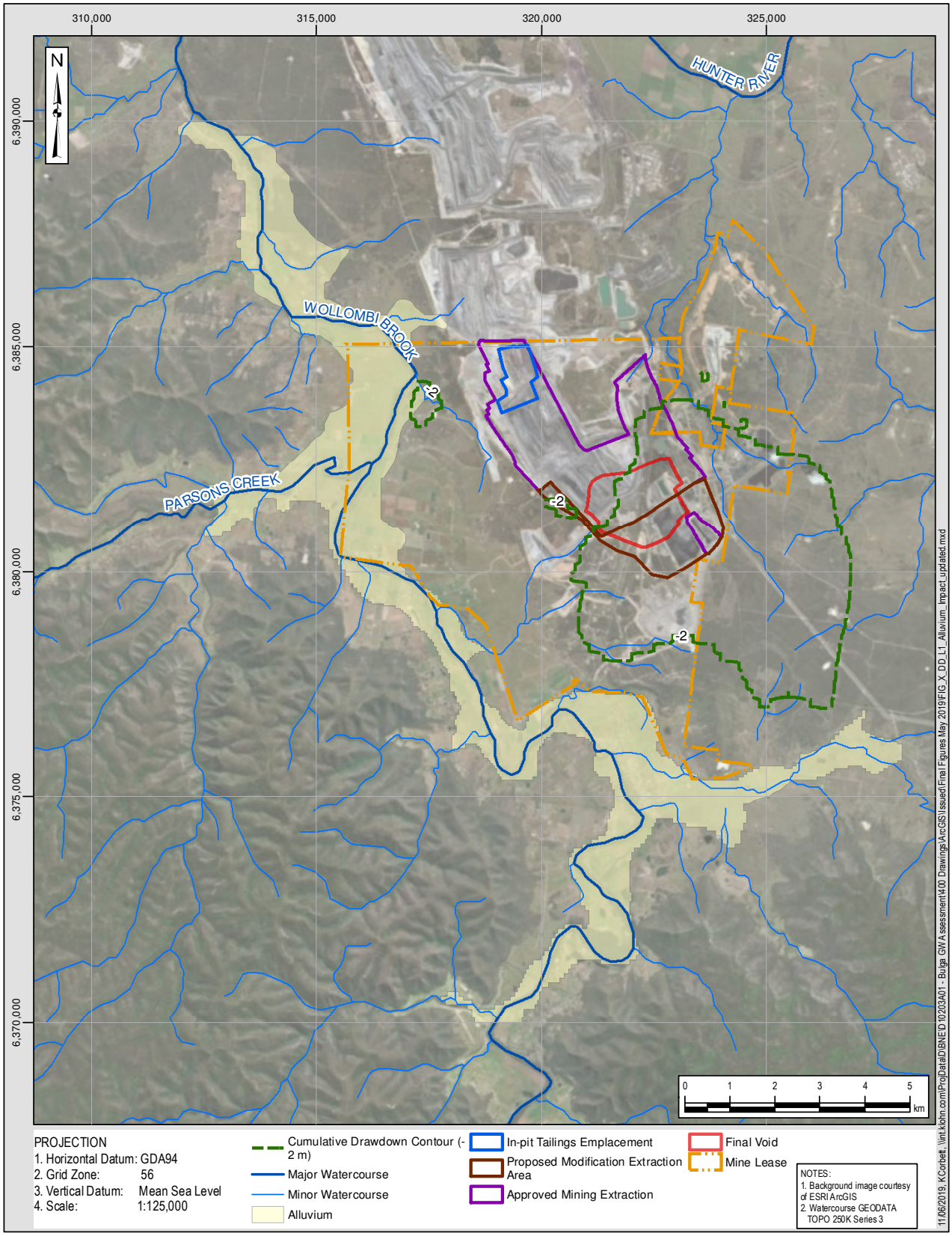


Figure 5-1: Areas where maximum predicted drawdown is greater than 2m

5.2.2 GDE Impacts

There are no proximal springs mapped near to the mining area. The nearest mapped spring or GDE is the Parnell spring, which is located about 15 km to the west of the mine in Triassic Sandstone (Figure 5-2). The nearest mapped wetlands are some 40 km to the east near Maitland. The project-only impact of the Proposed Modification is considered to be negligible to nil to each of these features.

The Warkworth Sands are interpreted to be perched, thin deposits of aeolian sands lying predominantly over low permeability Permian and weathered Permian rock. The model results indicate that the change to Permian groundwater levels as a result of the Proposed Modification in this area is negligible (Figure 5-3). In addition, the Warkworth Sands are expected to be hydraulically disconnected from the regional saturated groundwater systems and, because of this isolation, are unlikely to be impacted by either the already-approved case or the Proposed Modification case.

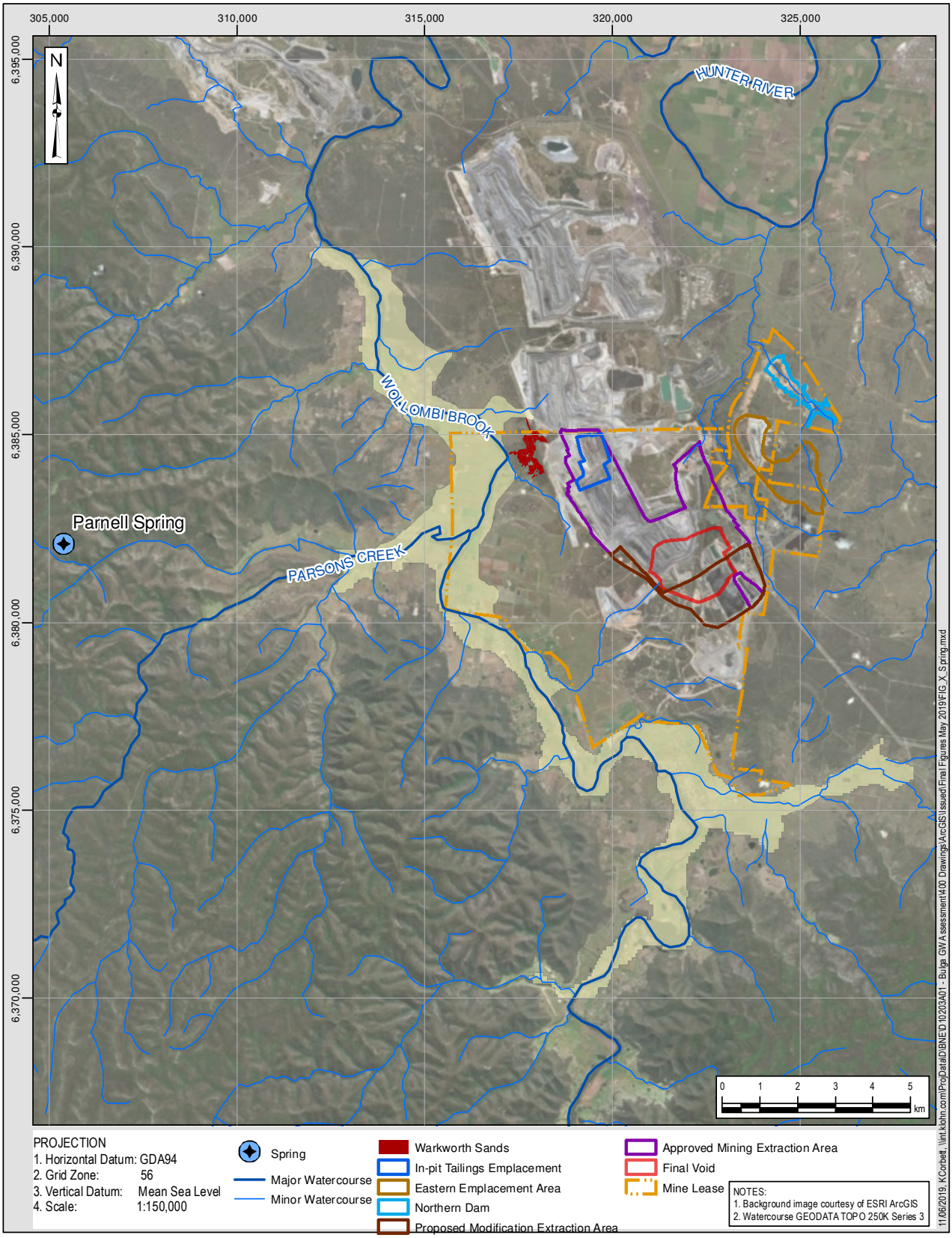


Figure 5-2: Location of Parnell Spring and Warkworth Sands to the Bulga Mine Operation

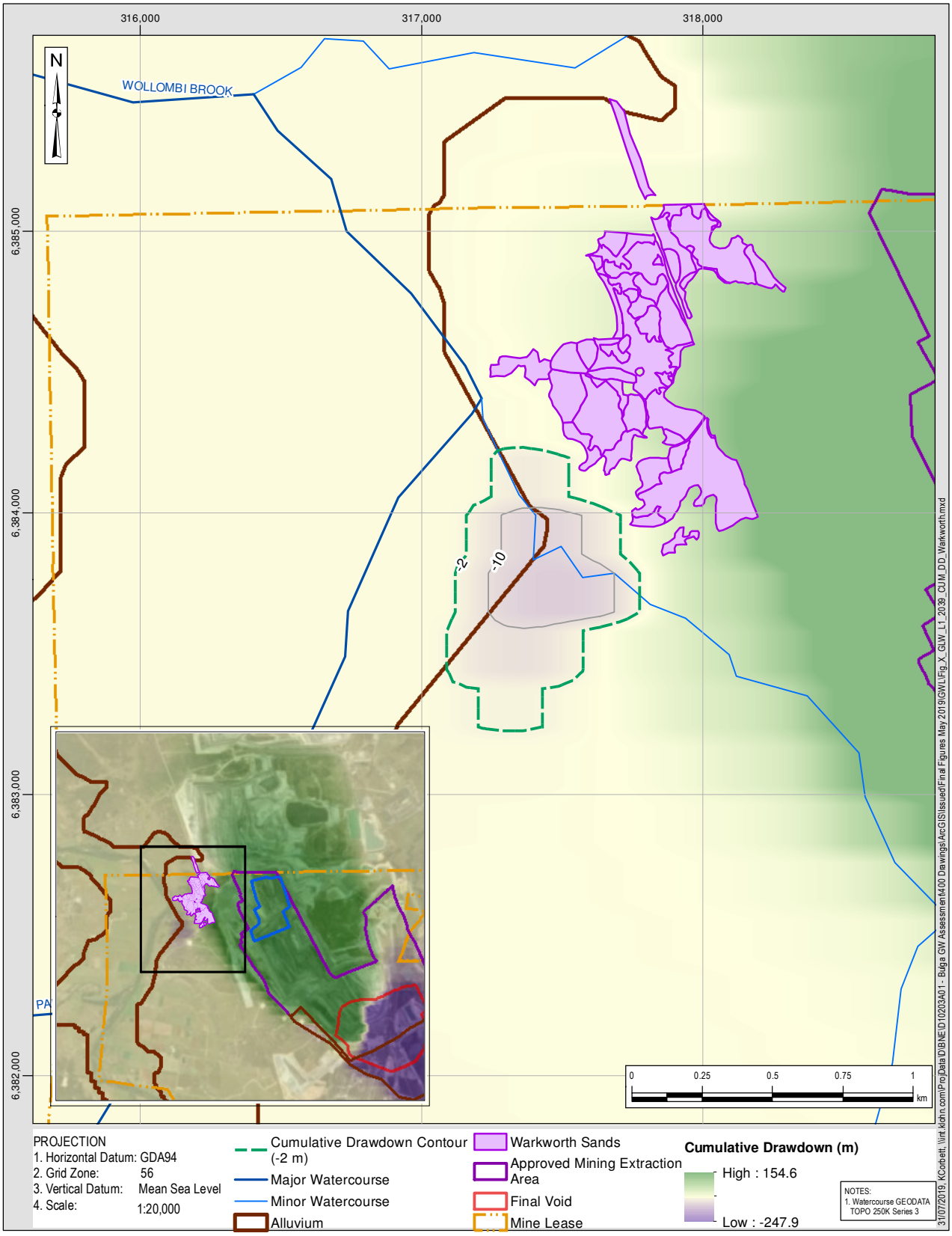


Figure 5-3: Warkworth Sands and the Proposed Modification drawdown imposed

5.3 Mining Impacts on Surface Drainage

Mining impacts on creeks are discussed in Section 4.6 in the context of cumulative (final) and project-only (Project Modification) predictions. Predicted incremental impacts from the Proposed Modification are considered negligible and are summarised in the following:

Wollombi Brook & Monkey Place Creek

- Proposed Modification impacts are small to negligible to these two systems. Both sensitivity analysis and predictive uncertainty analysis support this prediction from the Propopsed Modification results, as do monitoring data which indicates strong hydraulic isolation from deeper effects.
- There is a minor change in flows; and is not expected to have a meaningful impact on water quality in these surface water drainages (receptors).

Loders Creek

- Proposed Modification impacts are negligible.

Nine Mile Creek

- Flow toward Nine Mile Creek decreases by up to 5 m^3/day, or 0.05 L/s.

5.4 TSF Predicted Impacts

An estimate of the predicted impacts of the relocated TSF (for maximum conditions at 2039) is shown in Figure 5-4.

The results indicate the TSF provides a source of additional water to the system and increases local groundwater levels in the northern part of the mining area due to mounding effects. This is not unexpected for a mass of low permeability and saturated material. A component of the groundwater flow as a consequence of this local mounding is toward Mt Thorley in the north and is predicted to be in the order of 100 m^3/d (peaking at about 1.6 L/s, longer term <1.0L/s, with seasonal variation). This northerly flow is a relatively small component of total flow which falls under the regional gradient of the deeper Permian strata, and flows toward the south under the gradient controlled by the deeper periods of open cut mining, and after mining ceases, to the final pit lake.

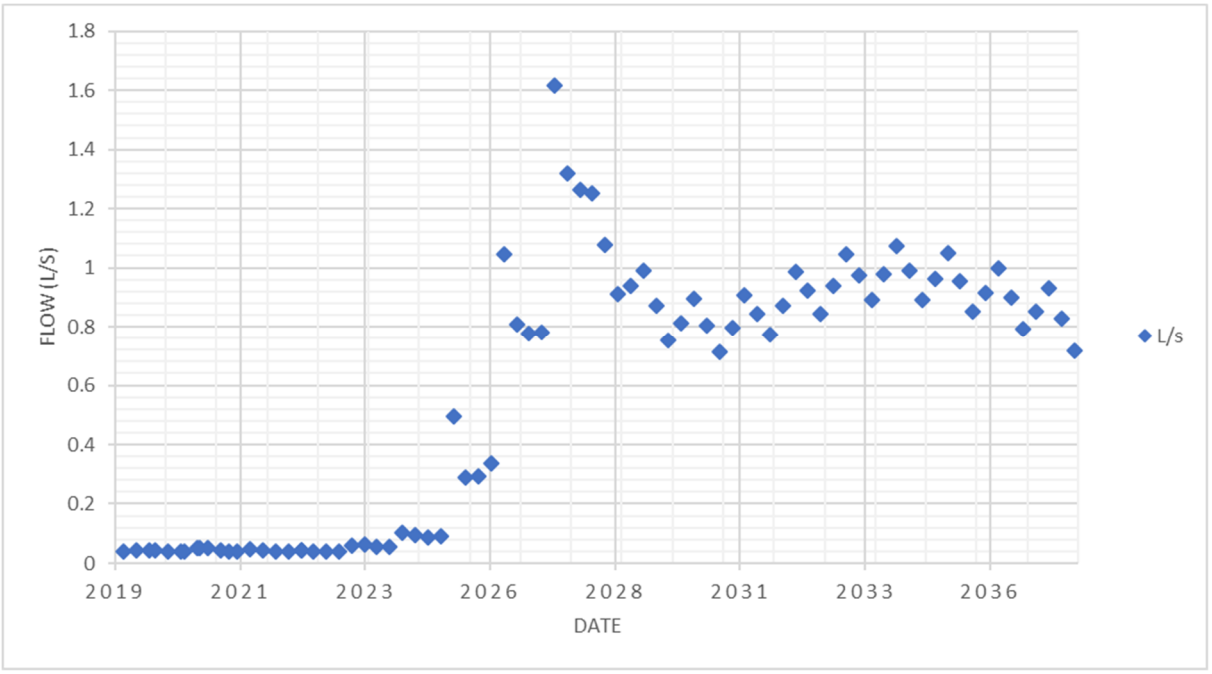


Figure 5-4: Predicted Flow from Bulga Mine Operation to the north

5.4.1 Emergent Seepage Pathways

Groundwater flow vectors for Permian strata are shown for the end of mining condition and indicate a preference for flow under regional gradients toward the south (underground workings in the Woodland Hills and Glen Munro Seam) and the final pit void. Conceptually this is a mining-developed preferred flow path diverting seepage to the south, to what will be a significant groundwater sink to the local Permian strata (Figure 5-5).

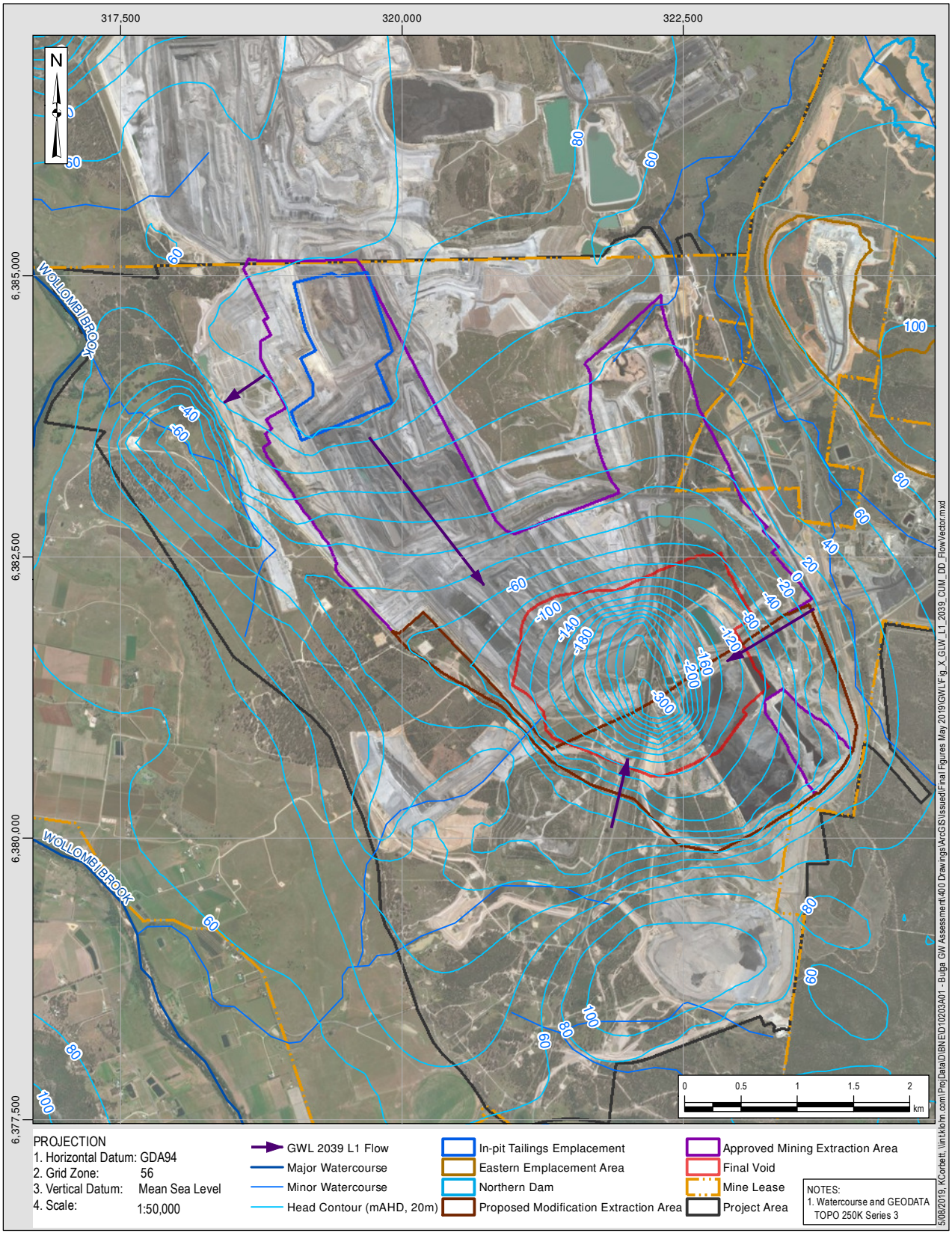


Figure 5-5: Groundwater Flow Direction, End of Mining 2039

To complement the flow vectors, particle seeds were placed within, and adjacent to, the TSF. These particles were forward-tracked using "streamlines" (which are flow paths within an instantaneous flow field) based on the modelled flow fields at the end of mine life (i.e. 2039) and after recovery of the pit void. In the figures shown time markers (yellow dots) are set at 10 year intervals (Figure 5-6). Since the predictive simulation has a total run time of around 20 years, path-line tracking does little to show the fate of particles (due to their slow travel time).

Particles were seeded vertically in all model layers, at the locations shown. The two particle tracking snapshots indicate that when released, the particles travel in a predominantly southerly direction and are intercepted by the pit void which acts as a groundwater sink. They appear to be contained within the area of open-cut mining disturbance, falling under the gradient of the pit which is a groundwater sink to the local Permian strata. This is consistent with the groundwater flow patterns predicted by the model.

The flux estimates, water balance, flow vectors and particle seeds all predict dominance under regional gradients of flow from the TSF toward the pit. There is a transient component of flow toward the north (as the tailings elevation increases relative to the operations to the north), and local conditions will need to be monitored as the TSF is filled to assess the presence of potential local pathways or changed material parameter assumptions to those used in this model. Long-term closure conditions indicate that flows will remain toward the recovering final void in the post-closure period (Section 4.6.5).

5.4.2 Impact Summary

Summary tables for the impacts have been compiled to provide a succinct indication of potential impact. In Table 5-1, the impacts from the proposed modification are assessed while in Table 5-2 the assessment according to the AIP guidelines is provided.

Table 5-1: Summary of the Proposed Modification only

Description	Cumulative Impact	Assessment
Change in water-level	Minor to negligible changes in water level and drawdown in alluvial.	Negligible; incremental impacts are predicted on the eastern edge of the alluvial system. Near the Northern Drainage Line, potential for drawdown has been identified. This does not transfer further westward toward Wollombi Brook nor does it have a meaningful impact on groundwater flow through the alluvium in the Beltana reach. Incremental impacts of the Proposed Modification are negligible.
	Drawdown impacts in the Permian strata are 10's to 100's of metres above mined through coal seams in approved underground mining areas.	The Proposed Modification does not include any changes to approved underground mining. Results indicate that this drawdown does not extend significant distances from the edge of the mining activities. Using a conservative 2 m drawdown contour indicated that almost all the drawdown is near or very close to mining, and that drawdown greater than 2 m does not impact alluvials or encroach to within 40 m of potentially sensitive receptors. Incremental impacts from the Proposed Modification are negligible.

Description	Cumulative Impact	Assessment
Mine inflow rates	The open cut presents the development of a substantial groundwater sink. The Proposed Modification represents a small incremental increase in that sink around the approved open cut and approved underground mines.	The Proposed Modification results in incremental change to the approved open cut inflows of 346 ML/a (~10.9L/s). The predicted cumulative inflows from approved open cut combined with the Proposed Modification indicated that the hard rock licenced abstraction will not be exceeded.
Alluvium and surface creeks	Nine Mile Creek is predicted to observe small changes in flows.	The alluvium impacts are consistently small due to the strong hydrogeological isolation.
TSF and additional spoils	Seepage (~200 - 300 ML/a) from the relocated tailings are predicted to flow toward the dominant groundwater sink that is the final void. The increased head from the tailings and spoil in the north will increase flow toward Mount Thorley.	Moderate rise in head is noted in area of spoil pile development and near the TSF in the north. Flows of ~ 1 L/s to the north may result from the Proposed Project Modification.
Spring/GDEs and other sensitive receptors	There are no proximal springs mapped near to the mining area (nearest spring is Parnell, located ~15 km to the west of the mine). The Workworth Sands are near the operations, but results indicate that these will not be incrementally impacted by the Proposed Modification.	None of the GDEs or springs are incrementally impacted by the Proposed Modification. Notwithstanding that the Warkworth Sands are regarded as disconnected to the underlying units, the results indicate that the Proposed Modification will not increase drawdown of the units immediately below these sands, compared to the Approved scenario.
Other users	No other registered groundwater users identified within the 2 m drawdown.	No impact to other registered groundwater users.

Table 5-2: AIP Assessment Summary

Description	Assessment
Accounting for the amount of water taken to ensure the amount taken does not exceed the extraction limit in the WSP.	The Proposed Modification will result in a minor incremental increase in predicted inflows (~475 ML/a). Glencore has access to adequate hard rock aquifer allocation to ensure coverage for the cumulative inflows of the Approved Mining and the Proposed Modification.
Water table – drawdown impacts must be less than or equal to 10% of the cumulative variation in the water table and at least 40 m from high priority GDE's or culturally significant sites with a maximum of a 2 m decline. If it is more than 10% or 2 m or closer than 40 m, the long-term viability of the GDE or significant site must be demonstrated.	Not triggered by the predicted cumulative groundwater impacts of the Approved Mining operations or the Proposed Modification.
Water pressure -cumulative pressure head decline of less than 40% of the prescribed pressure head to a maximum of 2 m at any water supply work. Should the decline be greater than 40% or 2 m, the decline cannot affect the long-term viability of the water supply works unless make good provisions apply.	No drawdown near water supply works from the Proposed Modification.
Water quality – there are three conditions: • No decrease of water quality lower than the beneficial use category beyond a 40 m buffer zone around the mining activity, • No increase of more than 1% per activity in the long-term average salinity in highly connect surface water sources, and • No mining below natural ground surface within 200 m laterally or 100 m vertically of a connected (alluvial) water source.	Not triggered by any of the groundwater impacts from the Proposed Modification.

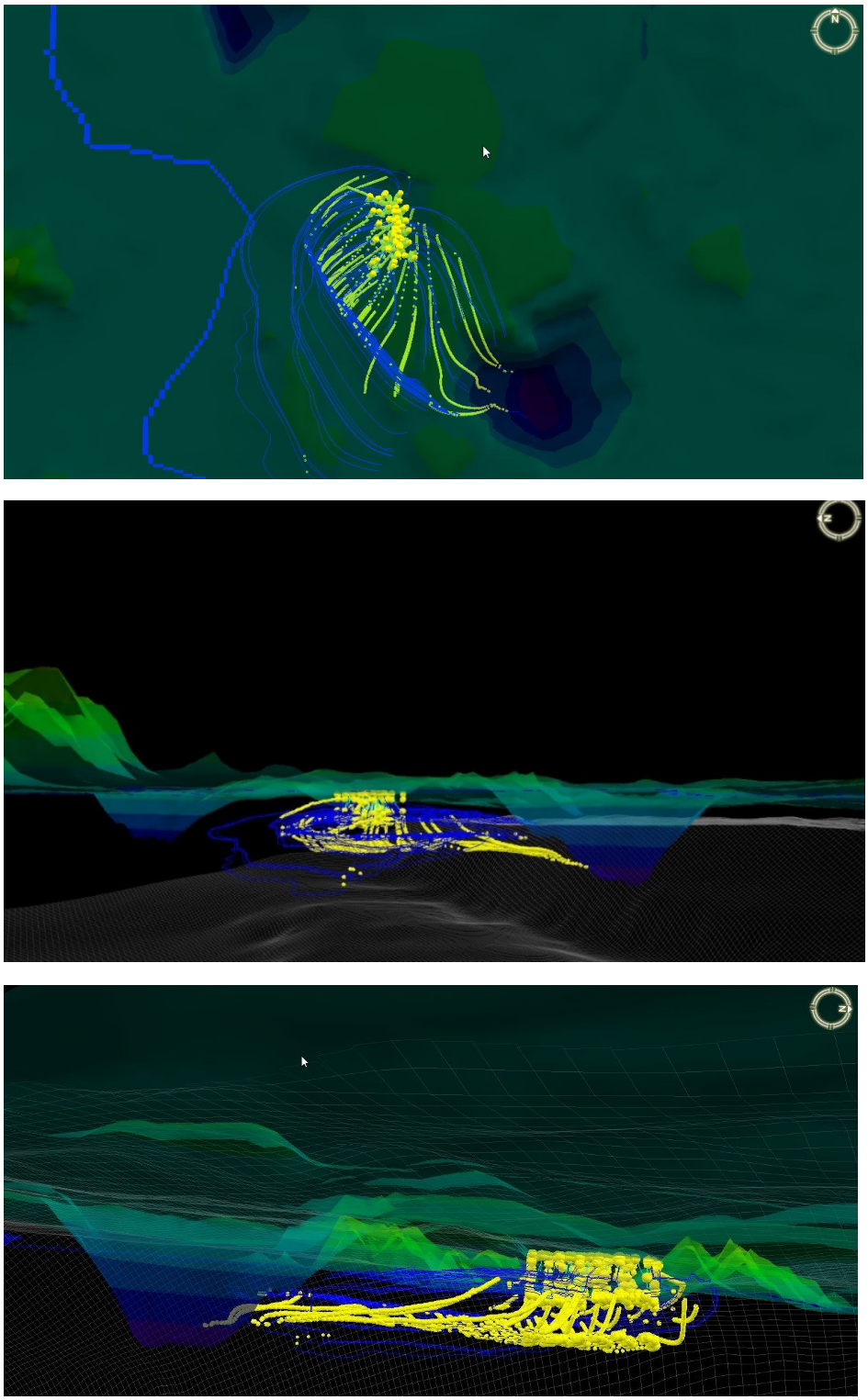


Figure 5-6: Particle Tracking, End of Mining 2039 (Plan view, E-W and W-E sections indicated)

5.5 Monitoring, Triggers and Mitigation

The Bulga Coal Water Management Plan (BCWMP) was last updated in June 2016; and is due for review in June 2019. This is a comprehensive document which addresses all activities associated with the management of water at BCC, with exception of the potable water supply. The monitoring network at BCC is comprehensive as detailed in Appendix I, and reporting obligations are met through online posting of routine monitoring reports.

With focus on groundwater, the BCWMP provides "*the aim of the groundwater monitoring program is to provide the early warning of the potential changes in groundwater levels and quality which exceed trigger levels determined for the site and are outside of the predicted (modelled) values."* The program currently comprises:

- Bi-monthly water level monitoring in all standpipe piezometers including the measurement of electrical conductivity (EC);
- Continuing monitoring of pressure heads in 15 VWPs;
- Continuing monitoring of water levels in 22 standpipe piezometers which are equipped with data loggers; and
- Comprehensive hydrogeochemical sampling and analysis undertaken on a half-yearly basis in all 49 standpipe piezometers (including major ions and metals).

Model predictions of incremental impacts from the Proposed Modification do not identify potential impacts that may necessitate further monitoring. This is largely a result of the strongly contrasting conditions between the alluvium and Permian, the differing stress and recharge conditions each are exposed to, and the fact that the Proposed Modification is not a significant excursion from the Approved case.

The development of the Proposed Modification and the imminent review of the BCWMP provide a good opportunity to consider and adapt the monitoring network to suit the future needs of the operation. This may include:

- Increased monitoring near the edge of the alluvial in the reach of the northern flow where this thins. This is an area where modelling suggests that an increased level of scrutiny is required to confirm that drawdown does not impact on the alluvial system;
- More detailed mapping of Loders and Nine Mile creek alluvium, to provide improved conceptual understanding of the easterly and northerly flowing drainages for future groundwater model upgrades;
- Hydrogeological ground-truthing at the Warkworth Sands Woodlands, located to the west, to verify current understanding of perched aquifers of aeolian sand sheet deposits, and assess the suitability of a site for monitoring if warranted;
- Consideration of establishment of monitoring, or confirmation of assumed conceptualisation, of perched groundwater conditions in the area of the Warkworth Sands Woodlands. In the event such assessment indicates these systems are confirmed to require closer monitoring, establishment of suitable monitoring of creek flows (levels, temperature and quality) should be made;

- Inclusion of these new locations, if warranted, into the suite of sites that are currently included in the groundwater quality data collection program, noting ion-balance and water speciation may become very important in understanding the source of water which may give rise to changes in system hydrogeology.

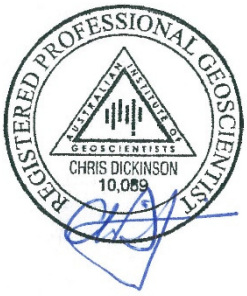
Mining activity to the north of Bulga in the short and long term remains uncertain. The timing of mine development and the nature of post-mining landforms outside of the Bulga tenement will affect predictions of impact from the Proposed Modification, and consequent model updates may be needed to inform mitigation.

6 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Umwelt (Client) for the specific application to the Bulga Proposed Modified Groundwater Impact Assessment (GIA). The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Yours truly,

KLOHN CRIPPEN BERGER LTD.



Chris Dickinson, RPGeo
Principal Hydrogeologist

CD:BU

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APPENDIX I

Bulga Coal Project, Review of Monitoring Data (KCB, 2018)

September 4, 2018

Glencore Coal
Bulga Coal Mine, NSW
e-delivery

Greg Newton
Approvals Manager - Glencore

Dear Mr. Newton:

Bulga Coal Project
Review of Monitoring Data

1 INTRODUCTION

Klohn Crippen Berger Ltd (KCB) is pleased to provide Glencore Coal (Glencore) with this summary of the Bulga Mine groundwater and surface water monitoring network.

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Glencore Coal (Client) for the specific application to the Bulga Coal Mine. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

1.1 Project Background

The Bulga Coal Complex (BCC) has both open cut and underground operations, and is located 12 km southwest of Singleton and approximately 2 km from the townships of Broke and Bulga in the Upper Hunter Valley, NSW.

The BOP (the original 'Bulga Optimisation Project') was initiated as a continuation of the existing open cut operations, extending and deepening the mine pit towards the east. During the BOP, it was identified that there would be improved efficiency of removing resources from the Piercefield coal seams by extending the pit to the south east.

The Bulga Optimisation Project Modification 2 (BOPM2) relates to the extension of the open cut operations to the south east which will also allow for the extraction of resources below the approved pit. To extract the additional resources, ±30 million cubic metres of tailings need to be relocated from the current tailings storage facilities (TSF), Deep Pit and Bayswater Pit, to the Main Pit TSF. This Main Pit TSF will consequently need to be expanded.

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The Project will have a 12.2 Mtpa[1] ROM, extract an additional 64 Mt of coal and extend the life of mine (LOM) by ~4 years. Mining will still be undertaken within the existing Mining Licence with all proposed BOPM2 works within the approved mine footprint. Access to approved underground resources to the south and west of the pit will not be affected.

1.2 Data Reviewed

Data reviewed as part of this appraisal was collected from the mine as part of a broader assessment of the BOPM2, which is currently underway and due for completion later in 2018. This larger project comprises an updated hydrogeological conceptualisation, and remodelling (including re-calibration) of the proposed mining activity.

Key data reviewed and presented in this document include:

- Piezometric and VWP records;
- Stream flow data for Wollombi Brook;
- Field collected EC correlated with groundwater level information;
- Fracture development surface expression across the mining area;
- Surface water sample analysis; and
- Historical report, for geological and hydrogeological conceptualisation, modelling and predictive work.

1.3 Physical Setting

1.3.1 Topography and Drainage

The site lies in the Upper Hunter Coalfields of the central NSW coast, and straddles a gentle topographic high around which the Wollombi Brook flows (Figure 1). This feature strikes roughly southeast to northwest, coincident with Jerrys Plain Subgroup outcrop. Underground mine development is to the west of this feature, and open cut mining straddles the high.

The site is bounded by Monkey Place Creek to the south-south west and Wollombi Brook to the west (David 2017). Wollombi Brook is the most dominant drainage and is largely perennial in flow. Loders Creek is an ephemeral system which flows south east to north west along the eastern perimeter of the tenement, before flowing northward and merging with the Hunter River.

[1] Mtpa – million tonnes per annum

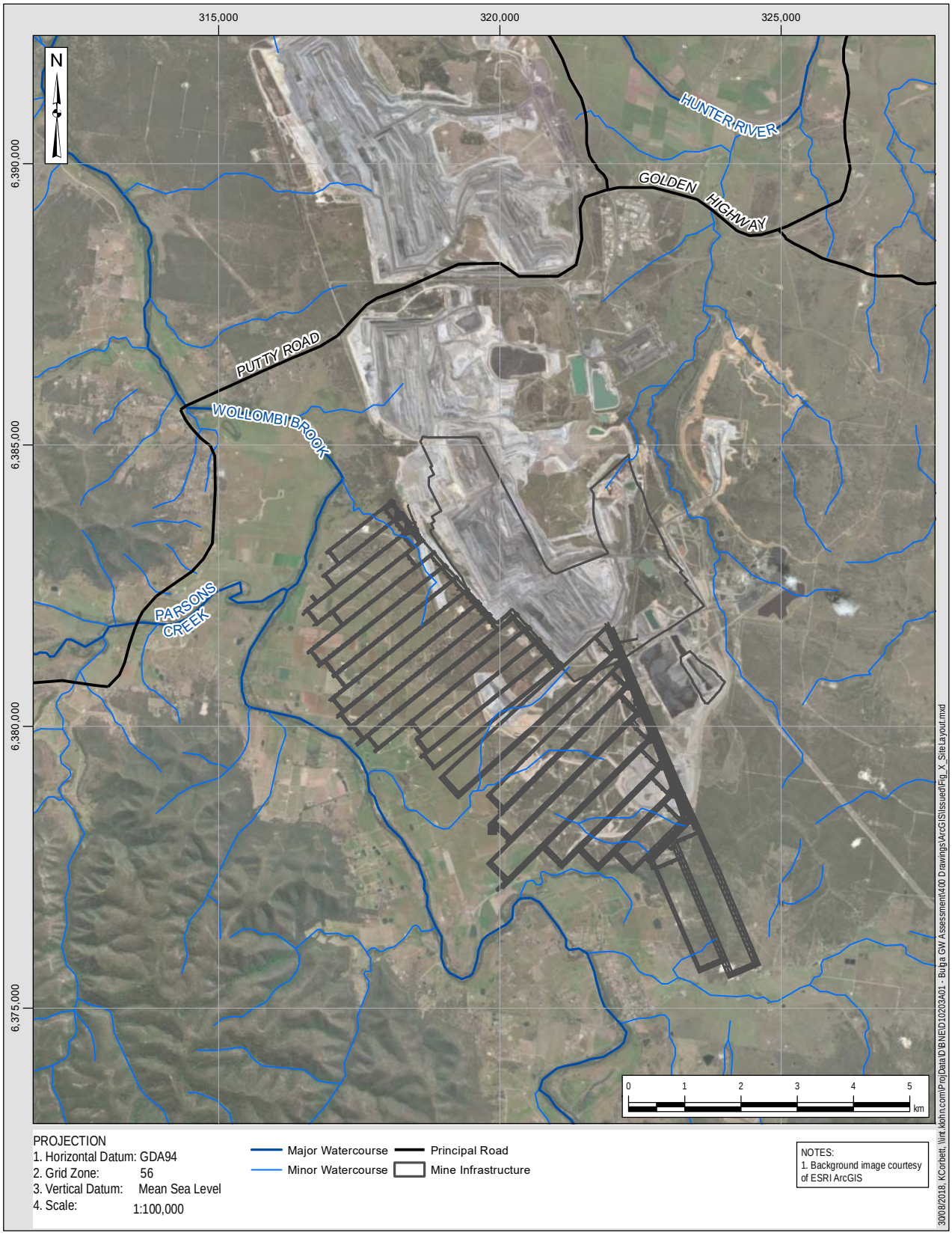


Figure 1: Local Mine Topography and Drainage

Creek flow (gauge height and flow rate) is provided in Figure 2 for the Wollombi Brook station 210028 for the period 2000 to 2018. This station is located to the north-west of the mine, with the following key statistics, for the ~18-year period of record assessed:

- The creek has a median daily flow of 0.153 m^3/sec;
- Average daily flow exceeding 10 m^3/sec has occurred on 199 days (~3% of the time);
- Average daily flow exceeding 100 m^3/sec has occurred on 18 days (~0.3% of the time);
- Gauge height indicates most flow occurs between 0.5 m and 1.5 m; and
- Reduction in flow following major events can take weeks to months to abate, with several periods of prolonged flow height above 1 m.

Gauge height data has been applied to all piezometer hydrographs presented later in this report.

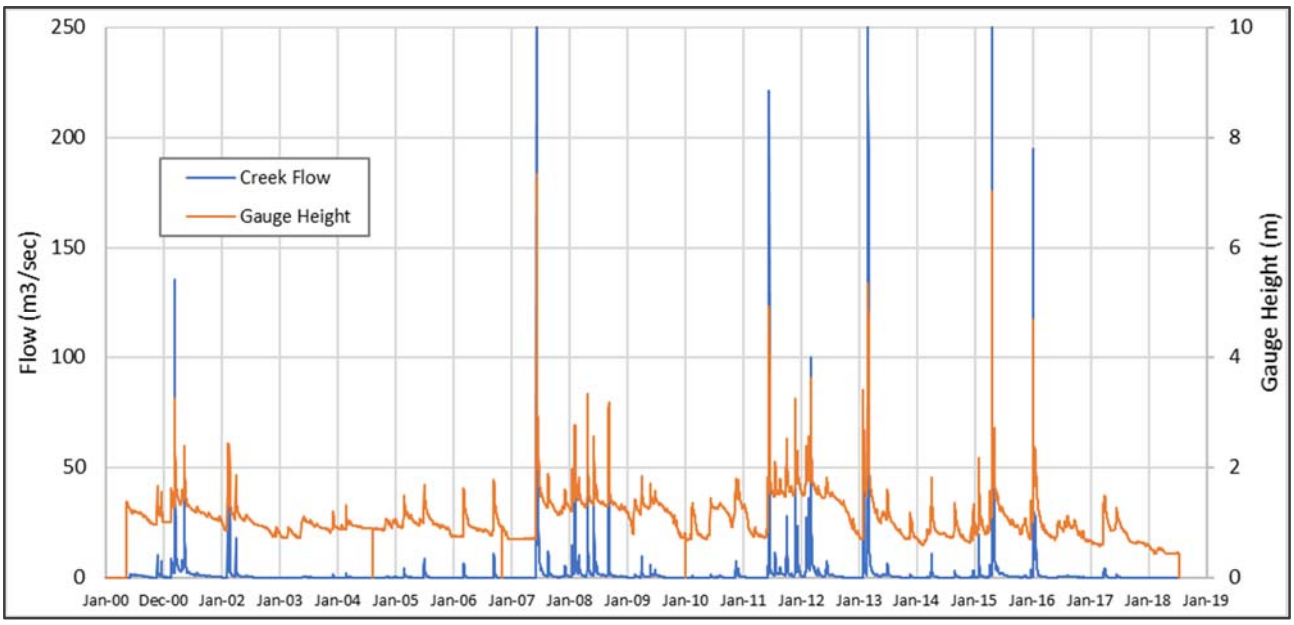


Figure 2: Wollombi Brook, Station 210028, Flow and Creek Height Records, 2000-2018

1.3.2 Regional Geology

The mine is located in the northern part of the Sydney Basin and accesses coal from Permian strata from surface, which dip to the south west beneath the alluvium of the Wollombi Brook and outcropping Triassic sandstone of the Narrabeen Group and the Hawkesbury Sandstone. Local remnants of Jurassic basalt flank the eastern side of the Wollombi Brook.

Regional and local geology of the area are shown in Figure 3 and Figure 4 respectively. A modified stratigraphic summary of key strata based on the 1:100,000 Hunter Coalfield Regional Geology map ref.9033 is shown in Table 1. Relevant geology of the project site includes (from youngest to oldest)

- Quaternary alluvium;
- Tertiary / Jurassic basalt;
- Triassic sandstone; and
- Permian Coal Measures.

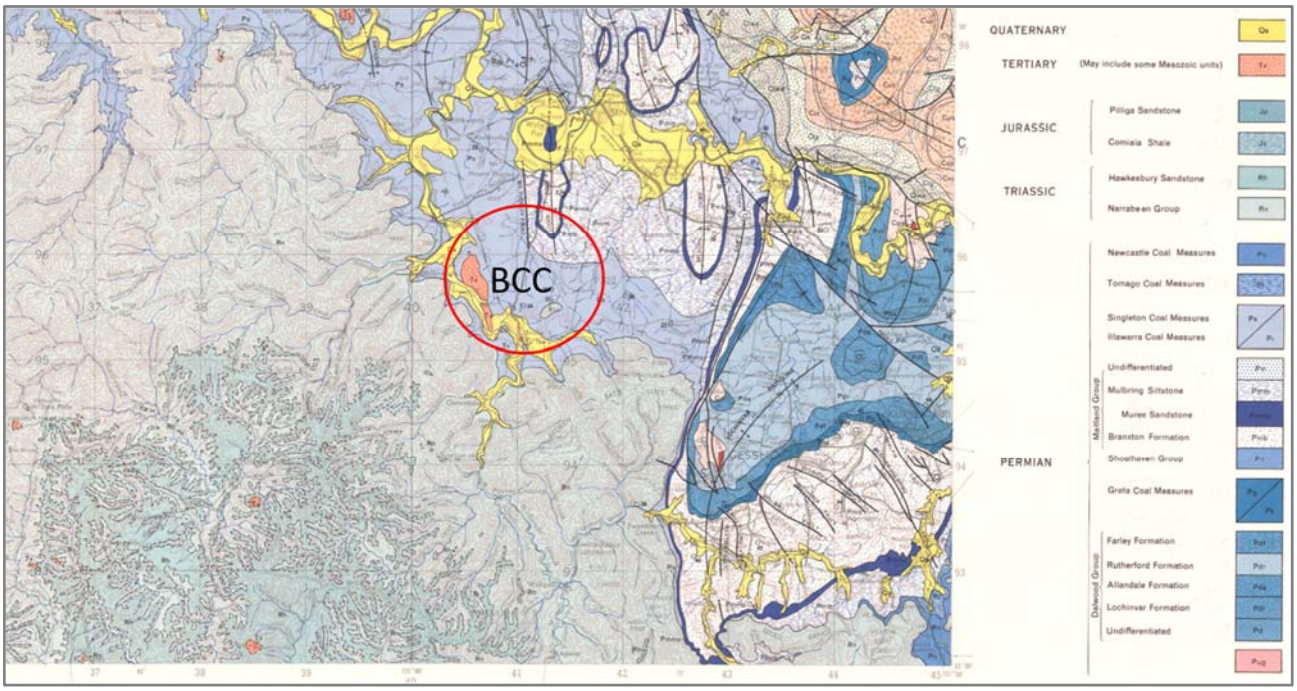


Figure 3: Regional Geology, Singleton 1:250,000 Geology Sheet

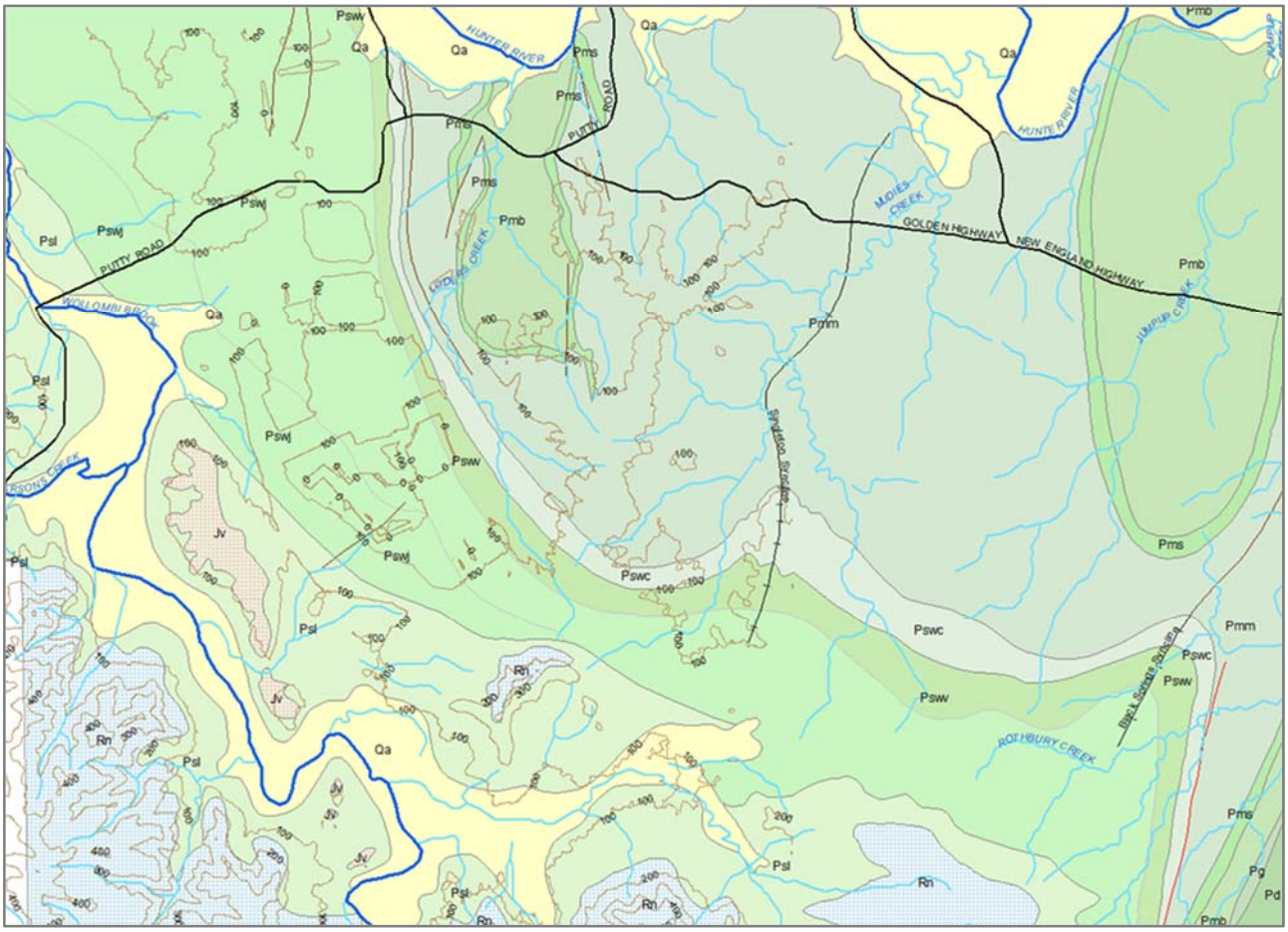


Figure 4: Local Geology after (Glen and Beckett 1993)

Table 1: Stratigraphy of the BCC area (after Glenn & Beckett, 1993)

Period	Unit		Stratigraphy		Lithology
Quaternary		Qa	undifferentiated alluvium		Alluvial terrace deposits, lay, silt, sand and gravel -
Jurassic		Jv	unnamed Basalt		Basalt, flows, sills and dykes
Triassic		Rn	Hawkesbury Sandstone		Massive bedded, cross bedded and horizontally bedded quartz sandstone and minor siltstone
	Narrabeen Group		Terrigal Formation		Sandstone, interbedded sandstone, siltstone and claystone
			Clifton Subgroup	Patonga Sandstone	
				Tuggerah Formation	
				Widden Brook Conglomerate	Sandstone and conglomerate
Upper Permian	Singleton Super Group	Psl	Wollombi Coal Measures	Glen Gallic Subgroup	Conglomerate, sandstone, siltstone, claystone, tuff and coal
				Doyles Creek Subgroup	
				Horseshow Creek Subgroup	
				Apple Tree Flat Subgroup	
				Watts Sandstone	Sandstone & minor conglomerate
		Pswj	Wittingham Coal Measures	Denman Formation	Sandstone-siltstone laminite and siltstone
				Jerrys Plains Subgroup [1]	Conglomerate, lithic sandstone, siltstone, coal and minor claystone
		Pswv		Archerfield Sandstone	Quartz-lithic sandstone
				Vane Subgroup	Conglomerate, lithic sandstone, siltstone, coal and conglomerate
		Pswc		Saltwater Creek Formation	Sandstone-siltstone laminite and minor coal bands

Note: [1] includes Whybrow, Wambo, Blakefield, Warkworth and Piercefield coal seams.

Quaternary Alluvium

Figure 4 shows the spatial distribution of regionally mapped Quaternary alluvium, which is limited to the channels and floodplains of the Wollombi Brook and Monkey Place Creek[2]. The waterways that host these deposits meander around the south-west, north-west and northern limits of the project area. There is no regionally mapped alluvium of Loders Creek.

Triassic Sandstone

Figure 4 shows the presence of several Triassic sedimentary units (Rn) within the project site and its surrounds, including the Hawkesbury Sandstone and the Narrabeen Group. These units lie west of Wollombi Brook and south of Monkey Place Creek and are prominent features of the landscape due to their steep terrain and high elevation (El.200m+).

The Hawkesbury Sandstone comprises medium to coarse grained cross-, planar-and massive-bedded quartzose sandstone intercalated with finer grained sandstone, siltstone and rare clast-supported conglomerate. The Narrabeen Group (further subdivided into the Terrigal Formation and Clifton Subgroup) comprises interbedded units of sandstone, siltstone and claystone.

[2] These represent the regionally mapped systems; sub-ordinate, unmapped sequences also occur.

Permian Coal Measures

Two stratigraphically significant geological groups comprise the Permian Coal Measures:

- The Wollombi Coal Measures (Psl); and
- The Wittingham Coal Measures (Pswj, Pswv and Pswc).

The Wollombi Coal Measures generally strike north-north-west to south-south-east with a 2-5° dip toward the west, and measure a combined thickness of about 230 m. They were deposited in a range of environments including alluvial plain, upper and lower delta plain to delta front, and operated as a volcanic ash catchment for locally erupting volcanic centers.

The Wittingham Coal Measures, similarly to the Wollombi Coal Measures, generally strike north-north-west to south-south-east with a 2-5° dip, and measure over 700 m in overall thickness. They were deposited in various environments ranging from upper and lower delta plains, marine shelf to delta front and operated as a volcanic ash catchment for locally erupting volcanic centers, though to a lesser degree than the Wollombi Coal Measures.

1.3.3 Structural Features

The project site is located within the Hunter Thrust System, which formed in response to east-west compression; the same force responsible for deforming the New England Orogen to the east.

A major structural feature within the Hunter Thrust System is the Redmanvale Fault Zone; a northwest-trending fault zone that controlled the local fault scarp development exposing the sediments of the Narrabeen Group. The Project site is located to the east of the Redmanvale Fault Zone, within a region of north-west-trending, north-east-dipping thrust faults with a cumulative throw of ~120 m (identified from seismic reflection data by Moloney, 1990). Faults in this area tend not to be transmissive and may compartmentalise the groundwater flow system.

The Mt Thorley Monocline is located to the north east of the project site and forms the western limb of the Loder Anticline (within the Wittingham Anticlinorium). The western shallowing of the Mt Thorley Monocline is attributed to the west-south-west thickening of the Jerrys Plains Subgroup and the Wollombi Coal Measures fluvial package.

Jointing is found throughout the project area, with a dominant north-east and north-west orientation which is common throughout the Upper Hunter region. Joint formation lessens with depth, and joints are observed to occur sparsely in underground operations. As such, their influence on deeper groundwater flows is assumed to be minimal and is consistent with matrix dominated permeability.

1.4 System Conceptualisation

A summary of the system conceptualisation with respect to water resources is provided:

- There are two relevant hydrogeological systems across the mine lease:
  - the regionally mapped alluvium of Monkey Place Creek and Wollombi Brook which overlie Permian strata and wrap around the south and west of the main mining area; and,

    - the Permian coal measures of the Singleton Super Group which host the mined resource and represent outcrop in all areas where regionally mapped alluvium is absent.
- Although locally present, the Jurassic basalt and Triassic sandstones of the Narrabeen Group and the Hawkesbury Sandstone are not aquifers of relevance to local mining conditions.
- Although the mining area straddles a local topographic high, all perimeter drainage ultimately reports to the Hunter River.
- Longwall mining operations are mature, and lie west of the central topographic high, while open cut mining, spoil placement / management and tailings storage straddles and lies to the east of the high.

The mine has a substantial monitoring network which has developed and evolved throughout the operations' life. This monitoring network is described in the following sections, and a summary of the key outcomes of this monitoring are provided following discussion of the network.

2 MONITORING NETWORK

2.1 Groundwater and Surface Water Monitoring Locations

The monitoring locations are shown in Figure 5, noting alluvium monitoring locations are coloured yellow, and Permian monitoring locations are coloured blue.

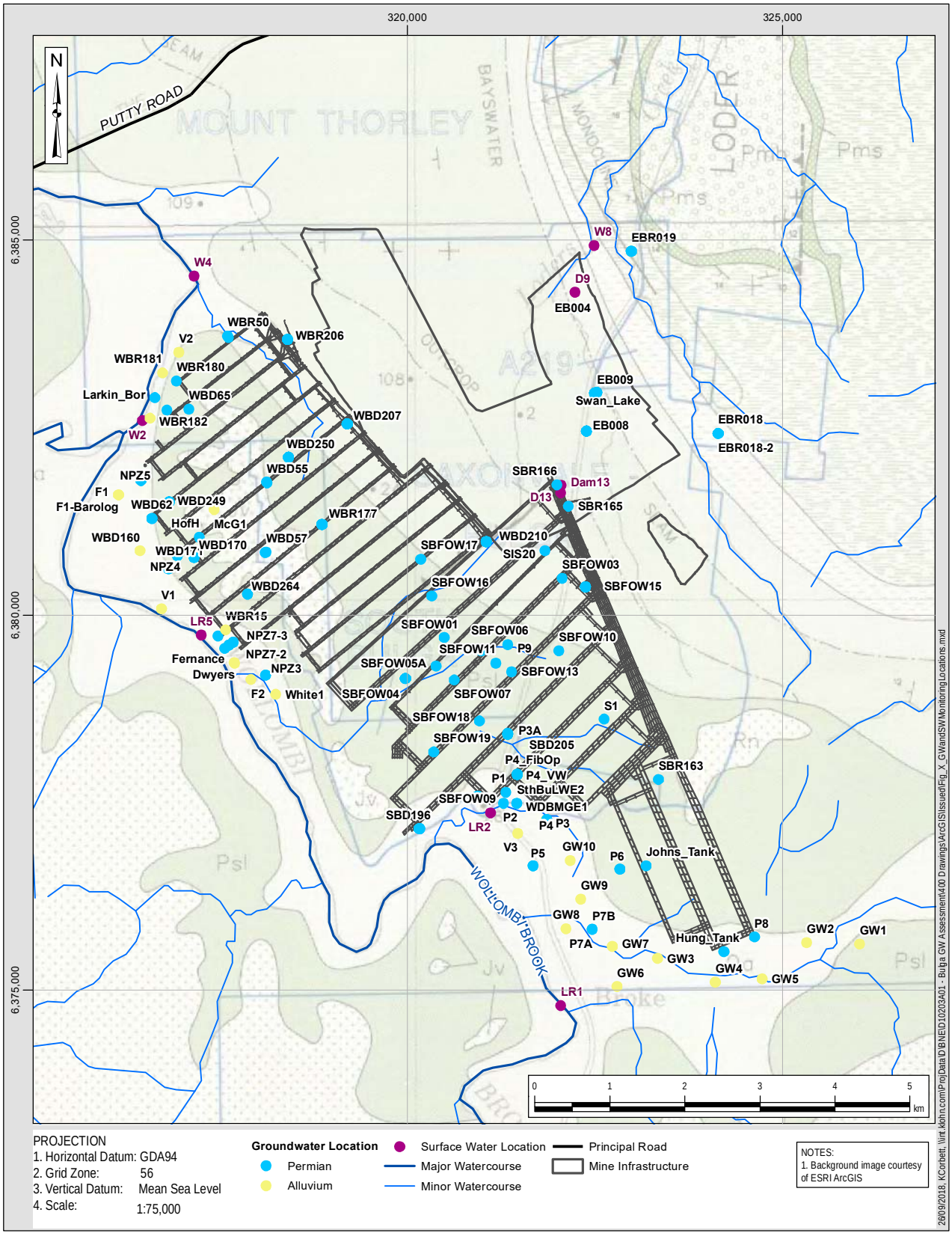


Figure 5: Bulga Mine Piezometer and VWP Monitoring Locations

2.2 Groundwater Monitoring

Groundwater monitoring data are constructed consistent with the composite hydrographs of Mackie (2013). Sites which have been destroyed or decommissioned have been included although their records are not current, while new sites more recently added to the program are also provided.

2.2.1 Hydrograph Records

All piezometer data is presented with the Wollombi Brook creek level and a corresponding EC[3] record where available. VWP sites are shown with vertical reference to the respective tip location, aligned with groundwater model layers as they currently exist, and as reported in Mackie (2013).

Data have been reduced to a 'monthly average record' for each site. This is to overcome practicality issues associated with the huge volume of information these sites have compiled (some records are over 100,000 rows of data in length). This also permits more meaningful vertical comparison of data between sites and instrumentation types.

The data are appended, in the following order, with each bullet point representing a composite hydrograph. Sites which have 2018 records are bolded in the below lists.

Appendix I: Piezometer Plots - 10 Hydrographs, 52 sites, 33 with 2018 data

- **Dwyers, Fernance, F1, F2, V1, V2**
- **WBR15,** HofH**, McG1, White1,** P9
- **WBR50A, WBR50**, WBD55A, WBD55, WBD65
- **WBD62A**, WBD62, WBD57A, WBD57
- NPZ3-A, **NPZ3-B, NPZ4-A, NPZ4-B, NPZ5-A, NPZ5-B**
- **NPZ7-1, NPZ7-2A, NPZ7-2B, NPZ7-3A, NPZ7-3B**
- **WBD160, WBR180, WBR181, WBR182, WBR183**
- **V3, GW7, GW8**, GW9, **GW10**
- P1, **P2**, P3, P4A, P4B
- **P5A,** P5B**, P6A, P6B**, P7A, P7B

Appendix II: VWP Plots - 17 Hydrographs, 108 sites, 54 with 2018[4] data

- WBD210 1, 2, 3, 4, 5, 6, 7, 8
- WBD207 1, 2, 3, 4, 5, 6, 7, 8
- **WBD170 1, 2, 3, 4**
- **WBD171 1, 2, 3, 4**
- EBD004 1, 2, 3, 4, 5
- **EBD008 1, 2, 3, 4, 5, 6, 7, 8**
- **EBD009 1, 2, 3, 4, 5, 6, 7**

[3] EC – Electrical Conductivity, uS/cm.
[4] SBFOW09 includes data to late 2017, and has been included in the list of sites with recent / current data

- **SBD194** **1, 2, 3, 4, 5, 6, 7, 8, 9**
- **EBR**18 and **19** 1, 2 and **1, 2**
- SBFOW… 01, 03, 05A, 07
- SBF0W04A 1, 2, 3, 4, 5, 6, 7
- SBFOW06 1, 2
- **SBFOW09** **1, 2, 3, 4, 5, 6**
- SBF0W… 10, 11, 13, 16, 17, 18, 19
- **SBF0W15** **1, 2, 3, 4, 5, 6**
- WBR177 2, 3, 4, 5, 6, 7, 8
- **WBR206** **1, 2, 3, 4, 5, 6, 7, 8**

2.2.2 Quaternary Alluvium

The alluvium of the Wollombi Brook and Monkey Place Creek are well instrumented, with 11 and 5 piezometers in each aquifer respectively, all with relatively intact records which show good correlation to Wollombi Brook flow elevation. In the Beltana mining area, coverage is relatively dense along the western margin of the mine footprint where it spatially approaches the edge of the alluvium. Distribution in the area of drainage mergence from Monkey Place Creek to Wollombi Brook is also well instrumented.

Alluvium response shows metre to sub metre scale vertical change to significant flow events. Hydrographs of sites Dwyers, Fernance, F1, F2, V1 and V2 are good examples of this, showing a moderate to strong response to creek flow particularly for events in 2007, 2011 and 2015. Regression of increased levels typically takes months to occur. Periods of increased creek flow appear to be the main driver of longer term response in the system. Groundwater levels across these sites generally lie within a 5 m elevation band of ~60 m to 65 m elevation.

The alluvium of Loders Creek to the north is not a regionally mapped system. Dip direction of underlying Permian strata is to the southwest, thus interaction (assumed to be most likely along bedding plane direction) between these two systems may develop if deep Bulga pit mining activity (300+m depth) interacts with strata which sub-crops near to or beneath the alluvium. Confirmation that alluvium of relevance exists in the upper reaches of the Loder Creek, and that future mining impacts have a plausible hydraulic connection to these systems, should be assessed to determine if monitoring is needed in this area.

2.2.3 Permian Coal Measures

Monitoring of Permian coal measures is extensive, particularly across the underground operations. Instrumentation is established along the longwall panels and at their edge extents, permitting data review within the seams being mined and above / below. This information is critical in understand vertical gradients and changes in permeability (observed as varying responses to mine progression).

A map of the distribution of Wittingham Coal Measure monitoring locations (which includes the Jerrys Plains Group) is provided in Figure 6.

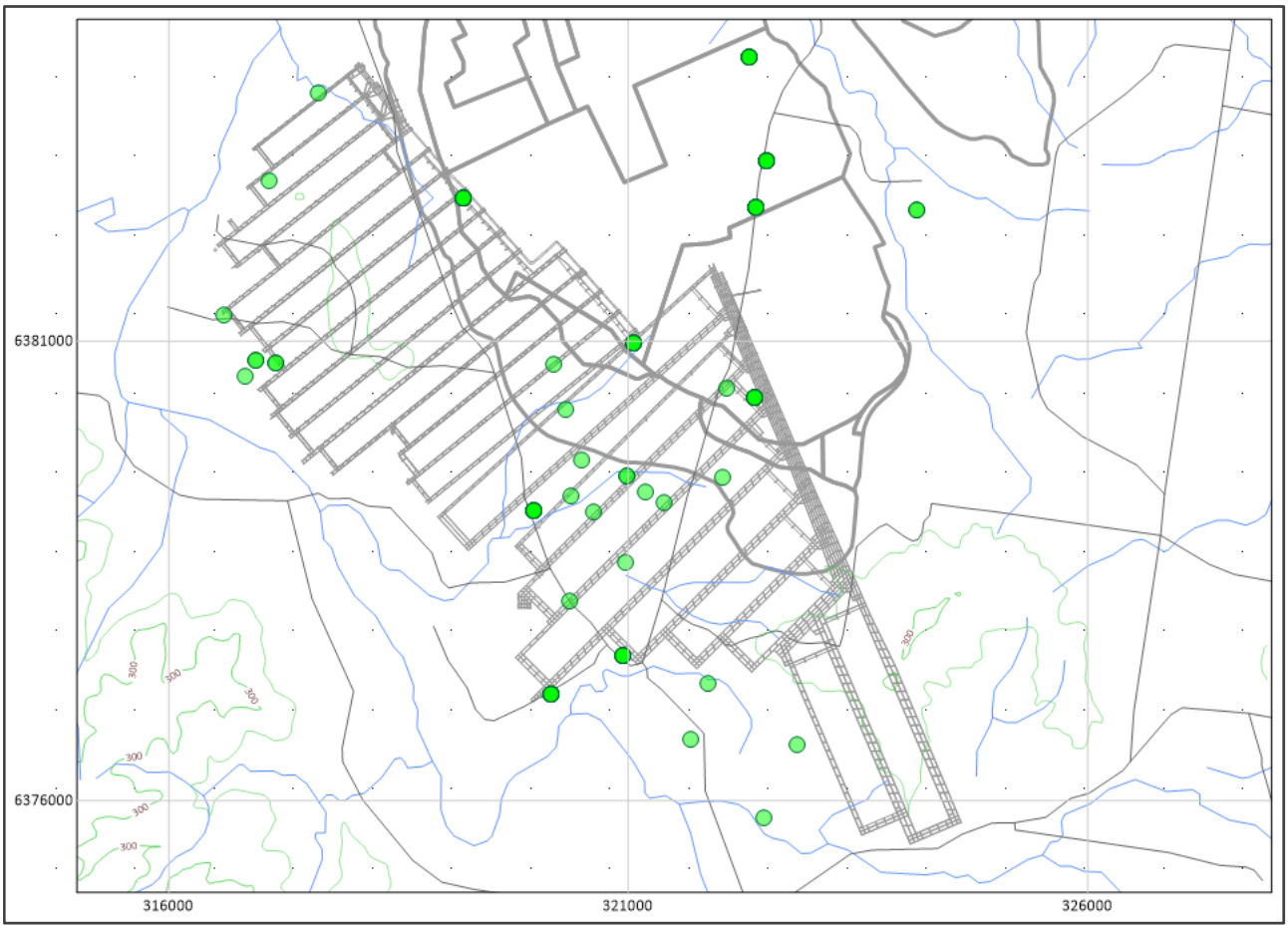


Figure 6: Wittingham Coal Measure Monitoring Locations

There are a number of Permian locations in the east and south that can easily be paired with alluvium monitoring sites to assess the strength and consistency of vertical gradients between the two systems. As example, sites V2 and WBR180 in the northern area of the Beltana area are about 400m apart. Site V2 is screened in Wollambi Brook alluvium to ~70m depth, site WBR180 is screened to a similar depth in shallow coal seams, however has shown a moderately strong response to mining with about 18 m of drawdown occurring in 2009 to 2011. Vertical gradients between these systems indicate a 25m downward driving head. This gradient can consequently be used to assess potential vertical leakage, or to assess for hydraulic disconnection between the systems. The response in WBR180 is not reflected in the alluvium hydrograph of V2, which over the same approximate period of mining stress observed approximately 1 m of variation, with levels at the start and end of the period roughly the same.

The VWP records shown in Appendix II show the nature of multiple level monitoring available for the site. These data are critical in establishing vertical mining impact progression and are a surrogate to assess vertical translation of fracture development. A good example of this is SBF09, reproduced below, which monitors strata between the Lower Whybrow Seam and the Vaux Seam (Figure 7). This shows two periods of mining impact: the first is from about 2010 to 2013 and has a similar effect on the four shallower seams. The second period is from 2014 to 2018, and shows a variable impact to each of these layers, although all respond to the mining activity.

	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
SBFOW09-5, -6	09. Permian CM
	10. Permian CM
SBFOW09-4	11. Blakefield Seam
	12. Permian CM
SBFOW09-3	13. Glen Munro Seam
	14. Permian CM
SBFOW09-2	15. Woodlands Hill S.
SBFOW09-1	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm

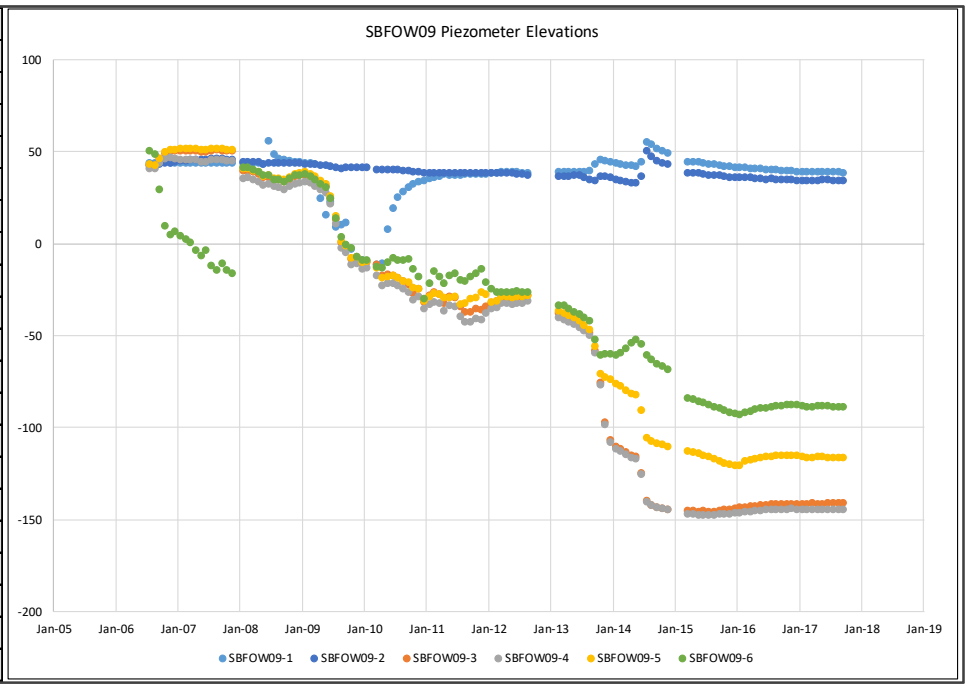


Figure 7: Example Vertical VWP Data, SBFOW09 1-6

A map showing the spatial distribution of these vertical arrays is provided in Figure 8. This network is extensive and is considered adequate for verification of hydrogeological concepts and model recalibration purposes.

Depending on the location and depth of monitoring, and the timing of data collection, Permian strata have observed significant response to mining development, of the scale of 10's to 100's of metres. This is in significant contrast to the response of the alluvium which is more strongly aligned with creek flow (aand possibly local alluvial abstraction which has not been accounted for in this memorandum).

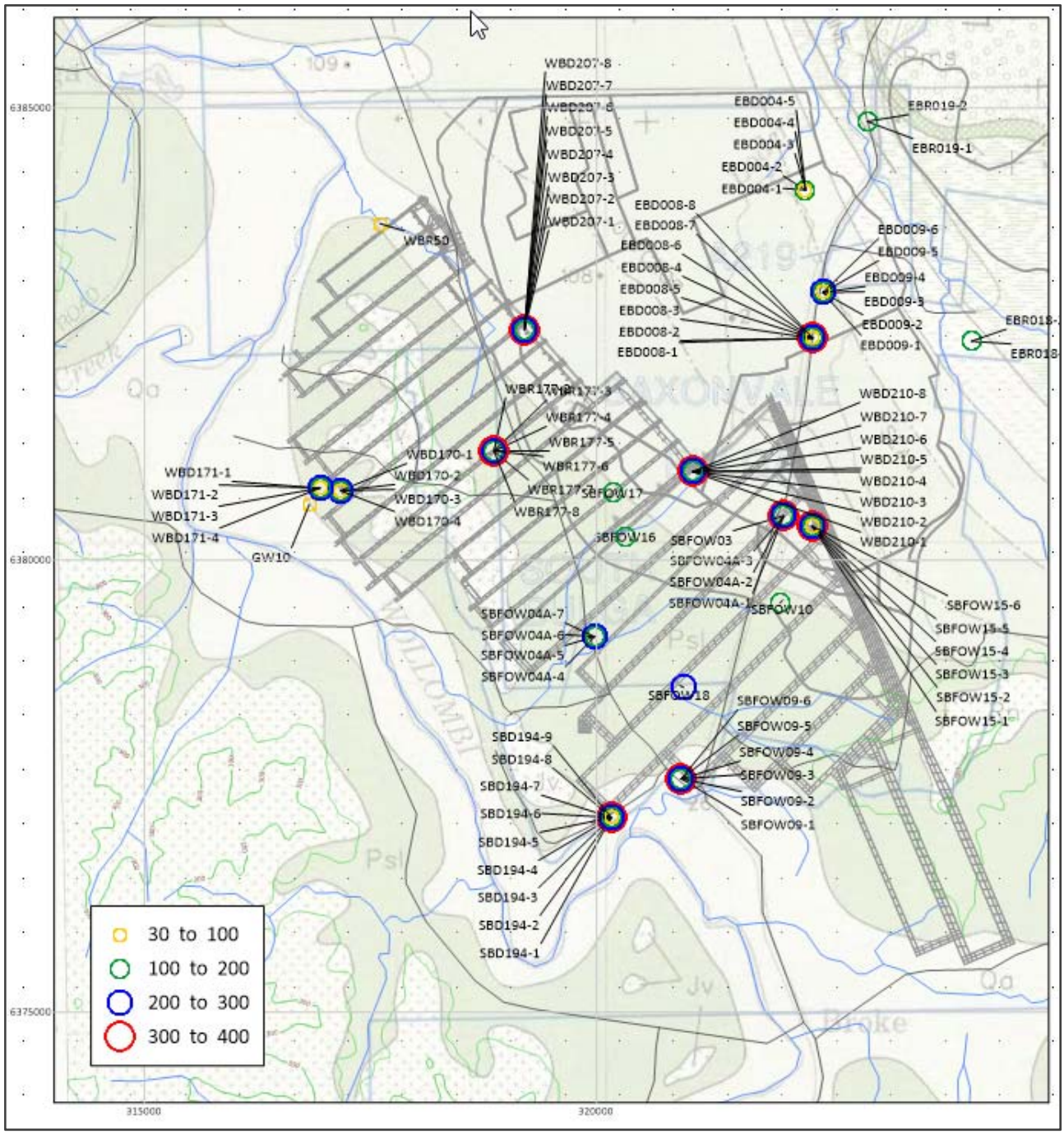


Figure 8: Distribution and Depth Profile of VWP Arrays

2.3 Surface Water Monitoring

2.3.1 Monitoring Sites

Surface water quality monitored at the mine comprises pH, electrical conductivity (EC) (µS/cm) and total suspended solids (TSS) (mg/L). Monitoring site Dam 13 is shown in the map but is not included, as the database contained only a single data point.

For consistency with groundwater monitoring data, parameters are plotted as single average monthly values for the reporting period[5]. This coincides with the monitoring frequency defined as part of the environmental protection license (EPL) 563 requirements (Northey 2017) which requires monthly monitoring. A cumulative rainfall departure trend is also plotted to show seasonal conditions and long term dry or wet spells which may affect local surface water quality.

The mine reports environmental compliance though annual reporting which is available online.

2.3.2 Surface Water pH

The pH monitoring indicates results within the pH limits set by EPL 563; lower limit 6.5 and upper limit 9.5 (Figure 9). Results can be discussed in terms of their source collection location.

Sites LR1, LR2, LR5, W2 and W4 are located along Monkey Place Creek and Wollombi Brook, and generally exhibit a range of pH between 7.0 and 8.5, with a tighter grouping of pH 7.0 to 8.0 in the past 4 years. This indicates neutral to slightly alkaline conditions and consistent with what might be expected of an alluvial system in this area. Variability of these sites is generally across one pH unit.

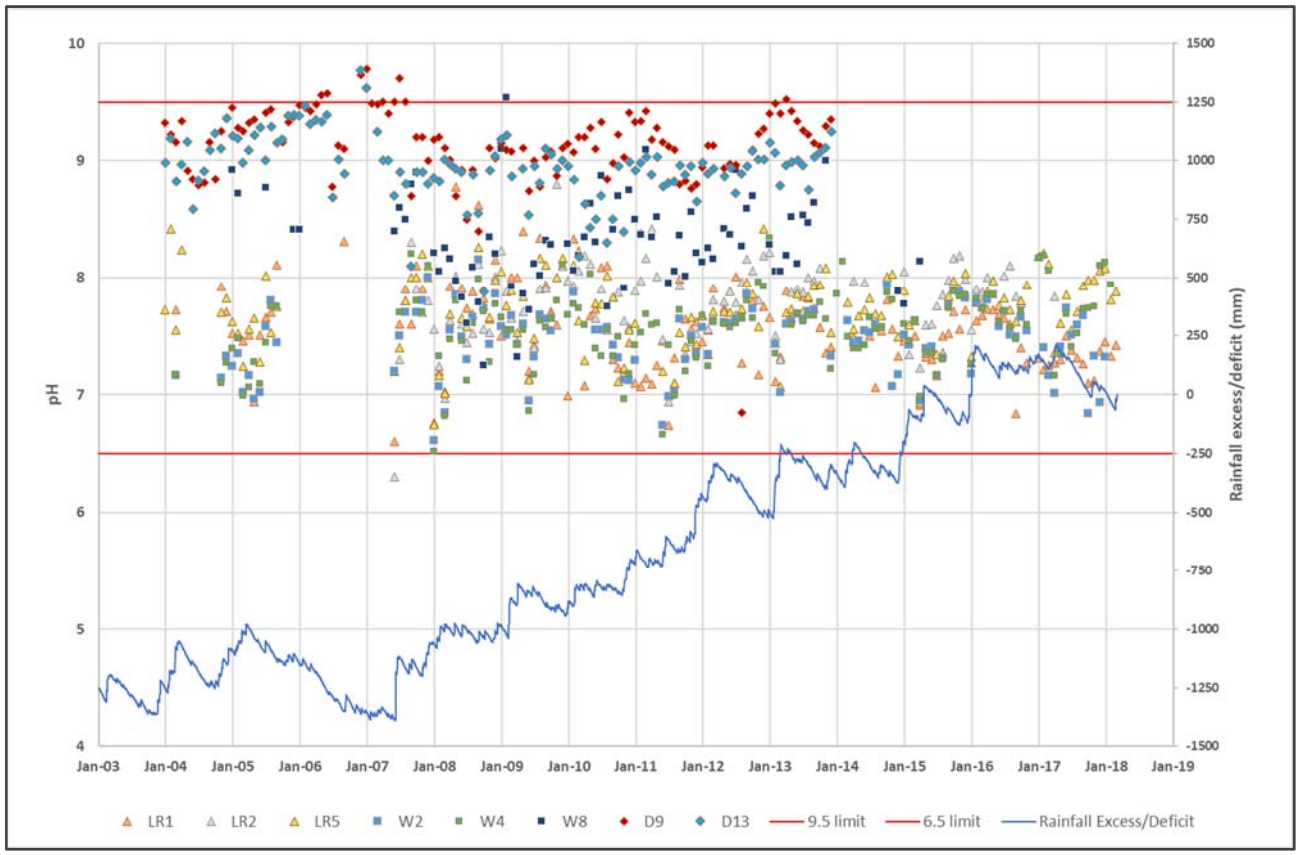


Figure 9 Monitoring Results, Monthly pH - Surface Water Monitoring Locations

Sites W8, D9 and D13 are located within the mining area, and show a generally higher pH range of about 8.0 to 9.5. Some trend variability is apparent, for example in the period late-2011 to early-

[5] Data is presented in this manner for trend analysis and in general conformance with the frequency of monitoring completed. Local influences such as first flush are not represented using this approach.

2013 where D9 shows a slow but consistent increasing trend. This reduces through the following year and may be a response to the early rainfall events of 2013, or local water management practices at the time. No current monitoring is available for these sites.

2.3.3 Electrical Conductivity

EPL 563 does not provide a limit for Electrical Conductivity (EC) (Northey 2017). As with pH, discussion of results is provided based on the source location of each sample.

Creek monitoring sites of LR1, LR2, LR5, W2 and W4 exhibit ranges of EC from 100's to 1,000's uS/cm. In 2017, highest EC levels are noted in LR2, and exceed 5,000 uS/cm. Lowest EC values occur in LR1 and W4, at the upstream and downstream extent of monitoring conducted by the mine.

Mine area monitoring ceased in late 2014 with exception of two monitoring events for W8 collected in late 2014 and early 2015 respectively. EC at W8 is generally higher than those of the creek alignments, with site W8 consistently greater than 10,000 uS/cm.

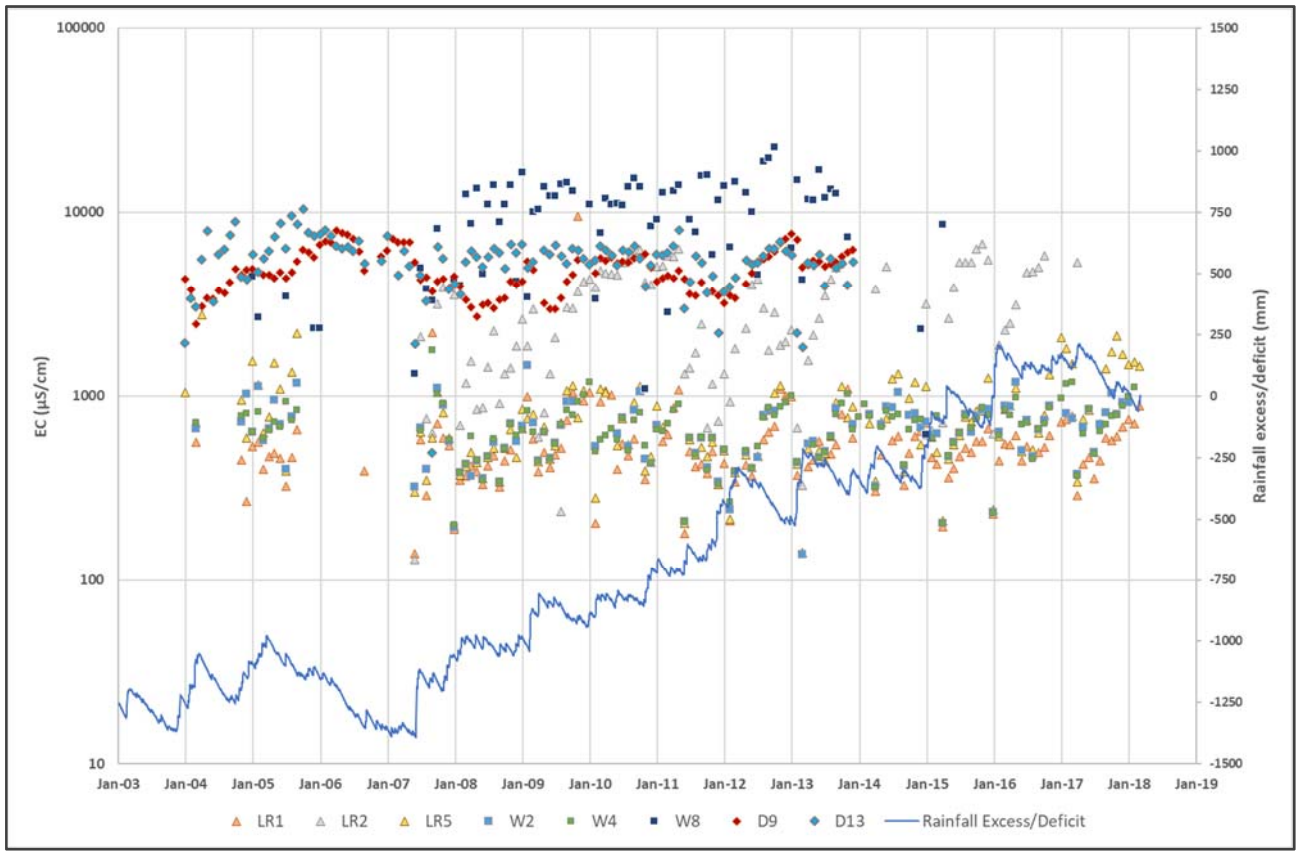


Figure 10 Monitoring Results, Monthly EC - Surface Water Monitoring Locations

2.3.4 Total Suspended Solids

Monitoring results for TSS are bound by an upper limit of 120 mg/L, which is identified as the trigger limit for the two license discharge points (LDP) set out in EPL 563 (Northey 2017). The two LDP are Swan Lake (LDP3) and CHPP Surge Dam (LDP4). Where a value was reported as being at

the laboratory detection limit, the value was halved i.e. 2.5 mg/L was used and included in the plot of the data points.

There is a broad dispersion of readings until approximately 2011, when the data shows a greater regularity of readings recorded less than 100 mg/L. This is most likely due to cessation of monitoring of the mine area sites which are more likely to experience elevated TSS events. No exceedance of the TSS trigger by average monthly data has occurred in the prior 3 years.

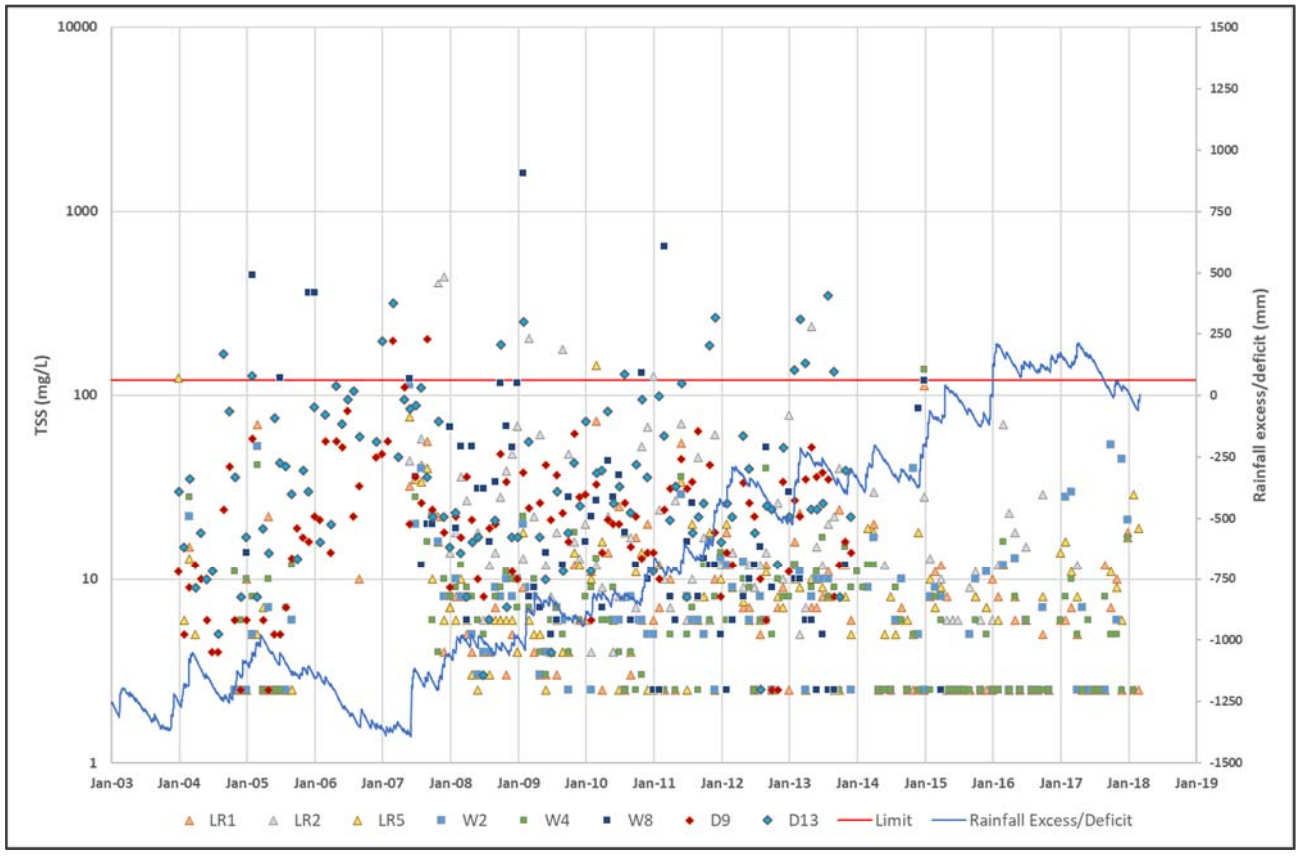


Figure 11 Monitoring Results, Monthly TSS - Surface Water Monitoring Locations

3 MONITORING OBSERVATIONS & DISCUSSION

Groundwater level monitoring indicates a strong difference in long-term trends between alluvium and Permian sequences.

Alluvium exhibits a small seasonal vertical variability (generally sub-metre scale) and a strong relationship to large flow events in the main creek systems. The response of these flow events is observable in a number of hydrographs – both in terms of their physical response and in several sites, a noted reduction post-flow in EC levels (dilutional effects). Any apparent dewatering effects from deeper mining operations are either too small to easily discern or are masked by the stronger recharge events which drive the shallow alluvium water balance.

The Permian strata show a very strong response to mining activity, and a very weak to absent (particularly for deeper conditions) response to surficial recharge processes. Dewatering can occur very quickly – 10's to 100's of metres over months to quarters, and often shows a relatively fast

re-equilibration to the mining stresses at or near the elevation of the mined seam. Translation of vertical stress across the direction of bedding appears to be limited, as is evident in nest SBFOW4A which shows mining drawdown in the Lower Whybrow Seam of the order of 100 m magnitude over a 1-2 year period, with no expression of this impact in deeper strata. Upward vertical leakage in this case is negligible and affirms the assumption of strong contrasts in horizontal to vertical permeability in the Permian units. This observation is also consistent with the interpretation that surficial recharge plays a minimal, if not negligible, role in deeper recharge, most likely due to the very low vertical permeability of the basinal sediments.

Interconnectivity between the Permian and the Quaternary appears negligible. Transient head trends between the two systems are contrasting, and as long as a sustained dewatering impression exists in the Permian, the direction of driving gradients across the two systems will be from the alluvium downward. Impacts of local abstraction for water supply or irrigation have not been included or considered.

Surface water quality data is limited to pH, EC and TSS, and in more recent years is constrained to the sites along the Monkey Place Creek and Wollombi Brook only. For these creek sites, pH remains consistent with that of system which receives periodic to regular contribution from rainfall. EC levels are more variable, although the record indicates such variability has occurred throughout the record and may be attributed to a number of factors. TSS in recent years is low.

Yours truly,

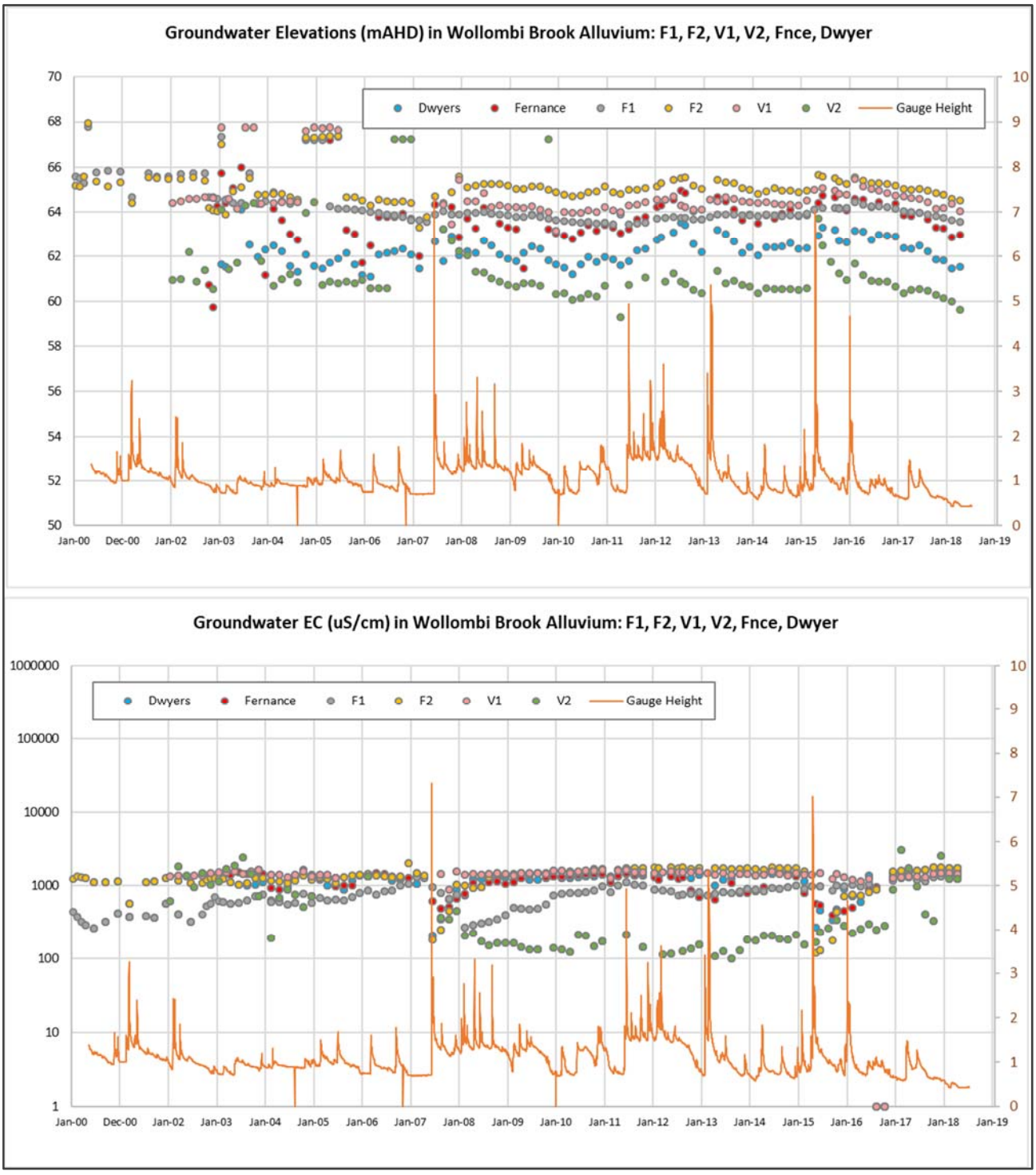
KLOHN CRIPPEN BERGER LTD.



Chris Dickinson, RPGeo
Principal Hydrogeologist

CGD:SJ

ATTACHMENTS


Groundwater Elevations (mAHD) in Wollombi Brook Alluvium: F1, F2, V1, V2, Fnce, Dwyer
Dwyers
Fernance
F1
F2
V1
V2
Gauge Height
70
68
66
64
62
60
58
56
54
52
50
10
9
8
7
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Jan-18
Jan-19
Groundwater EC (uS/cm) in Wollombi Brook Alluvium: F1, F2, V1, V2, Fnce, Dwyer
Dwyers
Fernance
F1
F2
V1
V2
Gauge Height
1000000
100000
10000
1000
100
10
1
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9
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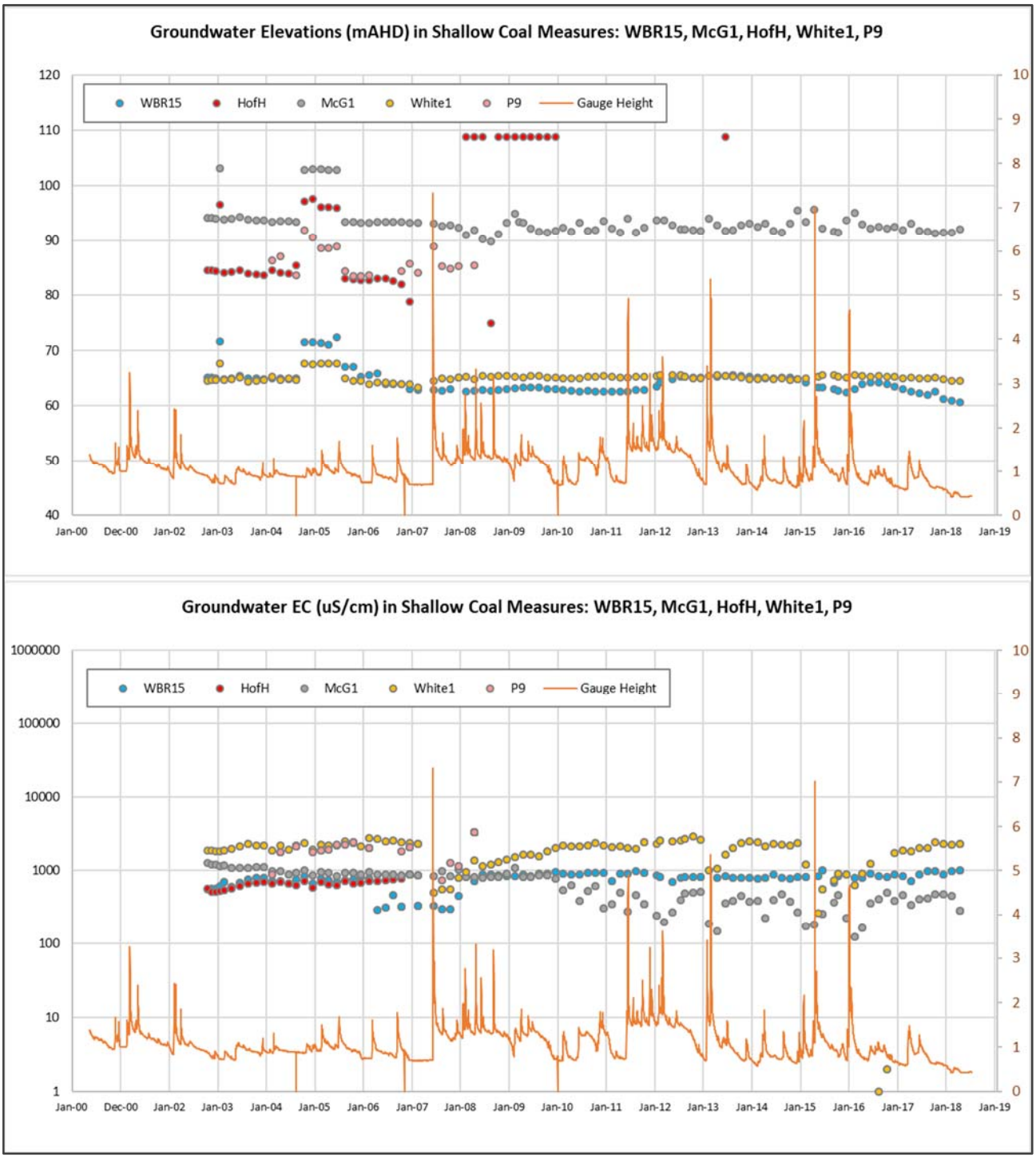
Jan-19


Groundwater Elevations (mAHD) in Shallow Coal Measures: WBR15, McG1, HofH, White1, P9
WBR15
HofH
McG1
White1
P9
Gauge Height
120
110
100
90
80
70
60
50
40
10
9
8
7
6
5
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3
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Jan-18
Jan-19
Groundwater EC (uS/cm) in Shallow Coal Measures: WBR15, McG1, HofH, White1, P9
WBR15
HofH
McG1
White1
P9
Gauge Height
1000000
100000
10000
1000
100
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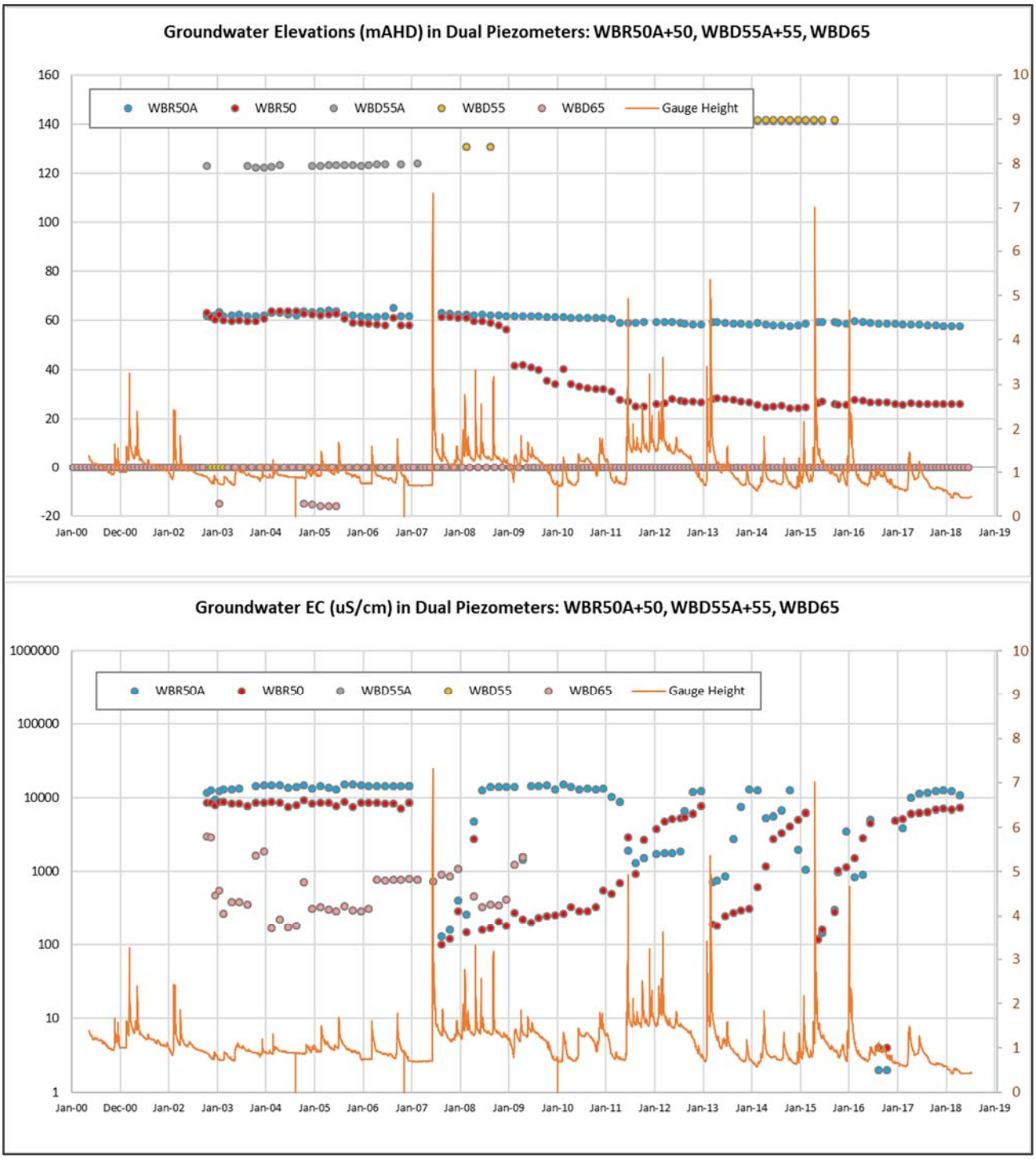
Groundwater Elevations (mAHD) in Dual Piezometers: WBR50A+50, WBD55A+55, WBD65
WBR50A
WBR50
WBD55A
WBD55
WBD65
Gauge Height
160
140
120
100
80
60
40
20
0
-20
10
9
8
7
6
5
4
3
2
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Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in Dual Piezometers: WBR50A+50, WBD55A+55, WBD65
WBR50A
WBR50
WBD55A
WBD55
WBD65
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
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4
3
2
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0
Jan-00
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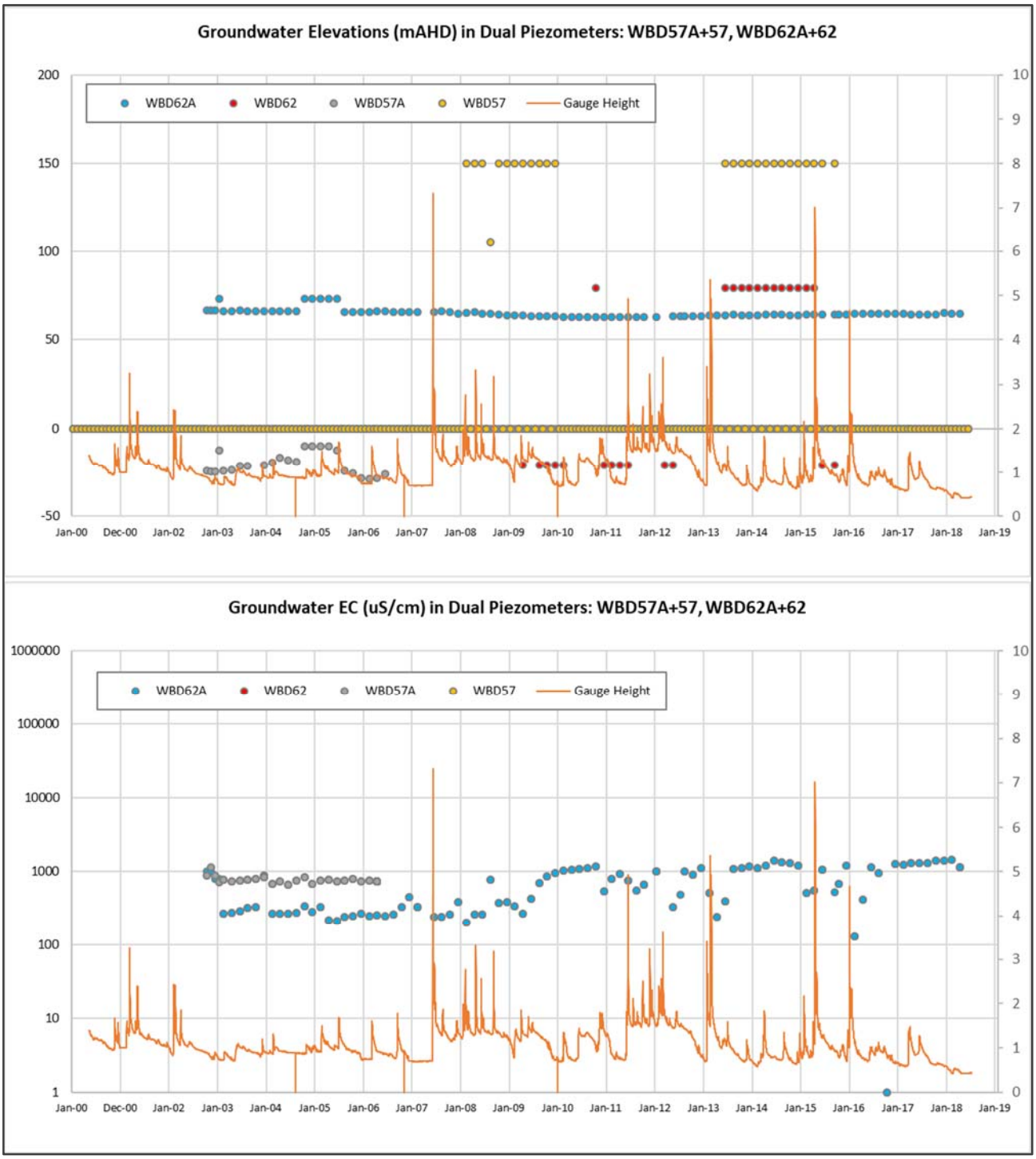
Jan-19


Groundwater Elevations (mAHD) in Dual Piezometers: WBD57A+57, WBD62A+62
WBD62A
WBD62
WBD57A
WBD57
Gauge Height
200
150
100
50
0
-50
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
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Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in Dual Piezometers: WBD57A+57, WBD62A+62
WBD62A
WBD62
WBD57A
WBD57
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
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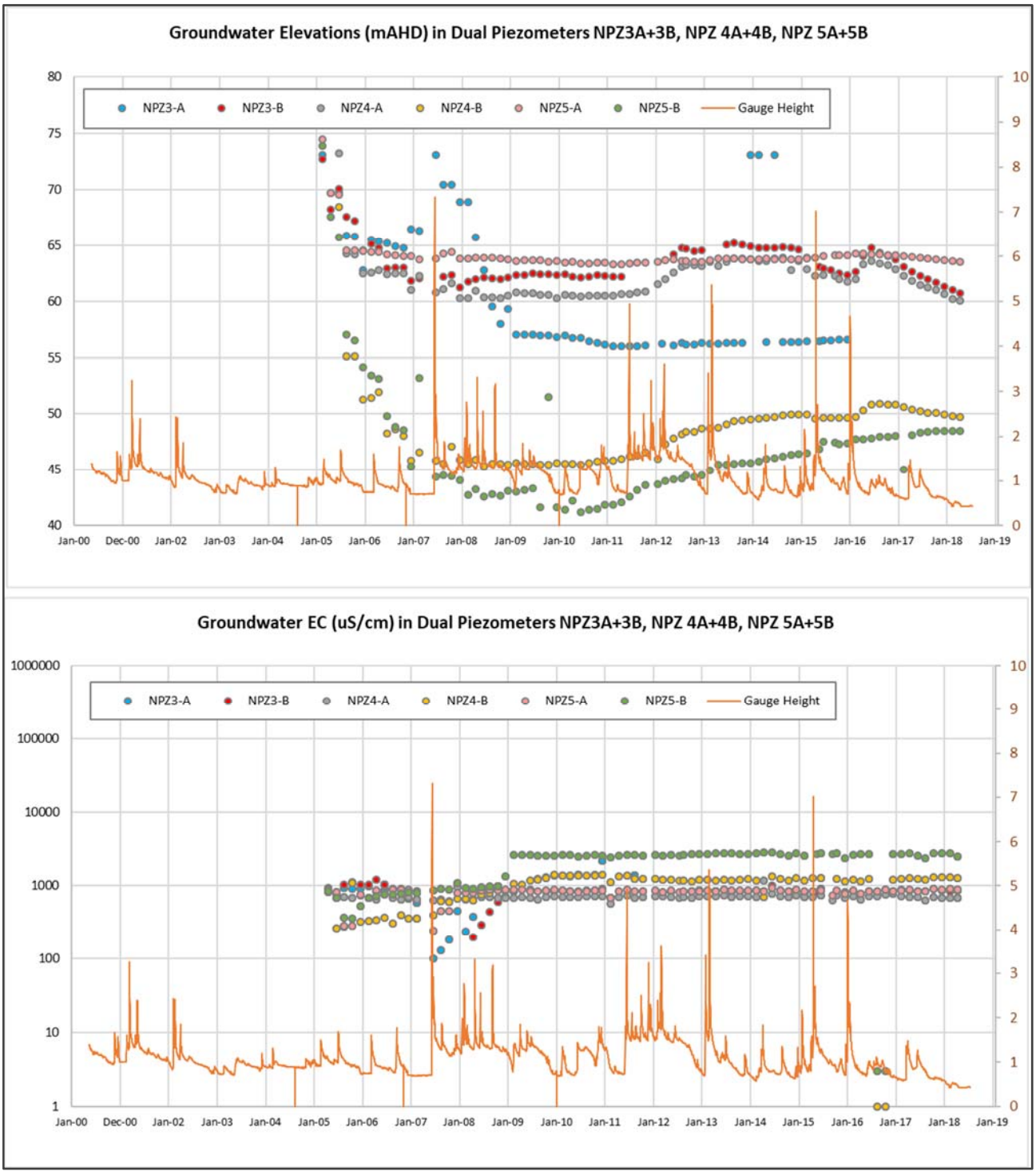
Jan-16
Jan-17
Jan-18
Jan-19


Groundwater Elevations (mAHD) in Dual Piezometers NPZ3A+3B, NPZ 4A+4B, NPZ 5A+5B
NPZ3-A
NPZ3-B
NPZ4-A
NPZ4-B
NPZ5-A
NPZ5-B
Gauge Height
80
75
70
65
60
55
50
45
40
10
9
8
7
6
5
4
3
2
1
0
Jan-00
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Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in Dual Piezometers NPZ3A+3B, NPZ 4A+4B, NPZ 5A+5B
NPZ3-A
NPZ3-B
NPZ4-A
NPZ4-B
NPZ5-A
NPZ5-B
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
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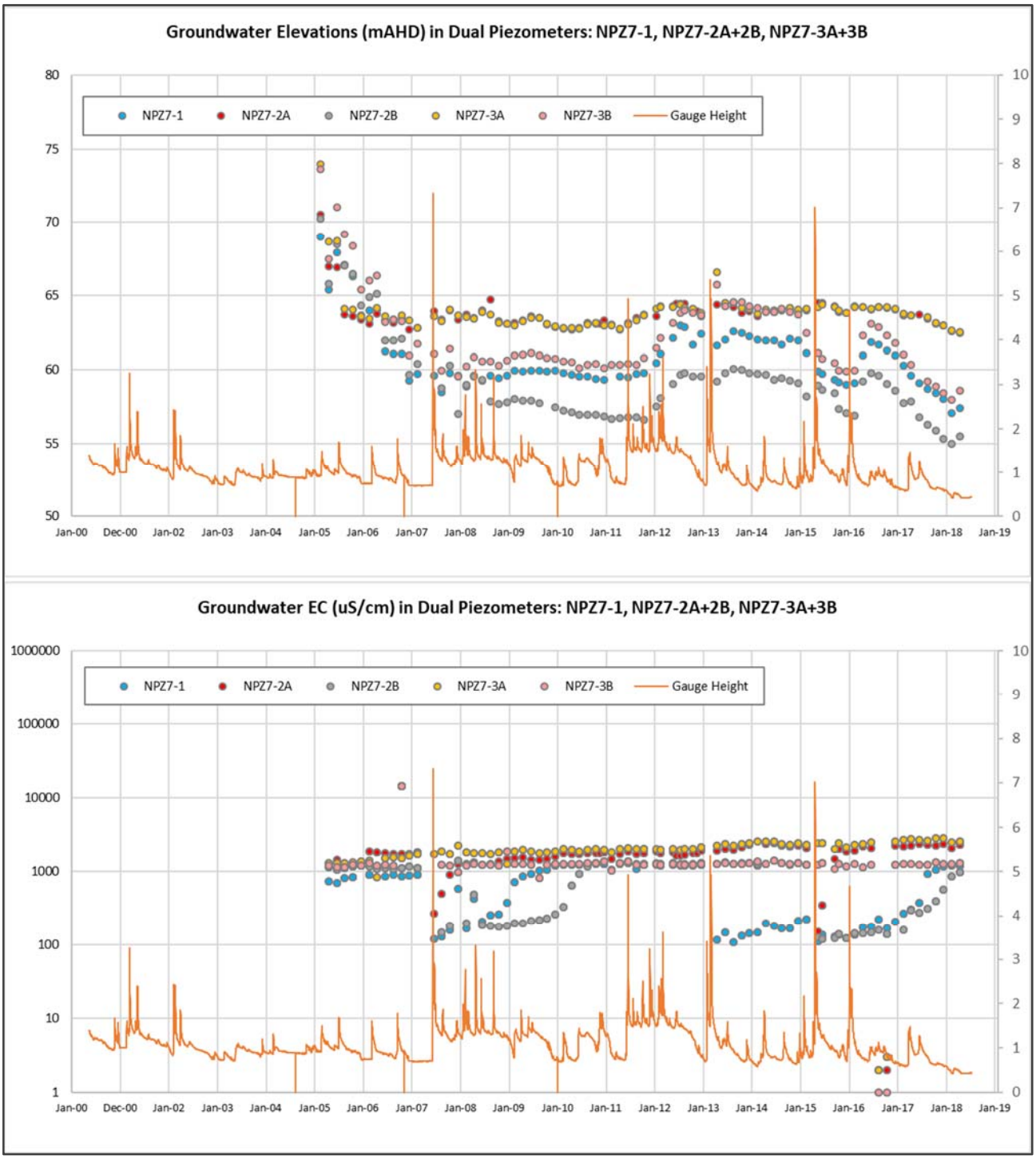
Jan-17
Jan-18
Jan-19


Groundwater Elevations (mAHD) in Dual Piezometers: NPZ7-1, NPZ7-2A+2B, NPZ7-3A+3B
NPZ7-1
NPZ7-2A
NPZ7-2B
NPZ7-3A
NPZ7-3B
Gauge Height
80
75
70
65
60
55
50
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
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Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in Dual Piezometers: NPZ7-1, NPZ7-2A+2B, NPZ7-3A+3B
NPZ7-1
NPZ7-2A
NPZ7-2B
NPZ7-3A
NPZ7-3B
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
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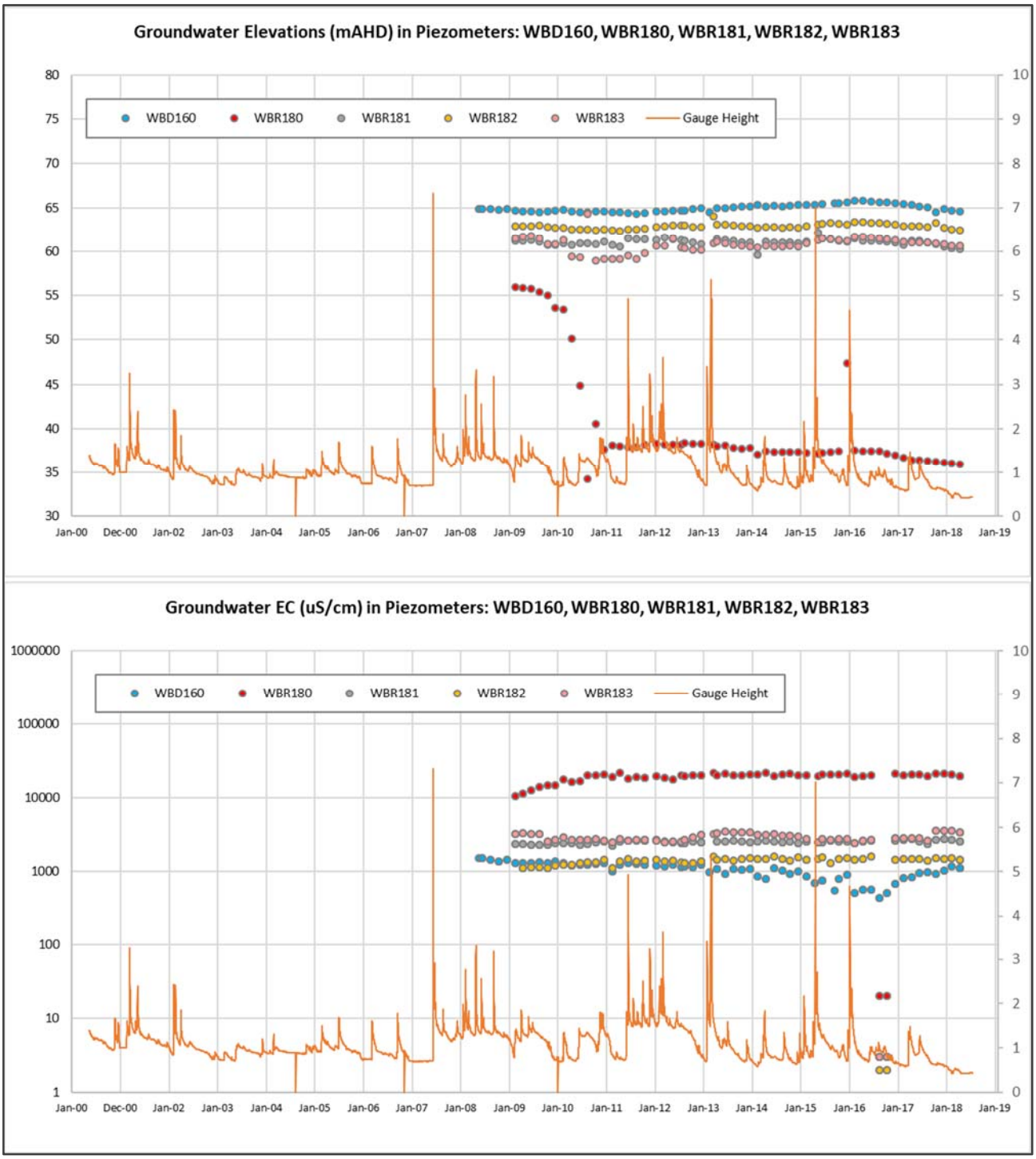
Jan-17
Jan-18
Jan-19


Groundwater Elevations (mAHD) in Piezometers: WBD160, WBR180, WBR181, WBR182, WBR183
WBD160
WBR180
WBR181
WBR182
WBR183
Gauge Height
80
75
70
65
60
55
50
45
40
35
30
10
9
8
7
6
5
4
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2
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Jan-00
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Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in Piezometers: WBD160, WBR180, WBR181, WBR182, WBR183
WBD160
WBR180
WBR181
WBR182
WBR183
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
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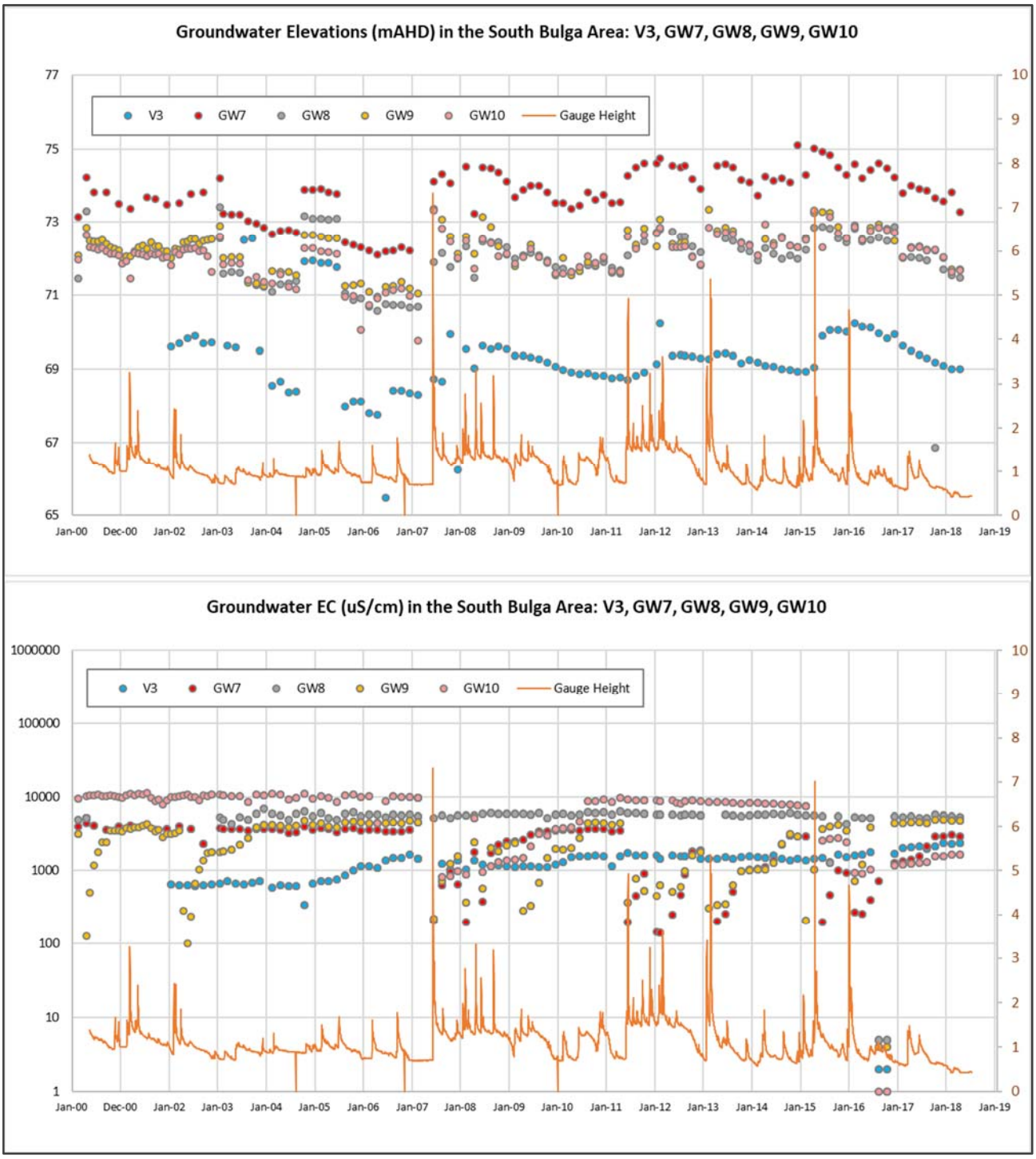
Jan-18
Jan-19


Groundwater Elevations (mAHD) in the South Bulga Area: V3, GW7, GW8, GW9, GW10
V3
GW7
GW8
GW9
GW10
Gauge Height
77
75
73
71
69
67
65
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
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Jan-07
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Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in the South Bulga Area: V3, GW7, GW8, GW9, GW10
V3
GW7
GW8
GW9
GW10
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
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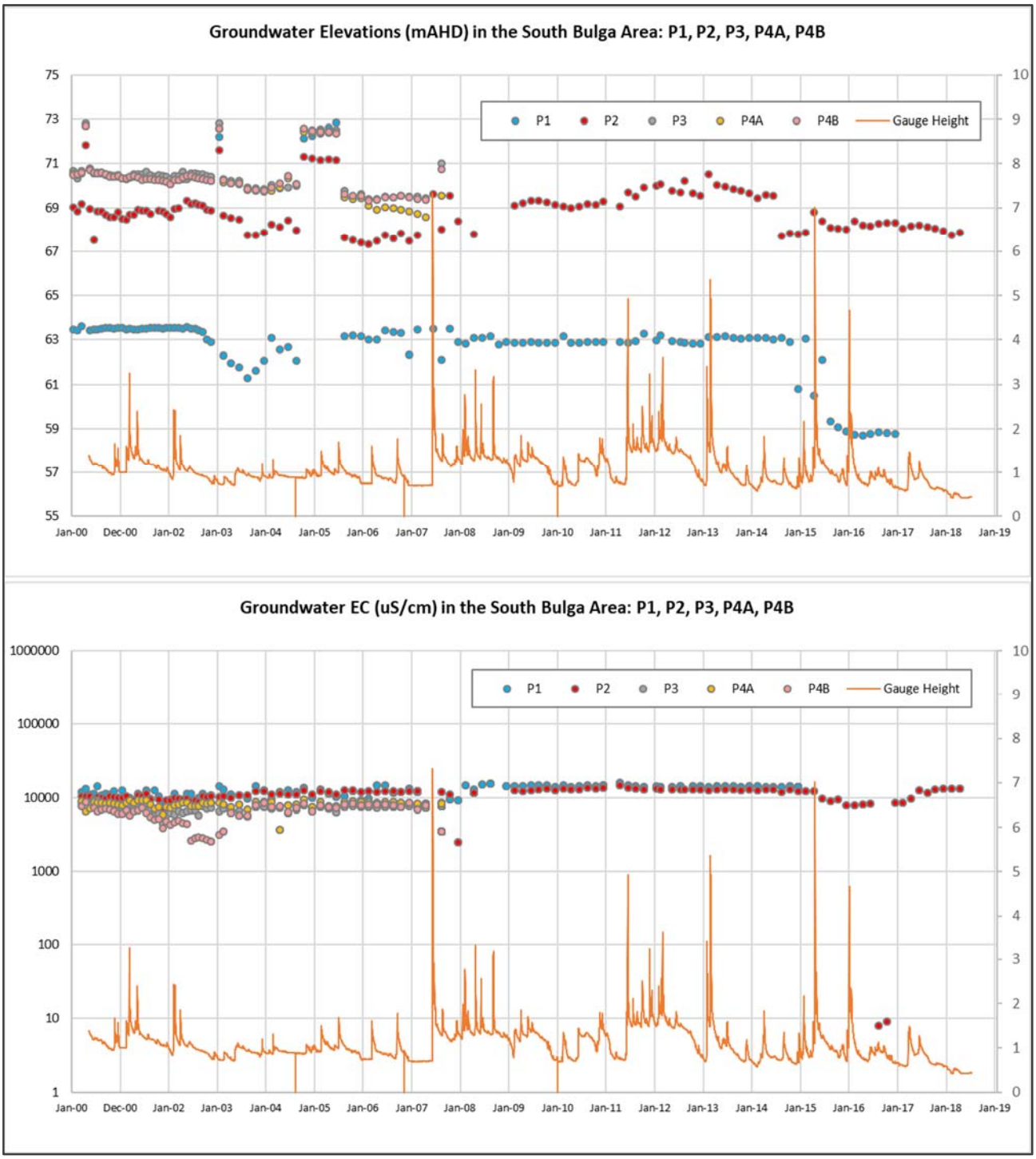
Jan-16
Jan-17
Jan-18
Jan-19


Groundwater Elevations (mAHD) in the South Bulga Area: P1, P2, P3, P4A, P4B
P1
P2
P3
P4A
P4B
Gauge Height
75
73
71
69
67
65
63
61
59
57
55
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Groundwater EC (uS/cm) in the South Bulga Area: P1, P2, P3, P4A, P4B
P1
P2
P3
P4A
P4B
Gauge Height
1000000
100000
10000
1000
100
10
1
10
9
8
7
6
5
4
3
2
1
0
Jan-00
Dec-00
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
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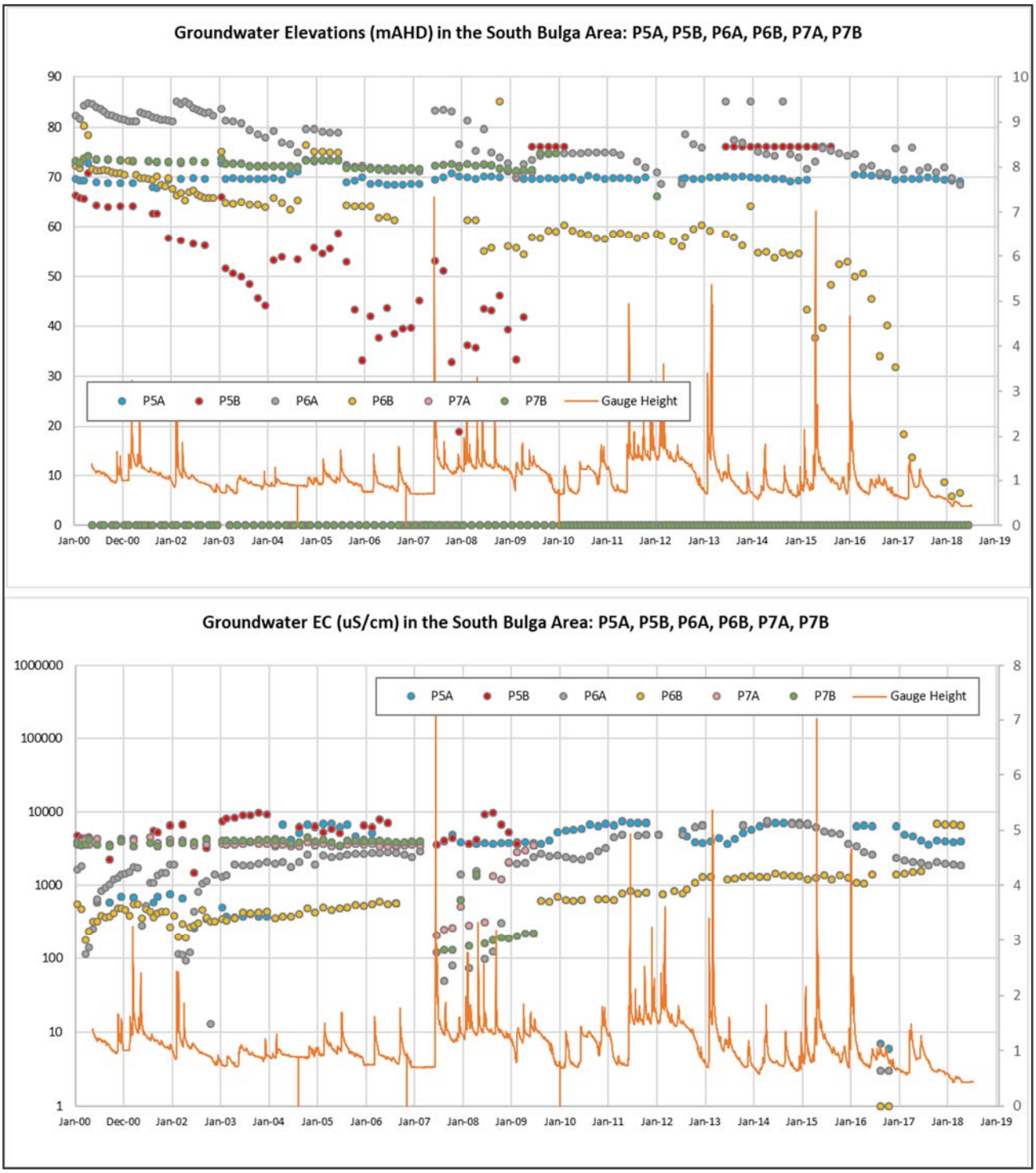
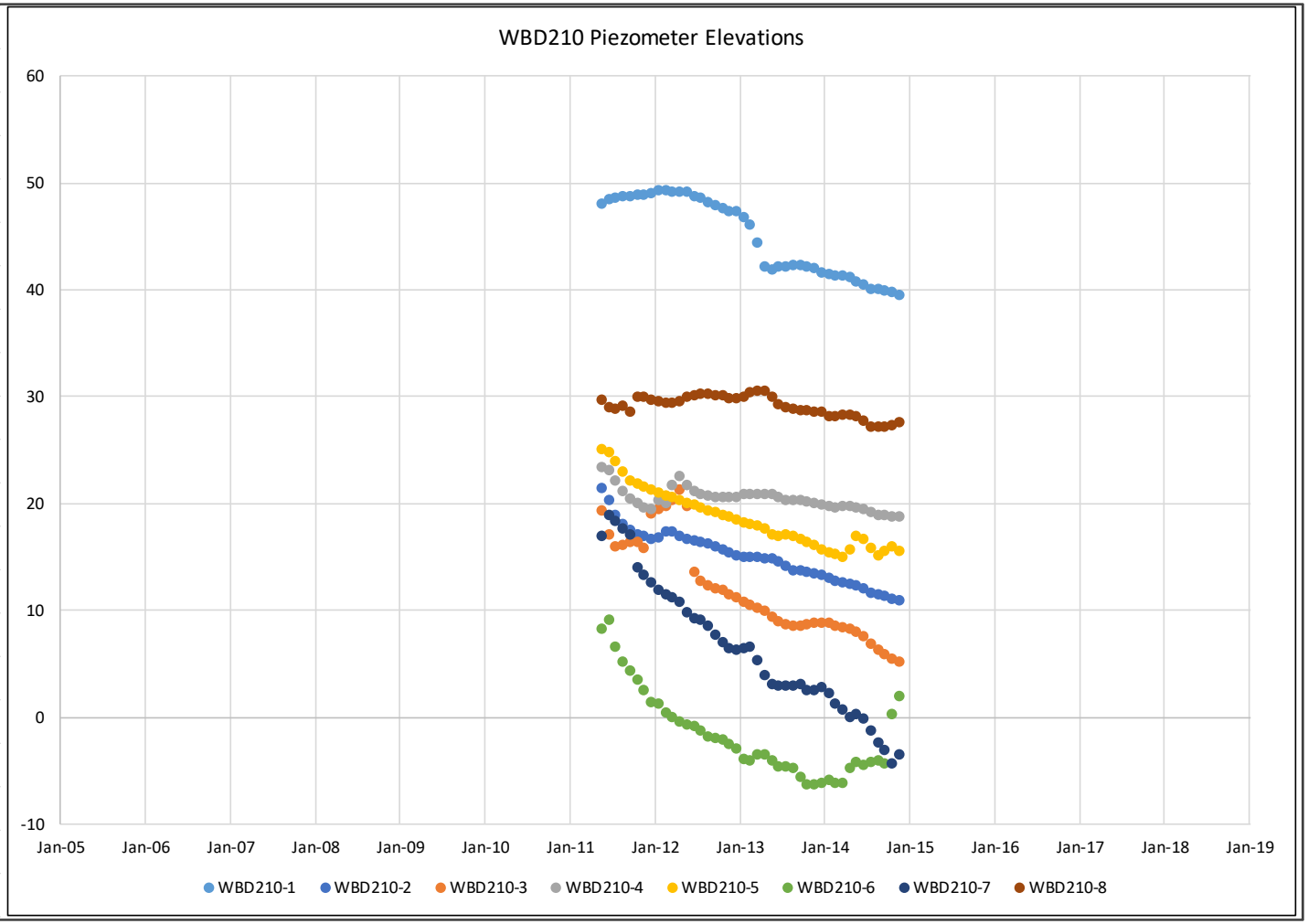
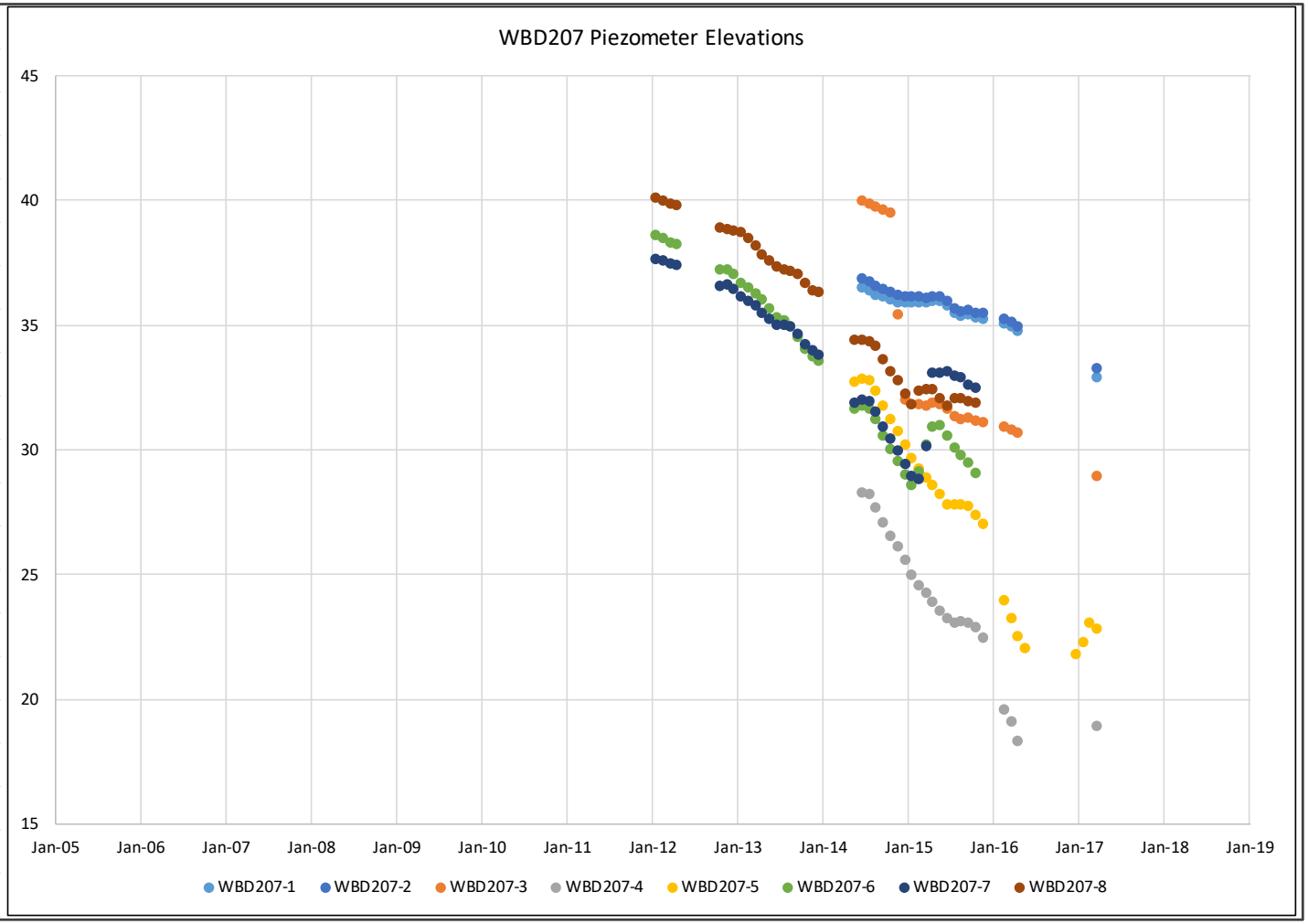
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19


Groundwater Elevations (mAHD) in the South Bulga Area: P5A, P5B, P6A, P6B, P7A, P7B
P5A
P5B
P6A
P6B
P7A
P7B
Gauge Height
Groundwater EC (uS/cm) in the South Bulga Area: P5A, P5B, P6A, P6B, P7A, P7B
P5A
P5B
P6A
P6B
P7A
P7B
Gauge Height

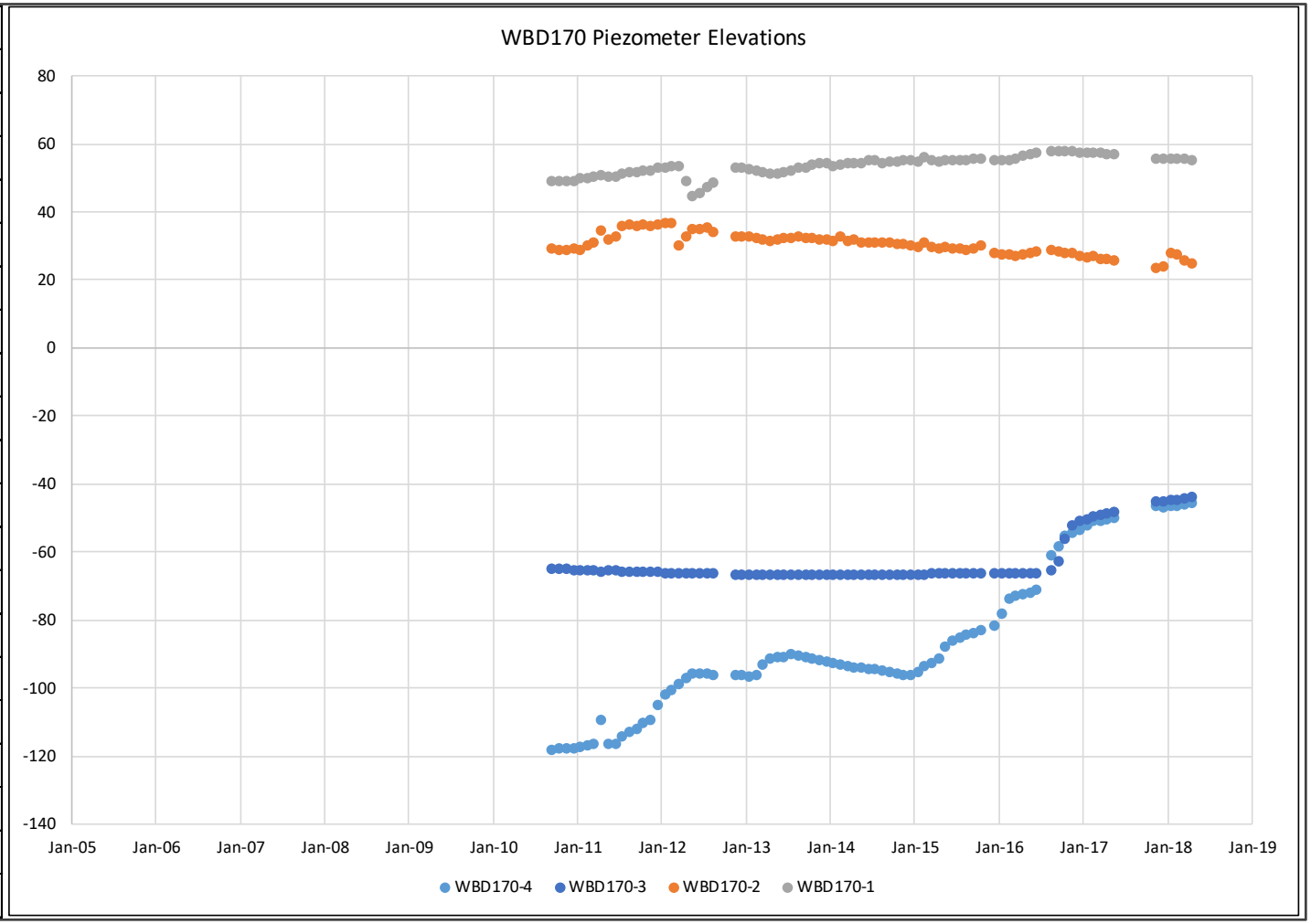
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
WBD210-8	09. Permian CM
	10. Permian CM
WBD210-7	11. Blakefield Seam
	12. Permian CM
WBD210-6	13. Glen Munro Seam
	14. Permian CM
WBD210-5	15. Woodlands Hill S.
WBD210-3, -4	16. Permian CM
WBD210-2	17. Vaux Seam
WBD210-1	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



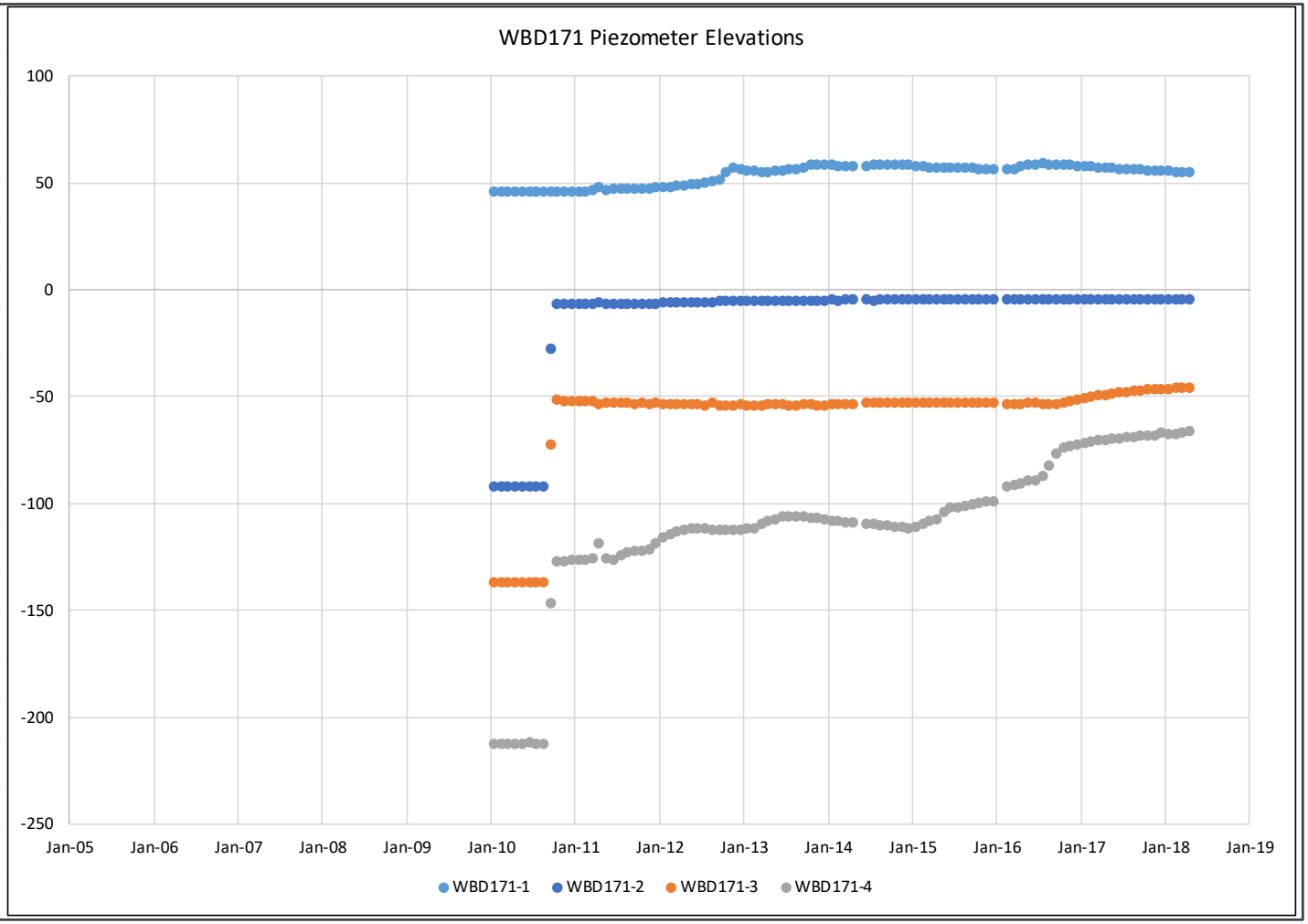
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
WBD207-8	09. Permian CM
	10. Permian CM
WBD207-7	11. Blakefield Seam
	12. Permian CM
WBD207-6	13. Glen Munro Seam
	14. Permian CM
WBD207-5	15. Woodlands Hill S.
WBD207-3, -4	16. Permian CM
WBD207-2	17. Vaux Seam
WBD207-1	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



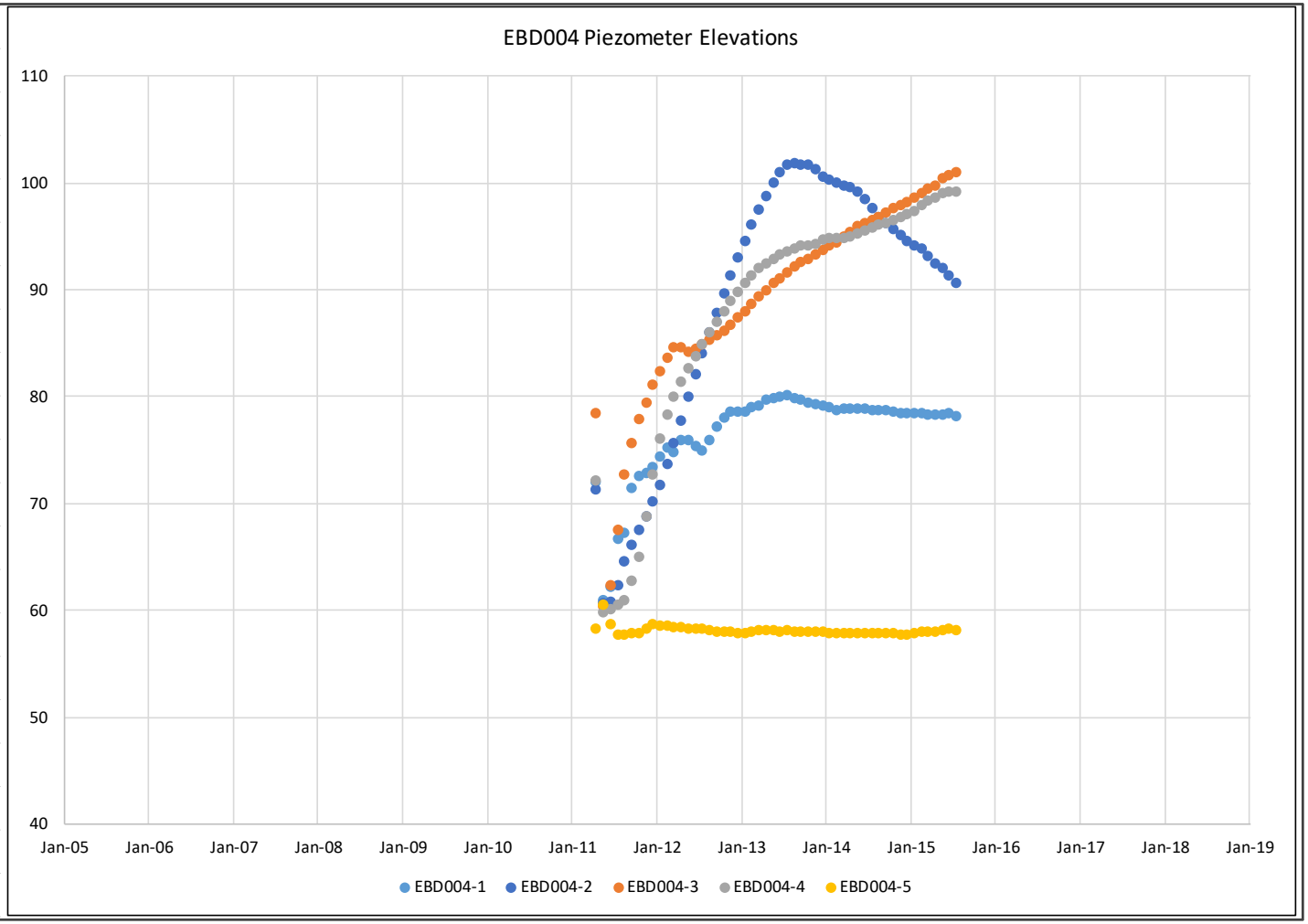
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
WBD170-1	08. L.Whybrow Seam
WBD170-2	09. Permian CM
WBD170-3	10. Permian CM
	11. Blakefield Seam
WBD170-4	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



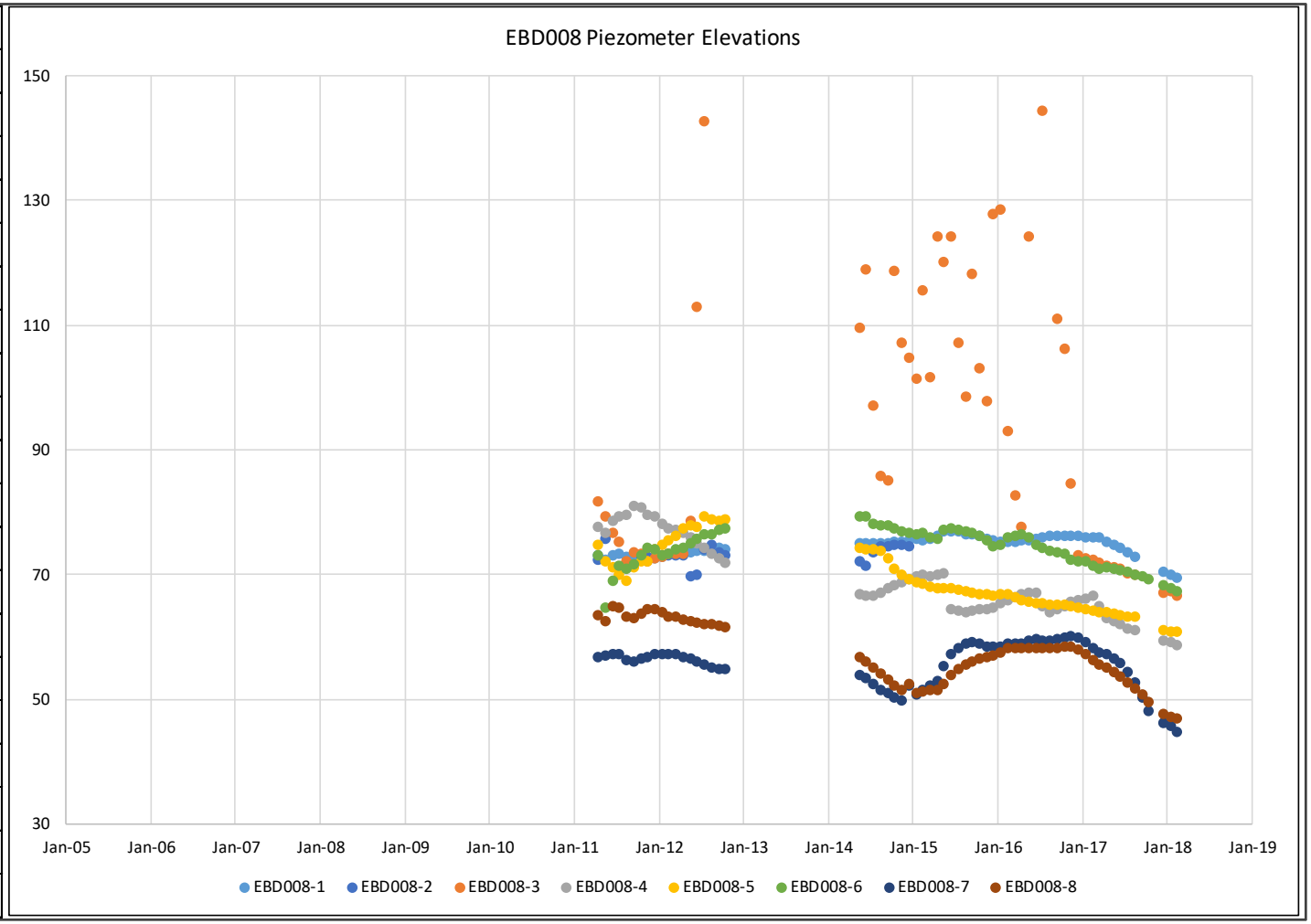
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
WBD171-1	08. L.Whybrow Seam
WBD171-2	09. Permian CM
WBD171-3	10. Permian CM
	11. Blakefield Seam
WBD171-4	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



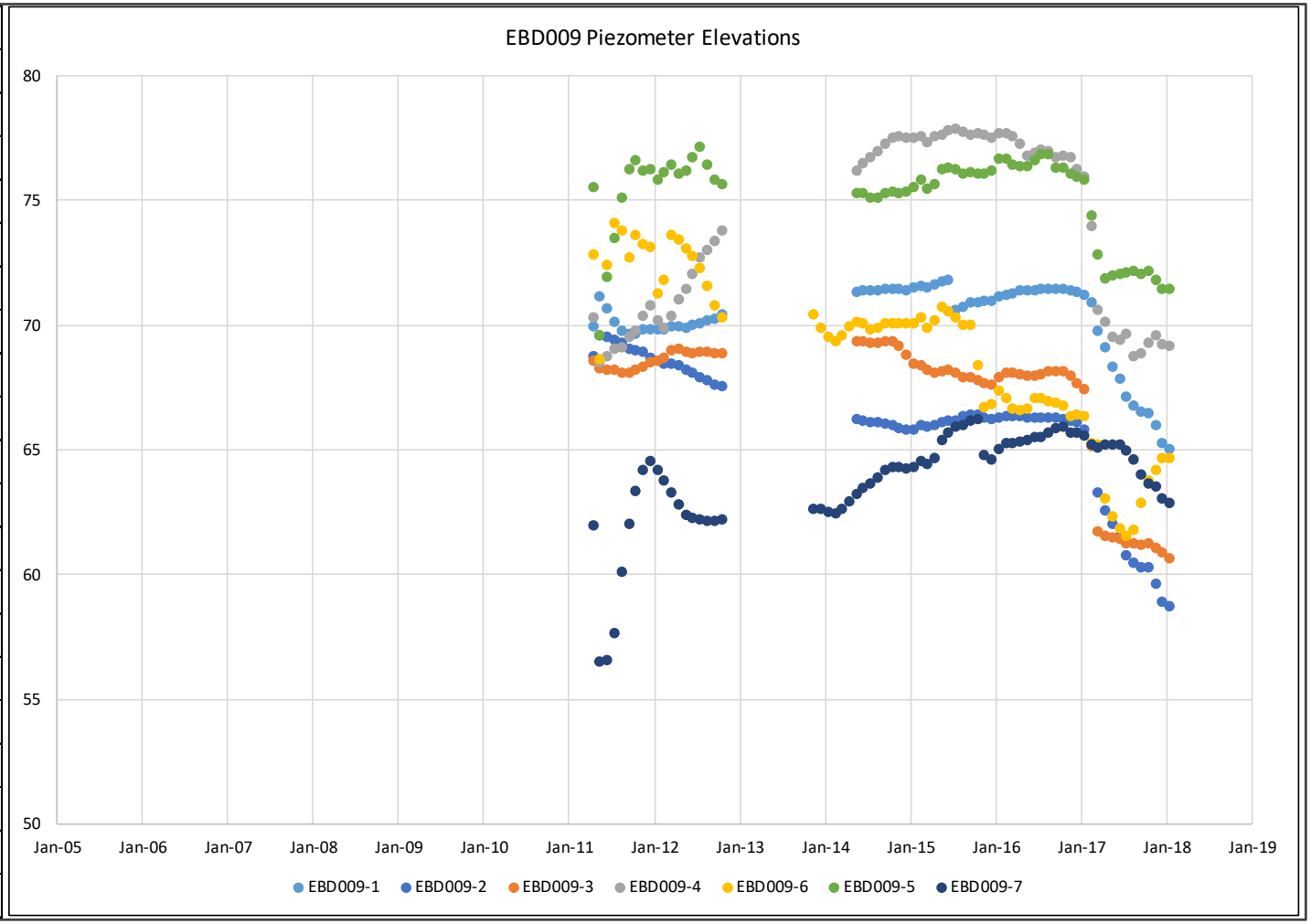
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
All Piezos	19. Permian CM
	20. Saltwater Ck. Fm



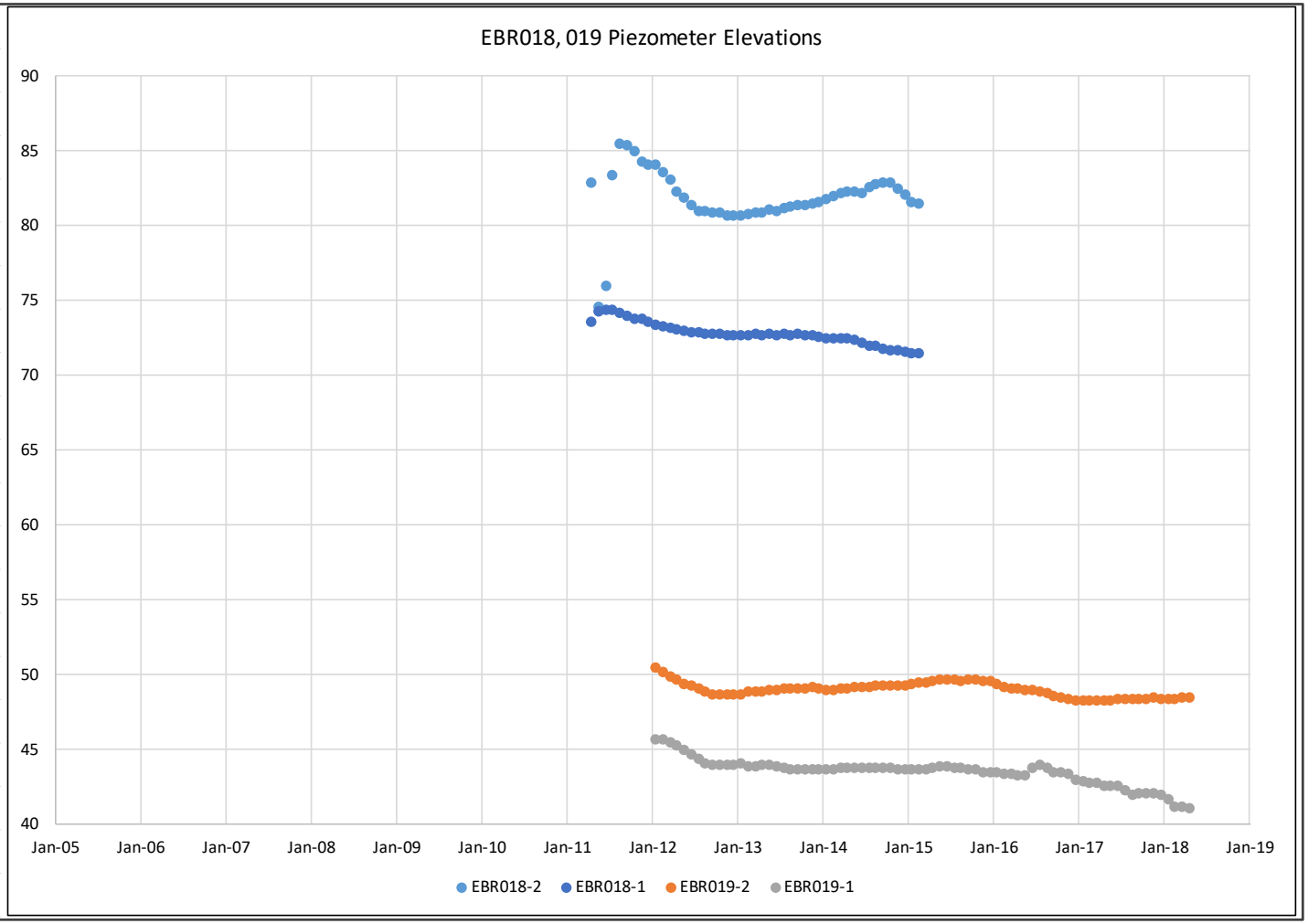
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
EBD008-8	16. Permian CM
EBD008-7	17. Vaux Seam
EBD008-6	18. Permian CM
Other Piezos	19. Permian CM
	20. Saltwater Ck. Fm



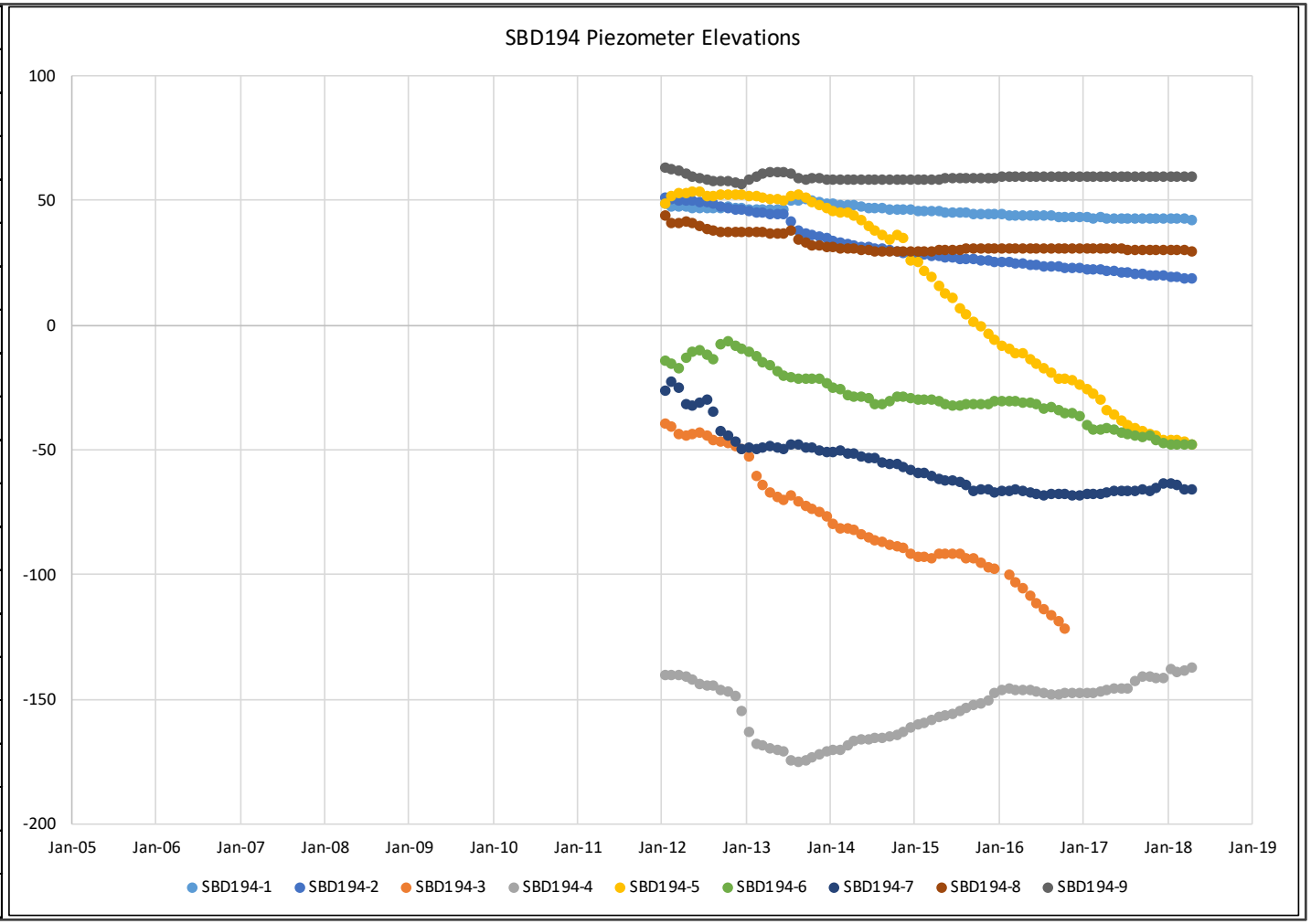
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
EBD009-7	18. Permian CM
Other Piezos	19. Permian CM
	20. Saltwater Ck. Fm



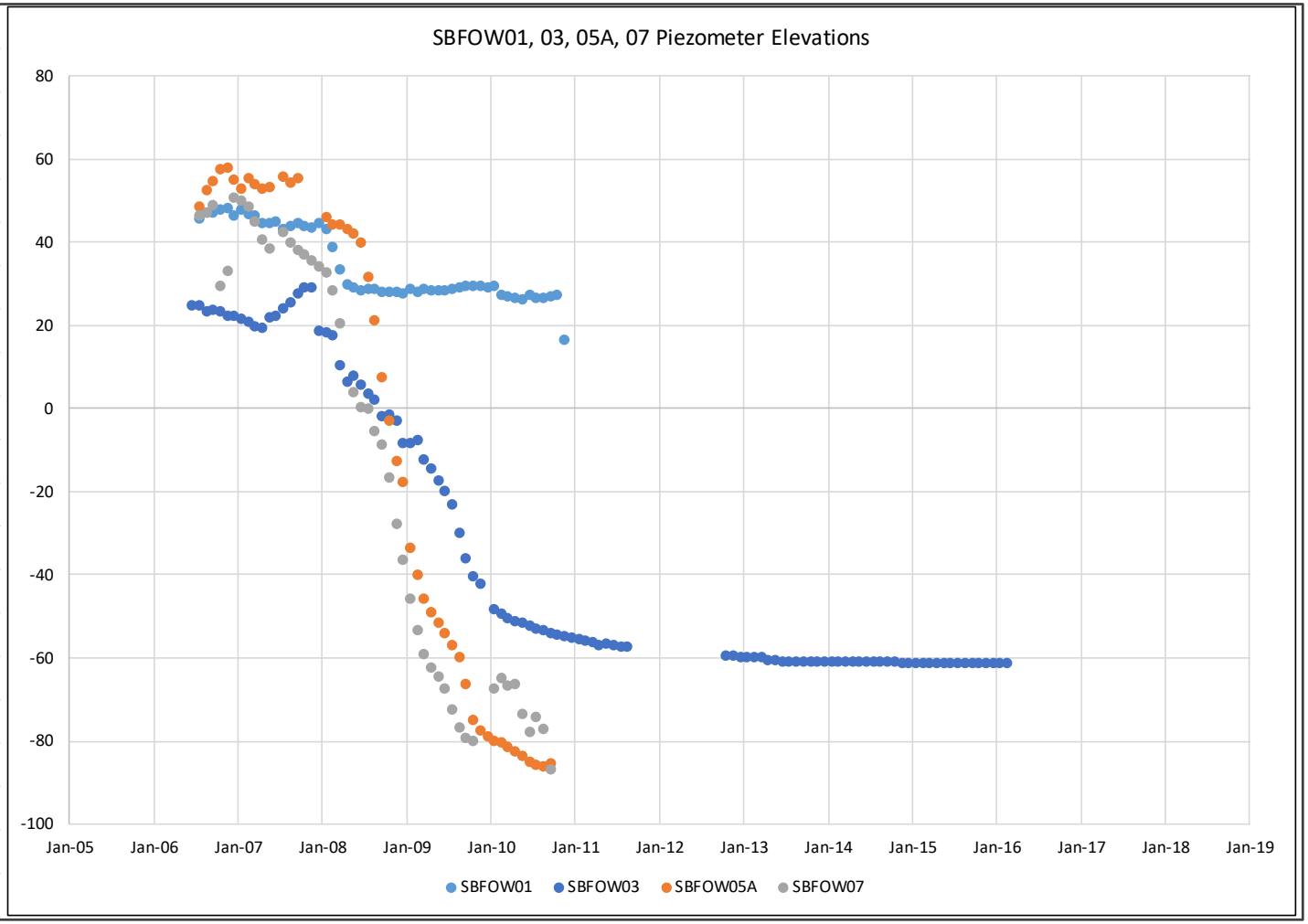
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
All Piezos	20. Saltwater Ck. Fm



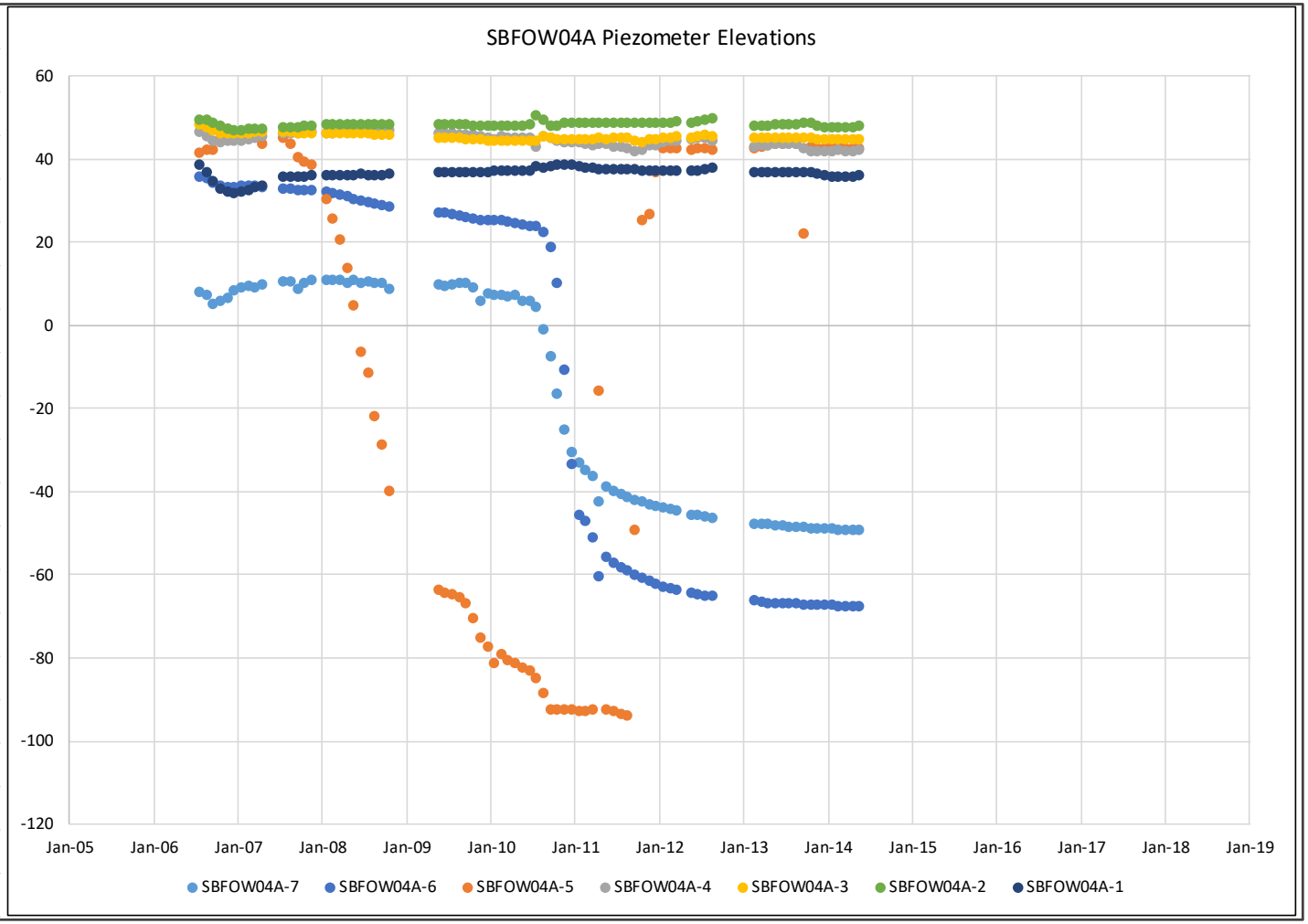
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
SBD194-9	04. Alcheringa Seam
	05. Permian CM
SBD194-8	06. Permian CM
	07. Permian CM
SBD194-7	08. L.Whybrow Seam
SBD194-6	09. Permian CM
SBD194-5	10. Permian CM
SBD194-4	11. Blakefield Seam
	12. Permian CM
SBD194-3	13. Glen Munro Seam
	14. Permian CM
SBD194-2	15. Woodlands Hill S.
SBD194-1	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



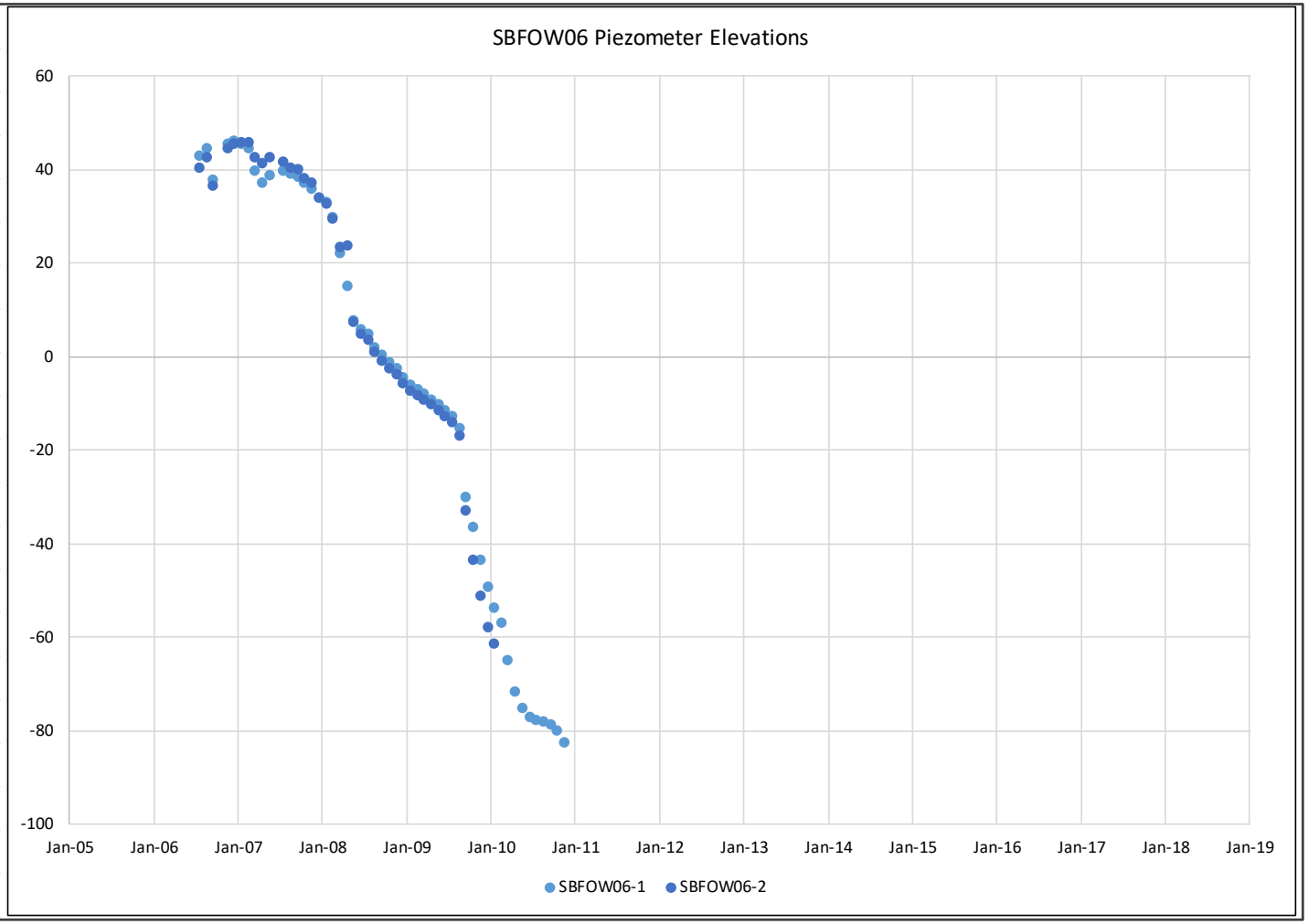
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
SBFOW01, 03, 05A, 07	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



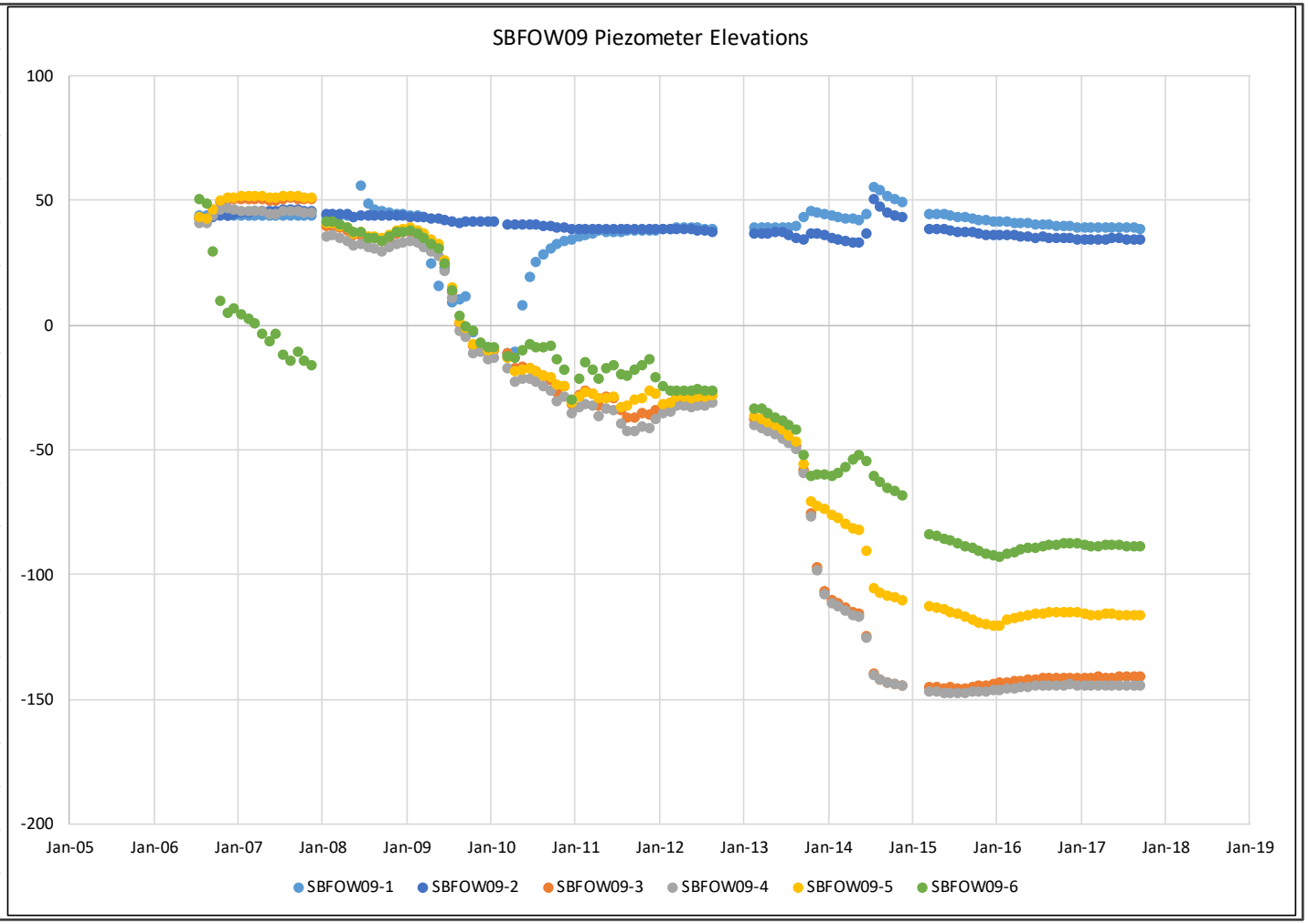
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
SBFOW04A-6, -7	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
SBFOW04A-5	11. Blakefield Seam
	12. Permian CM
SBFOW04A-4	13. Glen Munro Seam
	14. Permian CM
SBFOW04A-1, -2, -3	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



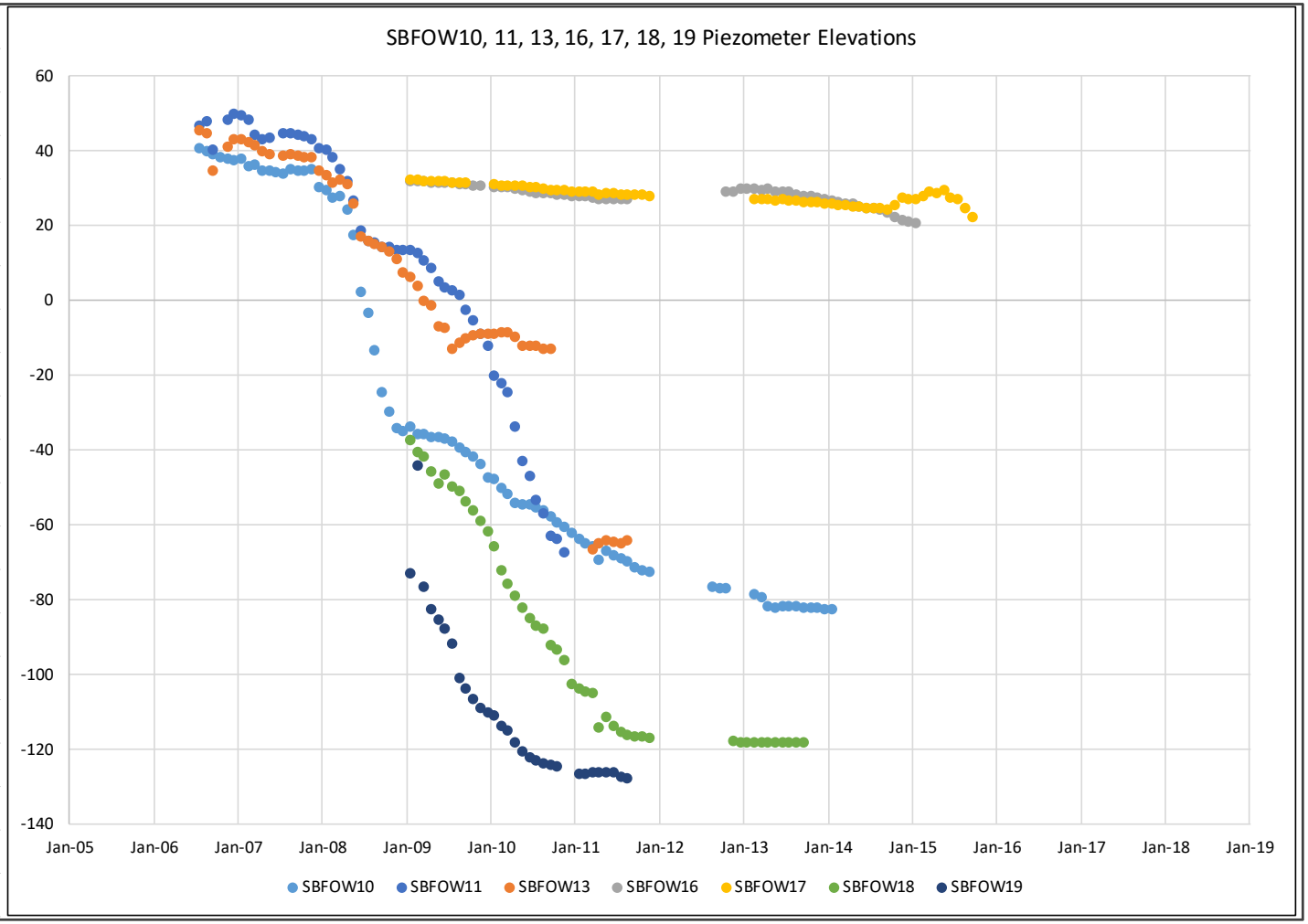
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
SBFOW6-1, -2	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



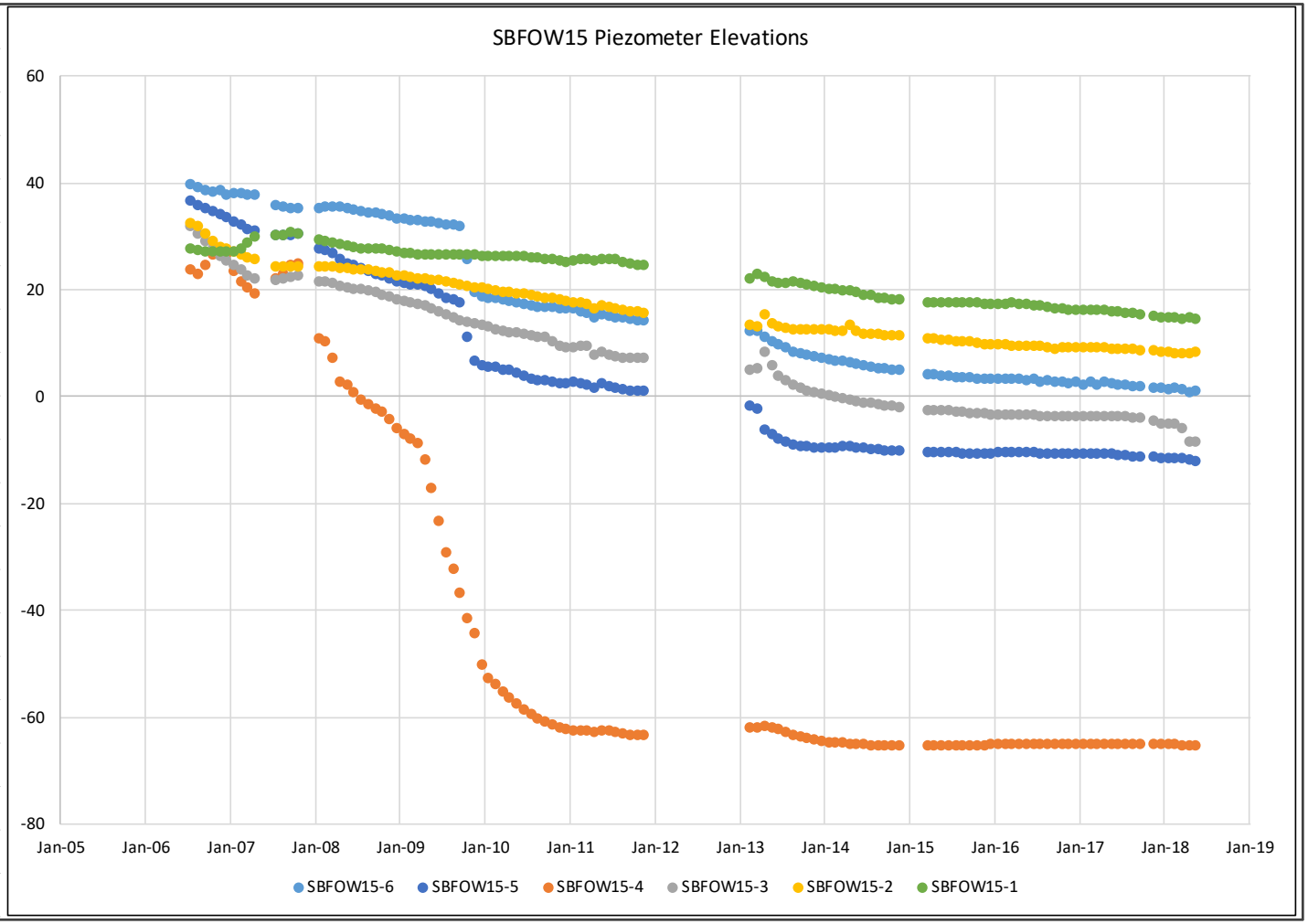
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
SBFOW09-5, -6	09. Permian CM
	10. Permian CM
SBFOW09-4	11. Blakefield Seam
	12. Permian CM
SBFOW09-3	13. Glen Munro Seam
	14. Permian CM
SBFOW09-2	15. Woodlands Hill S.
SBFOW09-1	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



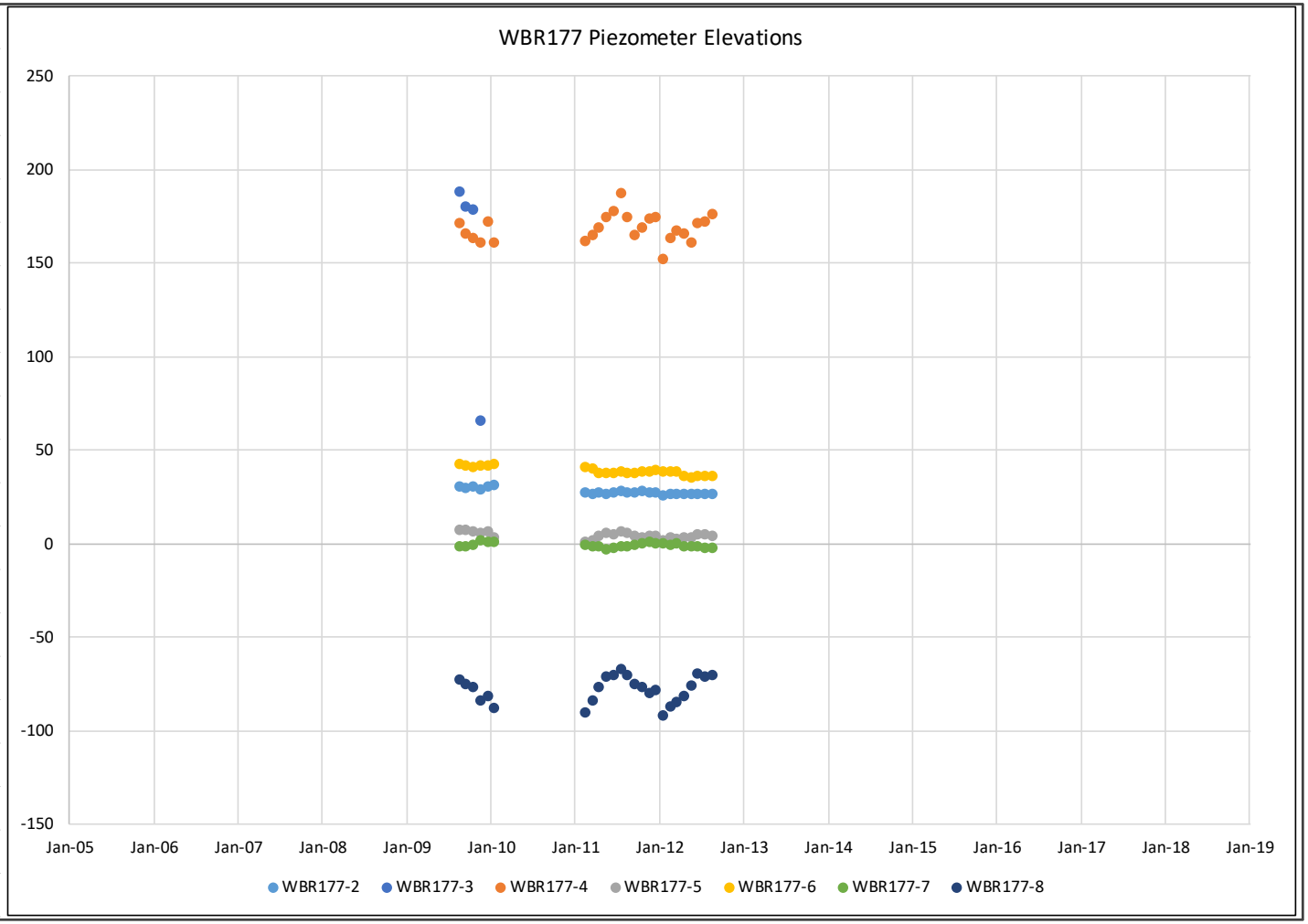
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
All Piezos on plot	11. Blakefield Seam
	12. Permian CM
	13. Glen Munro Seam
	14. Permian CM
	15. Woodlands Hill S.
	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



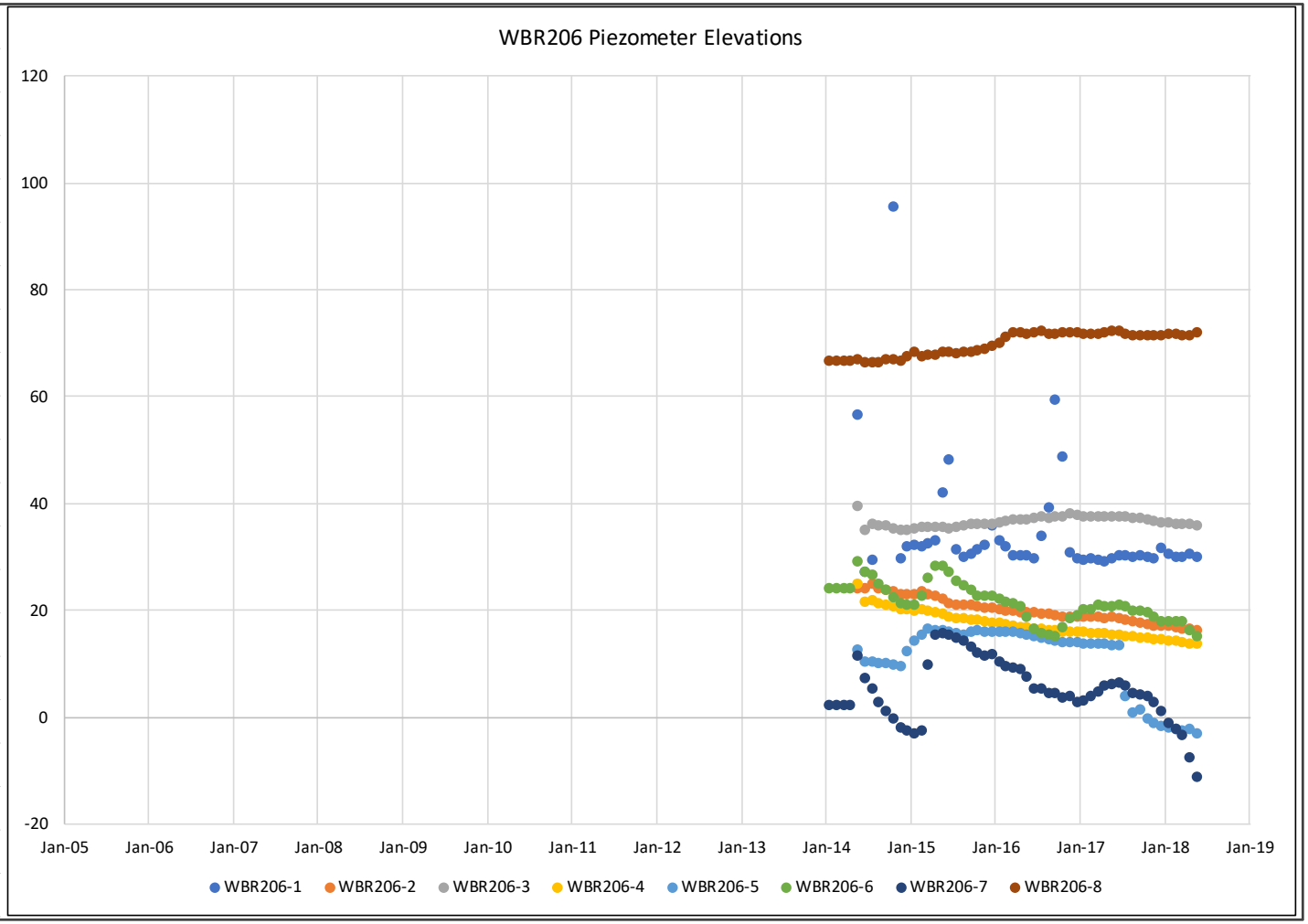
	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
SBFOW15-6	08. L.Whybrow Seam
SBFOW15-5	09. Permian CM
	10. Permian CM
SBFOW15-4	11. Blakefield Seam
	12. Permian CM
SBFOW15-3	13. Glen Munro Seam
	14. Permian CM
SBFOW15-2	15. Woodlands Hill S.
SBFOW15-1	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
	08. L.Whybrow Seam
WBR177-2	09. Permian CM
	10. Permian CM
WBR177-3, -4	11. Blakefield Seam
	12. Permian CM
WBR177-5	13. Glen Munro Seam
	14. Permian CM
WBR177-6	15. Woodlands Hill S.
WBR177-7, -8	16. Permian CM
	17. Vaux Seam
	18. Permian CM
	19. Permian CM
	20. Saltwater Ck. Fm



	01. Regolith
	01. Alluvium
	02. Narabeen Group
	03. Permian CM
	04. Alcheringa Seam
	05. Permian CM
	06. Permian CM
	07. Permian CM
WBR206-8	08. L.Whybrow Seam
	09. Permian CM
	10. Permian CM
WBR206-7	11. Blakefield Seam
	12. Permian CM
WBR206-6	13. Glen Munro Seam
	14. Permian CM
WBR206-5	15. Woodlands Hill S.
WBR206-3, -4	16. Permian CM
WBR206-2	17. Vaux Seam
	18. Permian CM
WBR206-1	19. Permian CM
	20. Saltwater Ck. Fm



APPENDIX II

Model Calibration Summary and Comparison

I-1 MODEL CALIBRATION SUMMARY

MODEL CALIBRATION HISTORY

The following model calibration history is provided to place context on model evolution and to assist in the evaluation of model calibration suitability for the Proposed Modification predictions.

Mackie (2013)

Mackie (2013) completed a steady state calibration "*to establish a pre-mining (undisturbed) water table and virgin pore pressure distribution for the area of interest*". Available data applied included monitoring bores in the alluvium and "*a few hard rock bores where pre-mining levels could be reasonably estimated*". It was noted that most piezometers had been installed subsequent to commencement of mining (and were therefore not appropriate for the purpose of steady state calibration).

A normalised RMS error on this steady state calibration of 8.03% was achieved. It is not apparent which bores were applied in the process. It is assumed this calibration was manually achieved.

Appendix E of Mackie (2013) provides further detail on the process applied. The steady state calibration was developed as a starting condition for transient calibration which relied on history matching of piezometric head data measured at numerous piezometers, and measured mine water make in underground operations. The transient calibration process is described as iterative with manual adjustment of material properties (hydraulic conductivity, compressible storage and specific yield) followed by steady state simulation / calibration, before undertaking further transient simulations.

It is assumed the process of transient calibration was manual as no mention of automated parameter estimation was included. Transient calibration RMS is not presented.

AGE (2016a)

AGE (2016a) determined that recalibration of the model (of Mackie, 2013) was not required based on review of an additional 3.5 years of monitoring data. The report applies the predicted mine inflows prior to 2013 work on the basis that the model calibration has not changed. Individual predicted and observed hydrographs are provided.

AGE (2016b)

AGE (2016b) applied the same assumption of model suitability as that of AGE (2016a), with no modification to the model calibration conducted.

I-1.1 Calibration Performance Review

In reviewing the performance of the Proposed Modification model, calculated metrics as a means of numerical performance review (for the transient conditions) have been included, however, these transient simulation comparisons should not be considered in the same manner as a normalised RMS on a subset of bores under steady state conditions. The latter are only presented to show comparison with previous modelling results.

Previously, assignment of hydraulic properties to distribute parameters in the coal seams was achieved by means of a few discrete zones. Such an approach leads to abrupt changes in properties at the boundaries of these zones. Also, in earlier modelling, distribution of vertical hydraulic conductivity enhancement was done nominally based on layers; with no consideration to depth of cover. The two amendments applied and discussed in earlier sections appear to have improved the model calibration performance. They have also been incorporated into the predictive run.

I-1.1.1 Calibration Process & Model Modifications

A summary of modified K_h and accompanying comments are provided in Table 1-1 to Table 1-4, and the final calibration data compared with starting values for K_h, K_v, S_s and S_y are shown graphically in Figure 1-1 to Figure 1-4.

An automatic calibration using PEST was initiated. All observations provided to KCB from previous models were assigned an equal weight and included in the calibration exercise. Regularisation was employed that used a preferred value Tikhonov scheme to ensure parameter values did not vary wildly in the absence of observation data to support such deviations from initial preferred values. A total of 96 parameters were adjusted during calibration and include K_h, K_v, S_s, S_y and Recharge factors. This calibration is the first attempt to adjust hydraulic storage properties.

Table 1-1: Summary Calibrated K_h (m/d)

Geological Unit	Model Layer	Parameter Name	Initial Value	Calibrated Value	Min Bound	Max Bound	Adjusted during calibration	Comment
Regolith	1 - 20	kh_z1	1.00E-02	1.48E-02	1.00E-03	1.00E-01	Yes	
Alluvium	1	kh_z2	5.00E+00	3.96E+00	5.00E-01	5.00E+01	Yes	
Narrabeen Group	2	kh_z3	4.00E-03	4.80E-03	4.00E-04	4.00E-02	Yes	
(Monocline)	3 - 15	kh_z4	5.00E-04	5.00E-04			No	
Permian Coal Measures	3	kh_z5	4.00E-03	4.00E-03	4.00E-04	4.00E-02	Yes	No Change
Alcheringa Seam	4	kh_z6	8.00E-03	3.00E-02	8.00E-04	8.00E-02	Yes	
Permian Coal Measures	5	kh_z9	3.00E-04	1.64E-03	3.00E-05	3.00E-03	Yes	
Permian Coal Measures	6	kh_z10	1.00E-04	1.00E-04	1.00E-05	1.00E-03	Yes	
Permian Coal Measures	7	kh_z11	6.00E-05	1.68E-04	6.00E-06	6.00E-04	Yes	
Lower Whybrow Seam	8	kh_z12	9.00E-02	9.00E-02	9.00E-03	9.00E-01	Yes	No Change
Permian Coal Measures	9	kh_z14	4.00E-05	6.40E-05	4.00E-06	4.00E-04	Yes	
Permian Coal Measures	10	kh_z15	3.00E-05	1.68E-05	3.00E-06	3.00E-04	Yes	
Blakefield Seam	11	kh_z16	1.00E-01	7.44E-02	1.00E-02	1.00E+00	Yes	
Permian Coal Measures	12	kh_z17	4.00E-05	5.87E-05	4.00E-06	4.00E-04	Yes	
Glen Munro Seam	13	kh_z18	7.00E-02	1.93E-02	7.00E-03	7.00E-01	Yes	
Permian Coal Measures	14	kh_z19	4.00E-05	3.69E-05	4.00E-06	4.00E-04	Yes	
Woodlands Seam	15	kh_z20	6.00E-02	4.02E-02	6.00E-03	6.00E-01	Yes	
Permian Coal Measures	16	kh_z21	5.00E-05	4.96E-05	5.00E-06	5.00E-04	Yes	
Vaux Seam	17	kh_z36	5.00E-05	5.00E-05			No	
Permian Coal Measures	18	kh_z22	1.00E-05	1.43E-05	1.00E-06	1.00E-04	Yes	
Permian Coal Measures	19	kh_z23	7.00E-06	6.44E-06	7.00E-07	7.00E-05	Yes	
Saltwater Ck Formation	20	kh_z24	3.00E-06	2.53E-06	3.00E-07	3.00E-05	Yes	

Table 1-2: Summary Calibrated K_v (m/d)

Geological Unit	Model Layer	Parameter Name	Initial Value	Calibrated Value	Min Bound	Max Bound	Adjusted during calibration	Comment
Regolith	1 - 20	Kv_z1	1.00E-02	1.48E-02	1.00E-05	1.00E-02	Yes	
Alluvium	1	Kv_z2	5.00E+00	3.96E+00	5.00E-03	5.00E+00	Yes	
Narrabeen Group	2	Kv_z3	4.00E-05	4.80E-05	4.00E-08	4.00E-03	Yes	
(Monocline)	3 - 15	Kv_z4	7.50E-05	7.50E-05	0.00E+00	0.00E+00	No	
Permian Coal Measures	3	Kv_z5	2.20E-05	2.20E-05	2.20E-08	4.00E-03	Yes	
Alcheringa Seam	4	Kv_z6	8.00E-03	8.00E-03	8.00E-06	8.00E-03	Yes	No Change
Permian Coal Measures	5	Kv_z9	5.00E-06	2.73E-05	5.00E-09	3.00E-04	Yes	
Permian Coal Measures	6	Kv_z10	3.50E-06	3.50E-06	3.50E-09	1.00E-04	Yes	
Permian Coal Measures	7	Kv_z11	2.00E-06	5.61E-06	2.00E-09	6.00E-05	Yes	
Lower Whybrow Seam	8	Kv_z12	9.00E-02	9.00E-02	9.00E-05	9.00E-02	Yes	No Change
Permian Coal Measures	9	Kv_z14	5.00E-07	8.00E-07	5.00E-10	4.00E-05	Yes	
Permian Coal Measures	10	Kv_z15	5.00E-07	2.80E-07	5.00E-10	3.00E-05	Yes	
Blakefield Seam	11	Kv_z16	1.00E-01	7.44E-02	1.00E-04	1.00E-01	Yes	
Permian Coal Measures	12	Kv_z17	5.00E-07	7.34E-07	5.00E-10	4.00E-05	Yes	
Glen Munro Seam	13	Kv_z18	7.00E-02	1.93E-02	7.00E-05	7.00E-02	Yes	
Permian Coal Measures	14	Kv_z19	6.00E-07	5.54E-07	6.00E-10	4.00E-05	Yes	
Woodlands Seam	15	Kv_z20	6.00E-02	4.02E-02	6.00E-05	6.00E-02	Yes	
Permian Coal Measures	16	Kv_z21	8.00E-07	7.94E-07	8.00E-10	5.00E-05	Yes	
Vaux Seam	17	Kv_z36	8.00E-07	8.00E-07			No	Single Zone
Permian Coal Measures	18	Kv_z22	3.00E-07	4.28E-07	3.00E-10	1.00E-05	Yes	
Permian Coal Measures	19	Kv_z23	7.00E-08	6.44E-08	7.00E-11	7.00E-06	Yes	
Saltwater Ck Formation	20	Kv_z24	7.00E-08	5.91E-08	7.00E-11	3.00E-06	Yes	

Table 1-3: Summary Calibrated Specific Storage (m^{-1}

Geological Unit	Model Layer	Parameter Name	Initial Value	Calibrated Value	Min Bound	Max Bound	Adjusted during calibration	Comment
Regolith	1 - 20	Ss_z1	1.00E-05	9.25E-06	2.00E-06	5.00E-05	Yes	
Alluvium	1	Ss_z2	1.00E-05	6.76E-06	2.00E-06	5.00E-05	Yes	
Narrabeen Group	2	Ss_z3	3.00E-06	2.73E-06	6.00E-07	1.50E-05	Yes	
(Monocline)	3 - 15	Ss_z4	6.00E-07	6.00E-07			No	
Permian Coal Measures	3	Ss_z5	1.00E-06	5.28E-07	2.00E-07	5.00E-06	Yes	
Alcheringa Seam	4	Ss_z6	6.00E-06	1.03E-05	1.20E-06	3.00E-05	Yes	
Permian Coal Measures	5	Ss_z9	8.00E-07	1.33E-06	1.60E-07	4.00E-06	Yes	
Permian Coal Measures	6	Ss_z10	7.00E-07	1.75E-06	1.40E-07	3.50E-06	Yes	
Permian Coal Measures	7	Ss_z11	6.00E-07	3.17E-07	1.20E-07	3.00E-06	Yes	
Lower Whybrow Seam	8	Ss_z12	1.00E-05	1.71E-05	2.00E-06	5.00E-05	Yes	
Permian Coal Measures	9	Ss_z14	9.00E-07	3.36E-06	1.80E-07	4.50E-06	Yes	
Permian Coal Measures	10	Ss_z15	9.00E-07	6.95E-07	1.80E-07	4.50E-06	Yes	
Blakefield Seam	11	Ss_z16	1.00E-05	1.13E-05	2.00E-06	5.00E-05	Yes	
Permian Coal Measures	12	Ss_z17	8.00E-07	1.56E-06	1.60E-07	4.00E-06	Yes	
Glen Munro Seam	13	Ss_z18	1.00E-05	1.19E-05	2.00E-06	5.00E-05	Yes	
Permian Coal Measures	14	Ss_z19	8.00E-07	1.25E-06	1.60E-07	4.00E-06	Yes	
Woodlands Seam	15	Ss_z20	1.00E-05	1.36E-05	2.00E-06	5.00E-05	Yes	
Permian Coal Measures	16	Ss_z21	8.00E-07	7.95E-07	1.60E-07	4.00E-06	Yes	
Vaux Seam	17	Ss_z36	8.00E-07	8.00E-07			No	Single Zone
Permian Coal Measures	18	Ss_z22	1.00E-07	1.17E-07	2.00E-08	5.00E-07	Yes	
Permian Coal Measures	19	Ss_z23	1.00E-07	1.17E-07	2.00E-08	5.00E-07	Yes	
Saltwater Ck Formation	20	Ss_z24	1.00E-05	5.68E-06	2.00E-06	5.00E-05	Yes	

Table 1-4: Summary Calibrated Specific Yield

Geological Unit	Model Layer	Parameter Name	Initial Value	Calibrated Value	Min Bound	Max Bound	Adjusted during calibration	Comment
Regolith	1 - 20	Sy_z1	5.00E-03	6.41E-03	2.50E-03	1.00E-02	Yes	
Alluvium	1	Sy_z2	3.00E-01	3.00E-01	5.00E-02	5.00E-01	Yes	No Change
Narrabeen Group	2	Sy_z3	5.00E-03	7.73E-03	2.50E-03	1.00E-02	Yes	
(Monocline)	3 - 15	Sy_z4					No	
Permian Coal Measures	3	Sy_z5	2.00E-03	3.24E-03	1.00E-03	4.00E-03	Yes	
Alcheringa Seam	4	Sy_z6	6.00E-03	1.03E-02	3.00E-03	1.20E-02	Yes	
Permian Coal Measures	5	Sy_z9	1.10E-03	2.20E-03	5.50E-04	2.20E-03	Yes	
Permian Coal Measures	6	Sy_z10	1.40E-03	1.61E-03	7.00E-04	2.80E-03	Yes	
Permian Coal Measures	7	Sy_z11	1.20E-03	1.56E-03	6.00E-04	2.40E-03	Yes	
Lower Whybrow Seam	8	Sy_z12	3.10E-03	4.38E-03	1.55E-03	6.20E-03	Yes	
Permian Coal Measures	9	Sy_z14	2.30E-03	2.52E-03	1.15E-03	4.60E-03	Yes	
Permian Coal Measures	10	Sy_z15	2.00E-03	1.19E-03	1.00E-03	4.00E-03	Yes	
Blakefield Seam	11	Sy_z16	8.00E-03	8.00E-03	4.00E-03	1.60E-02	Yes	No Change
Permian Coal Measures	12	Sy_z17	2.10E-03	1.80E-03	1.05E-03	4.20E-03	Yes	
Glen Munro Seam	13	Sy_z18	9.00E-03	9.00E-03	4.50E-03	1.80E-02	Yes	No Change
Permian Coal Measures	14	Sy_z19	2.00E-03	1.66E-03	1.00E-03	4.00E-03	Yes	
Woodlands Seam	15	Sy_z20	7.00E-03	7.00E-03	3.50E-03	1.40E-02	Yes	No Change
Permian Coal Measures	16	Sy_z21	2.00E-03	2.84E-03	1.00E-03	4.00E-03	Yes	
Vaux Seam	17	Sy_z36	2.00E-03	2.00E-03			No	
Permian Coal Measures	18	Sy_z22	2.00E-03	1.32E-03	1.00E-03	4.00E-03	Yes	
Permian Coal Measures	19	Sy_z23	1.00E-03	2.00E-03	5.00E-04	2.00E-03	Yes	
Saltwater Ck Formation	20	Sy_z24	1.00E-02	1.40E-02	5.00E-03	2.00E-02	Yes	

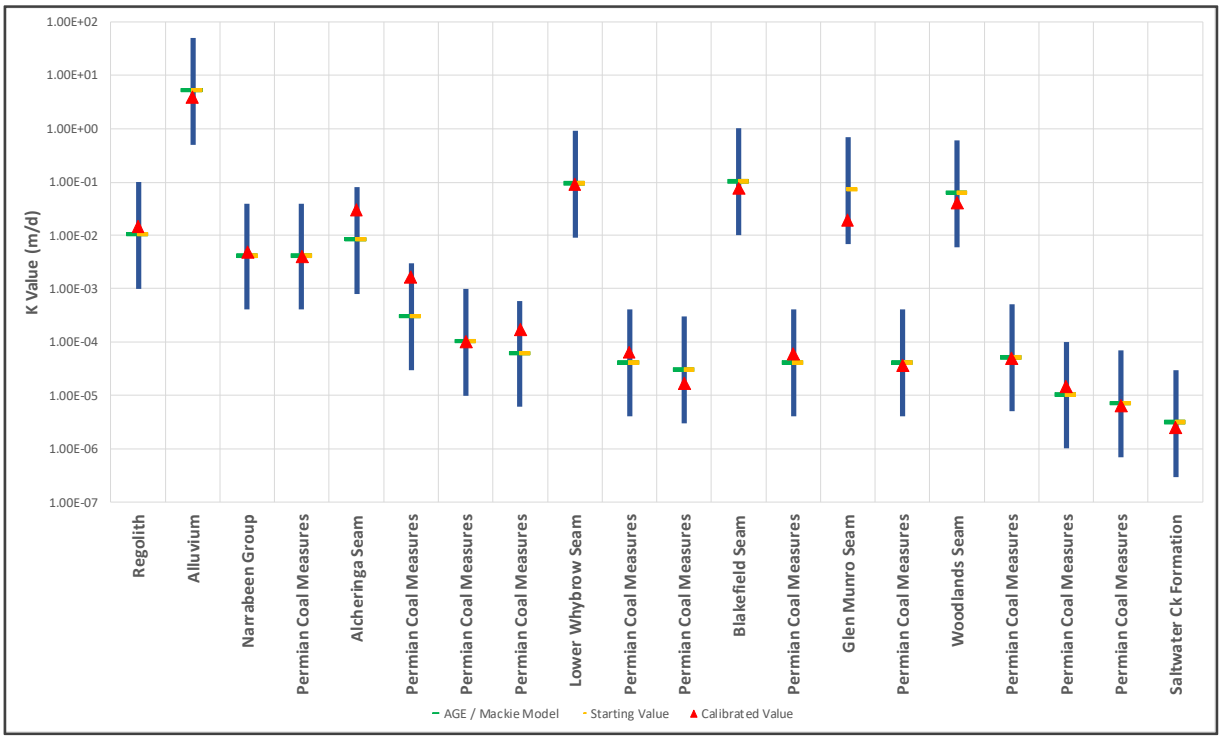


Figure 1-1: Horizontal Hydraulic Conductivity – Starting & Calibrated Values by Unit

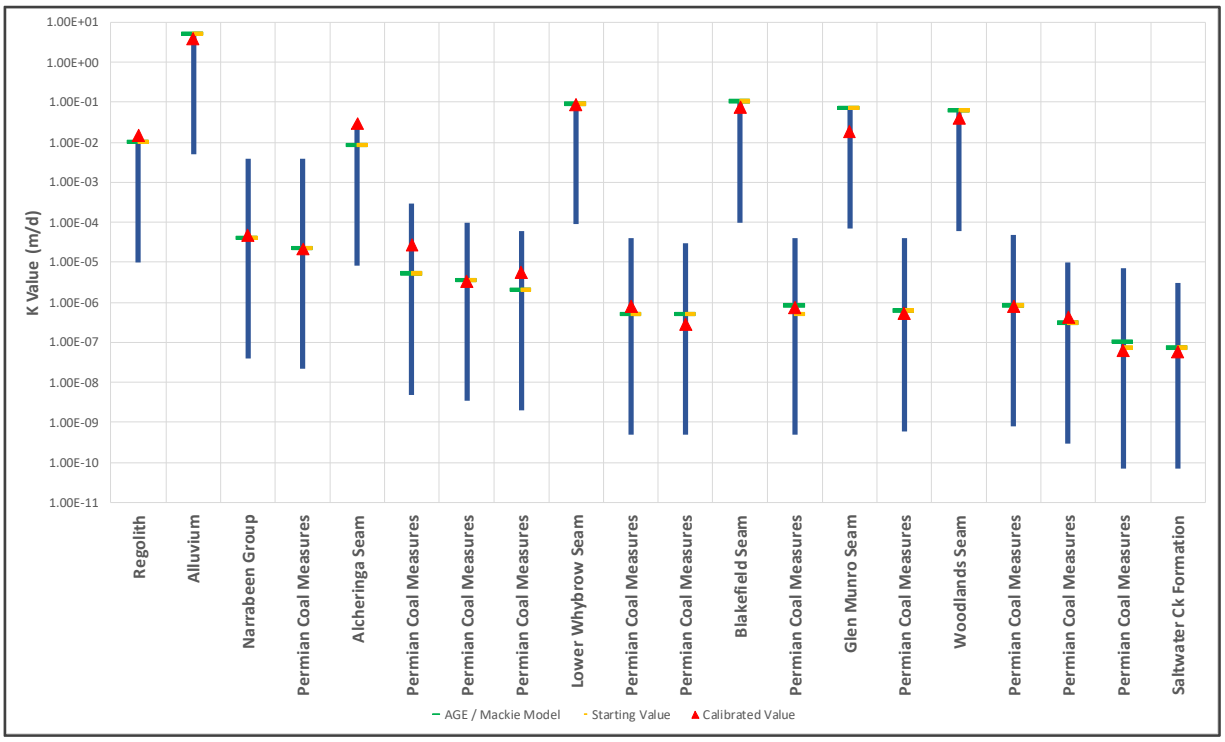


Figure 1-2: Vertical Hydraulic Conductivity – Starting & Calibrated Values by Unit

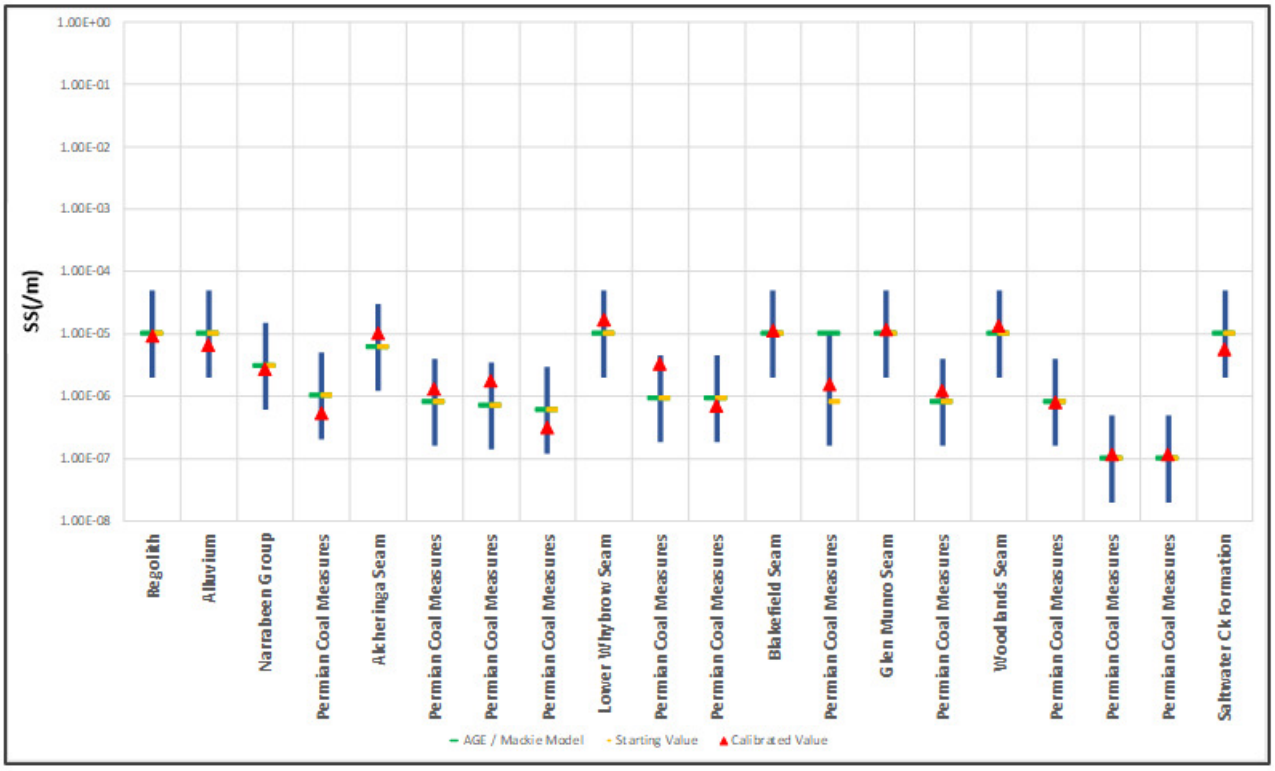


Figure 1-3: Specific Storage – Starting & Calibrated Values by Unit

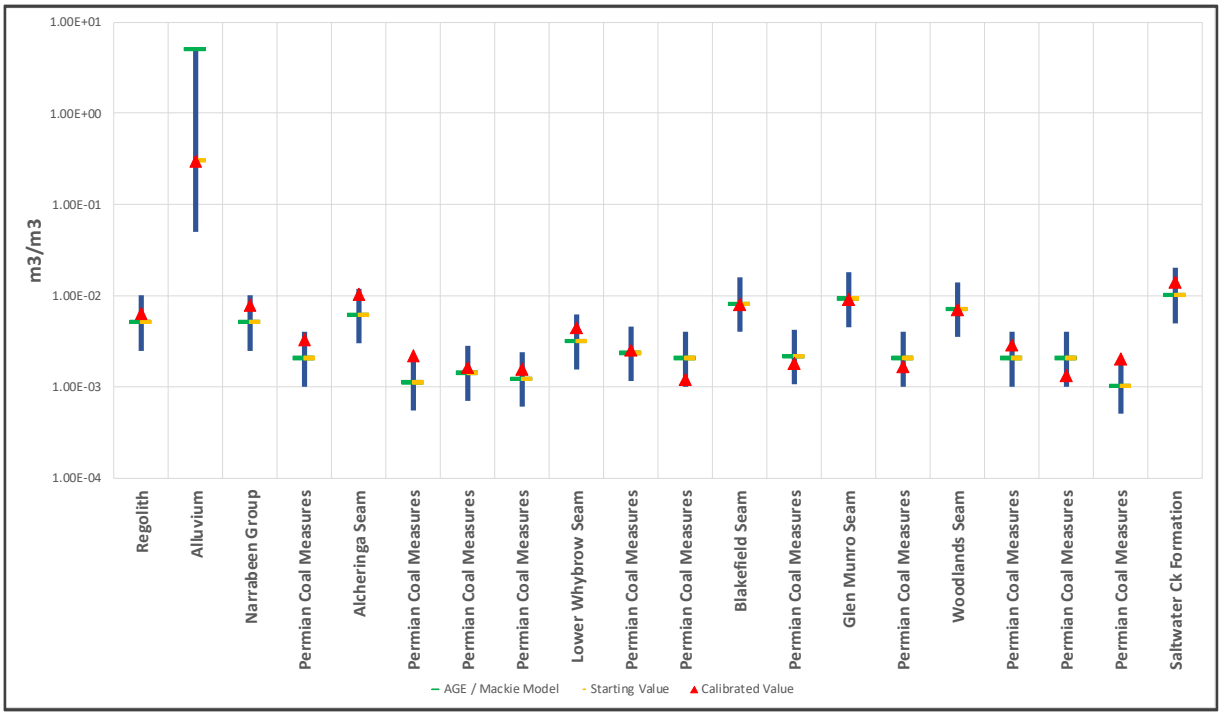


Figure 1-4: Specific Yield – Starting & Calibrated Values by Unit

Recharge to the model domain was calculated as a percentage of recorded rainfall within the model domain during each stress period of the calibration model run. During the calibration period, cumulative historical rainfall totals for the corresponding period were tabulated. These

were then converted to average daily rainfall for that period. The percentage of this average daily rainfall that results as recharge were estimated during calibration and these are provided in Table 1-5.

Table 1-5: Summary Calibrated Recharge Rates

Modelled Recharge Zone	Percentage of Daily Rainfall
Quaternary alluvium	8.0 %
Regolith (weathered Permian)	0.2 %

I-1.2 Calibration Results

I-1.2.1 RMS

To provide a reasonable review of an RMS performance metric, we extracted transient monitoring points used across all bores in the AGE/Mackie calibration period (up to 2018) (with the exception of bores P1, WBD55, WBD62 and WBD57 as these display unreliable / erroneous data). These were compared with the results of the Proposed Modification's PEST-optimised transient calibration as a numerical means of comparing the models only; and is not a measure of model calibration performance.

- KCB model RMS error, 7,203 observations from 96 bores / piezometers 27.22 m.
- AGE model RMS error, applying same data set 34.50 m.

The Proposed Modification model results show a modest improvement in this statistic. Most notably however, the Proposed Modification's calibration process explicitly included storage parameters in the parameter estimation process, allowing for improved estimation of these values.

The normalised RMS achieved for the Proposed Modification model is 10% whereas the same statistic produced from the AGE/Mackie model is 13%. While this does not yet achieve the previously reported 8.03% reported by Mackie for the alluvial bores, this 10% RMS is focussed on the Permian mining sequence, using almost all data available. Without the ability to numerically differentiate the pre-mining processes which can skew the early mining time data, this is considered an improvement.

Figure 1-5 provides a visual comparison of modelled versus observed data for the entire transient data set used. Figure 1-5 provides a subset of this information focussed on late calibration period (2018 data) which is indicative of the starting point for the transient simulation for this project.

The erratic nature of the data evident in Figure 1-5 is removed, the lineal regression performance is improved to a correlation of 87%, from 79%, RMS error is reduced from 27.2 m to 23.5 m. Calculation of the normalised RMS using this 2018 data set indicates a value of 8.7%, which suggests that the model better replicates late-time observations; that is observations that are not as influenced by mining stress mis-timings; and represents a considerable improvement on previously reported values.

Furthermore, this improvement supports the use of the "end of calibration period" modelled state for use as the initial state groundwater environment for use during predictive simulations.

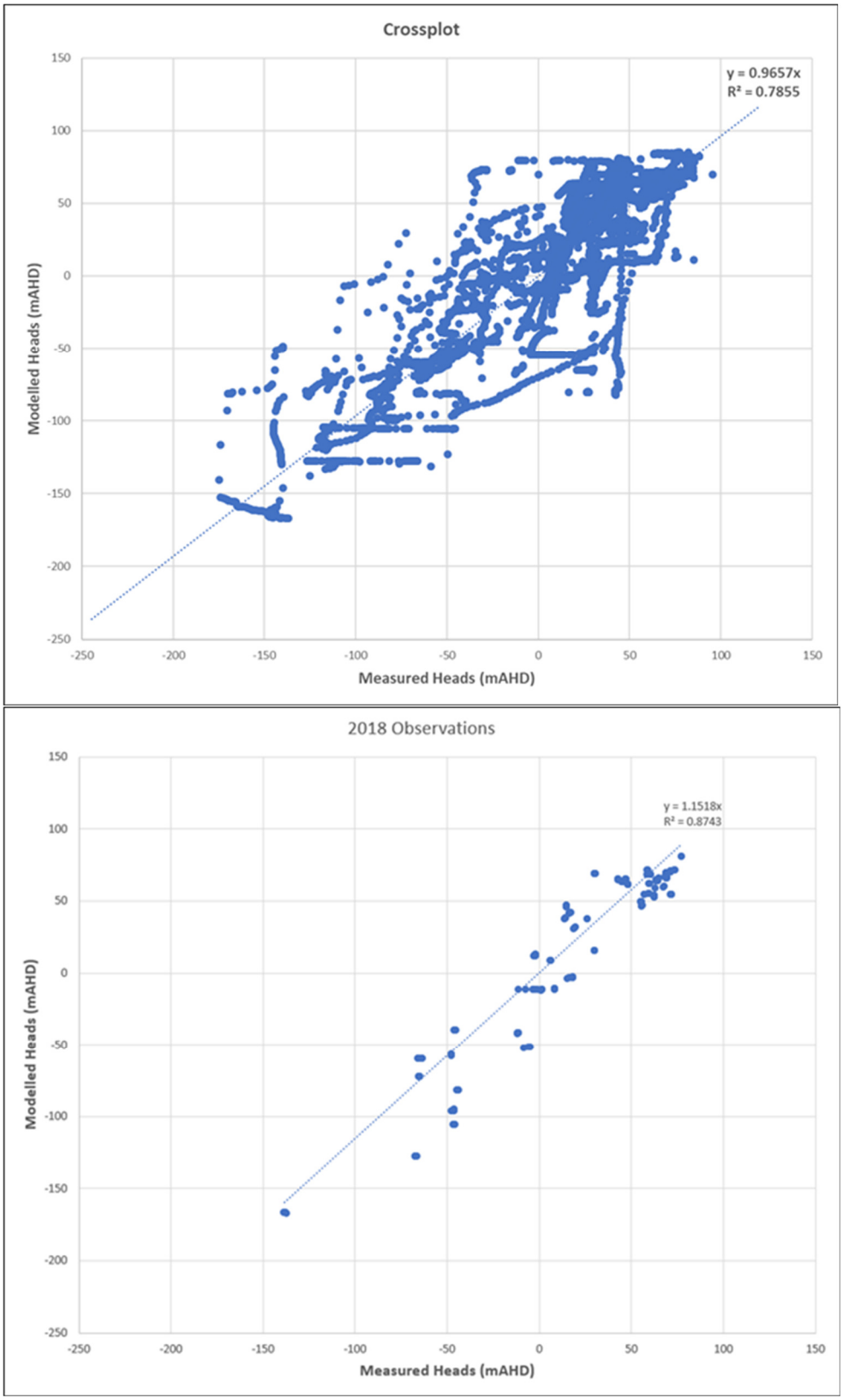


Figure 1-5: Crossplot of Model Observations and Measured Data for the Transient Calibration period – all data (T), 2018 data only (B).

I-1.2.2 Historical Mine Inflows

A comparison of historical mine inflows predicted from previous simulations and the Proposed Modification calibrated model is provided in Figure 1-6.

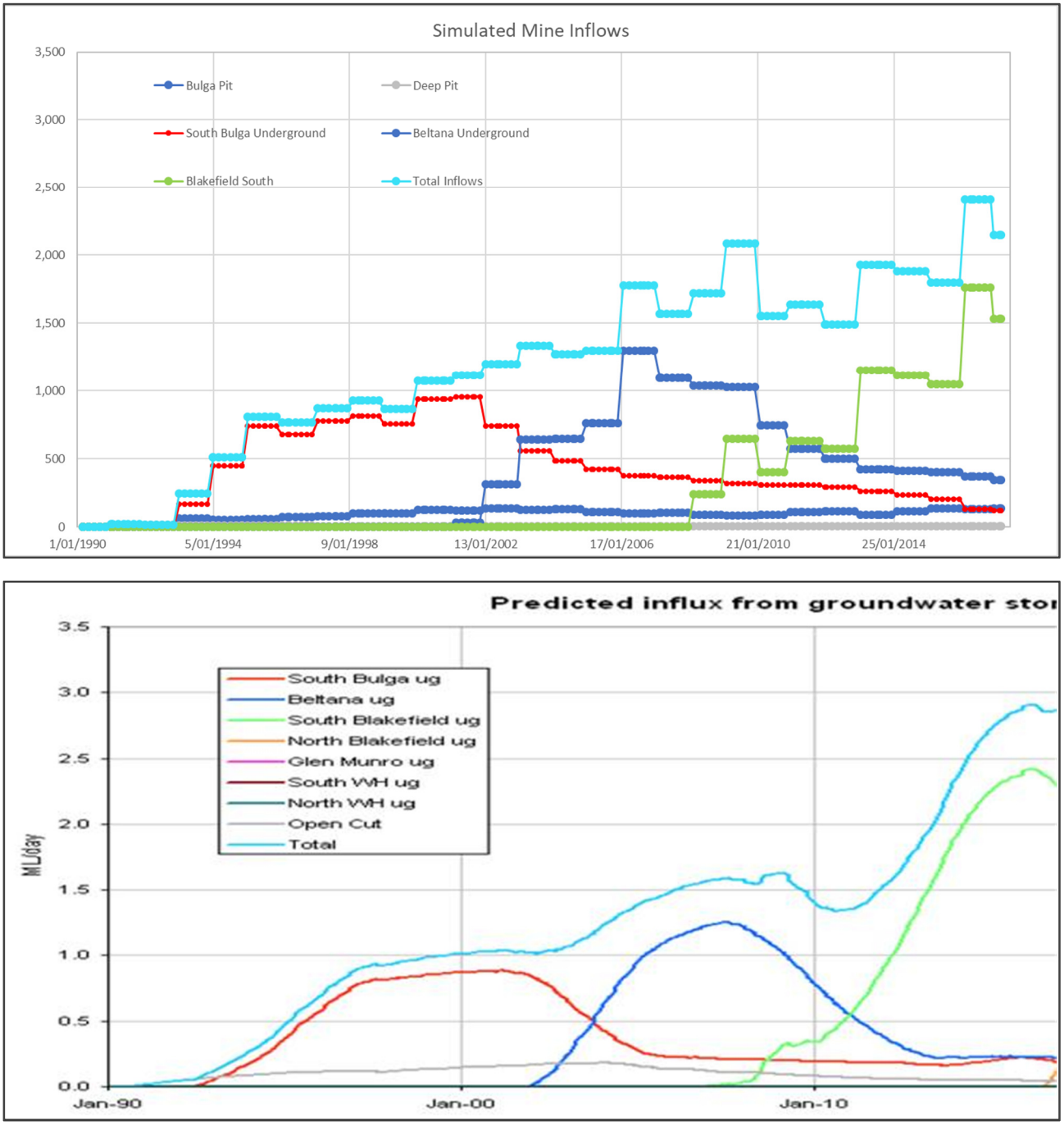


Figure 1-6: Comparison of Mine Inflow Estimation between Models for the calibration period

Key mining area inflow predictions are discussed in the following, noting colour matching is provided in the above figure to assist in correlation between results:

- South Bulga Underground: good correlation in terms of amount of water produced and the period over which production occurs. Peak production occurs at about year 2001 in

both simulations, with the Mackie (2013) model predicting about 850 m^3/day, and the Proposed Modification model predicting about 950 m^3/day.

- Beltana Underground: good correlation in terms of amount of water produced and the period over which production occurs. Peak production occurs at about year 2006 in the Proposed Modification model, and about 2008 in the Mackie (2013) model, with the Mackie (2013) model predicting 1,250 m^3/day, and the Proposed Modification model predicting about 1,350 m^3/day.
- Blakefield South Underground: good correlation in terms of peak water production dates, and good correlation in the amount of water produced and the period over which production occurs. Peak production occurs in both models at about year 2016/17, with the Mackie (2013) model predicting about 2,400 m^3/day, and the Proposed Modification model predicting about 1,800 m^3/day.
- Other mining areas predict low and steady production in both cases.
- Total water produced varies slightly, and is worth considering at key dates as follows:

1995	Mackie (2013) ~750 m^3/day	Modification ~800 m^3/day
2000	Mackie (2013) ~1,000 m^3/day	Modification ~1,050 m^3/day
2005	Mackie (2013) ~1,500 m^3/day	Modification ~1,300 m^3/day
2010	Mackie (2013) ~1,500 m^3/day	Modification ~1,600 m^3/day
2016	Mackie (2013) ~2,900 m^3/day	Modification ~2,400 m^3/day

I-1.2.3 Predicted Versus Measured Drawdown Extent

A review of predicted versus measured drawdown is made through visual comparison of plotted data in the Mackie (2013) report, with results extracted from the Proposed Modification model for the same approximate date. This is provided in Figure 1-7 to Figure 1-10. Consistent with inflow estimates, visual effects of mining across the layers presented are similar in both models. It is noted that improved treatment of the influence of continuous vertical fracturing as well as an improved imposition of hydraulic properties (in a more continuous fashion) results in some differences between the respective sets of drawdown figures.

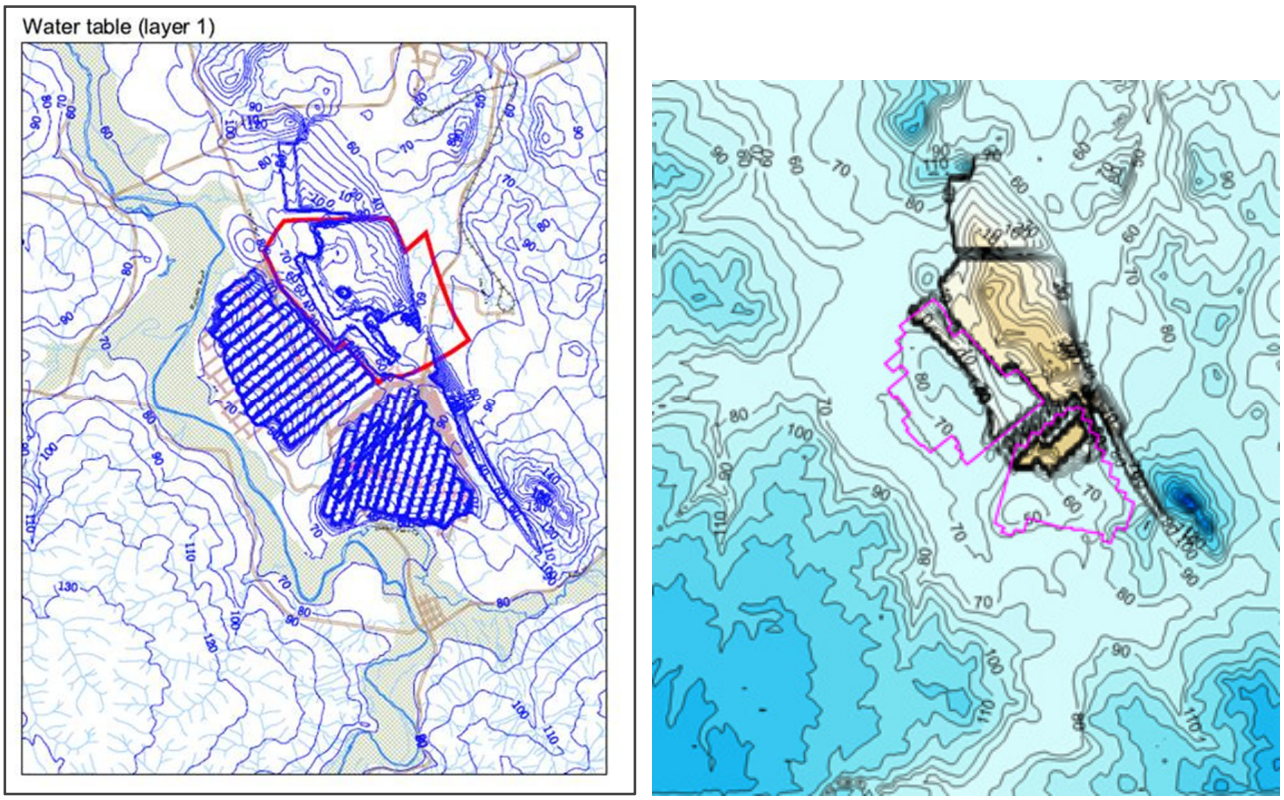


Figure 1-7: Modelled Head, Mackie (2013) left, KCB right – Water Table, Layer 1

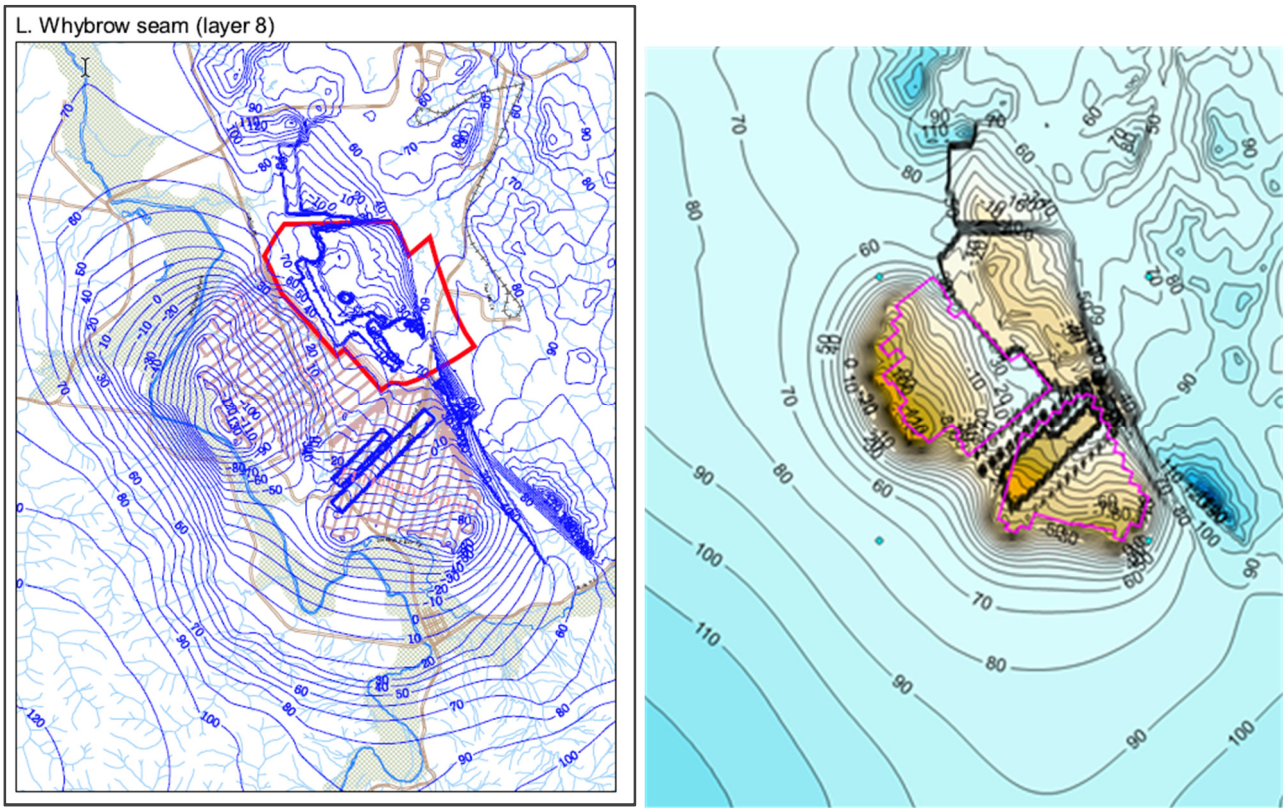


Figure 1-8: Modelled Head, Mackie (2013) left, KCB right – Lower Whybrow Seam, Layer 8

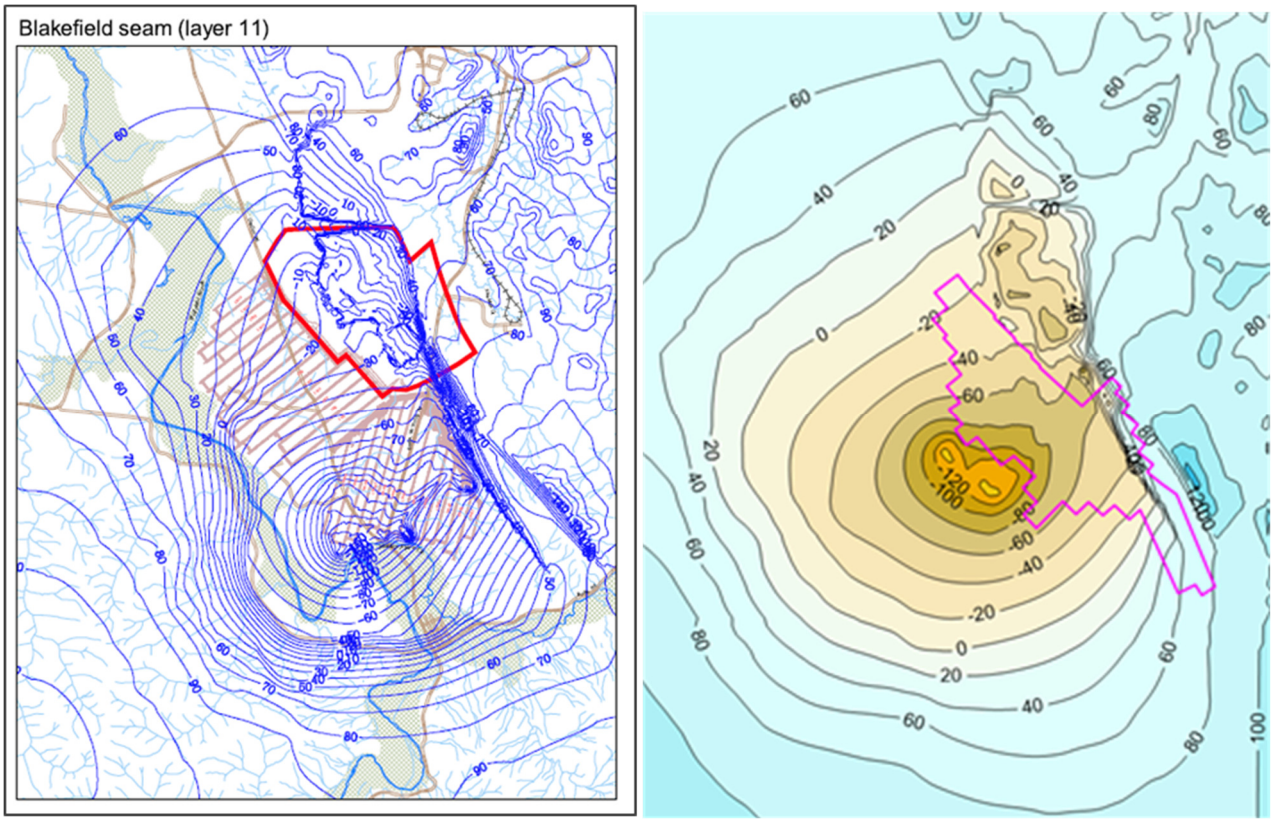


Figure 1-9: Modelled Head, Mackie (2013) left, KCB right – Blakefield Seam, Layer 11

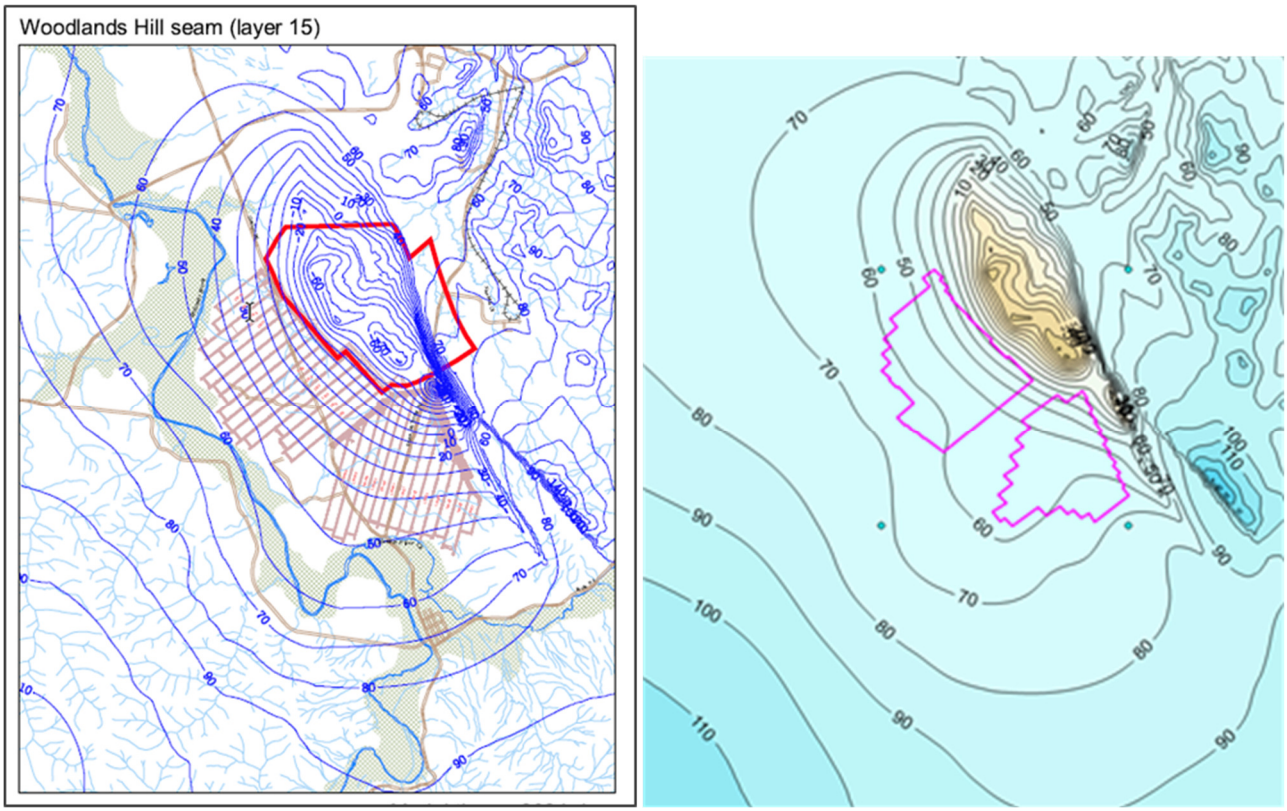


Figure 1-10: Modelled Head, Mackie (2013) left, KCB right – Woodlands Hill Seam, Layer 15

APPENDIX III

Model Sensitivity and Uncertainty Analysis

I-1 MODEL SENSITIVITY ANALYSIS

In the prediction presented here, the Specific Yield (S_y[1]) within the area of open-cut development and the Tailings Storage Facility (TSF) area has been specified as 1 m^3/m^3. The value of Sy assigned to this area has a noted influence on the prediction of inflows that are estimated for the open-cut. This is likely due to instantaneous release of water from storage during pit development. A value of 1% S_y is considered reasonably conservative as this is consistent with the in-situ values for S_y that have been estimated for these materials.

The model has been run in predictive mode over the period May 2018 to Apr 2039. For comparison, the predictive scenario has also been run with high and extreme S_y values of 5% and 30%. Resulting inflows from these scenarios are presented in Figure 1-1. Further focussed sensitivity analysis is described in Section 4.8.

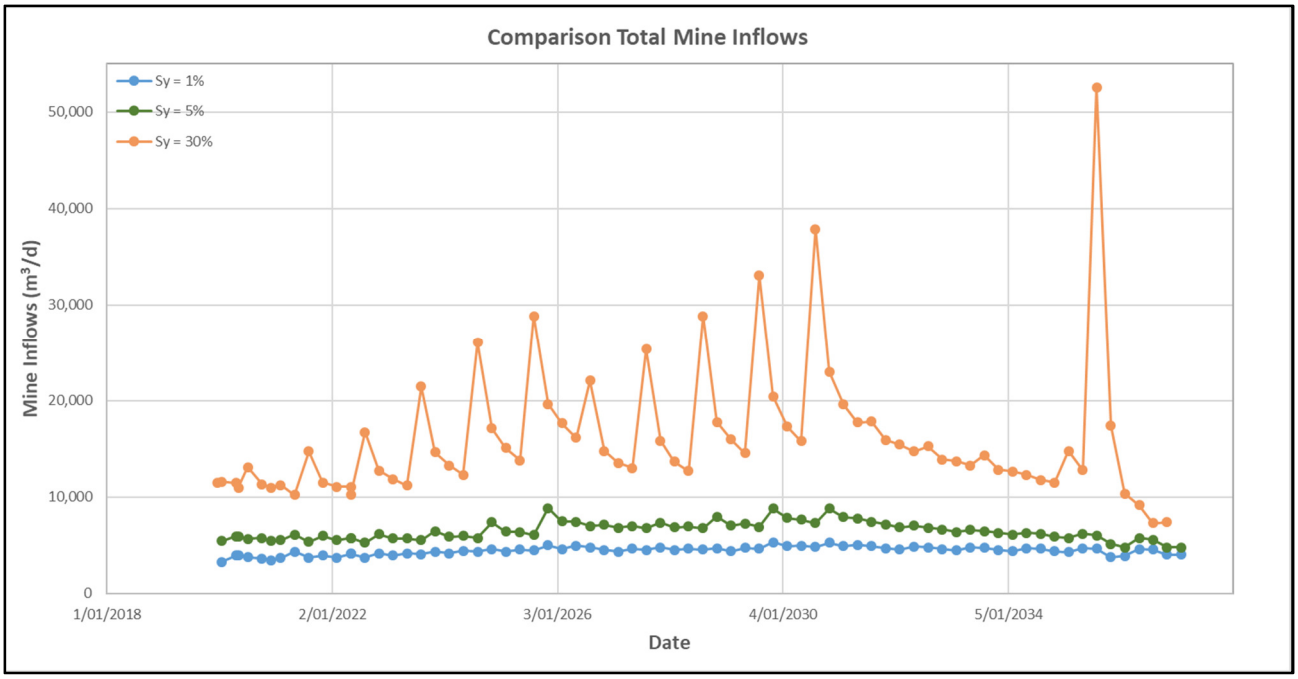


Figure 1-1: Comparison of Total Mine Inflows resulting from variations in Specific Yield applied to the Open-Cut Development Area (Penultimate model)

A suite of sensitivity analysis was completed for three specific runs, being variants of spoil recharge and spoil hydrogeological conditions, aimed at understanding the potential changes these may have on prediction of interactions between alluvium and Permian strata, and on potential groundwater derived baseflow discharge in mine proximal creeks.

The three scenarios are:

- SA1 - Spoil Kh = 1 m/day; Spoil Kv = 0.1 m/day; Recharge factor = 1% of daily rainfall
- SA2 - Spoil Kh = 0.05 m/d; Spoil Kv = 0.05 m/d; Recharge factor = 5% of daily rainfall

[1] S_y represents the amount of water a rock will release under unconfined conditions under the natural force of gravity (Driscoll, 1995). Sy of unconfined aquifers range from 0.01 to 0.30 (Ralph C. Heath 1983).

- SA3 - Spoil Kh = 0.1 m/d; Spoil Kv = 0.01 m/d; Recharge factor = 2% of daily rainfall

As a visual comparison of these results, the main model has the following parameters for the spoil: Kh = 0.1 m/day; Spoil Kv = 0.01 m/day; recharge factor = 8% of daily rainfall.

Results are collectively provided in Figure 1-2 for prediction of flux variance across the Alluvium / Permian contact for each of the creek reach sections.

For nearly all sections of alluvium, there is no visible variability in predicted flux between the alluvium and Permian strata. This is a consequence of the strength of hydrogeological isolation of the alluvium from the Permian strata. The spoil pile is placed entirely on Permian material with no direct pathway for translation of impacts into (or from) the alluvium. Further, any small head variations which are translated to the alluvium are expected to be absorbed to a large degree due to the contrasting material parameters of this unit compared with the Permian, and the greater frequency and scale of recharge events that the alluvium will experience. Each of the simulations also impose a lower recharge rate into the spoil pile, thus fluxes are lower. This is particularly evident in predicted impacts in the Wollombi North reach of the main alluvium. At this location, this sequence passes very close to the western most extent of the Mt Thorley operation. the model adjusts with time however, and sensitivity results for this reach eventually merge, to a common value less than the project only or cumulative prediction.

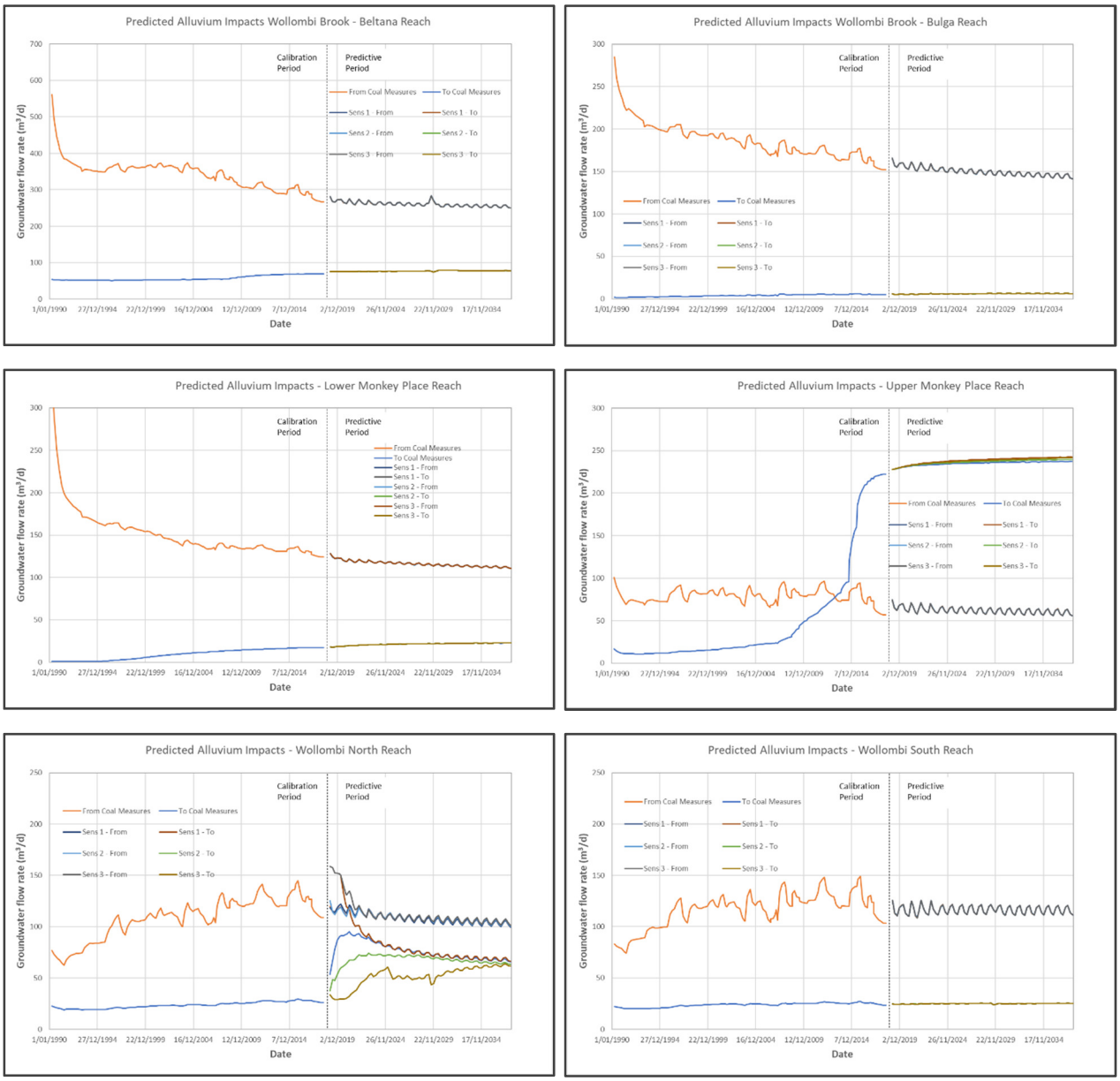


Figure 1-2: Prediction of Flux across the Alluvium / Permian Contrast for major Alluvium Reaches

Figure 1-3 provides sensitivity analysis results for creek discharge in the two drainages east and north of the Proposed Modified area which exhibited a noted response to the mine development in the project only case. In each location the results indicate lower discharge to the creeks, which supports the concept that the main driver for increased flow in these systems is the hydraulic effect of the raised saturated conditions in the spoil pile. Reducing these conditions through reduction in recharge has the direct consequence of reducing creek baseflow discharge.

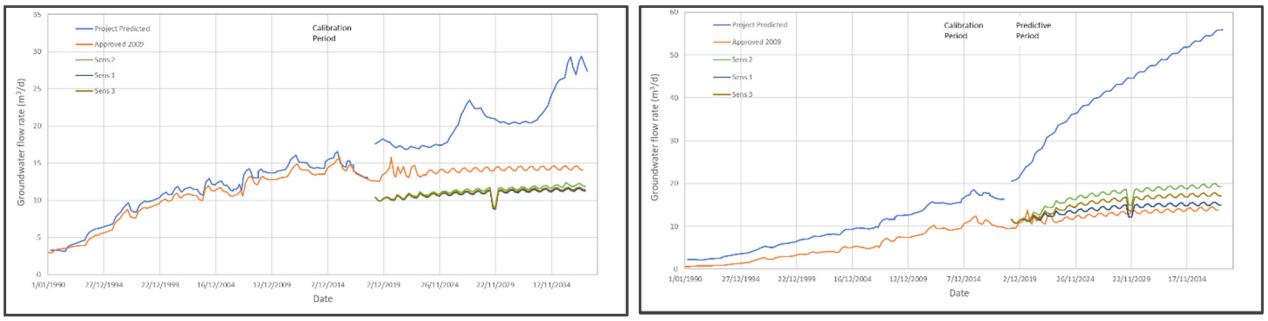


Figure 1-3: Prediction of Creek Baseflow Discharge east and north of the Proposed Modification Mining Area

I-1.1 Predictive Uncertainty

The following uncertainty analysis was completed before finalisation of the scenarios. Predictive Uncertainty Preamble

A degree of uncertainty is inherent in modelling of groundwater interactions in any complex mining environment, including Bulga, with various changes required to the model to represent mining practices and progress over the period of prediction. In an attempt to understand the potential magnitude of these uncertainties and to provide a plausible envelope of predictions, the simple sensitivity analysis has been supplemented by a more comprehensive analysis that provides a means to quantify the uncertainty in key predictions of potential mining-related impact.

Parameter uncertainties arise from the non-uniqueness that is inherent in most environmental model calibration exercises. Parameter uncertainty relates to the inability of the calibration process to accurately define parameter values. Some parameters used within the prediction simulation may not even be present under calibration conditions. Therefore, each parameter may take on a range of values that are all acceptable when adjudged within the metrics of the calibration process. This range of acceptable parameter values may, or may not, have an impact on the outcomes of the model that are of interest. When errors in observations are large then the calibration process may do little to constrain this parameter uncertainty from their prior uncertainty ranges. It is therefore diligent, that an attempt to quantify the range of uncertainties in those predictions of interest, is made, so that an understanding of the potential for prediction error may be gained.

I-1.1.1 Uncertainty Analysis Simulations

For this project, a non-linear, Monte-Carlo methodology has been applied which allows a suite of models, which collectively include the plausible range in key input parameters, to be run so that the range of outcomes can be obtained from the suite of models.

A total of 360 model runs were completed. The Monte-Carlo multi-parameter assessment found that around 60% of stochastic parameters sets ran successfully, leaving over 200 model outcomes that have been be used to assess the variability in predictions of interest. A check on a subset of these parameters sets confirms that model-to-measurement variance resulting under calibration conditions is within an envelope of around 20% of the final variance resulting from the calibrated parameter set.

I-1.1.2 Uncertainty Results and Discussion

The results of the uncertainty analysis are presented as histograms, using common scale axes, and presented as a percentage of successful runs versus drawdown variance at the eight locations shown in Figure 1-4 and the summary of results is provided in Figure 1-5.

The following general comments are provided:

- Upper Monkey Place alluvium (Segment 8): over 80% of model runs aligned with the cumulative model case predicted value, with the balance of runs falling in the +0.50 m (head decline) group of results;
- Lower Monkey Place alluvium (Segment 9): 100% of model realisations aligned with the 0.00 m drawdown bin of results, with the cumulative model case predicting a slight water level rise of 0.50 m, indicating minimum impacts in these alluvium segments;
- The stochastic model outcomes indicate the potential for a groundwater level decline in the Wollombi Brook, Bulga Reach (Segment 10): However the range is between 0.0 and 0.5 m;
- Wollombi Brook, Beltana Reach (Segment 11): the uncertainty analysis predicts a range of outcomes which are generally indicative of groundwater level decline in the alluvium. A maximum groundwater level decline of 1.5 m is possible at this location;
- Nine Mile Creek, Eastern Embankment: A possible groundwater level decrease of between 1.0 and 4.0 m is indicated at this point, which is consistent with other modelling results and observations of decreased flow in this drainage due to a deeper open-cut;
- Nine Mile Creek, Mine Side: there is potential for groundwater level decrease of up to 4.50 m at this location. The cumulative model case predicted a decrease of 2.5 m. This location is in the weathered rock, and not modelled alluvium;
- Loders Creek, Upstream: shows a range of possible groundwater level rise outcomes between 0.00 m and 6.50 m. Again, the cumulative model case predicted a groundwater level rise of between 3.00 m and 3.50 m. This location is also in weathered rock and relates to increase seepage from the spoils.
- Loders Creek, Northern: stochastic model outcomes indicate potential for groundwater level rises of up to 6.5 m for this location. The cumulative model case predicted a groundwater level rise of 1.50 m.

In general, the uncertainty analysis has shown that there is the potential for slight groundwater level drawdowns in the alluvium segments of the Wollombi Brook (Bulga Reach). The range of predicted drawdowns in these segments is localised and indicates a relatively high level of confidence with similar predictions made by the cumulative case predictive model. In the case of Nine Mile and Loders Creeks, uncertainty analysis shows that there is generally a potential for groundwater levels to decrease or rise at nearby points that potentially translate as decreased or increased baseflows in these systems. The potential range of groundwater level change is quite large and indicates a reduced level of confidence in the prediction made by the cumulative case predictive model.

The above information is useful in understanding the uncertainty of the current model build in terms of predicting changes in head or flow from the cumulative model case. Practical application

of these results is used in the recommendation of monitoring, to permit the future collection of site data to better inform future modelling, observe observational changes to the system as mining operations evolve, and to address these key areas of uncertainty.

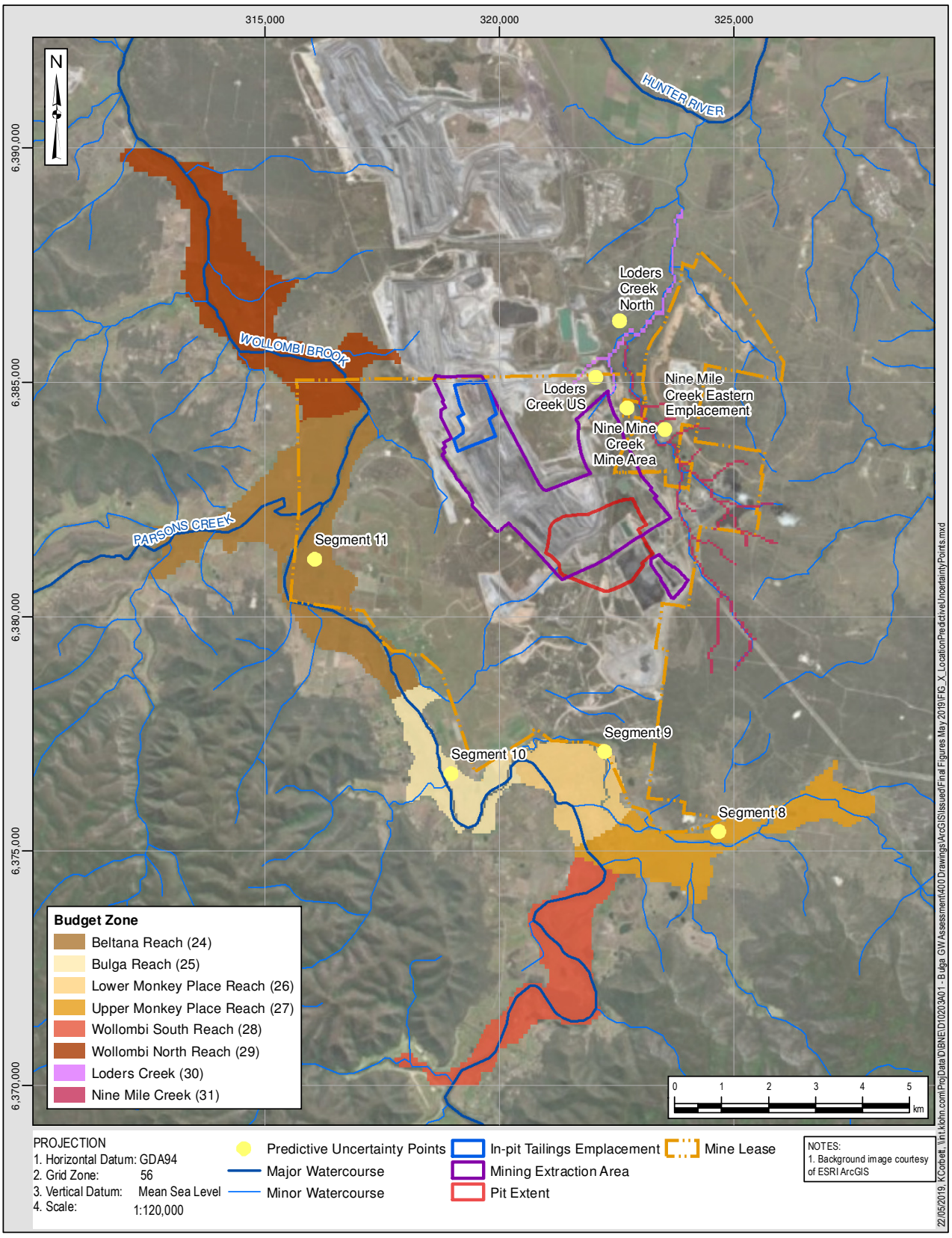


Figure 1-4: Location of Points used in Predictive Uncertainty Assessment

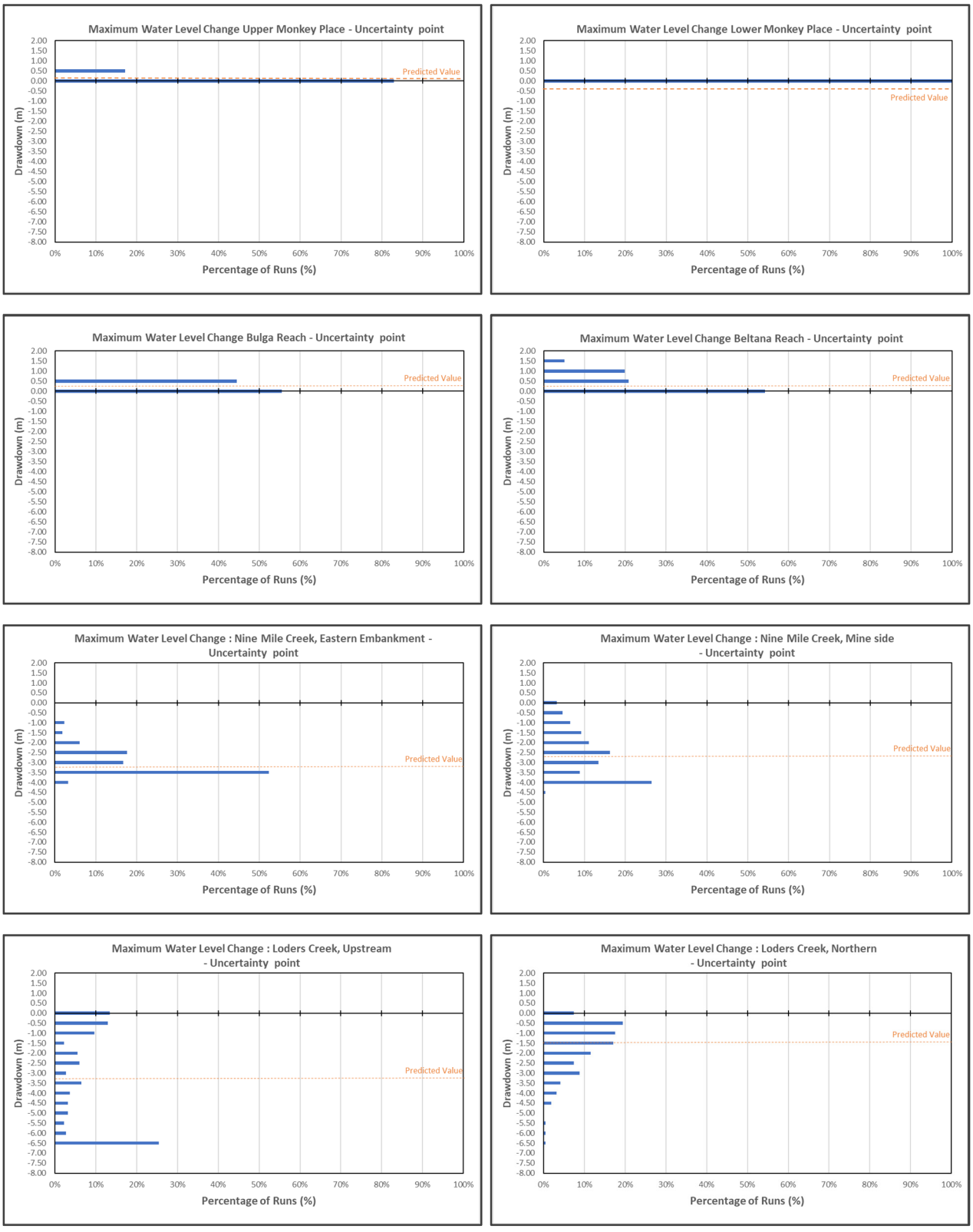
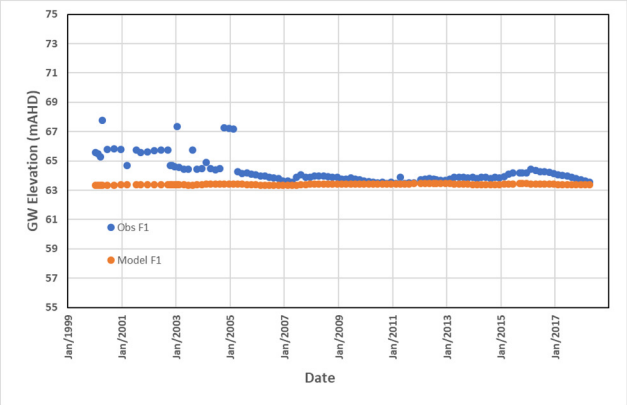


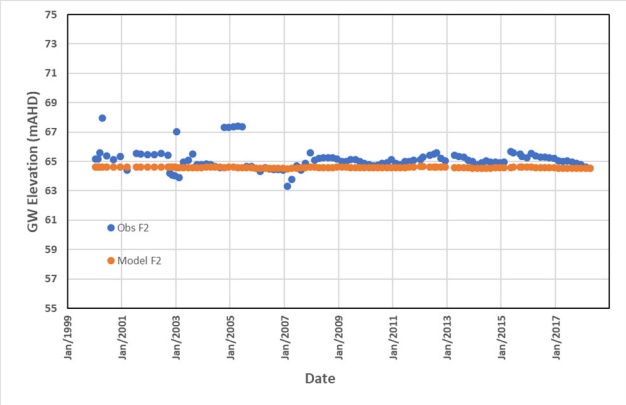
Figure 1-5: Model Uncertainty Analysis Output

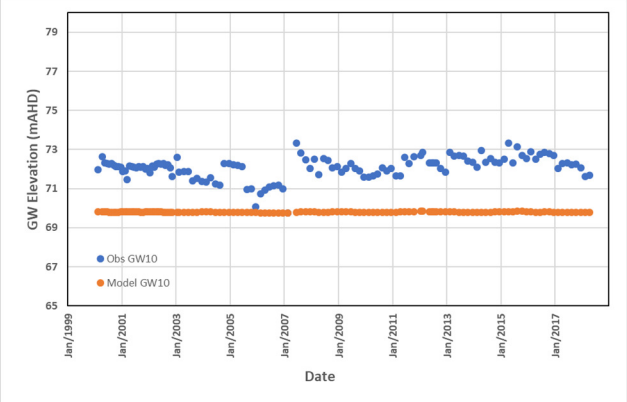
APPENDIX IV

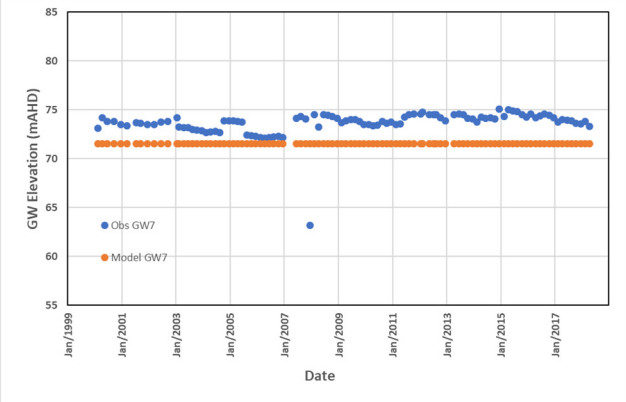
Groundwater Model Transient Calibration Hydrographs

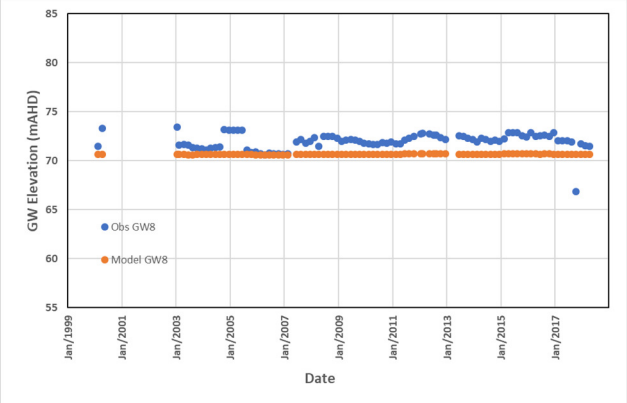
Hydrographs
Layer 1

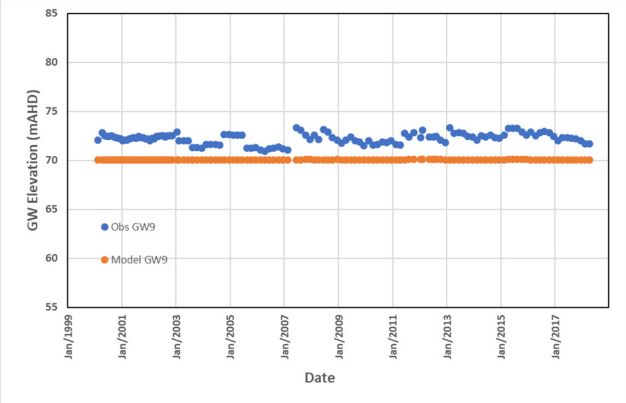


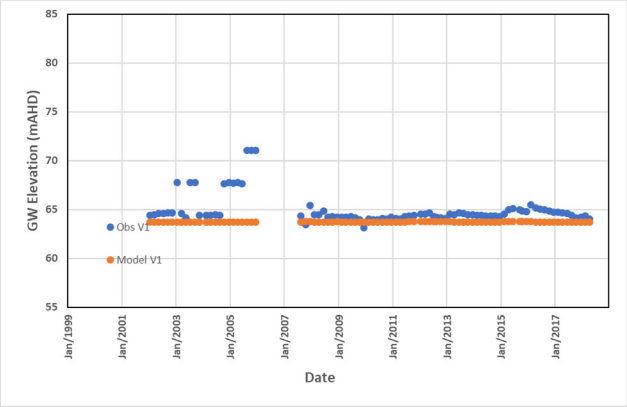








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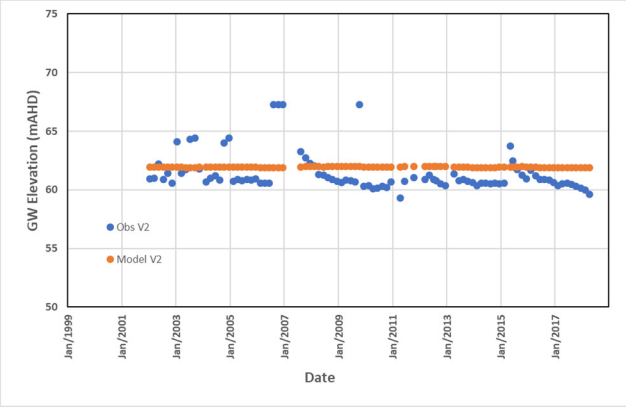
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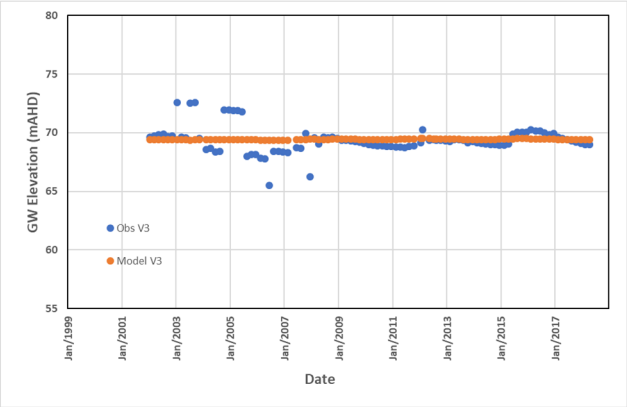
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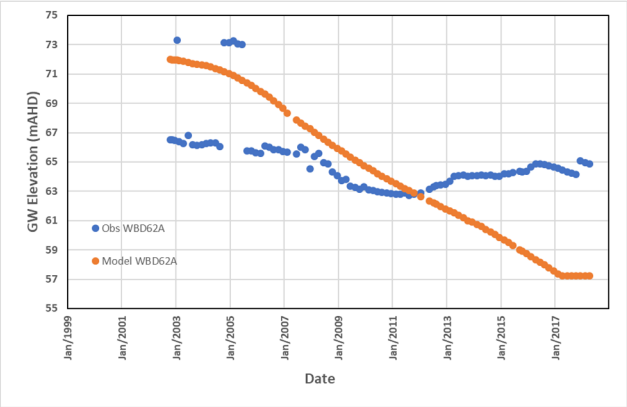
Layer 4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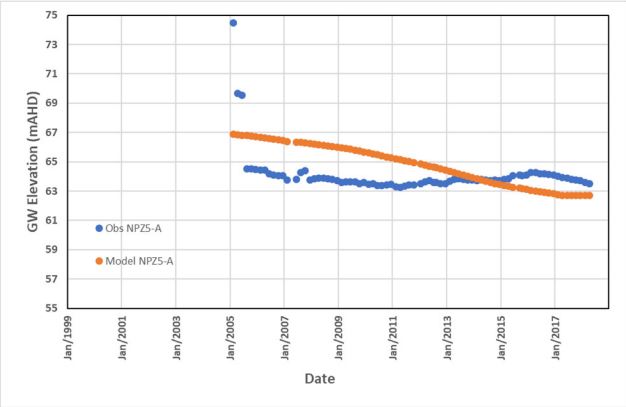
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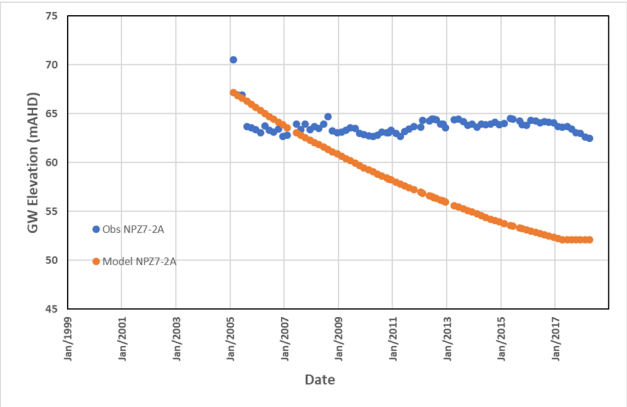
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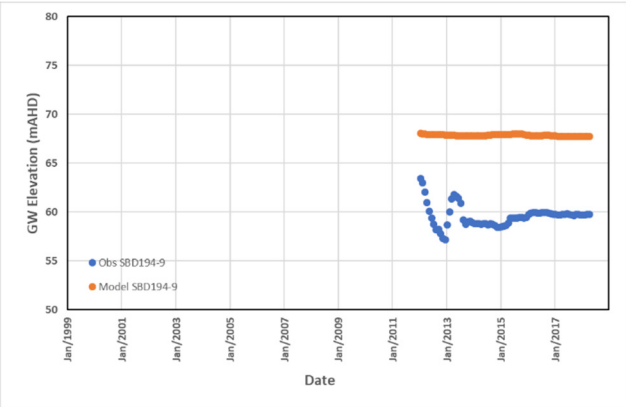
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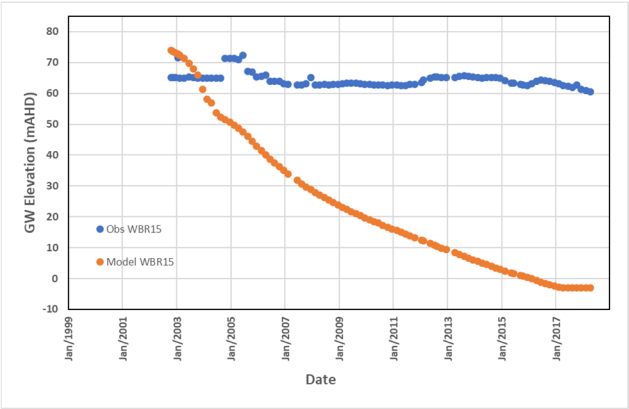
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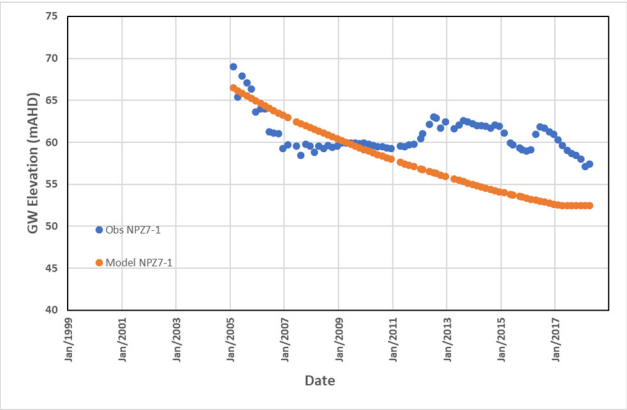
Layer 5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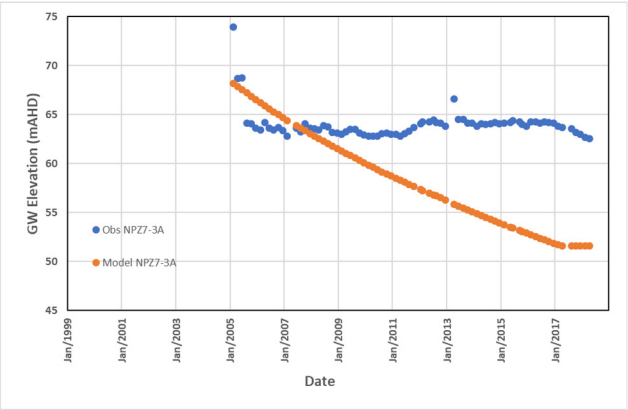
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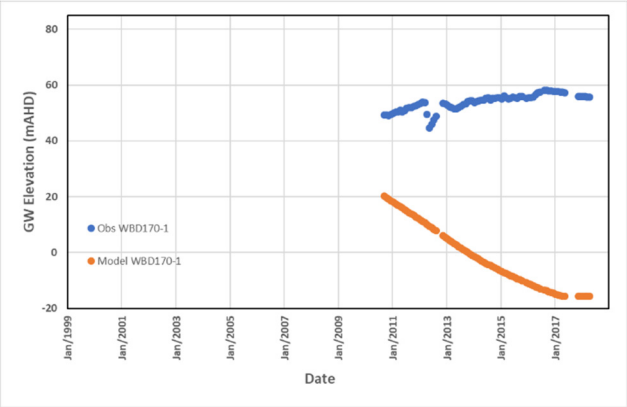
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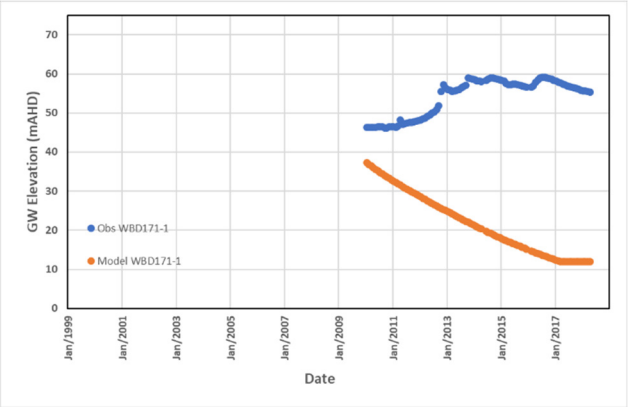
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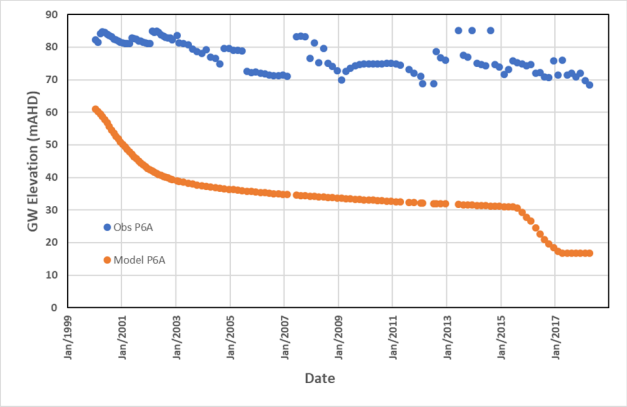
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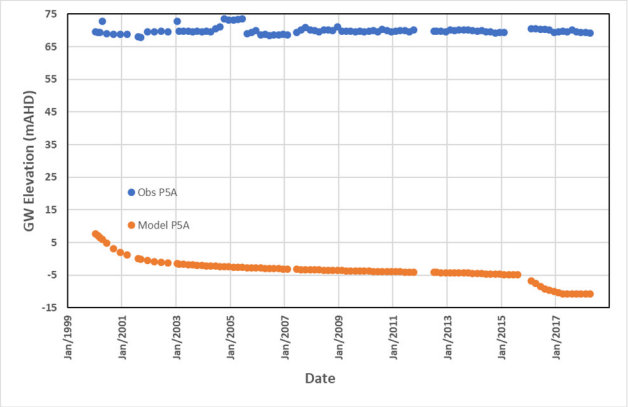
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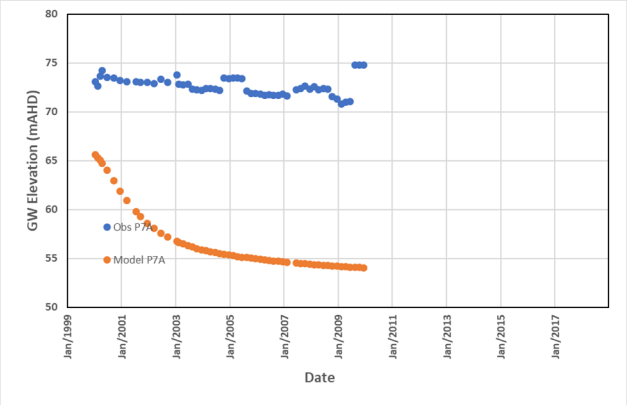

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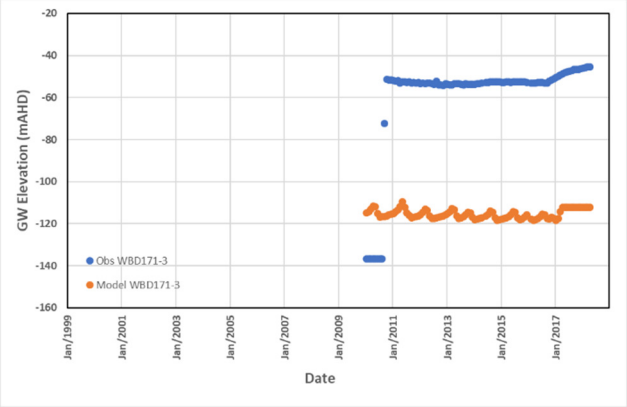

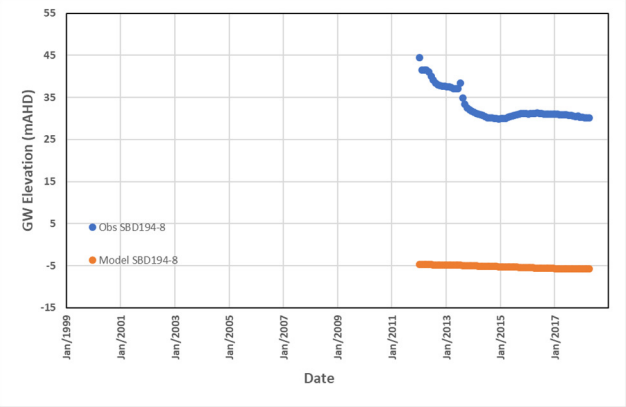

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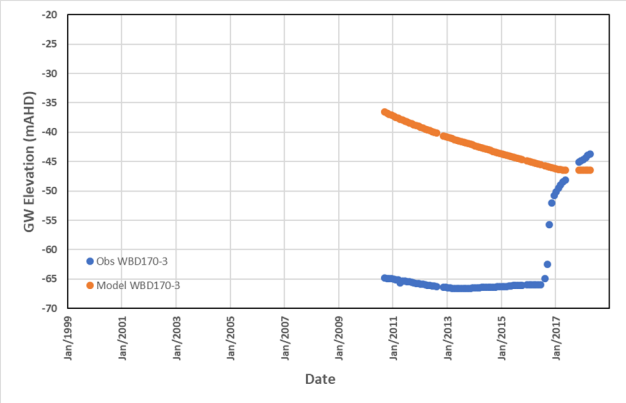

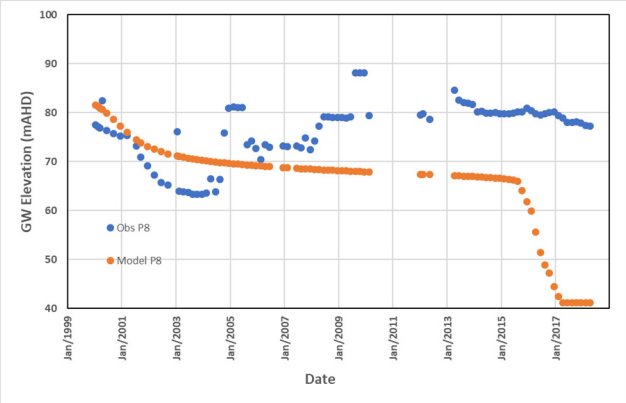

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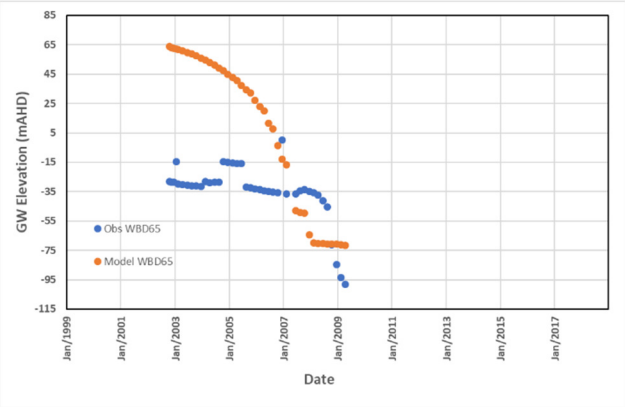
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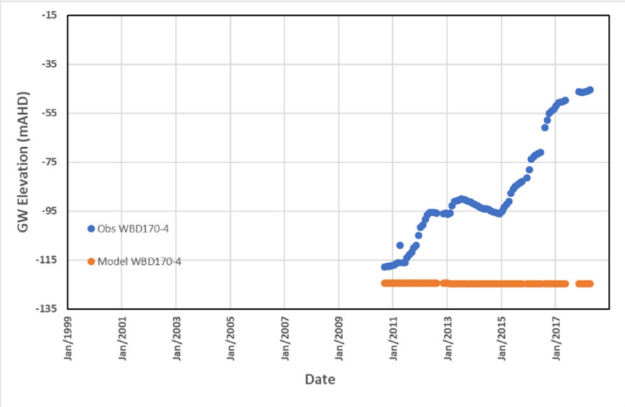
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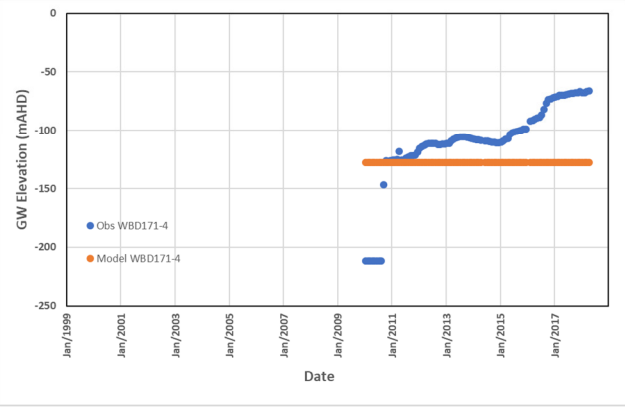
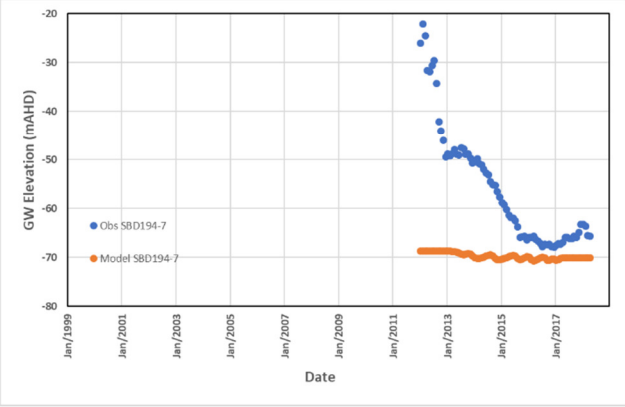
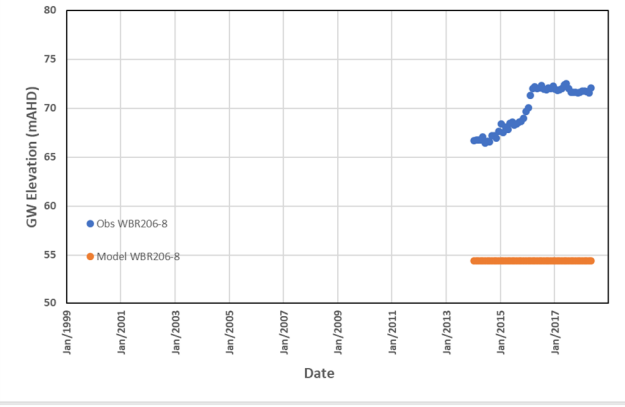
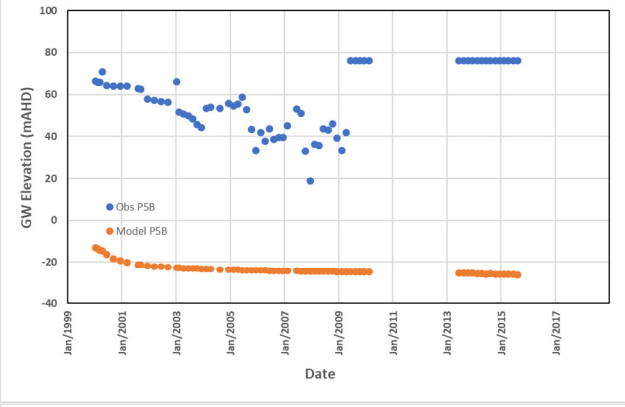
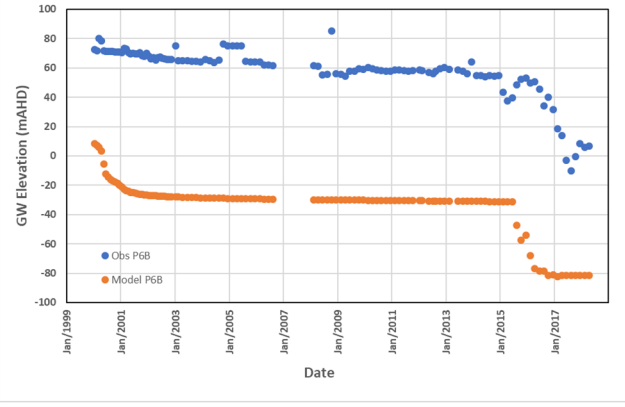
Date

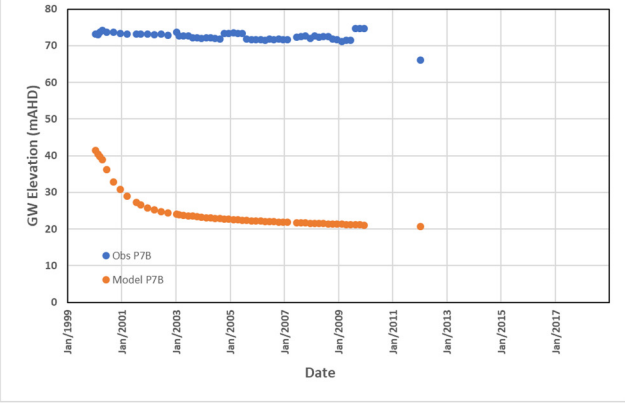

GW Elevation (mAHD)
Obs WBD171-4
Model WBD171-4
Date


GW Elevation (mAHD)
Obs SBD194-7
Model SBD194-7
Date

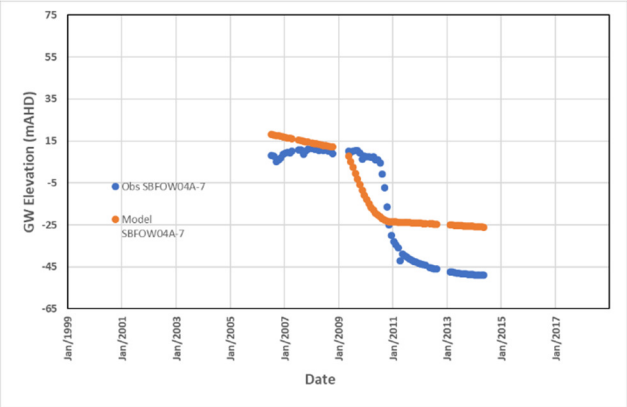

GW Elevation (mAHD)
Obs WBR206-8
Model WBR206-8
Date

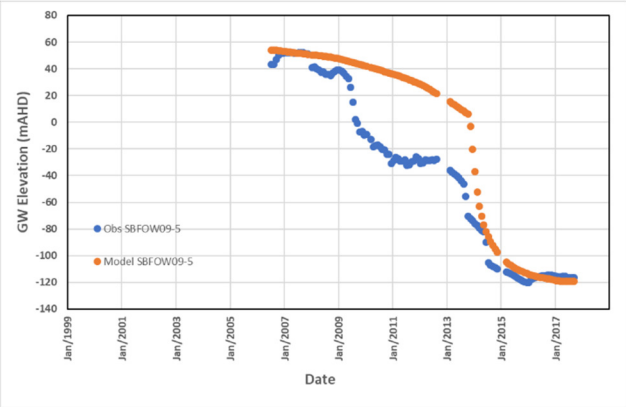

GW Elevation (mAHD)
Obs P5B
Model P5B
Date

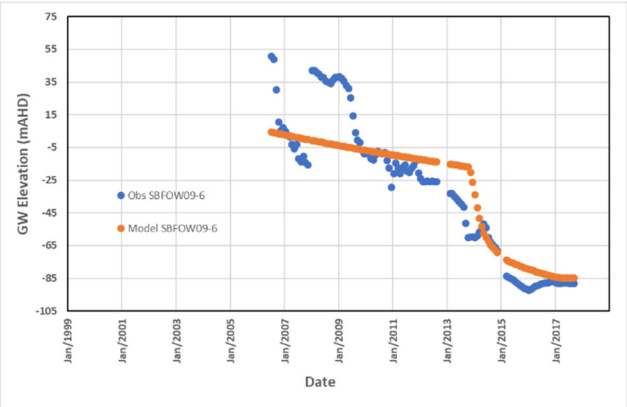

GW Elevation (mAHD)
Obs P6B
Model P6B
Date

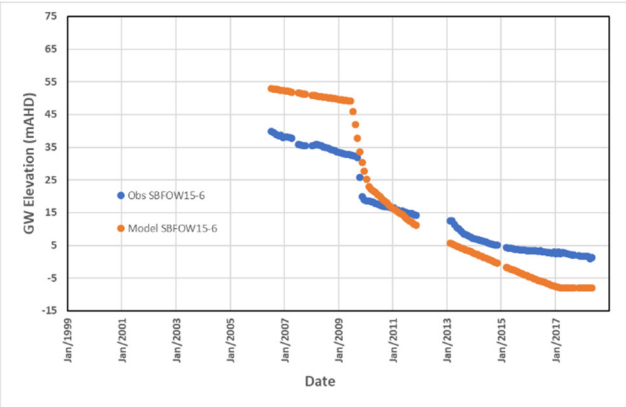

GW Elevation (mAHD)
Obs P7B
Model P7B
Date

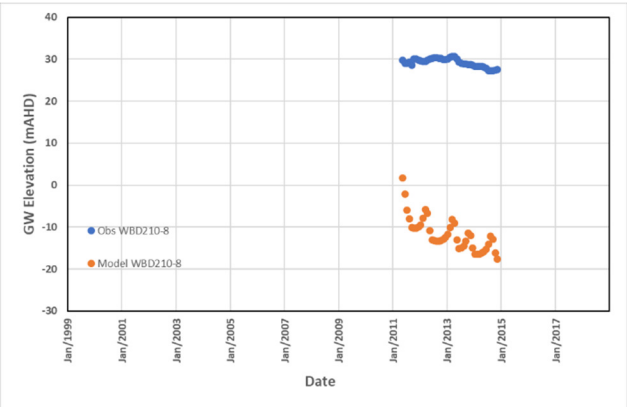
Layer 9

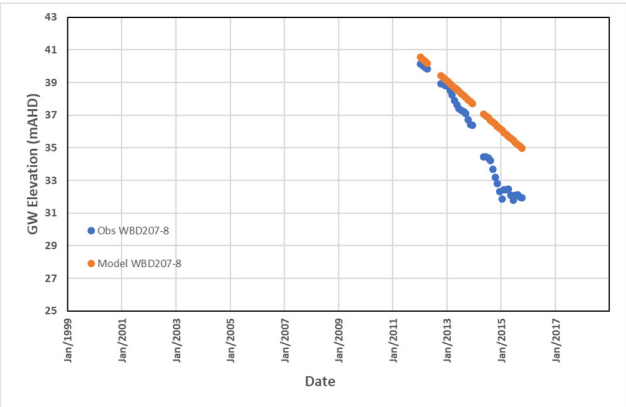

GW Elevation (mAHD)
Obs SBFOW04A-7
Model SBFOW04A-7
Date

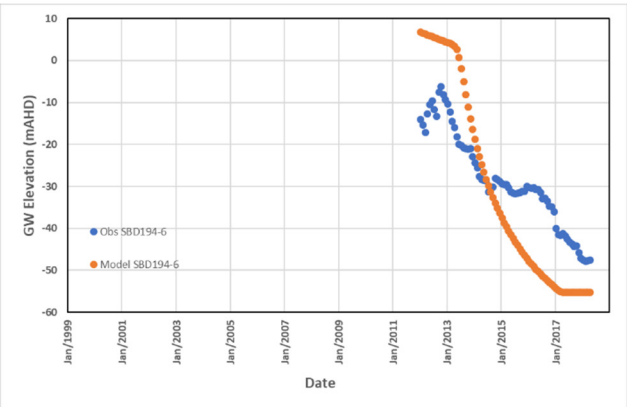

GW Elevation (mAHD)
Obs SBFOW09-5
Model SBFOW09-5
Date


GW Elevation (mAHD)
Obs SBFOW09-6
Model SBFOW09-6
Date

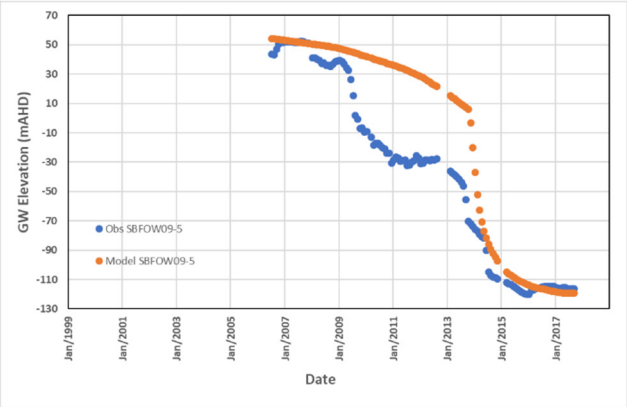

GW Elevation (mAHD)
Obs SBFOW15-6
Model SBFOW15-6
Date

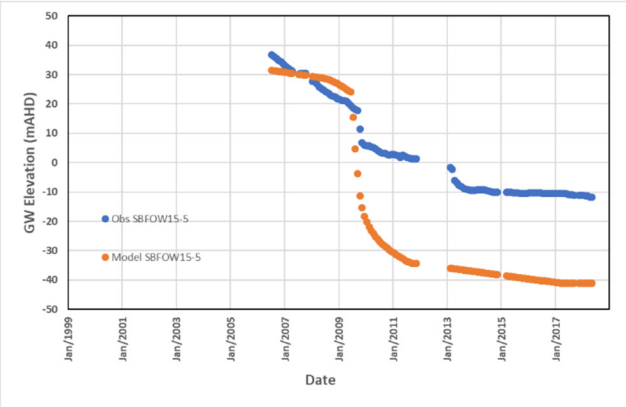

GW Elevation (mAHD)
Obs WBD210-8
Model WBD210-8
Date

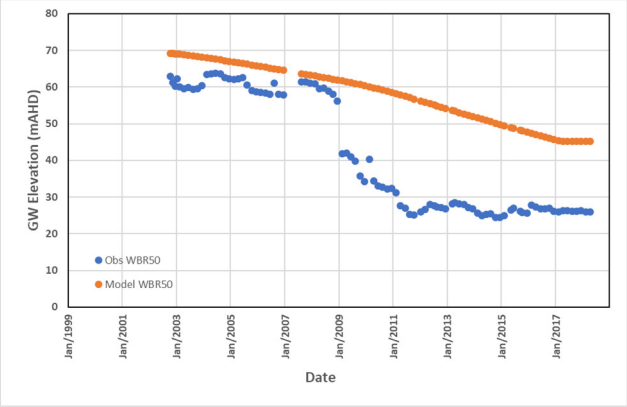

GW Elevation (mAHD)
Obs WBD207-8
Model WBD207-8
Date

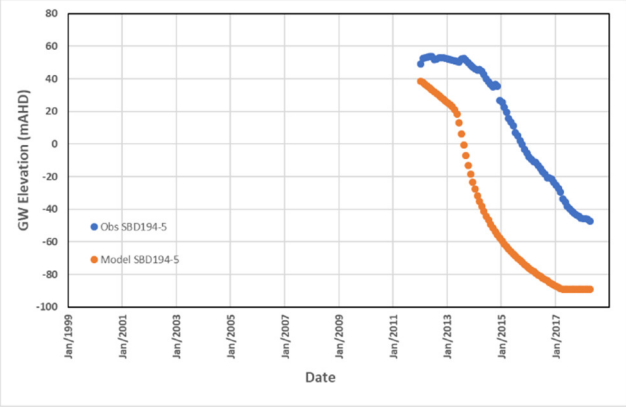

GW Elevation (mAHD)
Obs SBD194-6
Model SBD194-6
Date

Layer 10

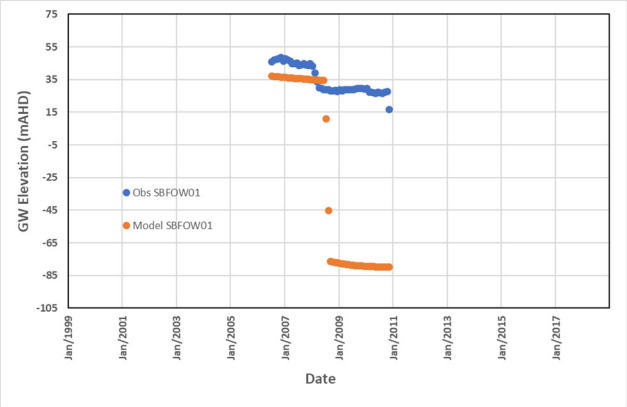


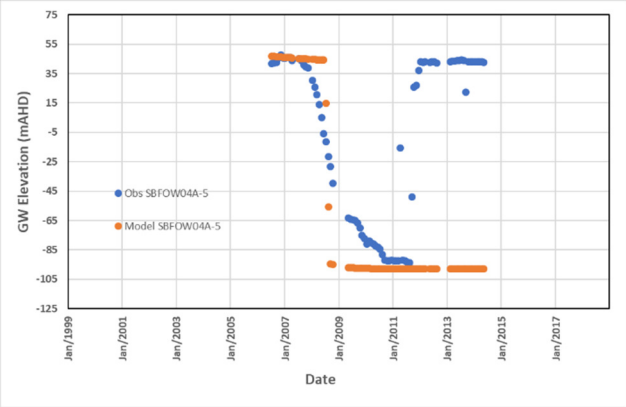


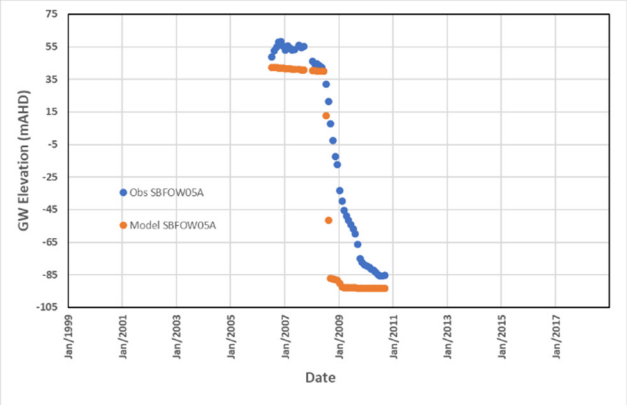


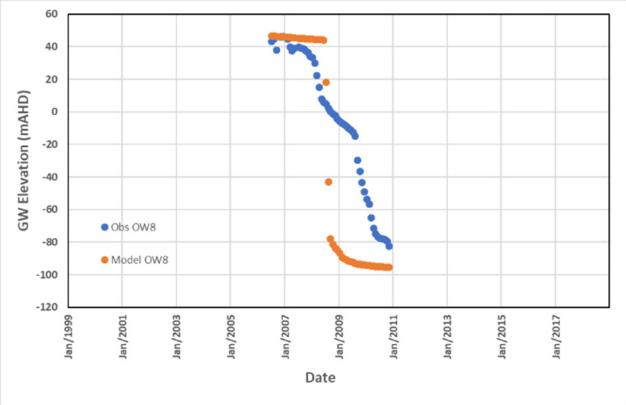


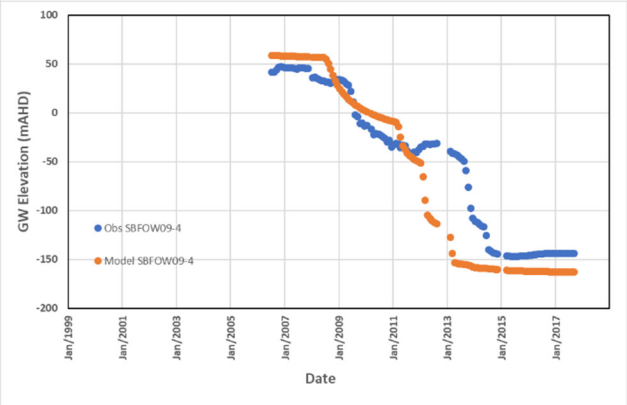
Layer 11

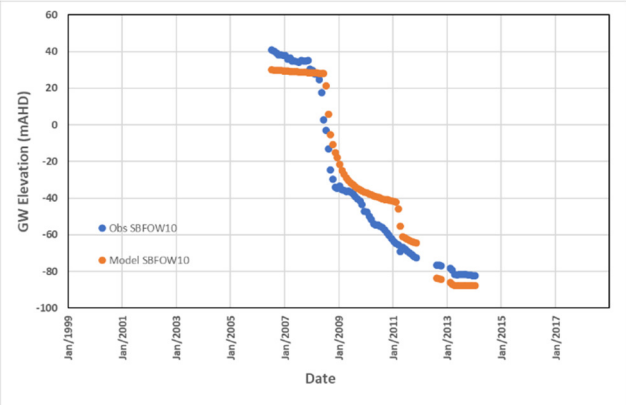


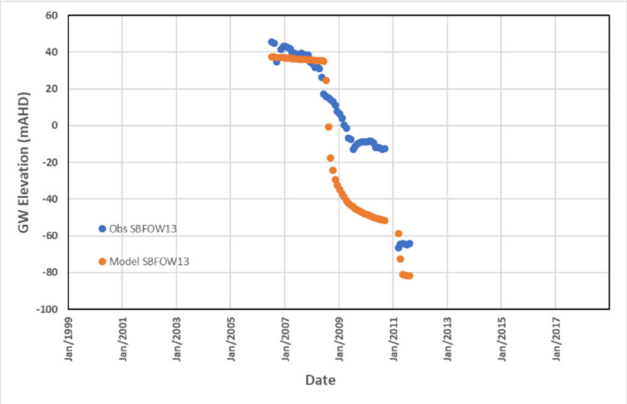


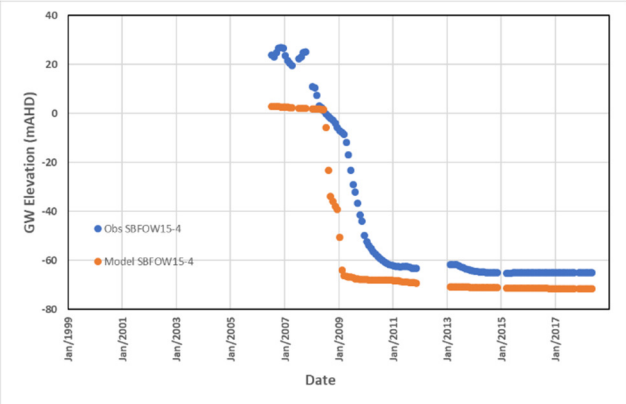

GW Elevation (mAHD)
Obs SBFOW05A
Model SBFOW05A
Date

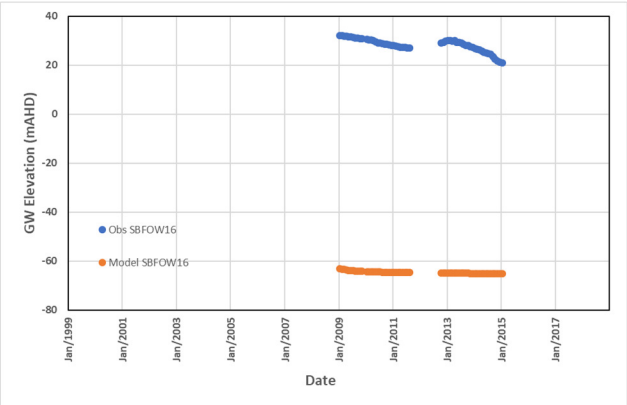

GW Elevation (mAHD)
Obs OW8
Model OW8
Date

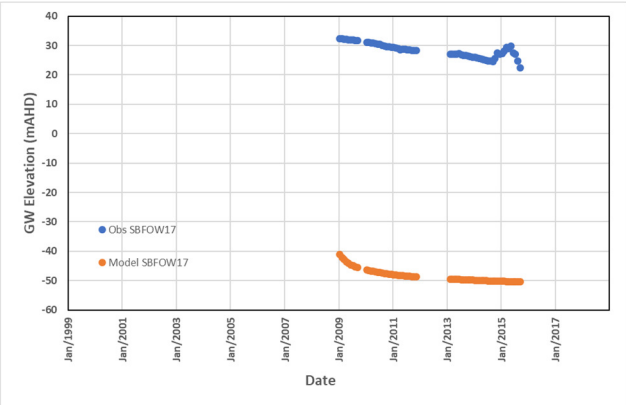

GW Elevation (mAHD)
Obs SBFOW09-4
Model SBFOW09-4
Date

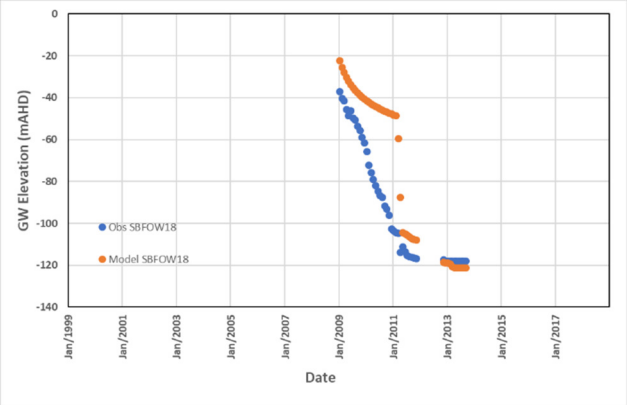

GW Elevation (mAHD)
Obs SBFOW10
Model SBFOW10
Date

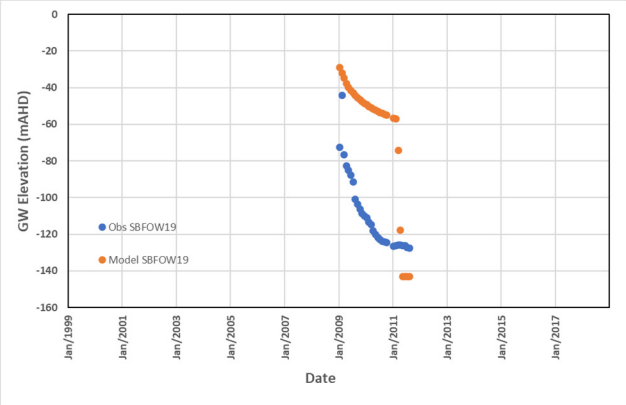

GW Elevation (mAHD)
Obs SBFOW13
Model SBFOW13
Date

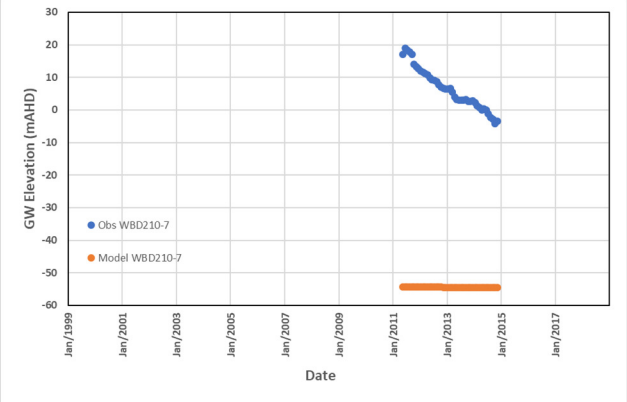

GW Elevation (mAHD)
Obs SBFOW15-4
Model SBFOW15-4
Date

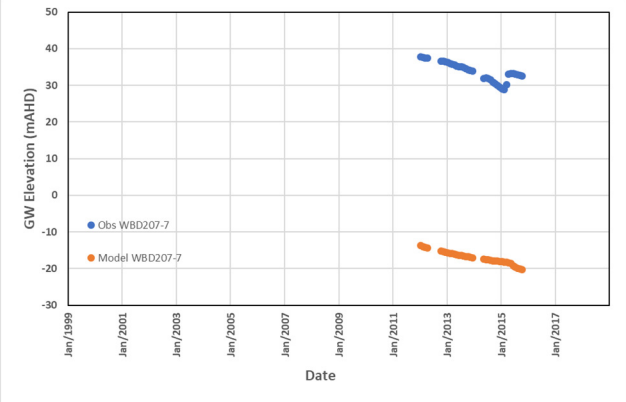

GW Elevation (mAHD)
Obs SBFOW16
Model SBFOW16
Date

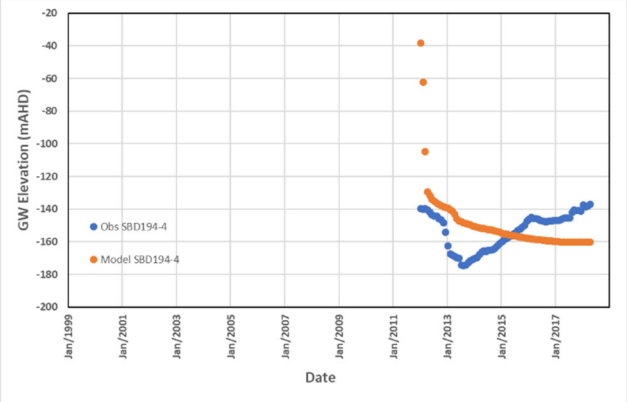

GW Elevation (mAHD)
Obs SBFOW17
Model SBFOW17
Date

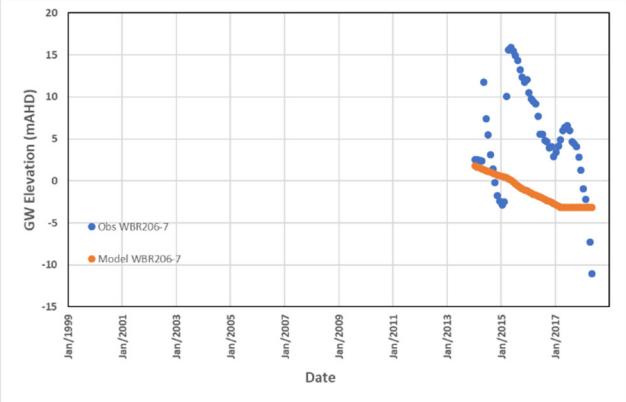

GW Elevation (mAHD)
Obs SBFOW18
Model SBFOW18
Date

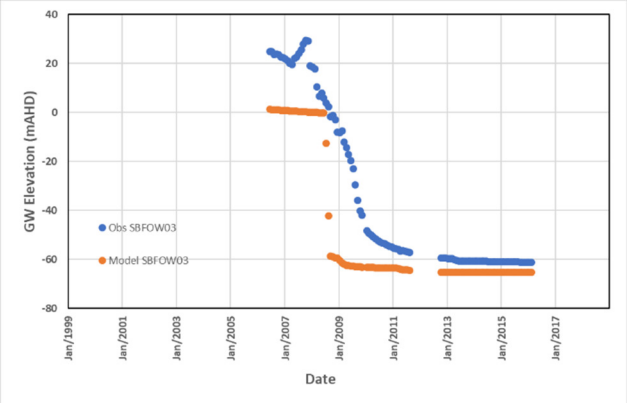

GW Elevation (mAHD)
Obs SBFOW19
Model SBFOW19
Date


GW Elevation (mAHD)
Obs WBD210-7
Model WBD210-7
Date

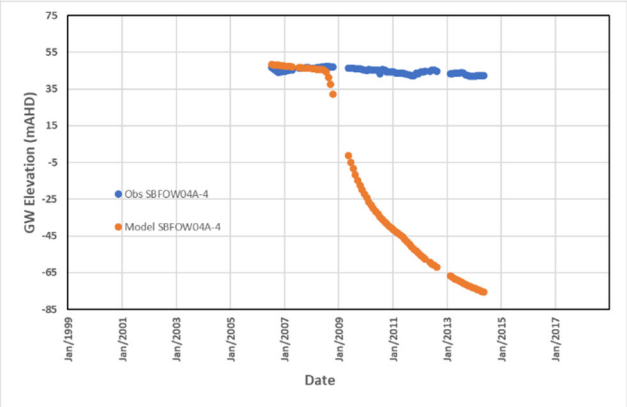

GW Elevation (mAHD)
Obs WBD207-7
Model WBD207-7
Date

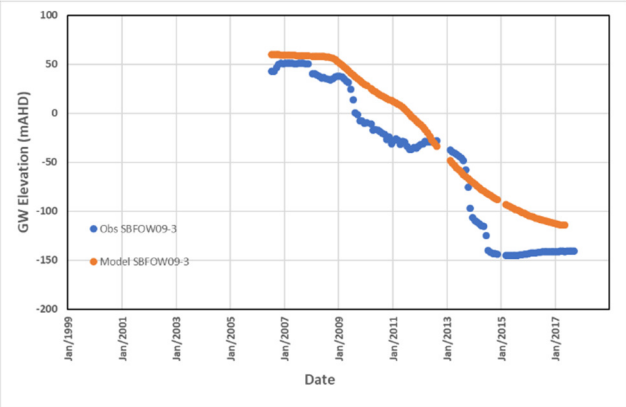

GW Elevation (mAHD)
Obs SBD194-4
Model SBD194-4
Date

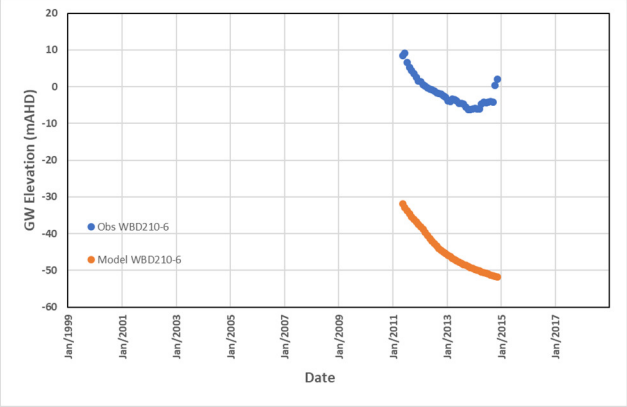

GW Elevation (mAHD)
Obs WBR206-7
Model WBR206-7
Date

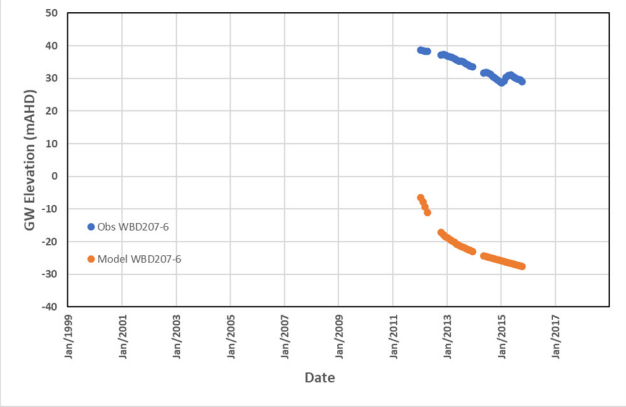

GW Elevation (mAHD)
Obs SBFOW03
Model SBFOW03
Date

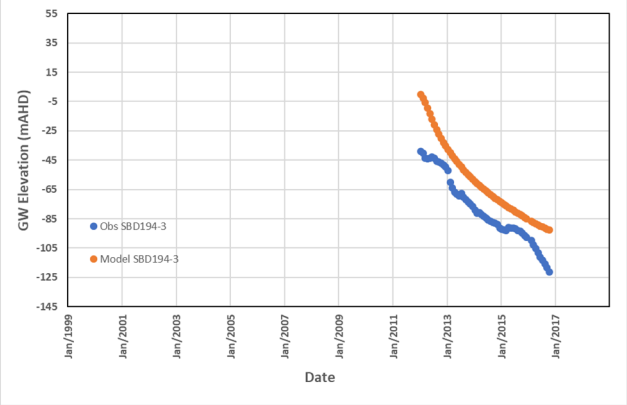
Layer 13

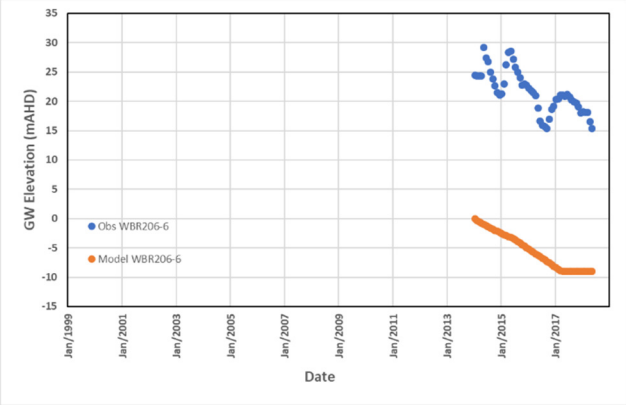

GW Elevation (mAHD)
Obs SBFOW04A-4
Model SBFOW04A-4
Date

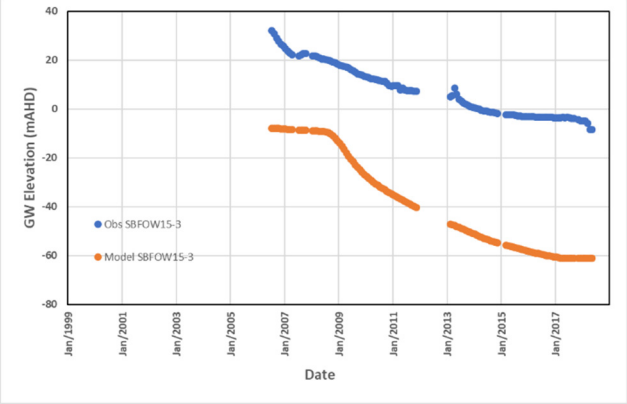

GW Elevation (mAHD)
Obs SBFOW09-3
Model SBFOW09-3
Date


GW Elevation (mAHD)
Obs WBD210-6
Model WBD210-6
Date

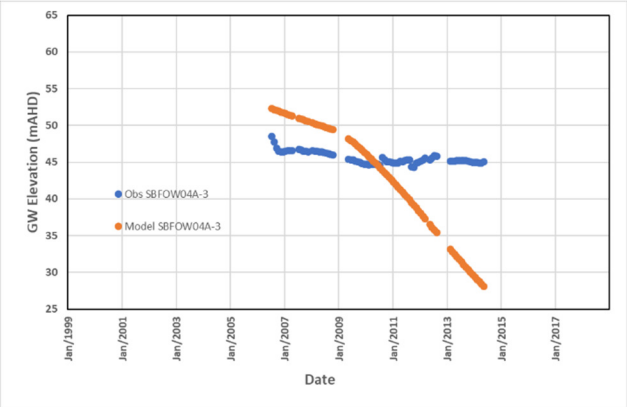

GW Elevation (mAHD)
Obs WBD207-6
Model WBD207-6
Date

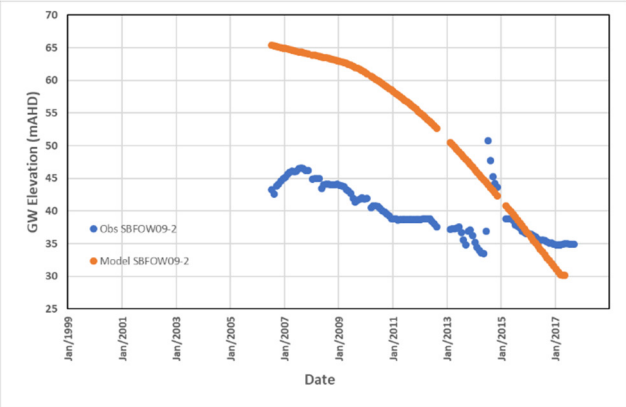

GW Elevation (mAHD)
Obs SBD194-3
Model SBD194-3
Date

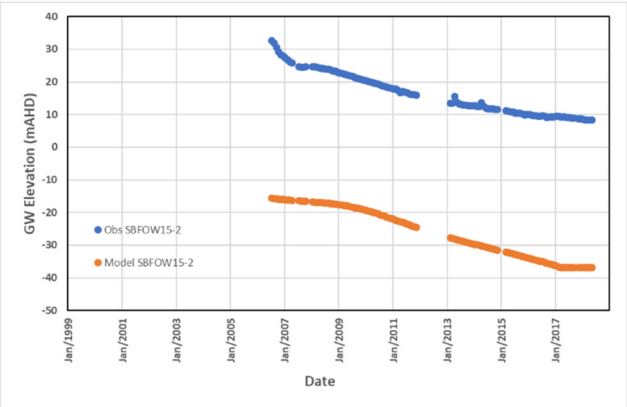

GW Elevation (mAHD)
Obs WBR206-6
Model WBR206-6
Date

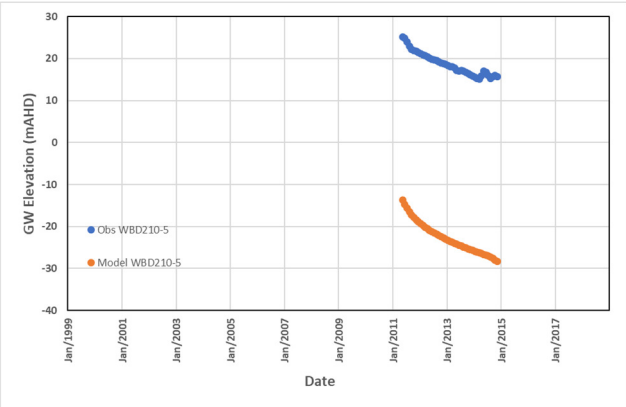

GW Elevation (mAHD)
Obs SBFOW15-3
Model SBFOW15-3
Date

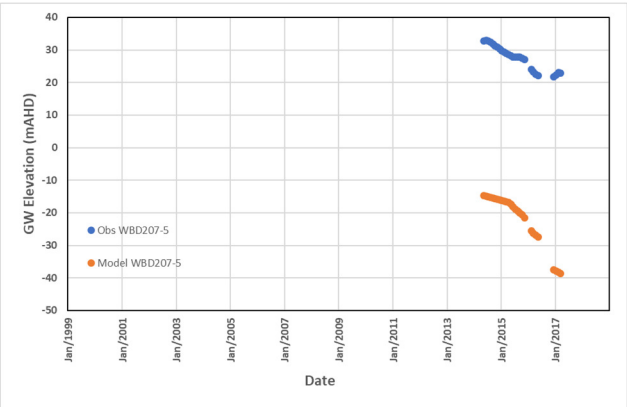
Layer 15

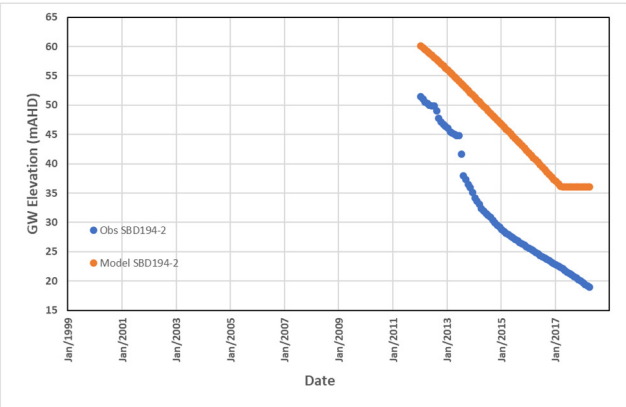

GW Elevation (mAHD)
Obs SBFOW04A-3
Model SBFOW04A-3
Date

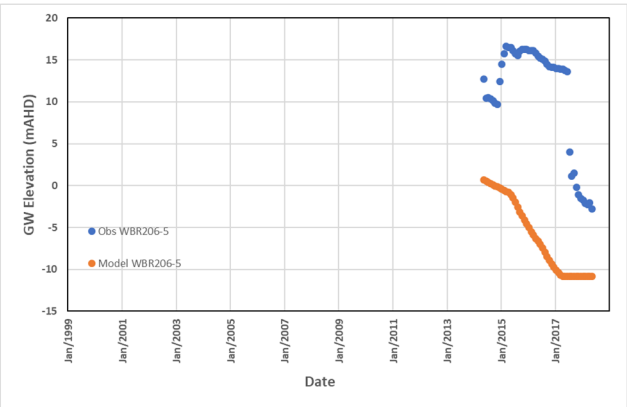

GW Elevation (mAHD)
Obs SBFOW09-2
Model SBFOW09-2
Date


GW Elevation (mAHD)
Obs SBFOW15-2
Model SBFOW15-2
Date

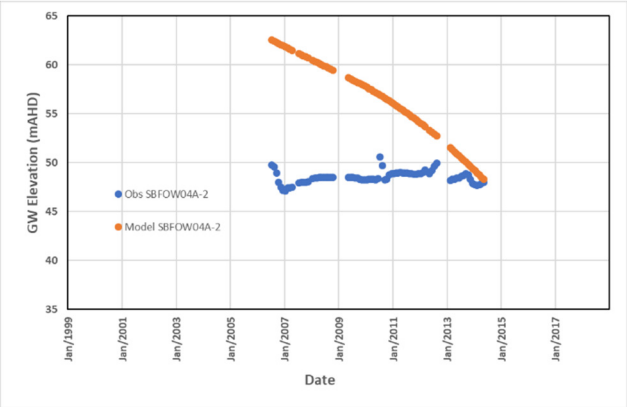

GW Elevation (mAHD)
Obs WBD210-5
Model WBD210-5
Date

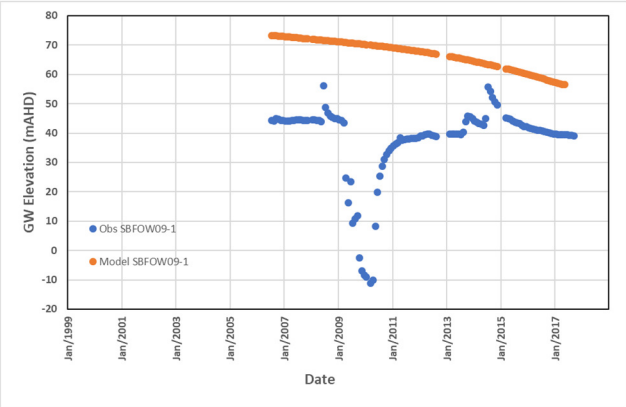

GW Elevation (mAHD)
Obs WBD207-5
Model WBD207-5
Date


GW Elevation (mAHD)
Obs SBD194-2
Model SBD194-2
Date


GW Elevation (mAHD)
Obs WBR206-5
Model WBR206-5
Date

Layer 16


GW Elevation (mAHD)
Obs SBFOW04A-2
Model SBFOW04A-2
Date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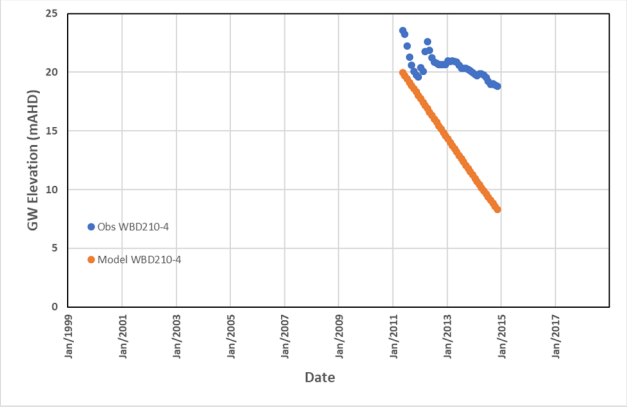
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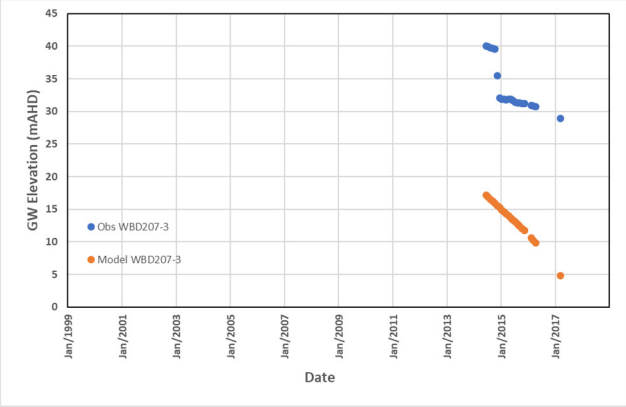
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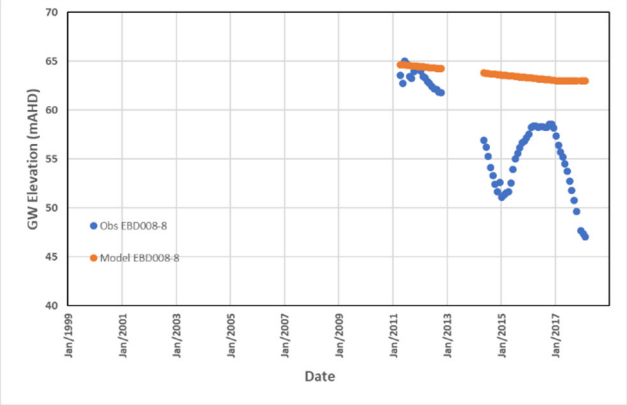
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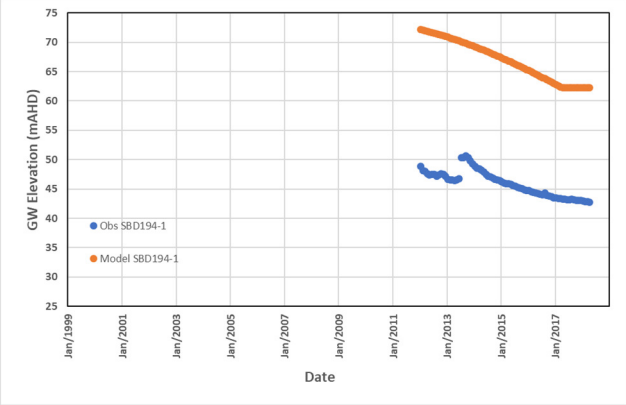
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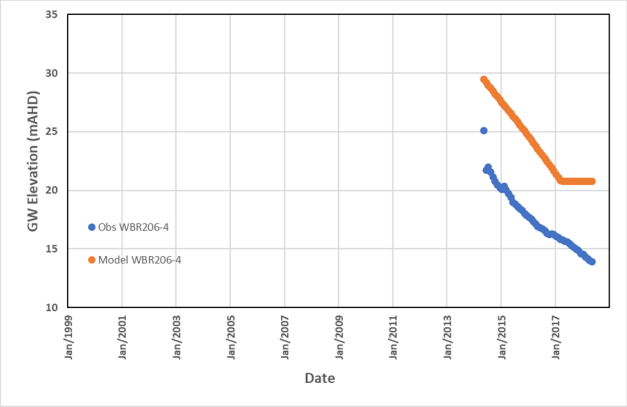
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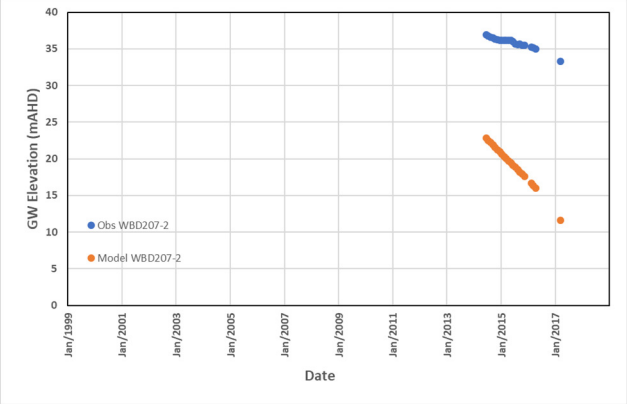
Layer 17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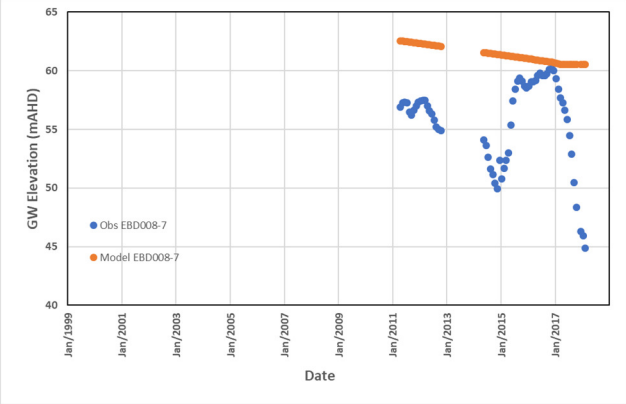
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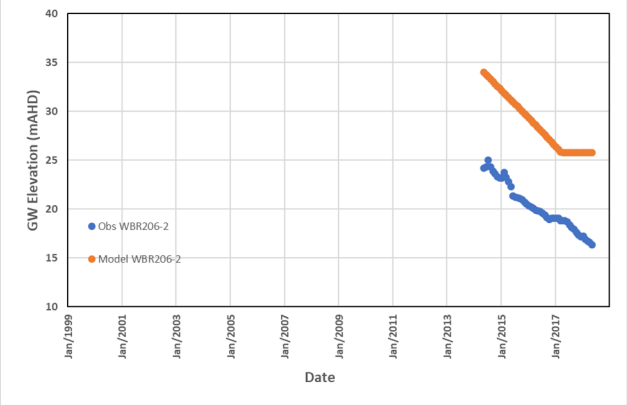
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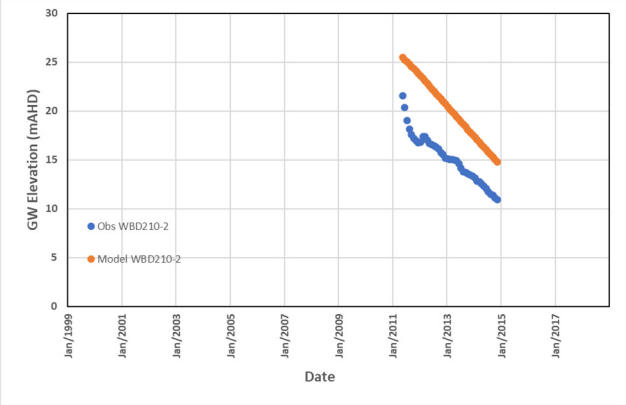
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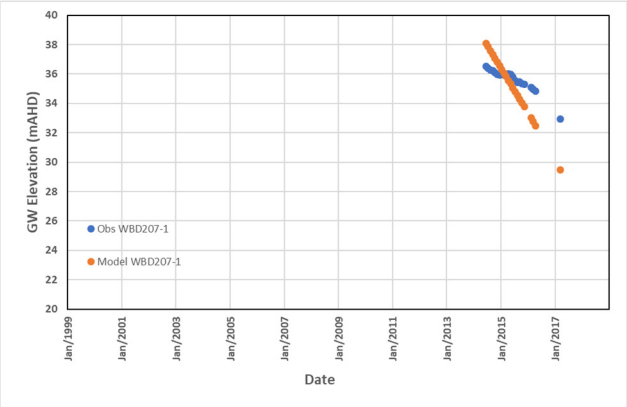

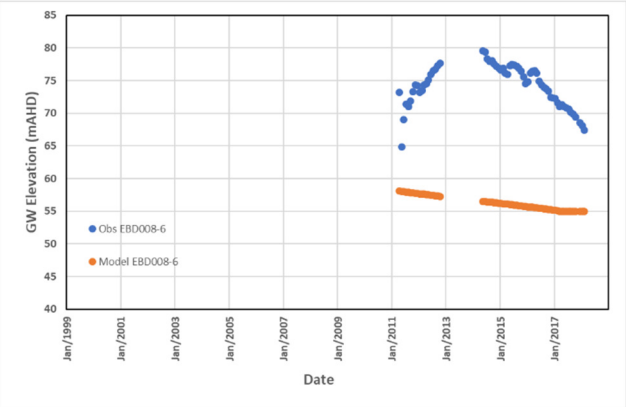

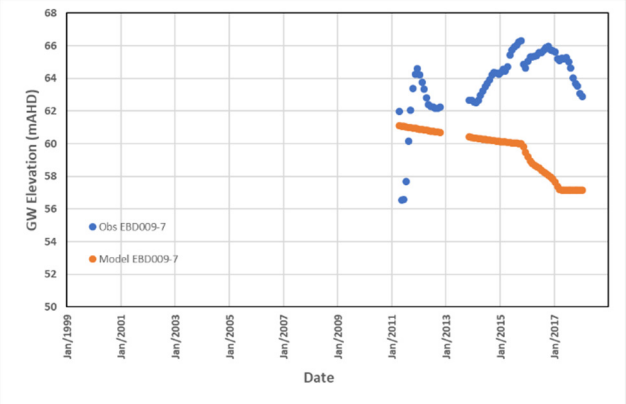

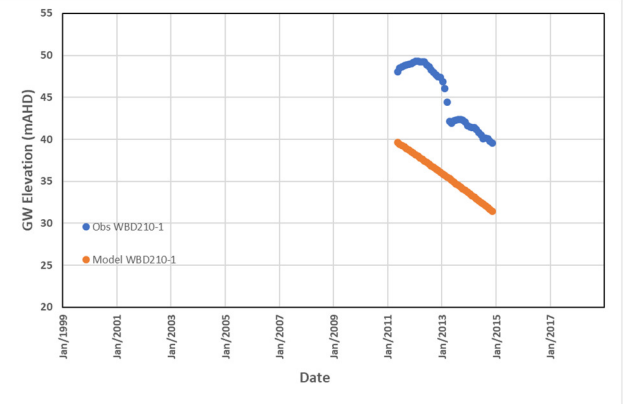

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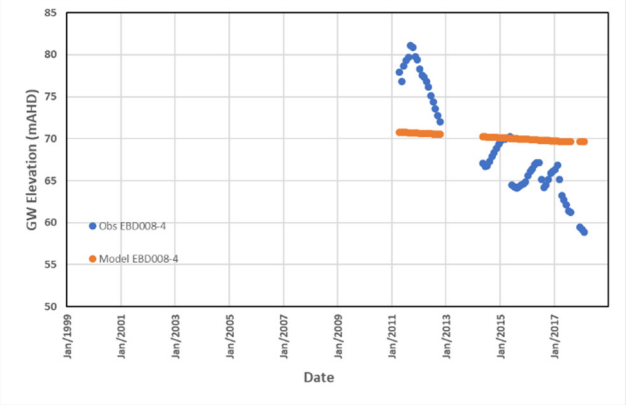

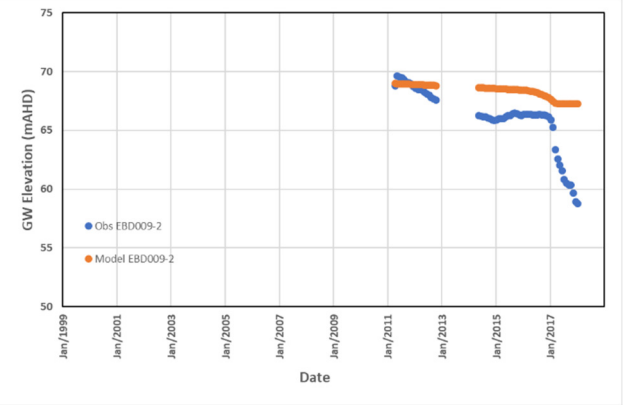

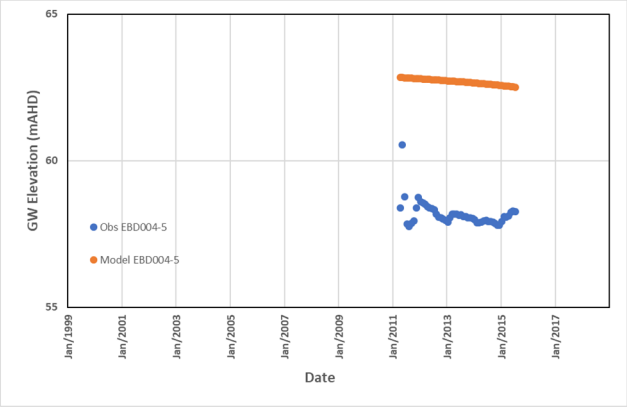
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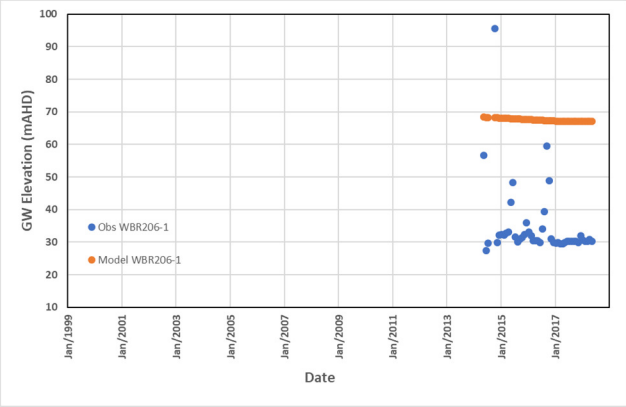
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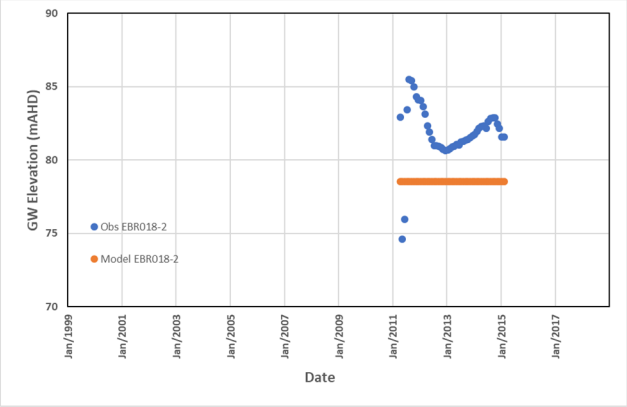
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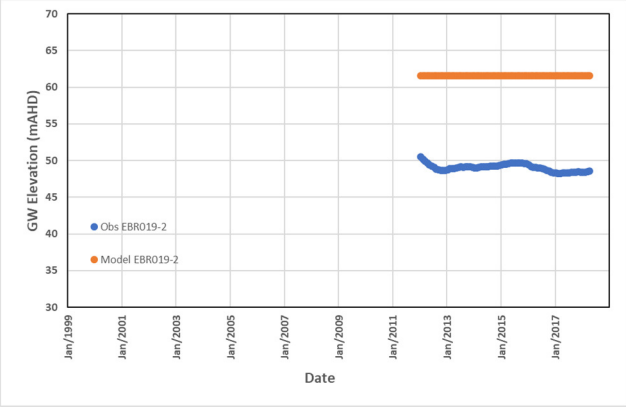
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APPENDIX V

Groundwater Flows to Alluvials and Local Creeks

Appendix V

I-1 GROUNDWATER FLOW TO ALLUVIAL REACHES

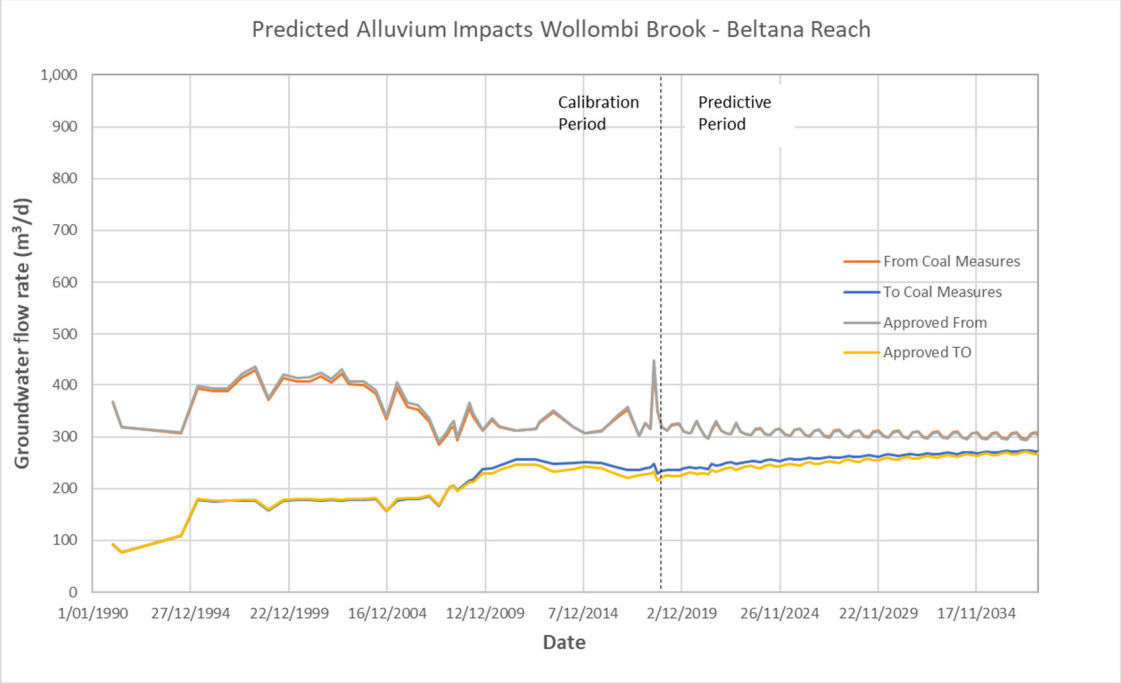

Figure 1-1: Predicted groundwater flow into and out of Wollombi Brook Alluvium - Beltana Reach (Approved and Proposed Modification case shown)

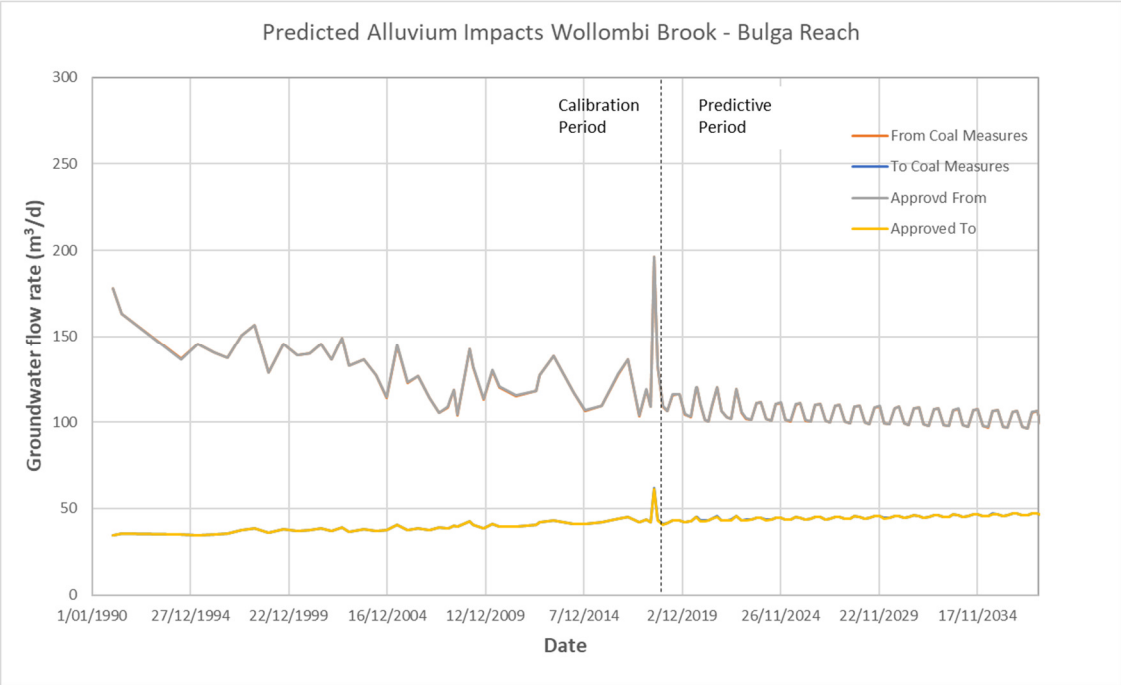

Figure 1-2: Predicted groundwater flow into and out of Wollombi Brook Alluvium - Bulga Reach (Approved and Proposed Modification case shown)

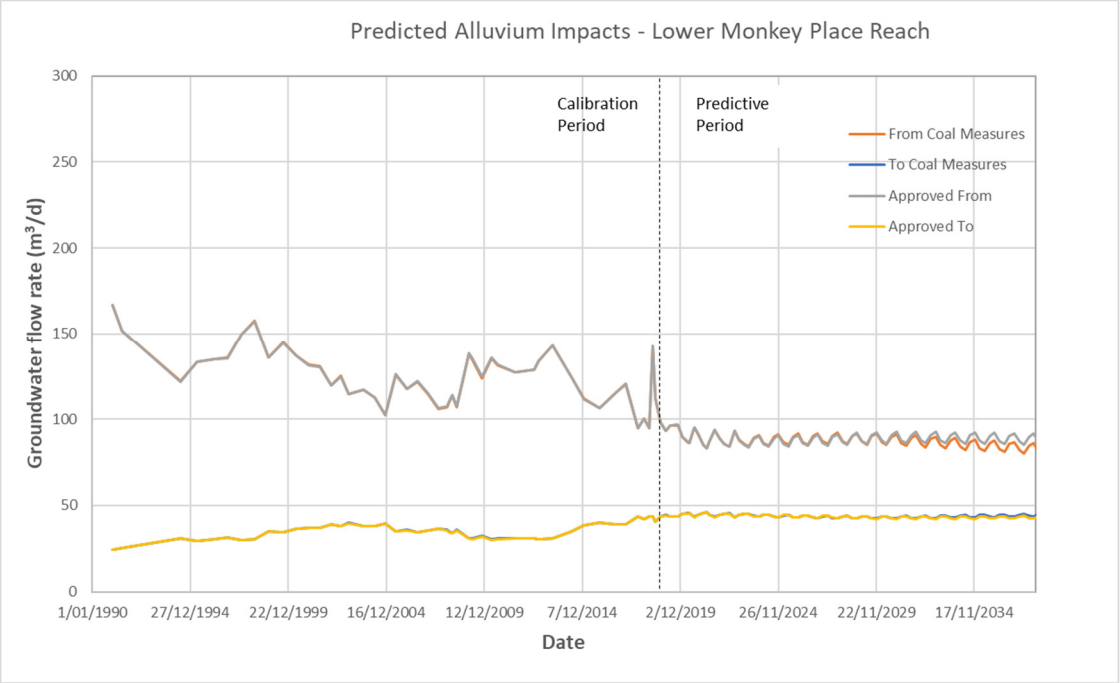

Figure 1-3: Predicted groundwater flow into and out of Monkey Place Alluvium – Lower Reach (Approved and Proposed Modification case shown)

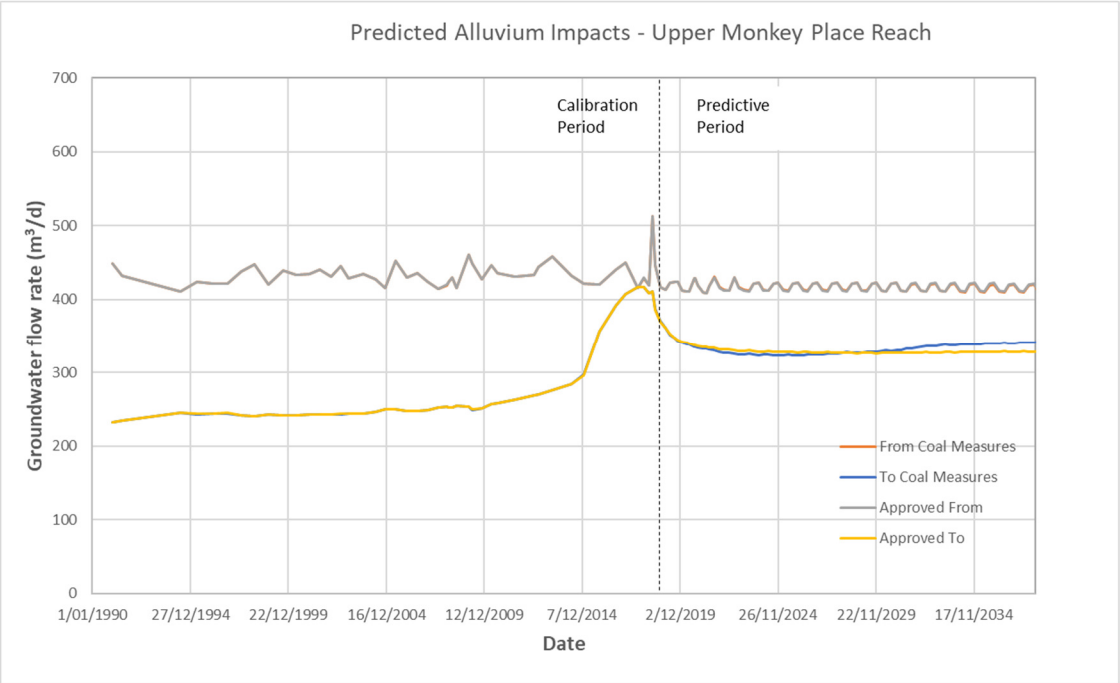

Figure 1-4: Predicted groundwater flow into and out of Monkey Place Alluvium – Lower Reach (Approved and Proposed Modification case shown)

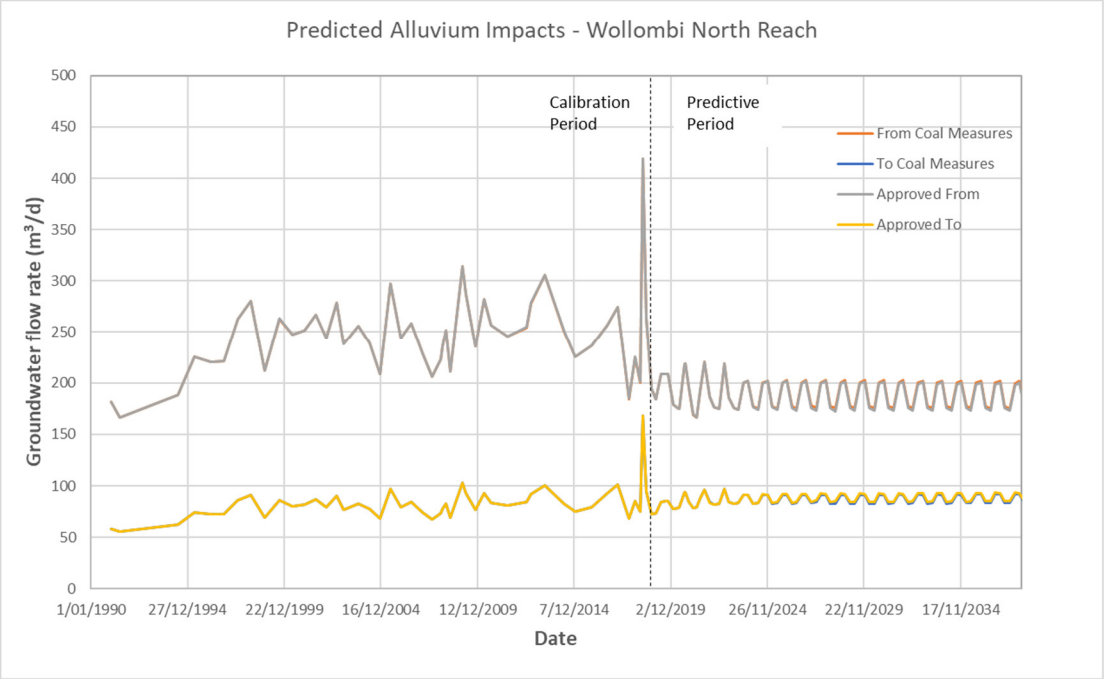

Figure 1-5: Predicted groundwater flow into and out of Wollombi Brook Alluvium - Bulga Reach (Approved and Proposed Modification case shown)

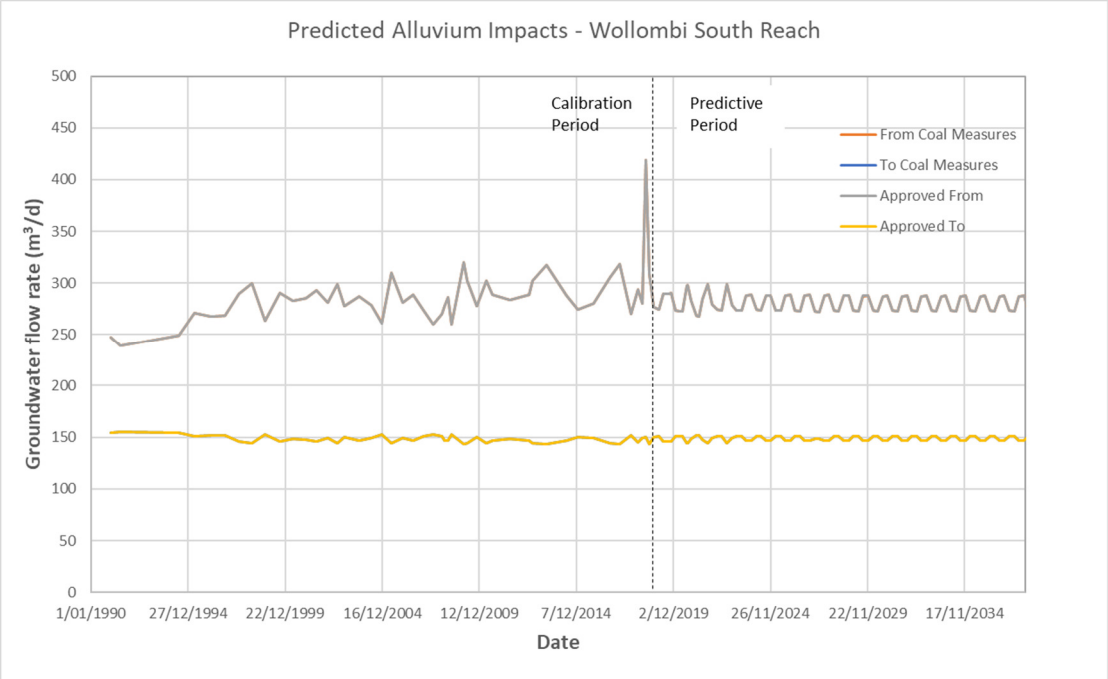

Figure 1-6: Predicted groundwater flow into and out of Wollombi Brook Alluvium - Bulga Reach (Approved and Proposed Modification case shown)

I-2 GROUNDWATER FLOW TO STREAM REACHES

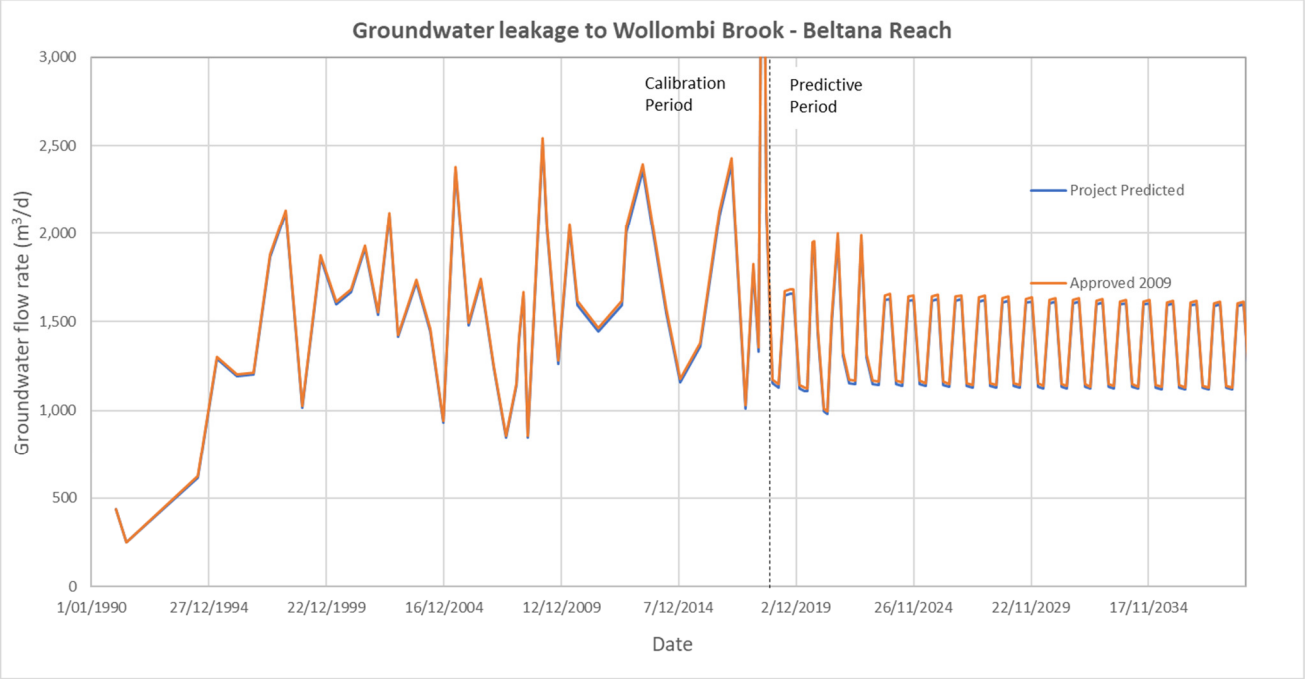

Figure 2-1: Predicted groundwater flow to Wollombi Brook Alluvium - Beltana Reach (Approved and Proposed Modification case shown)

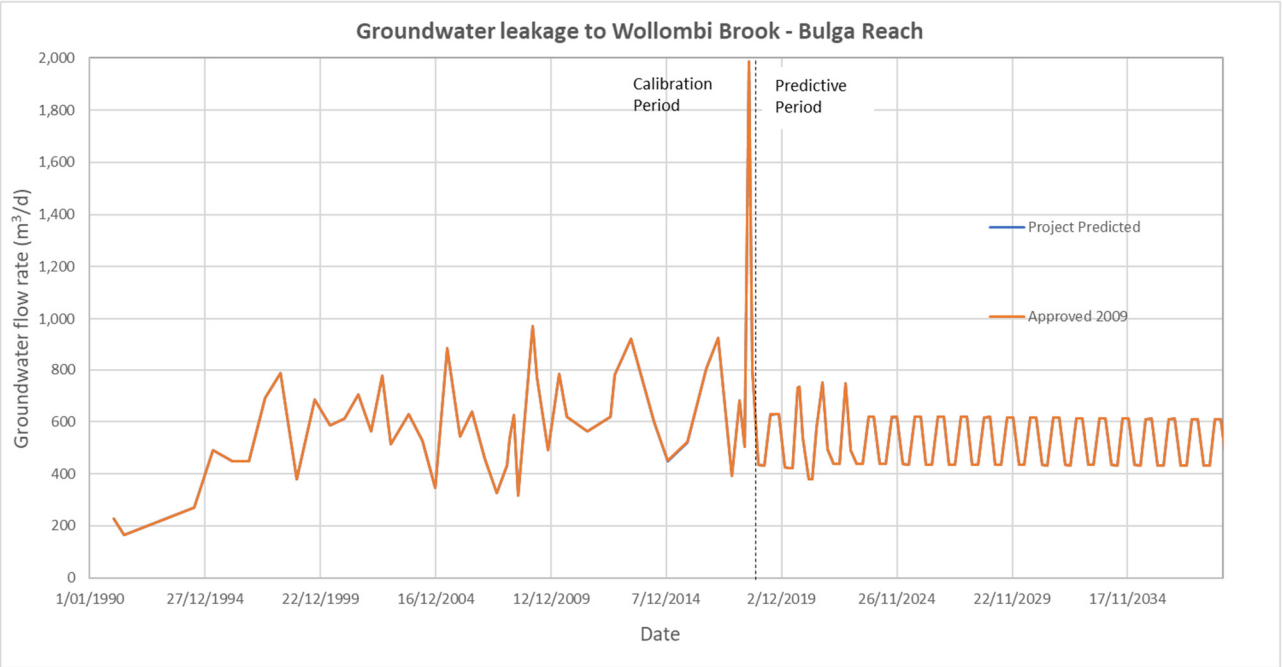

Figure 2-2: Predicted groundwater flow to Wollombi Brook Alluvium - Bulga Reach (Approved and Proposed Modification case shown)

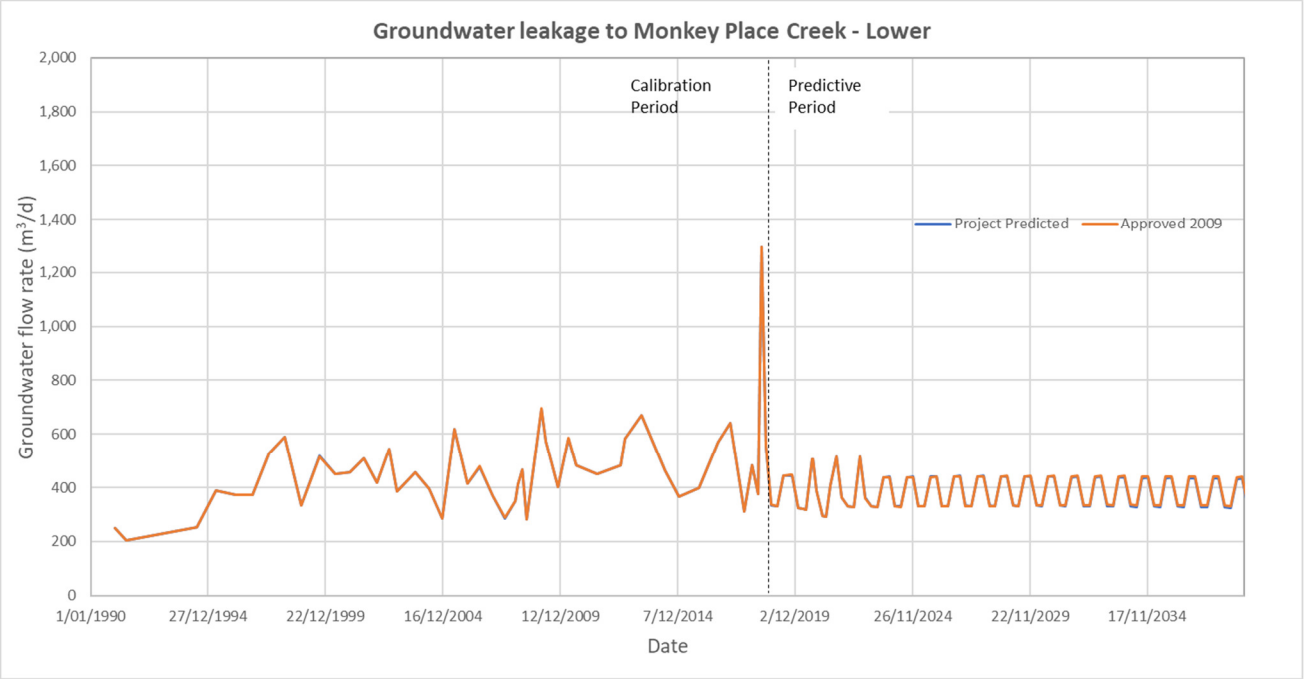

Figure 2-3: Predicted groundwater flow to Monkey Place Creek - Lower Reach (Approved and Proposed Modification case shown)

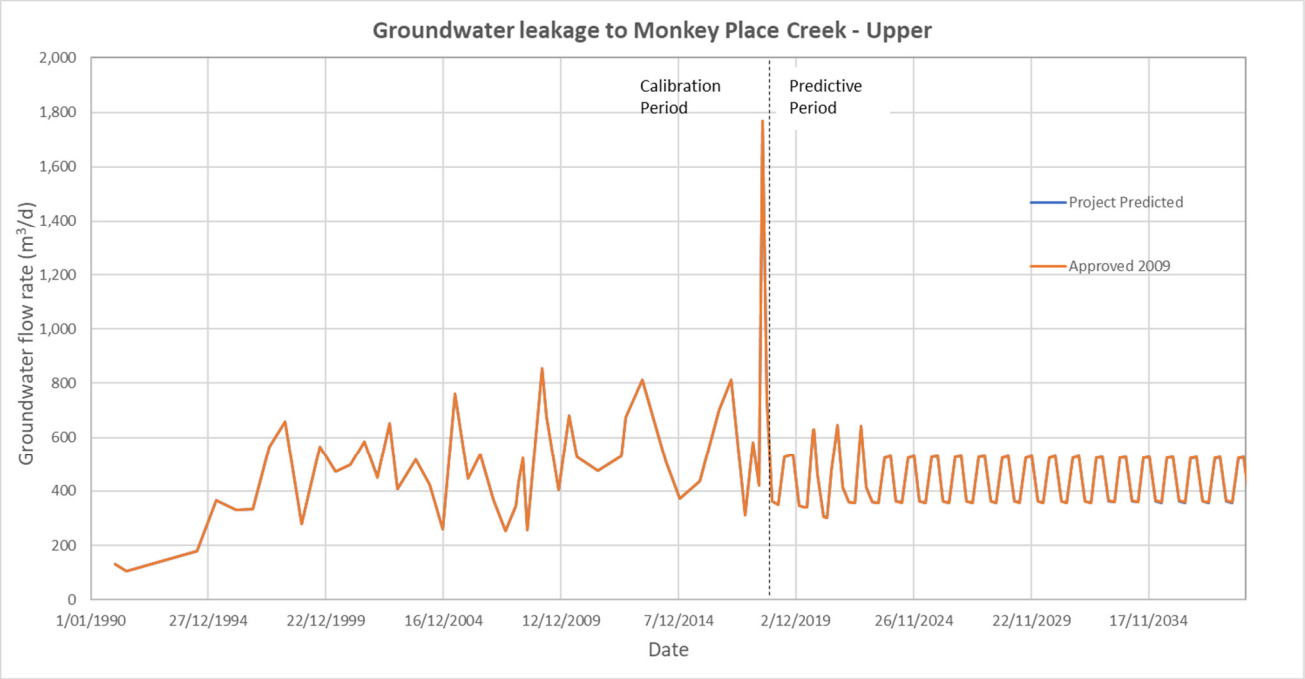

Figure 2-4: Predicted groundwater flow to Monkey Place Creek - Lower Reach (Approved and Proposed Modification case shown)

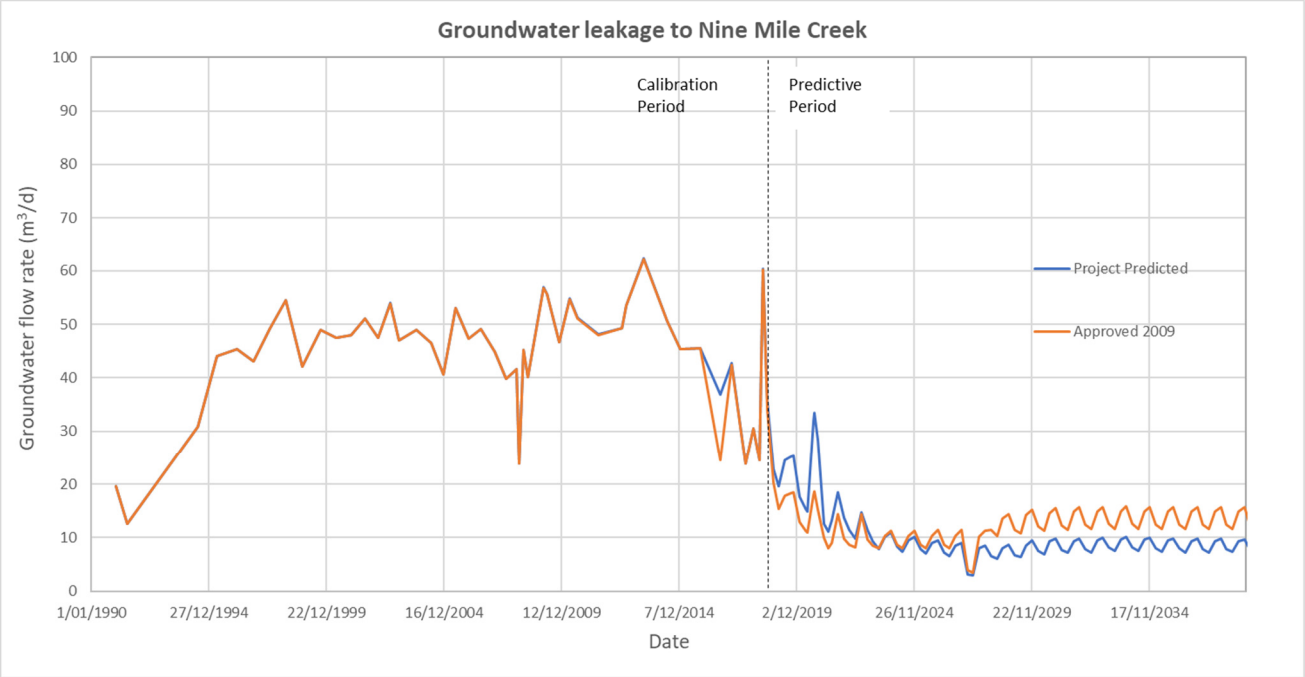

Figure 2-5: Predicted groundwater flow to Nine Mile Creek (Approved and Proposed Modification case shown)

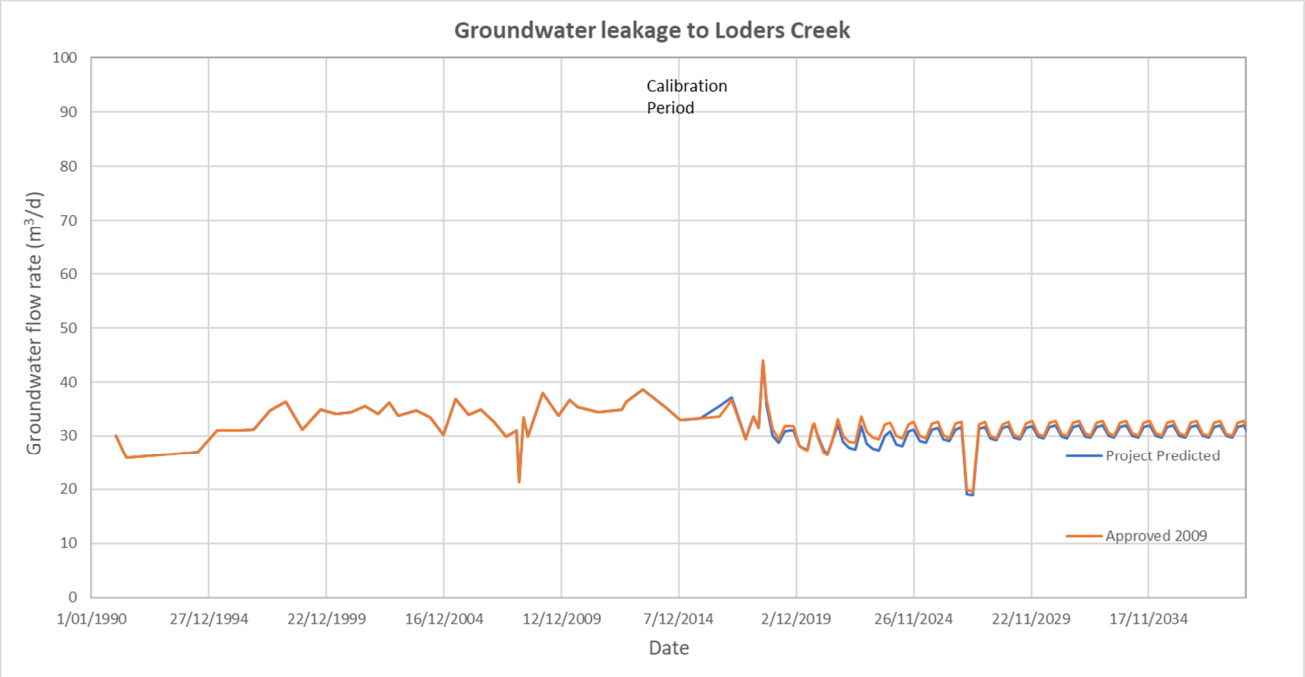

Figure 2-6: Predicted groundwater flow to Loders Creek (Approved and Proposed Modification case shown)

APPENDIX VI

Model Peer Review Report

HydroAlgorithmics Pty Ltd ● ABN 25 163 284 991
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

noel.merrick@hydroalgorithmics.com

DATE: 6 August 2019

TO: Kirsty Davies
Senior Environmental Consultant
Umwelt (Australia) Pty Limited
75 York Street
Teralba NSW 2284
Tel: (02) 4950 5322

FROM: Dr Noel Merrick

RE: Bulga Optimisation Project Mod 3 –
Groundwater Assessment Peer Review

YOUR REF: 4100

OUR REF: HA2019/10

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1. Introduction

This report provides a peer review of the groundwater impact assessment (GIA) and associated modelling for the Bulga Optimisation Project in the Hunter Valley, NSW. The GIA has been prepared by Klohn Crippen Berger Pty Limited [KCB] under the project management of Umwelt Australia Pty Ltd, for the client Bulga Coal Management Pty Ltd, a subsidiary of Glencore Coal.

The Proposed Modification involves continuation of open-cut operations to the south-east, including extraction of coal from beneath the level of the currently approved pit base, without any alteration to approved underground mining activity.

2. Documentation

The peer review is based on the following report:

1. KCB, 2019, Bulga Optimisation Project Modification: Groundwater Impact Assessment. Report D10203A01, Final, for Umwelt Australia Pty Ltd, August 2019. 90p plus 5 Appendices.

Appendix I is a substantial standalone report:

2. KCB, 2018, APPENDIX I: Bulga Coal Project, Review of Monitoring Data. Letter report, 4 September 2018. 46p.

Document #1 has the following sections:

Executive Summary
1. Introduction
2. Regulatory and policy framework
3. Conceptual hydrogeological model
4. Groundwater flow modelling
5. Groundwater impact assessment
6. Closing
7. References.

The Appendices are:

I. Bulga Coal Project, Review of Monitoring Data
II. Model Calibration Summary and Comparison
III. Model Sensitivity and Uncertainty Analysis
IV. Groundwater Model Transient Calibration Hydrographs
V. Groundwater Flows to Alluvials and Local Creeks

Document #2 has the following sections:

1. Introduction
2. Monitoring network

3. Review Methodology

While there are no standard procedures for peer reviews of entire groundwater assessments, there are guidelines for the numerical modelling that underpins the assessment.

There are two accepted guides to the review of groundwater models: (A) the Murray-Darling Basin Commission (**MDBC**) Groundwater Flow Modelling Guideline[1], issued in 2001, and (B) guidelines issued by the National Water Commission (**NWC**) in June 2012 (Barnett *et al.*, 2012[2]). The NWC national guidelines were built upon the original MDBC guide, with substantial consistency in the model conceptualisation, design, construction and calibration principles, and the performance and review criteria, although there are differences in details.

The NWC guide promotes the concept of "model confidence level", which is defined using a number of criteria that relate to data availability, calibration, and prediction scenarios. The NWC guide is almost silent on coal mine modelling and offers no direction on best practice methodology for such applications. There is, however, an expectation of more effort in uncertainty analysis, although the guide is not prescriptive as to which methodology should be adopted.

Guidelines on uncertainty analysis for groundwater models were issued by the Independent Expert Scientific Committee (**IESC**) on Coal Seam Gas and Large Coal Mining Development in February 2018 in draft form and finalised in December 2018[3].

The groundwater guides include useful checklists for peer review. This groundwater impact assessment has been reviewed according to the 2-page Model Appraisal checklist[4] in MDBC (2001). This checklist has questions on (1) The Report; (2) Data Analysis; (3) Conceptualisation; (4) Model Design; (5) Calibration; (6) Verification; (7) Prediction; (8) Sensitivity Analysis; and (9) Uncertainty Analysis. Non-modelling components of the groundwater impact assessment are addressed by the first three sections of the checklist.

[1] MDBC (2001). Groundwater flow modelling guideline. Murray-Darling Basin Commission. URL: www.mdbc.gov.au/nrm/water_management/groundwater/groundwater_guides

[2] Barnett, B, Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012). *Australian Groundwater Modelling Guidelines*. Waterlines report 82, National Water Commission, Canberra.

[3] Middlemis H and Peeters LJM (2018) *Uncertainty analysis—Guidance for groundwater modelling within a risk management framework*. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

[4] The newer guidelines include a more detailed checklist with yes/no answers but without the graded assessments of the 2001 checklist, which this reviewer regards as more informative for readers.

The review has also considered whether compliance with the minimal impact considerations of the *NSW Aquifer Interference Policy* (AIP) (NSW Government, 2012[5]) has been addressed adequately.

It should be recognised that the effort put into the modelling component of a groundwater impact assessment is very dependent on possible timing and budgetary constraints that are generally not known to a reviewer. However, this is less of an issue with a progressive review.

This review has been conducted progressively since May 2018, with involvement of the peer reviewer through several teleconferences in addition to three face-to-face meetings:

1. Inception meeting (held on 29 October 2018 at Teralba).
2. Meeting #2 (held on 12 November 2018 at Brisbane).
3. Meeting #3 (held on 30 May 2019 at Brisbane).

Report revision 5 was reviewed by HydroAlgorithmics on 29 July 2019. This comprised 6 pages of primarily editorial comments. The comments were discussed during a teleconference on 2 August 2019, and KCB responded in writing on the same day. Most comments have been addressed to the reviewer's satisfaction, except where noted below.

The detailed assessment of the GIA is recorded in the peer review checklist in **Table 1**. Supplementary comment is offered in the following sections of this review.

4. Report Matters

The GIA report consists of about 200 pages in total, of which 90 pages comprise the main report, providing an adequate groundwater impact assessment in support of the Project. The main report is not quite standalone as it relies on Appendix I for graphics of groundwater system responses. Some example graphics could have been brought into the main report to make it more complete.

The report commences with a succinct 4-page Executive Summary that addresses each potential impact and water licensing requirement in turn.

The report is well structured and is written clearly, with illustrations well chosen and informative. Consequently, there is a thorough basis for conceptualisation of the groundwater system.

The objectives are outlined at the start (Section 1.2), and at Section 4.1 for modelling, and those objectives are addressed at the end of the report with summaries of the predicted Project impacts and compliance with the minimal harm considerations of the Aquifer Interference Policy.

Included is a very good summary of legislative requirements.

However, there is no self-assessment of model confidence class according to the NWC guide. Class 2 is the appropriate target confidence level for a mining impact assessment. Justification could be provided by completion of a table modified from Table 2-1 in the NWC guide as recommended in the IESC guide on Uncertainty Analysis (see attached **Table 2** template). By examining counts for each relevant attribute in each Class, a model can be characterised as having stated percentages of each Class.

The reporting of water balances is inadequate. There is no model-wide water balance provided for calibration or for prediction. Partial water balances are provided for mine inflows, alluvial take and baseflow take.

[5] NSW Government, 2012, NSW Aquifer Interference Policy – NSW Government policy for the licensing and assessment of aquifer interference activities. Office of Water, NSW Department of Primary Industries, September 2012.

5. Data Matters

The regional and structural geology, and hydrogeology, of the area are explained clearly and in sufficient detail. However, there is no summary of the field investigations by previous workers which would have included packer testing and perhaps pumping tests and/or core laboratory measurements. The necessity for this is mitigated by the scope of work being the update of an existing numerical model with minimal need for re-calibration.

There is a very substantial groundwater monitoring network comprising groundwater hydrographs at 52 alluvium sites and VWP monitoring of hard rock by 108 sensors at 18 sites. Some sites have had ongoing monitoring for nearly 20 years.

In Appendix I, a sufficient cause-and-effect analysis has been conducted on groundwater hydrographs and EC charts to infer the importance of driver mechanisms. For alluvial sites, comparison is made with Wollombi Brook gauge height but not with rainfall or residual mass (or cumulative rainfall deviation, CRD), and there is no exploration of drawdown effects from private groundwater pumping. One example of alluvial hydrographs compared with CRD should have been shown in the main report. The VWP charts show many examples of mining effects. While there is discussion on vertical gradients inferred from approximately-paired alluvium-Permian bores in Section 3.4.1, there is no graphic to illustrate the findings. There is strong evidence for the main conclusion of the cause-and-effect analysis that the alluvial and Permian groundwater systems have “limited connectivity” under mining stress.

The conceptualisation of the groundwater system is depicted clearly in the conceptual model diagram of Figure 3-12.

6. Model Matters

The modelling has been undertaken competently and successfully. There are no issues with model design in terms of areal extent, vertical subdivision into model layers, spatial resolution scales, choice of boundary conditions, or software. It should be noted that the scope of work was for an update to an existing model that had been performing reliably, hence there was no need for a major overhaul.

The previously used MODFLOW-SURFACT software has been retained. An important feature of this software is that it supports temporal material changes that enable progressive inclusion of spoil in open cut mines and fracturing above underground voids. This has been particularly challenging with underground mining in four coal seams.

One major update of the model was the undertaking of transient calibration. In the event, very little alteration ensued for hydraulic conductivities but the storage properties were optimised for the first time. Also, earlier calibration was conducted by manual methods only, whereas automated calibration using PEST software has been adopted by KCB.

There are some deficiencies in reporting, namely:

- The main report has only a brief summary of model calibration, with detail provided in Appendix II.
- No scattergram is reported for transient calibration in the main report.
- No residuals map is reported for transient calibration (to allow an appreciation of spatial calibration performance).
- As already noted, water balance tables are missing.
- The main report includes only the initial model property values per layer, not the calibrated values.

Nevertheless, calibration statistics are acceptable, given that most of the water level target data is associated with VWP sensors in hard rock: 10 %RMS and about 23 mRMS. For 2018 data alone, Better performance is achieved: 8.7 %RMS.

Qualitative comparison of hydrographs (Appendix IV) suggests a mixture from “good” to “bad” agreement, but it is not easy for the reader to judge whether there is any spatial pattern to the degree of performance. There are some very good replications of trends at VWP sites that are heavily affected by mining.

In addition to matching groundwater levels, much emphasis was placed on reproducing the predicted mine inflows and drawdown extents of a previous worker, on the assumption that the previous model had been performing reliably. Very good agreement has been achieved, and where any differences persist the KCB model should be given priority as it has gone through transient automated calibration and includes a more thorough assessment of parallel operations in multiple coal seams.

Rainfall recharge is accomplished appropriately by a simple fraction of actual rainfall, partitioned into separate spatial zones for alluvium (8.0%) and regolith (0.2%). Maximum evapotranspiration (ET) rate is taken as Actual ET for the same divisions, with extinction depth uniformly 1.5 m. This approach is satisfactory.

While rigorous Monte Carlo uncertainty analysis has been done on 360 trial models, of which 200 models survived, the display of results using bar charts compared to baseline at nine discrete locations is not particularly informative. The recommended display of 2m drawdown maps for five IESC-preferred percentiles would be better, as would the alluvial and baseflow takes at standard percentiles.

7. Conclusion

The reviewer’s findings are:

- A sufficient level of background material has been provided for a groundwater assessment.
- The degree of model complexity and modelling effort for this Modification are considered to be appropriate for addressing the minimal impact considerations of the Aquifer Interference Policy, and for estimating water licensing requirements.
- Modelling has been conducted competently.
- The model is *fit for purpose*, where the purpose is jointly estimation of water takes from designated Water Sharing Plan areas and reduction in groundwater pressure heads regionally.

Yours sincerely



Dr Noel Merrick

Table 1. MODEL APPRAISAL: **Bulga Groundwater Model**

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
1.0	THE REPORT								
1.1	Is there a clear statement of project objectives in the modelling report?		Missing	Deficient	Adequate	Very Good			S1.2 & S4.1
1.2	Is the level of model complexity clear or acknowledged?		Missing	No	Yes				NWC national guidelines mentioned at S2.2.7. No reference to confidence classification. Class 2 likely.
1.3	Is a water or mass balance reported?		Missing	Deficient	Adequate	Very Good			No tables of recharge/discharge components for whole model for calibration or prediction. Separate tables provided for mine inflows, alluvial take and baseflow take.
1.4	Has the modelling study satisfied project objectives?		Missing	Deficient	Adequate	Very Good			Meets objectives
1.5	Are the model results of any practical use?			No	Maybe	Yes			Fit for purpose
2.0	DATA ANALYSIS								
2.1	Has hydrogeology data been collected and analysed?		Missing	Deficient	Adequate	Very Good			Strong regional, structural and local geology. Good lithology descriptions. No summary of previous packer/core work by Mackie.
2.2	Are groundwater contours or flow directions presented?		Missing	Deficient	Adequate	Very Good			No current head contours. Discussion on vertical flow.
2.3	Have all potential recharge data been collected and analysed? (rainfall, streamflow, irrigation, floods, etc.)		Missing	Deficient	Adequate	Very Good			Doc #2. Wollombi Brook flow.
2.4	Have all potential discharge data been collected and analysed? (abstraction, evapotranspiration, drainage, springflow, etc.)		Missing	Deficient	Adequate	Very Good			Private use from alluvium poorly known.
2.5	Have the recharge and discharge datasets been analysed for their groundwater response?		Missing	Deficient	Adequate	Very Good			Doc #2: Cause-and-effect analysis based on streamflow and mining – not CRD. Water levels and EC pairing. Doc #1: only VWP shown; no alluvium response example, or vertical pairs.

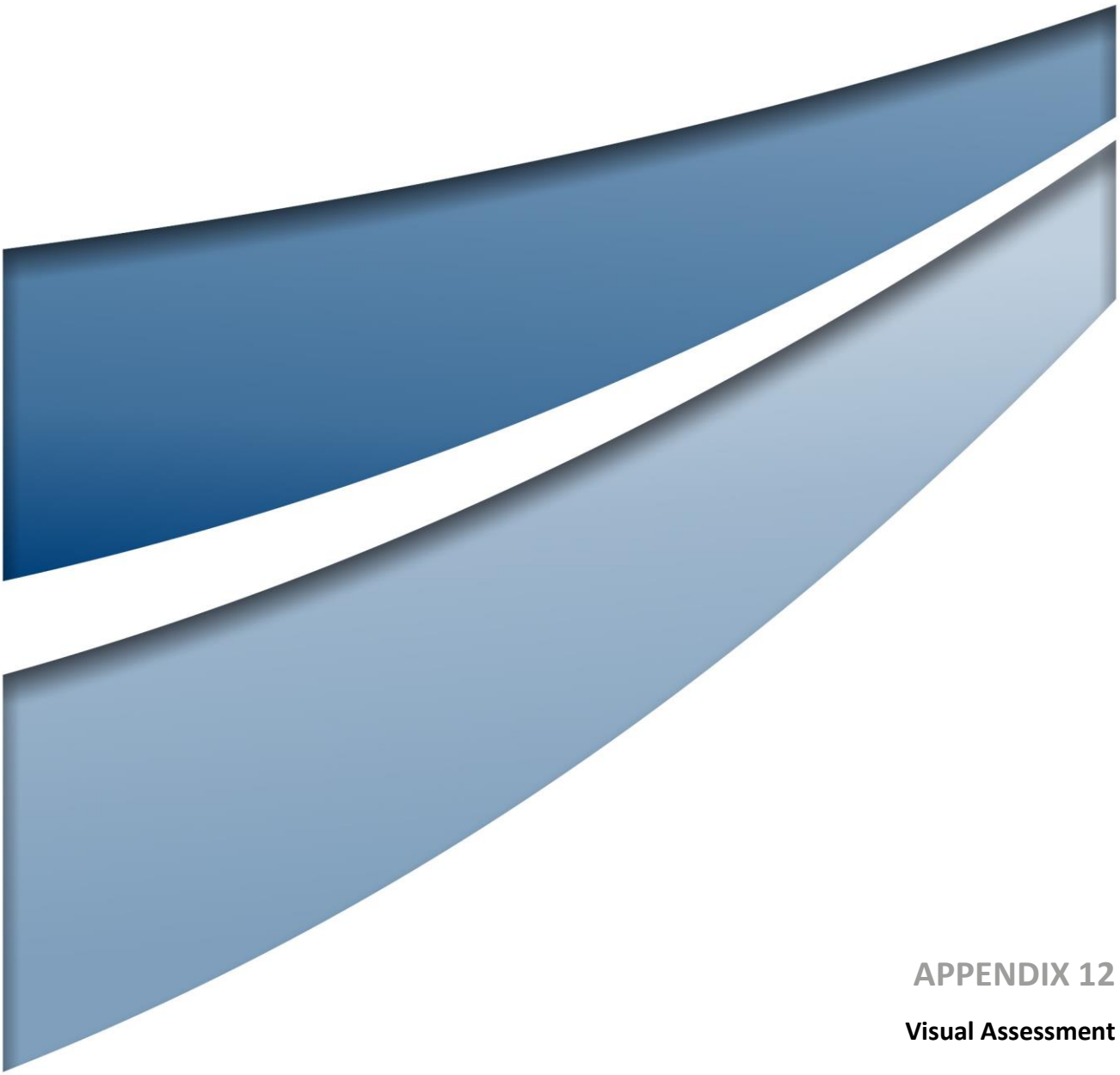
2.6	Are groundwater hydrographs used for calibration?			No	Maybe	Yes			Large number: 52 alluvium sites; 108 VWP sensors.
2.7	Have consistent data units and standard geometrical datums been used?			No	Yes				Missing unit for Ss.
3.0	CONCEPTUALISATION								
3.1	Is the conceptual model consistent with project objectives and the required model complexity?		Unknown	No	Maybe	Yes			
3.2	Is there a clear description of the conceptual model?		Missing	Deficient	Adequate	Very Good			S3.4 and App.I
3.3	Is there a graphical representation of the modeller's conceptualisation?		Missing	Deficient	Adequate	Very Good			Figure 3-12 during/post mining.
3.4	Is the conceptual model unnecessarily simple or unnecessarily complex?			Yes	No				
4.0	MODEL DESIGN								
4.1	Is the spatial extent of the model appropriate?			No	Maybe	Yes			Figure 4-2 map of grid. 18km x 20km. 263 cols x 299 rows. 20 layers. Cell sizes 50-100m. Variable size structured grid.
4.2	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very Good			Rectangular boundary using GHBs. River stage seems to match non-incised ground topography; this could be improved with LiDAR or incision in the next model update. Blanket DRNs at surface of waste emplacements.
4.3	Is the software appropriate for the objectives of the study?			No	Maybe	Yes			MODFLOW-SURFACT and PEST and bespoke FORTRAN programs.
5.0	CALIBRATION								
5.1	Is there sufficient evidence provided for model calibration?		Missing	Deficient	Adequate	Very Good			Transient calibration with groundwater level targets; matching Mackie mine inflows and drawdown maps. RMS and %RMS performance statistics and scattergram for transient.

5.2	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very Good			Can infer only from scattergram. Predicted contours are not compared with observed head contours. Simulated vertical head differences seem to be reproduced reasonably at most sites, but hard to check given VWP responses are not stacked.
5.3	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very Good			Observed mining effects are evident at most VWP sites and trends are matched mostly well. Seasonal response at alluvial sites is poor, but not important.
5.4	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes			K(z) applied to coal only. K, Ss and Sy values are reasonable. Fractured zone Kh and Kv seem constant with altitude, rather than reducing; both 0.001 m/d, which is reasonable.
5.5	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very Good			Transient model: 10 %RMS, 23 mRMS 2018 data only: 8.7 %RMS.
5.6	Are there good reasons for not meeting agreed performance criteria?		Missing	Deficient	Adequate	Very Good			Matching VWP data quantitatively is always a challenge. Timing assumptions can cause false RMS errors.
6.0	VERIFICATION								OPTIONAL
6.1	Is there sufficient evidence provided for model verification?	N/A	Missing	Deficient	Adequate	Very Good			
6.2	Does the reserved dataset include stresses consistent with the prediction scenarios?	N/A	Unknown	No	Maybe	Yes			
6.3	Are there good reasons for an unsatisfactory verification?	N/A	Missing	Deficient	Adequate	Very Good			
7.0	PREDICTION								
7.1	Have multiple scenarios been run for climate variability?		Missing	Deficient	Adequate	Very Good			A single average climate has been used – this is sufficient.

7.2	Have multiple scenarios been run for operational /management alternatives?		Missing	Deficient	Adequate	Very Good			One mine plan. Mt Thorley mine is included for cumulative impact assessment. Approved vs. Modification differentials. Final void 1500 year run.
7.3	Is the time horizon for prediction comparable with the length of the calibration / verification period?		Missing	No	Maybe	Yes			Calibration period 29 years (1990-2018). Prediction period 22 years (2018-2039).
7.4	Are the model predictions plausible?			No	Maybe	Yes			Drawdown maps and cross-sections are presented of Approved and Proposed at end of mining (2039): alluvium, water table, Whybrow, Woodlands Hill. Perennial sink, 40m freeboard.
8.0	SENSITIVITY ANALYSIS								Appendix III
8.1	Is the sensitivity analysis sufficiently intensive for key parameters?		Missing	Deficient	Adequate	Very Good			Investigated for: (1) Sy of spoil and TSF. (2) Spoil Kh, Kv, recharge% (3 variants)
8.2	Are sensitivity results used to qualify the reliability of model calibration?		Missing	Deficient	Adequate	Very Good			Only predictive mode.
8.3	Are sensitivity results used to qualify the accuracy of model prediction?		Missing	Deficient	Adequate	Very Good			For: (1) Open cut inflow predictions only. (2) Alluvial take and baseflow take.
9.0	UNCERTAINTY ANALYSIS								Appendix III
9.1	If required by the project brief, is uncertainty quantified in any way?		Missing	No	Maybe	Yes			Investigation for 200 of 360 model realisations by Monte Carlo analysis [IESC method 3}. Appropriate approach. Display of results could be more informative. Unusual display of results using bar charts compared to baseline. Cannot easily infer IESC-preferred percentiles. Normally present spatial 2m drawdown map for five percentiles, rather than discrete results at 9 points.
	TOTAL SCORE								PERFORMANCE: %

Table 2. Model Confidence Level Classification

CLASS	DATA	CALIBRATION	PREDICTION	INDICATORS
1	Not much. Sparse. No metered usage. Remote climate data.	Not possible. Large error statistic. Inadequate data spread. Targets incompatible with model purpose.	Timeframe >> calibration Long stress periods. Transient prediction but steady-state calibration. Bad verification.	Timeframe > 10x Stresses > 5x Mass balance > 1% (or single 5%) Properties <> field. Bad discretisation. No review.
2	Some. Poor coverage. Some usage info. Baseflow estimates.	Partial performance. Long-term trends wrong. Short time record. Weak seasonal replication. No use of targets compatible with model purpose.	Timeframe > calibration. Long stress periods. New stresses not in calibration. Poor verification.	Timeframe = 3-10x Stresses = 2-5x Mass balance < 1% Some properties <> field measurements. Some key coarse discretisation. Review by hydrogeo.
3	Lots. Good aquifer geometry. Good usage info. Local climate info. K measurements. Hi-res DEM.	Good performance stats. Long-term trends replicated. Seasonal fluctuations OK. Present day data targets. Head and flux targets.	Timeframe ~ calibration. Similar stress periods. Similar stresses to those in calibration. Steady-state prediction consistent with steady-state calibration. Good verification.	Timeframe < 3x Stresses < 2x Mass balance < 0.5% Properties ~ field measurements. Some key coarse discretisation. Review by modeller.



APPENDIX 12

Visual Assessment







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area

FIGURE 1

Visual Montage
Hill Street

umwelt







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area

FIGURE 2

Visual Montage
Hill Street







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

File Name (A3): R03/4100_125.dgn
20190403 16.30

FIGURE 3

Visual Montage
Catherine Vale Vineyard







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area

FIGURE 4

Visual Montage
Catherine Vale Vineyard







Legend

- Active Overburden Emplacement Area
- Inactive Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 5

Visual Montage
Putty Road

File Name (A3): R03/4100_119.dgn
20190403 16.03







Legend

- Active Overburden Emplacement Area
- Inactive Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

File Name (A3): R03/4100_120.dgn
20190403 16.07

FIGURE 6

Visual Montage
Putty Road







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 7

Visual Montage
Bulga Village







Legend

- Active Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 8

Visual Montage
Bulga Village

File Name (A3): R03/4100_122.dgn
20190403 16.13







Legend

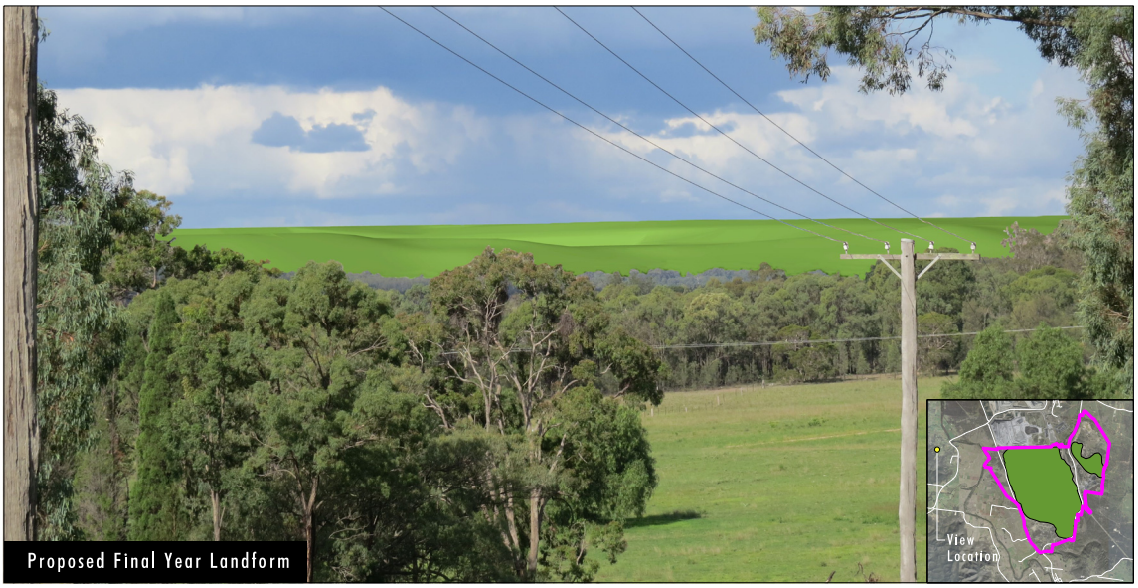
- Active Overburden Emplacement Area
- Rehabilitation Area

FIGURE 9

Visual Montage
Bulga Village
(H&H Upward)







Legend

- Active Overburden Emplacement Area
- Inactive Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 10

Visual Montage Bulga Village (H&H Upward)

File Name (A4): R03/4100_195.dgn
20190529 14.47







Legend

- Active Overburden Emplacement Area
- Inactive Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 11

Visual Montage
Bulga Community Centre

File Name (A3): R03/4100_123.dgn
20190528 14.57





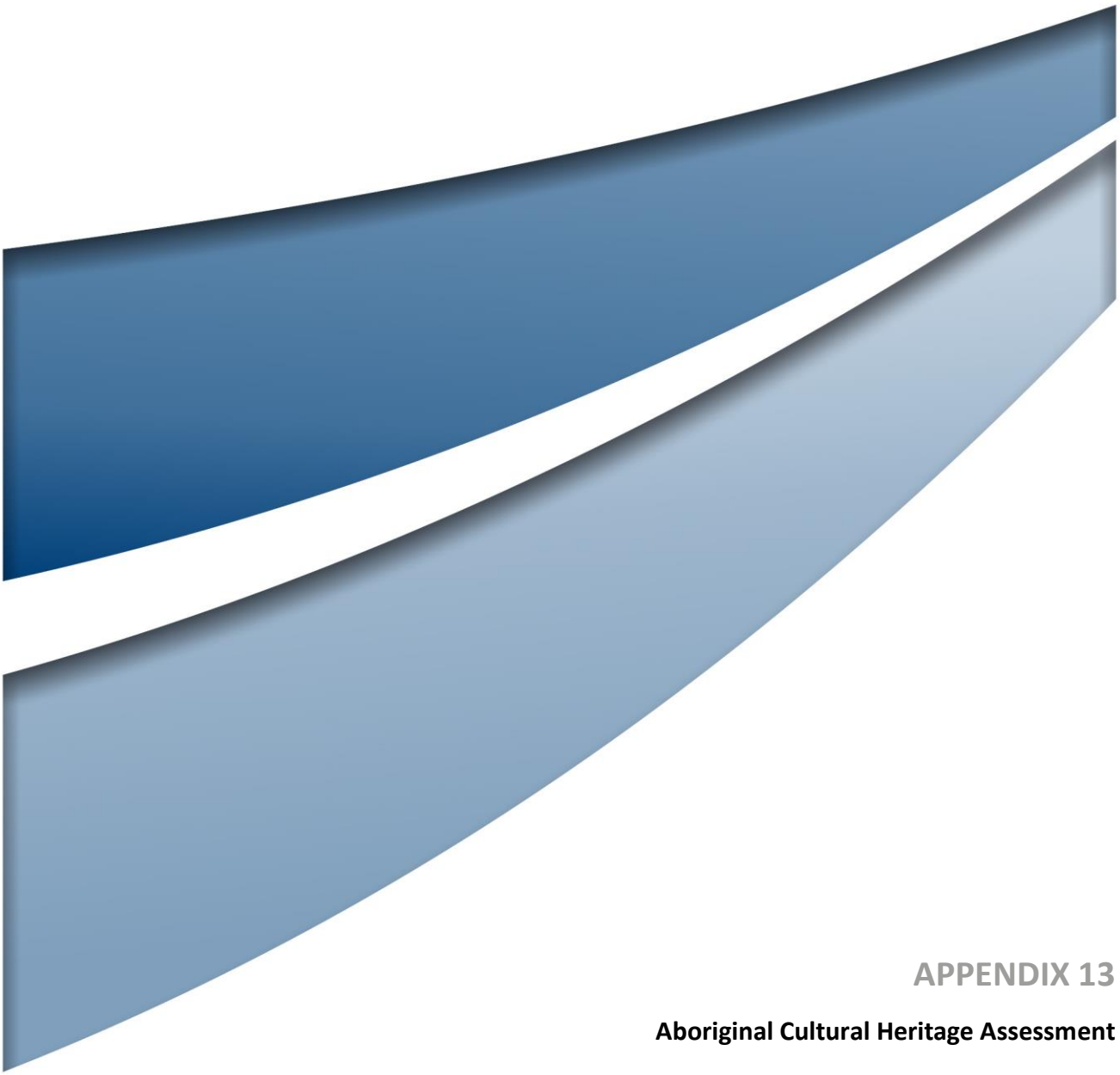


Legend

- Active Overburden Emplacement Area
- Inactive Overburden Emplacement Area
- Rehabilitation Area Temporary
- Rehabilitation Area

FIGURE 12

Visual Montage
Bulga Community Centre



APPENDIX 13

Aboriginal Cultural Heritage Assessment



View of the infrastructure study area showing a bund wall and large dam in the distance.

ABORIGINAL CULTURAL HERITAGE ASSESSMENT REPORT

BULGA OPTIMISATION PROJECT MODIFICATION 3

BULGA COAL COMPLEX

JUNE 2019

Report Prepared by

OzArk Environment & Heritage

for Bulga Coal Management Pty Limited

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ABORIGINAL CULTURAL HERITAGE ASSESSMENT REPORT COVER SHEET

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Enquiries should be addressed to OzArk Environmental & Heritage Management Pty Ltd.

Acknowledgement

OzArk acknowledge Traditional Owners of the area on which this assessment took place and pay respect to their beliefs, cultural heritage and continuing connection with the land. We also acknowledge and pay respect to the post-contact experiences of Aboriginal people with attachment to the area and to the elders, past and present, as the next generation of role models and vessels for memories, traditions, culture and hopes of local Aboriginal people.

EXECUTIVE SUMMARY

OzArk Environment & Heritage (OzArk) has been engaged by Umwelt (Australia) Pty Limited on behalf of Bulga Coal Management Pty Limited (the proponent), to complete an Aboriginal Cultural Heritage Assessment Report for the Bulga Optimisation Project Modification 3 (the Proposed Modification).

The Proposed Modification will be assessed under Division 4.7 of the *Environmental Planning and Assessment Act 1979* as a modification to the Bulga development consent SSD-4960.

This assessment concentrates on those landforms within the Proposed Modification that were not included in the disturbance footprint for the Bulga Optimisation Project (BOP) and which have not been highly modified by approved mining activities. These include the 'additional disturbance area' which includes two non-contiguous areas to the southwest and to the east the Deep Pit Tailings Storage Facility. In addition this report covers the 'infrastructure study area' that includes the route of a power line and the footprint of the proposed relocation of an existing power station under the Bulga Underground Consent. The additional disturbance area is approximately 20.2 hectares (ha) in size and the infrastructure study area is approximately 7.5 ha in size. This equates to a total assessment area of approximately 27.7 ha.

Aboriginal community consultation has followed the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*. In the evaluation of the cultural values of the entire study area, this assessment has also relied on the extensive consultation for the BOP that includes landforms surrounding the study area.

The BOP Aboriginal community consultation concluded, in part, that the BOP Project Area has:

> *…high social, cultural and spiritual significance to Traditional Owners and Knowledge Holders and other RAPs, because it has spiritual and ceremonial associations to extremely high value sacred Creation and ceremonial places located within the region.*
>
> Umwelt 2013: 193

The Aboriginal community consultation for the BOP included identified Knowledge Holder groups presenting their cultural values. As well, the cultural values of the wider Aboriginal community were also sought. This comprehensive assessment, encompassing the study area for the proposed Modification, identified a number of culturally significant places. While none of these are located within the study area for the Proposed Modification, this previous work enables the Proposed Modification to draw on this body of knowledge to ensure that significant cultural places

will not be harmed during the proposed work. A copy of the BOP cultural values assessment can be downloaded from:

- http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=4960 (scroll down to 'Attachments and Resources', then 'Environmental Impact Statement', then 'Appendix 13 (a & b)').

In addition, a search of the Aboriginal Heritage Information Management System (AHIMS) undertaken for the Proposed Modification shows that there is one previously recorded Aboriginal site within the additional disturbance study area likely to be impacted: AHIMS #37-6-3763 (Bulga IF-2), an isolated mudstone flake. The infrastructure study area contains three previously recorded Aboriginal sites: AHIMS #37-6-2844 (BOP OS-10), an artefact scatter; AHIMS #37-6-1659 (BP L5), an artefact scatter; and AHIMS #37-6-1660 (BP L6), an isolated chert core.

The fieldwork component for the Proposed Modification was undertaken by Philippa Sokol (OzArk archaeologist) and Aboriginal community representatives on 4–5 April 2018.

Two previously unrecorded Aboriginal cultural heritage sites were identified during the survey: Bulga IF3 (37-6-3880) and Bulga IF4 (37-6-3881). Both of these sites are isolated finds comprising a mudstone core and a silcrete flake respectively.

However, as is further detailed in **Section 6.9**, Bulga IF3 (37-6-3880) and Bulga IF4 (37-6-3881) were impacted by the construction of an approved laydown area subsequent to their recording. The proponent immediately informed the Office of Environment and Heritage on 6 September 2018 when the incident was identified, however, the result is that these two isolated finds have been unintentionally destroyed by mine related activities. BCM have implemented policies to ensure that such unauthorised impacts do not occur again and these are detailed in **Section 6.9**.

The results of the survey supported the predictive model that postulated that stone artefact sites would be sparse and of low density given the study area's distance from a permanent water source.

Given that only a low number of Aboriginal sites, all with a low artefact density, have been recorded in the study area, and that a high degree of land use and landform modification was noted, there is a low likelihood that intact subsurface archaeological deposits are present within the study area.

It is likely that all four sites known to exist in the study area will be harmed by the Proposed Modification. All sites are not considered to be associated with intact subsurface deposits and all have been assessed as having low archaeological values.

As all sites are surface manifestations only without a subsurface component, the recommended mitigation is to undertake a surface collection of all visible artefacts.

To this end, the following recommendations are made concerning the study area:

1. This assessment has noted that the Proposed Modification is likely to harm four Aboriginal sites (Bulga IF-2, BPL5, BPL6 and BOP OS-10). It is recommended that an appropriate mitigation is to salvage all sites through a collection of surface artefacts.
2. The surface collection of all visible artefacts should be undertaken under the protocol established in Section 6.3.1.1.1 of the Bulga Coal Complex *Aboriginal Cultural Heritage Management Plan* (BCC ACHMP).
3. The BCC ACHMP should be updated in consultation with the Aboriginal community to include the impacts associated with the Proposed Modification.
4. An ACHMP that includes the Proposed Modification and is approved by Department of Planning & Environment must be in place before harm occurs at any site associated with the Proposed Modification.
5. Section 6.3.3 of the BCC ACHMP will be followed should human skeletal material be noted either during the salvage of the sites or during the construction of the Proposed Modification.

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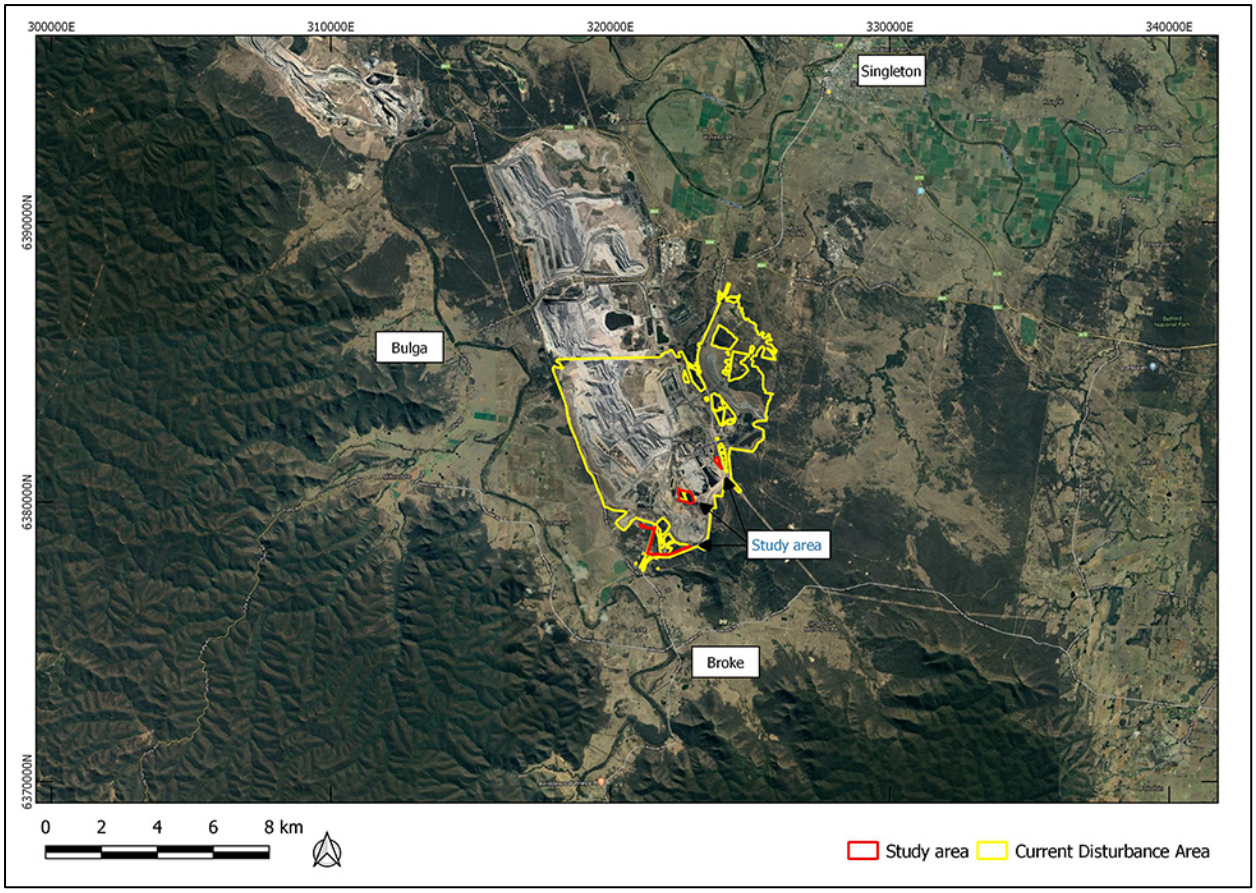
1 INTRODUCTION

1.1 BRIEF DESCRIPTION OF THE PROPOSED MODIFICATION

OzArk Environment & Heritage (OzArk) has been engaged by Umwelt Environment and Social Consultants (Umwelt) on behalf of Bulga Coal Management Pty Limited (BCM; the proponent), to complete an Aboriginal Cultural Heritage Assessment Report (ACHAR) for the Bulga Optimisation Project Modification 3 (the Proposed Modification). The Bulga Coal Complex (BCC) is an open cut and underground coal mine located approximately 12 kilometres (km) southwest of Singleton, 4 km north of Broke and 4 km east of Bulga in the upper Hunter Valley of NSW (**Figure 1-1**).

Figure 1-1: Aerial showing the location of the Proposed Modification.



1.2 BACKGROUND

Mining operations have been occurring at the site for over 35 years with BCM currently operating the BCC on behalf of the Bulga Joint Venture. BCM was granted approval for the Bulga Optimisation Project (BOP) (SSD-4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD-4960 was subsequently modified (SSD-4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy. The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga

Underground Consent). BCM also operates the BCC in accordance with Environment Protection and Biodiversity Conservation (EPBC) Approval 2012/6637 (as modified).

The assessment for the BOP was exhaustive and included a widespread archaeological assessment that took place in 2011–2012 (OzArk 2013), a comprehensive collation of the area's Aboriginal cultural values (Connect for Effect 2013) and a long-running archaeological salvage program that took place in 2015–2016 (OzArk 2017a).

The study of the Aboriginal cultural values for the BOP (Connect for Effect 2013) included the study area for the Proposed Modification. However, the archaeological values assessment for the BOP (OzArk 2013) did not fully include the study area for the Proposed Modification as this was not part of the original disturbance footprint for the BOP and was therefore not subjected to archaeological survey and assessment.

In 2017 OzArk was engaged to undertake a constraints and opportunities assessment of the study area (OzArk 2017b). This assessment included the western portion of the additional disturbance area and portions of the infrastructure disturbance area, including an alternative powerline alignment that was being considered at the time. This informal assessment informed the survey methodology for this assessment.

1.3 PROPOSED WORK

BCM is proposing a modification to SSD 4960 to maximise resource recovery within the approved BOP Area by a relatively small extension of the open cut operations to the southeast into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit.

The extension of the pit to the southeast also enables extraction of additional deeper resources below parts of the currently approved Bulga open cut operation. The Proposed Modification will maintain the current approved open cut coal extraction rate of up to 12.2 million tonnes per annum (Mtpa) run of mine (ROM) while enabling the extraction of an additional approximately 63 Mt of coal.

The Proposed Modification will extend the life of the existing operation by four years until 2039. Bulga Surface Operations will continue to utilise the existing mine facilities, including the Coal Handling and Preparation Plant (CHPP) and train loading facilities for the life of the operations. The Proposed Modification maximises the use of previously disturbed and previously mined areas and the currently approved disturbance areas, thereby minimising the additional disturbance area. The optimisation of productivity from the existing infrastructure will assist to minimise impacts.

The Proposed Modification generally comprises:

- An additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east by accessing deeper resources within the approved pit and proposed extension area;
- Utilisation of existing coal handling and coal processing infrastructure;
- Removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSFs to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings;
- Construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure;
- Construction of new water management facilities to manage site surface water catchments; and
- The use of all existing or approved infrastructure and equipment for the Bulga Coal mine with some minor additions to the existing mobile equipment fleet over the life of the operation.

The Proposed Modification will not preclude the ability to access approved underground mining resources to the south and west of the proposed pit in the future.

It is assumed in this report that all areas within the study area defined in **Section 1.4** will be impacted by activities associated with the Proposed Modification. These activities are associated with the proposed extension of open cut mining and from the installation of electricity infrastructure and the construction of access roads.

1.4 STUDY AREA

This assessment will concentrate on those landforms within the Proposed Modification that have been minimally impacted by approved mining activities and are not approved for disturbance as part of the BOP under SSD-4960. These consist of the 'additional disturbance area' which includes two non-contiguous areas to the southwest and to the east of the Deep Pit TSF. This report also includes the 'infrastructure study area' that includes the route of a power line and the footprint of a power station which were approved under the Bulga Underground Development Consent that are proposed to be relocated. The additional disturbance area is approximately 20.2 hectares (ha) in size and the infrastructure study area is approximately 7.5 ha in size. This equates to a total assessment area of approximately 27.7 ha (**Figure 1-2**).

The additional disturbance study area was not assessed for the BOP. Portions of the infrastructure study area were assessed for the BOP, however, the whole area was reassessed as part of the assessment for the Proposed Modification.

The additional disturbance study area consists of flat landforms supporting regrowth eucalyptus, casuarina and melaleuca species. This portion of the study area has been moderately modified

by the past agricultural land use of the area which has caused the depletion and movement of soils. This area also contains minor disturbances such as tracks, lay down areas and drill pads approved under the Bulga Underground consent.

The infrastructure study area has been modified in places by approved mining activities associated with the Bulga Underground consent. Of the 7.5 ha in this portion of the study area, approximately 3.8 ha has been heavily modified by overburden emplacements, dam construction, bund construction, and disturbances related to the former alignment of the Broke Road corridor (**Figure 1-3**).

Figure 1-2: Aerial showing the study area.

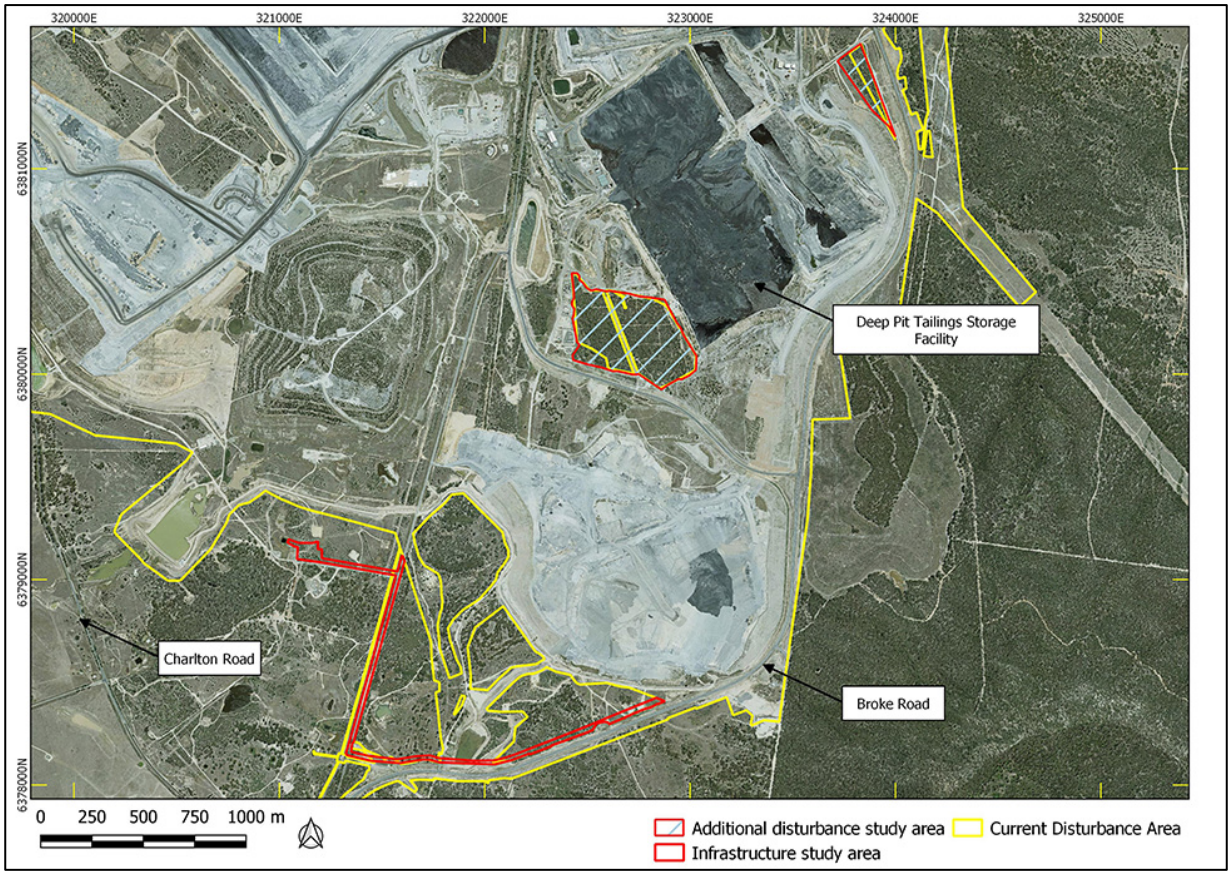
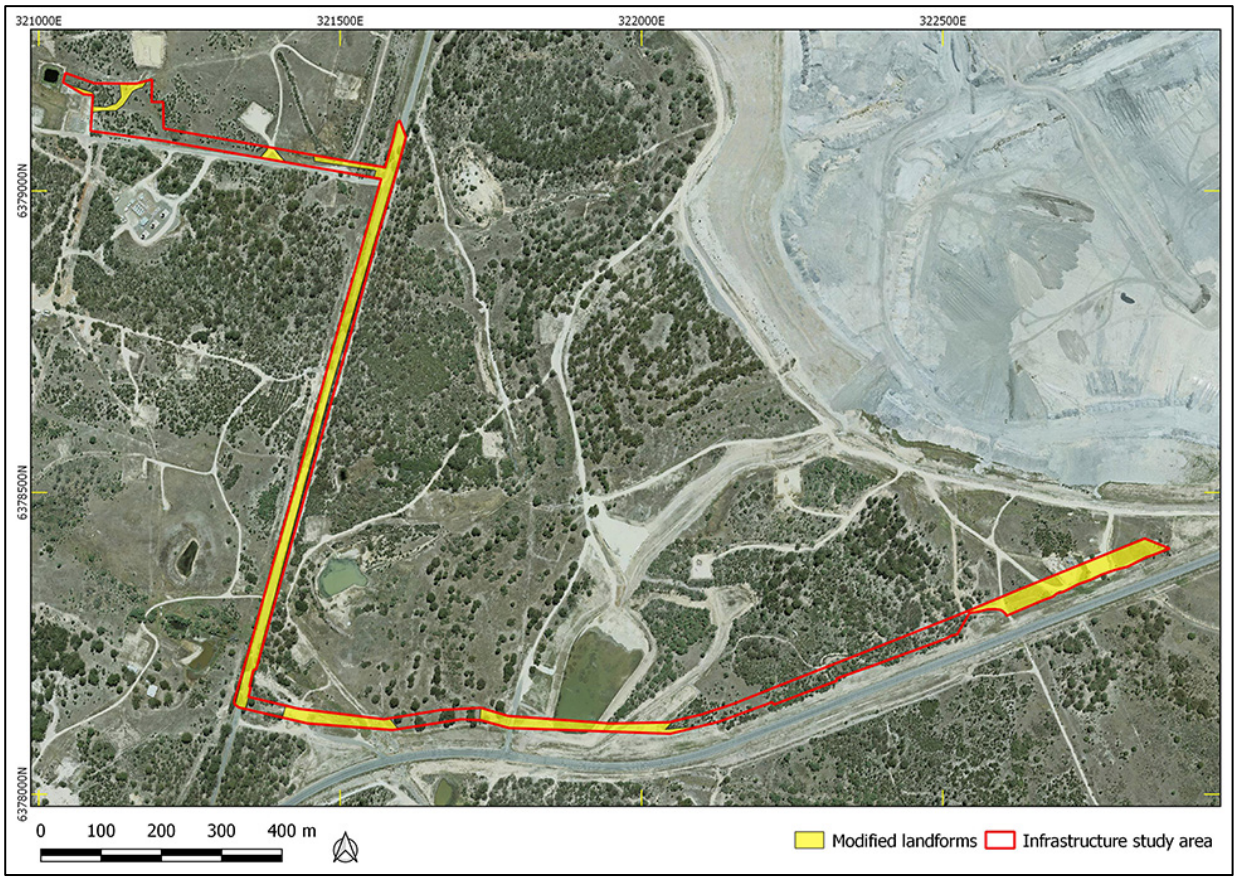


Figure 1-3: Aerial showing the modified landforms within the infrastructure study area.



1.5 RELEVANT LEGISLATION

Cultural heritage is managed by a number of state and national Acts. Baseline principles for the conservation of heritage places and relics can be found in the *Burra Charter* (Australia ICOMOS 2013). The *Burra Charter* has become the standard of best practice in the conservation of heritage places in Australia, and heritage organisations and local government authorities have incorporated the inherent principles and logic into guidelines and other conservation planning documents. The *Burra Charter* generally advocates a cautious approach to changing places of heritage significance. This conservative notion embodies the basic premise behind legislation designed to protect our heritage, which operates primarily at a state level.

A number of Acts of parliament provide for the protection of heritage at various levels of government as discussed further in **Sections 1.5.1** and **1.5.2**.

1.5.1 State legislation

Environmental Planning and Assessment Act 1979 (EP&A Act)

This Act, amended by the *Environmental Planning and Assessment Amendment Act 2017,* establishes requirements relating to land use and planning. The framework governing environmental and heritage assessment in NSW is contained within the following parts of the EP&A Act:

- **Part 4**: Local government development assessments, including heritage. May include schedules of heritage items;
    - **Division 4.7**: Approvals process for state significant development.

Section 4.41 of the EP&A Act stipulates that a state significant development does not require an *Aboriginal Heritage Impact Permit* (AHIP) to harm an Aboriginal object. Any proposed harm to an Aboriginal object is managed through the instrument of an *Aboriginal Cultural Heritage Management Plan* (ACHMP).

National Parks and Wildlife Act 1974 (NPW Act)

Amended during 2010, the NPW Act provides for the protection of Aboriginal objects (sites, objects and cultural material) and Aboriginal places. Under the Act (Part 6), an Aboriginal object is defined as: any deposit, object or material evidence (not being a handicraft for sale) relating to indigenous and non-European habitation of the area that comprises NSW, being habitation both prior to and concurrent with the occupation of that area by persons of European extraction, and includes Aboriginal remains.

An Aboriginal place is defined under the NPW Act as an area which has been declared by the Minister administering the Act as a place of special significance for Aboriginal culture. It may or may not contain physical Aboriginal objects.

Under Section 89A of the Act, it is a requirement to notify the Office of Environment and Heritage (OEH) Director-General of the location of an Aboriginal object. Identified Aboriginal items and sites are registered on Aboriginal Heritage Information Management System (AHIMS).

1.5.2 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Matters of National Environmental Significance listed under the EPBC Act include the National Heritage List and the Commonwealth Heritage List, both administered by the Commonwealth Department of the Environment and Energy. Ministerial approval is required under the EPBC Act for proposals involving significant impacts to National/Commonwealth heritage places.

1.5.3 Applicability to the Proposed Modification

The Proposed Modification will be assessed under Division 4.7 of the EP&A Act as a modification to SSD-4960.

Section 4.41 of the EP&A Act notes that AHIPs are not required to harm Aboriginal objects on a state significant development. Potential harm to Aboriginal objects will be managed under an approved ACHMP.

Any Aboriginal sites within the study area are afforded legislative protection under the NPW Act and the regulations associated with the NPW Act remain valid for a state significant development.

It is noted there are no Commonwealth or National heritage listed places within the study area, and as such, the heritage provisions of the EPBC Act do not apply.

1.6 ASSESSMENT APPROACH

The current assessment follows the *Code of Practice for the Investigation of Aboriginal Objects in New South Wales* (Code of Practice; DECCW 2010a).

Field assessment and reporting followed the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011).

Aboriginal community consultation has followed the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (ACHCRs, DECCW 2010b).

2 THE ARCHAEOLOGICAL ASSESSMENT

2.1 PURPOSE AND OBJECTIVES

The purpose of the current study is to identify and assess heritage constraints relevant to the proposed works within the additional disturbance area and infrastructure area.

2.1.1 Aboriginal archaeological assessment objectives

The current assessment will apply the Code of Practice, in the completion of an Aboriginal archaeological assessment, in order to meet the following objectives:

Objective One: Undertake background research on the study area to formulate a predicative model for site location within the study area;

Objective Two: Identify and record objects or sites of Aboriginal heritage significance within the study area, as well as any landforms likely to contain further archaeological deposits; and

Objective Three: Assess the likely impacts of the proposed work to Aboriginal cultural heritage and provide management recommendations.

2.2 DATE OF ARCHAEOLOGICAL ASSESSMENT

The fieldwork component of this assessment was undertaken by Philippa Sokol (OzArk archaeologist. BA Archaeology and Diploma in Science) and Aboriginal community representatives on 4–5 April 2018.

2.3 REPORT AUTHORSHIP

The reporting component of this ACHAR was undertaken by:

- Report Author: Ben Churcher (OzArk Principal Archaeologist. BA[Hons], Dip Ed);
- Contributor: Philippa Sokol.

3 ABORIGINAL COMMUNITY CONSULTATION

3.1 PREVIOUS ABORIGINAL COMMUNITY CONSULTATION

Consultation for the BOP was extensive and included identified Knowledge Holder groups preparing their own cultural values assessments. As the BOP Project Area encompasses the Proposed Modification's study area, the BOP Aboriginal community consultation, and the information gained, is applicable to the current study. A copy of the BOP cultural values assessment can be downloaded from:

- http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=4960 (scroll down to 'Attachments and Resources', then 'Environmental Impact Statement', then 'Appendix 13 (a & b)').

The BOP consultation recorded a number of cultural values associated with the immediate area surrounding the study area (Connect for Effect 2013: 147–149):

- Some Registered Aboriginal Parties (RAPs) stated that they believe the Broke and Bulga area is sacred as it is surrounded by features linked to spiritual Creation stories. The relationship of the BOP Project Area to Creation places and areas located outside of the BOP Project Area where ceremony and corroborees historically took place: and as such identified the project area as part of, and integral to, a larger cultural landscape that retains immeasurable values;

- The interaction between connections to Country and cultural identity is highly important especially as the traces of the past and their memories contributed to maintaining distinctive Wonnarua and other Aboriginal people's culture, spirituality and cultural interaction with the landscape;

- The pathways and water systems to and from Creation places and places of ceremony are of high cultural value. While the major waterways outside of the BOP Project Area were identified as having very high cultural significance; all waterways, creek lines and tributaries were identified as culturally important as they were believed to be part of the essential spiritual meaning of the place and the people. Nine Mile and Loders Creeks (within the BOP Project Area) and Wollombi Brook, Monkey Place Creek (outside of the BOP Project Area) and more broadly the Hunter and Goulburn Rivers are important parts of the pathways to and from ceremony and to and from sacred Creation places outside of the BOP Project Area and as such have immeasurable cultural values;

- Ethnobotanical knowledge identified indigenous flora and fauna as important cultural resources, and sought to ensure they would be regrown within the BOP Project Area as part of the rehabilitation;

- The BOP Project Area was a place of camping, and place where traditionally small groups would await participation for ceremony by ancestors. Camping areas within the BOP Project Area along the northern drainage line, Loders Creek and Nine Mile Creek were identified as significant in terms of their relationship to places of cultural and ceremonial importance external to the BOP Project Area; and

- Most RAPs expressed high levels of emotion regarding landscape transformation and fragmented cultural and archaeological sites.

Umwelt 2013: 193 summarises the cultural values of the BOP project area in which the current study area is located:

> *RAPs identified the* (BOP) *Project Area to be of high social, cultural and spiritual significance to Traditional Owners*[1] *and Knowledge Holders and other RAPs, because it has spiritual and ceremonial associations to extremely high value sacred Creation and ceremonial places located within the region.*
>
> *The* (BOP) *Project Area contains a number of specific archaeological sites of high cultural significance to RAPs including Traditional Owners and Knowledge Holders. The* (BOP) *Project Area was also identified as an area of continuing traditional and historic association for local Aboriginal families, which has been described as significant, although it is noted that the* (BOP) *Project Area has been subject to mining activity for the past 30 years.*

Key cultural values identified in the cultural values assessment included the Loders Creek grinding grooves and the significance of items in the cultural landscape located outside of the BOP Project Area such as Baiame Cave and Lizard Rock.

None of these locations are within the study area for the Proposed Modification.

3.2 ABORIGINAL COMMUNITY CONSULTATION FOR THE PROPOSED MODIFICATION

Aboriginal community consultation has followed the ACHCRs. A consultation log encompassing Stages 1 to 3 of the ACHCRs is contained in **Appendix 1**.

3.2.1 Stage 1

On 10 November 2017 Ben Churcher (OzArk) wrote to Nicole Davis (Archaeologist - Planning Hunter Central Coast Branch, OEH) asking whether it would be possible to use the BOP RAP list for the Proposed Modification. Nicole replied on 22 November 2017, stating:

> *I have discussed your email and query with Steven Cox, Senior Team Leader - Planning, Hunter Central Coast Branch. We both agree that the approach outlined below is reasonable and appropriate given there has been continuous and regular contact with the RAP's. We would recommend that you cross check with our most recent list for the Singleton LGA, which you indicate your intention to do so below. The Singleton OEH RAP list is attached.*

[1] The use of the terms 'traditional owner' and 'knowledge holder' were used generically in the 2013 EIS and was not based on documented research to identify the individuals these terms may apply to.

OEH's record of this decision is referenced as OEH DOC17/572612-2.

OzArk Consultation Officer, Sheridan Baker, crosschecked the BOP RAP list with the OEH Singleton LGA list and contacted all individuals/groups who appeared on the OEH list but not the BOP RAP list to see if they were interested in being consulted regarding the Proposed Modification. As a result, four additional groups were added to the Proposed Modification RAP list: JT Management; Didge Ngunawal Clan; Murra Bidgee Mullangari Aboriginal Corporation; and DFTV Enterprises.

In the process of sending information out to individuals/groups on the BOP RAP list, five individuals/groups could no longer be contacted: Cheryl Moodie Consulting; Galamaay Consultant; Roger Noel Matthews; Bunda Consultants; and Hunter Valley Natural and Cultural Resources Management.

As a result of the updating of the BOP RAP list and its amalgamation with the OEH Singleton RAP list, there are 56 individuals/groups who are regarded as RAPs for the Proposed Modification. These RAPs are listed in **Table 3-1**. **Appendix 2** presents the letter sent by OzArk to OEH to confirm the RAPs for the Proposed Modification.

Table 3-1: RAPS for the Proposed Modification.

ID	RAP name	ID	RAP name
1	Aboriginal Native Title Consultants	29	Lower Hunter Wonnarua Council Inc
2	AGA Services	30	Mingga Consultants
3	Aliera French Trading	31	Murra Bidgee Mullangari Aboriginal Corporation
4	Bawurra Consultants;	32	Muswellbrook Cultural Consultants
5	Breeza Plains Culture & Heritage Consultants	33	Myland Cultural & Heritage Group
6	Cacatua Culture Consultants	34	Ngarramang- Kuri Aboriginal Cultural & Heritage Group
7	Carrawonga Consultants	35	Smith Dhagaans Cultural Group
8	Crimson-Rosie	36	T & G Culture Consultants
9	Culturally Aware	37	T&G Cultural Consultants
10	Deslee Talbott Consultant	38	Tocomwall Pty Ltd
11	DFTV Enterprises	39	Ungooroo Aboriginal Corporation;
12	Didge Ngunawal Clan	40	Ungooroo Cultural & Community Services Inc
13	Divine Diggers Aboriginal Cultural Consultants;	41	Upper Hunter Wonnarua Council Inc; Junburra Aboriginal Consultancy Services
14	DRM Cultural Management	42	Upper Hunter Wonnarua Council; Wonnarua Elders Council
15	Gidawaa Walang Cultural Heritage Consultancy	43	Waabi Gabinya Cultural Consultancy
16	Giwiirr Consultants	44	Wallangan Cultural Services
17	Gomery Cultural Consultants	45	Wanaruah Local Aboriginal Land Council
18	Huckada Dreamin Heritage Group	46	Warragil Cultural Services
19	Hunter Traditional Owners	47	Warren Taggart
20	Hunter Valley Aboriginal Corporation	48	Wattaka Wonnarua Cultural Consultants Services
21	Hunter Valley Cultural Surveying	49	Widescope Indigenous Group P/L
22	Jarban and Mugrebea	50	Wonn 1 Contracting

ID	RAP name	ID	RAP name
23	JLC Cultural Services	51	Wonnarua Cultural Heritage;
24	JT Management	52	Wonnarua Culture & Heritage
25	Ka-u-ma Pondee Inc.	53	Wonnarua Nation Aboriginal Corporation
26	Kayaway Eco Cultural and Heritage Services	54	Wunda Cultural Consultants
27	Kevin and Laurell Taggart	55	Wurrumay Consultants
28	Lower Hunter Aboriginal Incorporated	56	Yinarr Culture Services

3.2.2 Stage 2

3.2.2.1 RAP information

At the annual BCC Annual Stakeholder meeting held on 16 November 2017, the Bulga Coal Environment and Community Manager (Ralph Northey), spoke to the Aboriginal community about the Proposed Modification. The major points set out in this introduction are listed below:

- Introduction of the Proposed Modification;
- Introduction to the archaeological process including the forthcoming survey methodology that would be issued to all RAPs. This methodology will note:
    - Areas outside of highly modified landforms that require archaeological assessment are relatively small;
    - There are no creek systems or other archaeologically sensitive landforms within the assessment area;
    - A Constraints and Opportunities assessment was undertaken by Ben Churcher, OzArk Principal Archaeologist, on 23 August 2017;
    - No further Aboriginal sites were recorded during this assessment and no landforms within the study area were assessed as having potential to contain further subsurface archaeological deposits;
    - Two sites within the likely disturbance area were visited: Bulga IF-2 (37-6-3763) an isolated mudstone flake; and BOP OS-10 (37-6-2844) is a low density artefact scatter that was partially salvaged in 2015 as part of the BOP salvage program. Artefacts were noted at both locations. As such, they remain valid sites and constitute a known constraint to the Proposed Modification;
    - Two further sites are also within the disturbance area but were not visited during the Constraints and Opportunities assessment: BP L5 (37-6-1659) an artefact scatter consisting of a pink chert flake and a pink chert core; and BP L6 (37-6-1660) an isolated chert core; and
    - An area of cultural sensitivity surrounding sites SBU3 (37-6-0902) and SBU9 (37-6-0908) (Harmony Hill) is located close to, but outside of, the Proposed Modification disturbance area. This area will be avoided by the Proposed Modification.
- BCM informed the RAPs at the Annual Stakeholder meeting that full survey with the assistance of Wonnarua Knowledge Holders/RAPs would be undertaken in the near

future to fully understand the archaeological context of the Proposed Modification disturbance area.

A community newsletter detailing the Proposed Modification is included in **Appendix 3**.

3.2.2.2 Wonnarua Knowledge Holder information

Information was sent to the two Knowledge Holder groups (the Plains Clans of the Wonnarua People [PCWP] and the Wonnarua Nation Aboriginal Corporation [WNAC]) on 13 December 2017 setting out the Proposed Modification and inviting them to a meeting should they require one. A sample letter is presented in **Appendix 3**.

PCWP

The Approvals Manager contacted Scott Franks (Tocomwall), as Native Title Claimant for the PCWP, to request whether a meeting was required. After a follow up emails on 2, 10 and 19 January 2018, Scott replied by email on 22 January 2018 stating that he felt sufficient survey had already been undertaken and that further field work would not add to the information already known about the heritage of the area.

WNAC

The Approvals Manager met with Laurie Petty (WNAC) on 8 January 2018. Laurie noted that he would have to consult the WNAC board as to the process going forward and to account for the cultural values of the additional disturbance area not covered as part of BOP. The next board meeting was not until end of February 2018 and the project team asked Laurie to keep them informed.

The Approvals Manager met with Laurie a second time on 21 February 2018 at the WNAC offices in order to gain the views of the WNAC regarding the cultural values of the additional disturbance area.

On 5 March 2018 the Approvals Manager received an email from Laurie stating that the WNAC felt the previous assessment and values statement for the BOP was sufficient and that there was little to add in terms of the Proposed Modification.

3.2.3 Stage 3

3.2.3.1 Survey Methodology

A draft survey methodology was sent to all Registered Aboriginal Parties (RAPs) for the Proposed Modification on 26 February 2018 (**Appendix 6**). As set out in the ACHARs, RAPs were provided with 28 days in which to review the draft and offer any comment on the proposed survey methodology. The closing date for comment was Wednesday 28 March 2018. At the conclusion of the review period, a number of responses had been received (**Table 3-2**), however, only the response from Scott Franks (Tocomwall) necessitated an addition to the survey methodology.

Table 3-2: RAP responses to the draft survey methodology (Stage 3).

Date	RAP	Comment
26.2.18	Tocomwall Pty Ltd	Sheridan Baker (SB) received an email from Scott Franks: *I have read the attached draft and need clarification on statements made with in the document.* *Section 3 makes the statement: Traditional Owners and Knowledge Holders. Could you please explain how this was confirmed and provide the anthropological researched that was u*sed to come to this conclusion please.
27.2.18	Wonnarua Nation Aboriginal Corporation	SB received email from Laurie stating*: Thank You WNAC will reply before the 28 day period.....and supply one worker*
27.2.18	Tocomwall Pty Ltd	Ben Churcher (BC) sent response to Scott Franks (Tocomwall) that the following footnote would be added: *The use of the terms 'traditional owner' and 'knowledge holder' were used generically in the 2013 EIS and was not based on documented research to identify the individuals these terms may apply to*. Footnote 1 was added to Section 3.3.2 of the survey methodology to address this comment (**Appendix 6**).
7.3.18	Divine Diggers Aboriginal Cultural Consultants;	SB received email from Deidre: Hi ....all seems good to me. Thanks Deidre
19.3.18	Hunter Traditional Owners	SB received email from Paulette: PAULETTE RYAN here I would like to put in a expression of interest in the upcoming of work Kind Regards Paulette Ryan HTO
26.3.18	Didge Ngunawal Clan	SB received an email from Paul and Lilly stating: Didge Ngunawal Clan agrees to all proposals of survey of methodology.
29.3.18	Wanaruah Local Aboriginal Land Council	SB received a response from the Wanaruah Local Aboriginal Land Council after the close of the review period. This is presented in **Appendix 6**.
13.4.18	Gidawaa Walang Cultural Heritage Consultancy via Barkuma Neighbourhood Centre Inc.	Greg Newton (GN) received the following email: I am writing to respond to the letter received by Gidawaa Walang Cultural Heritage Consultancy dated 22nd March 2018. I need to advise you that Ann Hickey no longer works for Barkuma. In regards to the above letter, our CEO Deb Dacey has said that her last conversation with Ann about this, was that Ann said she wasn't commenting on the methodology because she was not a part of it.

3.2.3.2 Survey

As part of Stage 3, a letter was sent to all RAPs on 22 March 2018 alerting them to the fact that the survey had been scheduled but noting that places were limited and that not all RAPs could attend the survey (**Appendix 4**). As a result, the Approvals Manager extended an invitation to any RAP who wished to view the study area to contact the BCC and arrange a suitable time. No RAPs availed themselves of this opportunity.

The Approvals Manager also wrote to the three umbrella service providers (Tocomwall, WNAC and the Hunter Valley Aboriginal Corporation [HVAC]) on 19 March 2018, requesting the provision of field staff for the upcoming survey (**Appendix 4**).

Georgina Berry (representing the WNAC) and Clifford Johnson (HVAC) were present for the survey on 4 April 2018. Only Clifford was available to complete the survey on 5 April 2018 as Georgina was ill.

3.2.4 Stage 4

All 56 RAPs (see **Table 3-1**) for the Proposed Modification were sent a draft of this ACHAR on the 21 December 2018, with the closing date for feedback being 31 January 2019. Extra time was allowed for the RAP review of the report to cover the Christmas break period.

At the close of the review period four responses to the draft ACHAR were received. These responses are set out in **Table 3-3**. As a consequence of these responses, no changes were required to be made to the ACHAR. However, a statement to reflect the views of the Wanaruah Local Aboriginal Land Council (WLALC) has been included in **Sections 6.8.2** and **6.11**.

Table 3-3: RAP responses to the draft ACHAR (Stage 4).

RAP	Date received	Response
Amanda Hickey (AHCS)	1/1/19	AHCS is happy with the ACHCR for stage 4. AHCS holds cultural knowledge to determining indigenous artefacts and cultural knowledge towards the land AHCS would like to be a part of the survey fieldworks
Norman Archibald	18/1/19	the significant of the whole area is such as it is not only one area that that is affected but the whole song line that is being destroy by the little bit that are taken away by development not to say that we can stop development but the impact on the whole cycle is that once destroyed then nothing...
Ryan Johnson (Murra Bidgee Mullangari)	23/12/18	I have read the ACHA Bulga optimisation project modification3 project and endorse the recommendations made by Ozark, please feel free to contact me if you require further details.
Noel Downs (Wanaruah Local Aboriginal Land Council [WLALC])	25/1/19	The WLALC response to the draft ACHAR is reproduced in **Appendix 5**. The WLALC response to the survey methodology is included in **Appendix 6**. • OzArk replied to the WLALC on 29/1/19 stating: Hi Noel, Ben (Churcher: principal report author) is currently abroad but will get in touch when he is back to discuss the issues you have raised. I note that OzArk at all times takes a professional and ethical approach to our work and we feel that the ACHAR fully complies with legislative requirements. While OzArk is disappointed that the WLALC sees things differently, we do note that the WLALC comments on the methodology are included in the ACHAR for consideration by OEH. While OzArk understands the views of the WLALC, it would seem that they are not project specific in this case, as a relatively small area of land, completely surrounded by existing mining, is the sole focus of this particular project. However, Ben will be happy to discuss this further when he's back in a few weeks. Regards Jodie (Benton. OzArk Director). • The WLALC replied to OzArk on 29/1/19: Dear Jodie, Your response is exactly our point. You cannot gauge cultural values on a small area of land. “a relatively small area of land, completely surrounded by existing mining, is the sole focus of this particular project“. Are you saying OZARK do not understand that concept? I do not believe that. That “relatively small area” is part of a landscape that has suffered cumulative impacts of the surrounding mining. To suggest there is ”no impact “or “minimal impact” is wrong. The more areas impacted in the landscape the more value the remaining areas hold… (that is really basic stuff) Which begs the question “WHY and How” did OZARK come to that conclusion? You folk have been to university, studied the same authors as we have on Cultural Landscapes. Worked with Aboriginal people in this area for long enough to know how cultural values work. Yet still you write this one tiny area IS NOT part of a cultural landscape already heavily impacted by mining. Therefore seemingly has no value. Whereas the reality is the more impact around it the more value it has. OZARK have been around long enough to KNOW this.

RAP	Date received	Response
		To act otherwise leaves us to question why. It was clearly a purposeful action by OZARK, as demonstrated by the defence of the action by OZARK. You think you are disappointed… Imagine how we feel. Your truly Noel Downs CEO

4 LANDSCAPE CONTEXT

An understanding of the environmental contexts of a study area is requisite in any Aboriginal archaeological investigation (DECCW 2010a). It is a particularly important consideration in the development and implementation of survey strategies for the detection of archaeological sites. In addition, natural geomorphic processes of erosion and/or deposition, as well as humanly activated landscape processes, influence the degree to which these material culture remains are retained in the landscape as archaeological sites; and the degree to which they are preserved, revealed and/or conserved in present environmental settings.

4.1 TOPOGRAPHY

The study area is situated within the Sydney Basin Bioregion, which lies on the central east coast of NSW and extends as far west as Mudgee.

The study area is also situated within the Central Hunter Foothills landscape (Mitchell 2002) (**Figure 4-2**). The topography of this landscape is described as being undulating lowlands, rounded to steep hills with rock outcrop on ridges (Mitchell 2002: 112). Specific to the study area, it is predominantly located on flat to gently sloping landforms, distant to permanent or semi-permanent water (**Figure 4-1**).

Figure 4-1: Topography of the study area.



1. View of the flat landform within the western portion of the additional disturbance study area.

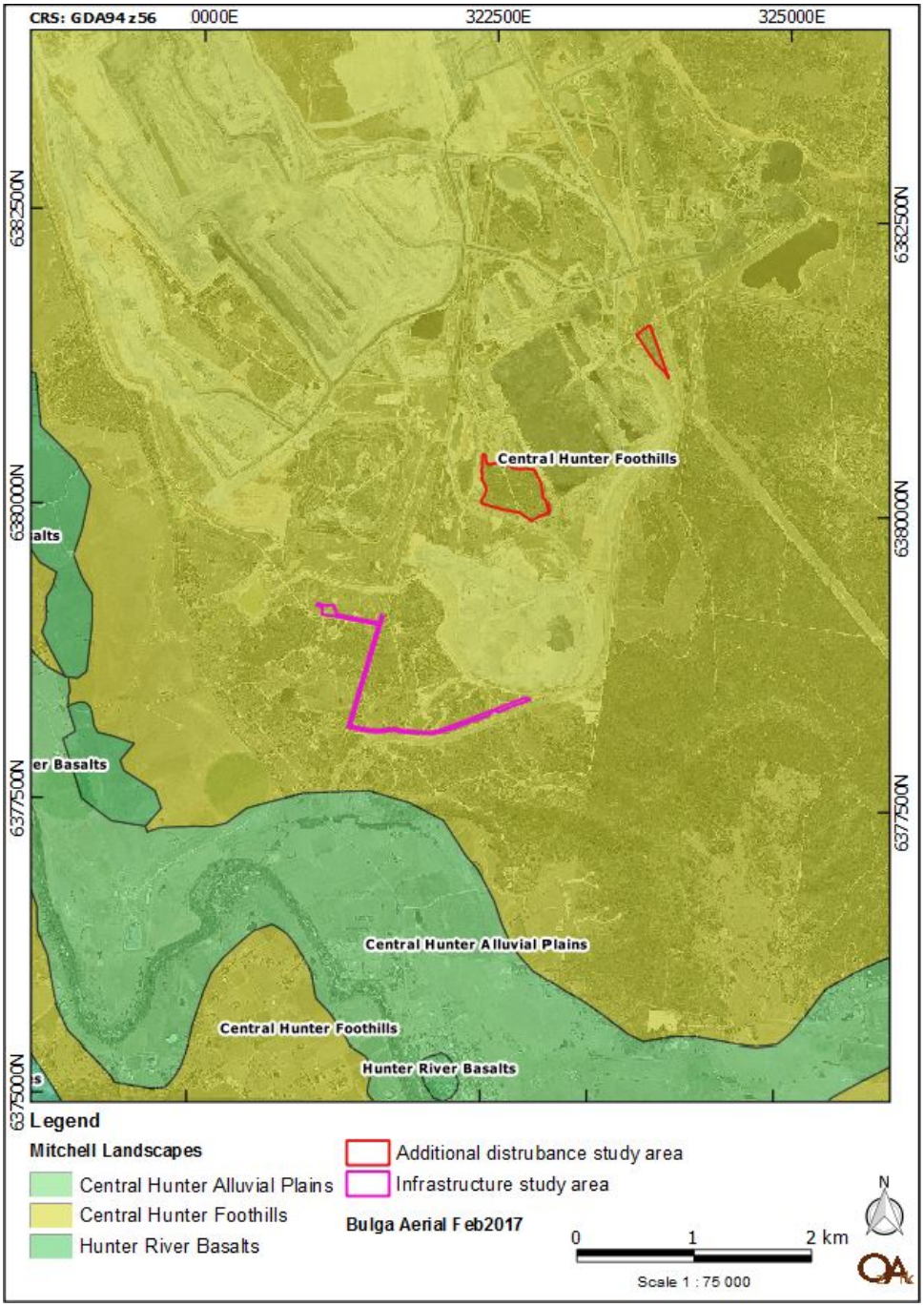


2. View of the flat landform in the west of the infrastructure study area.

4.2 GEOLOGY AND SOILS

The underlying geology of the study area and associated environmental landscape comprises Permian lithic sandstone, conglomerate, shale and coal. Soils of the Central Hunter Foothills consist of red-brown to yellow brown harsh texture-contrast soils on slopes, with dark coloured clays in valleys and limited accumulations of sand and gravel in streams (Mitchell 2002: 112).

Figure 4-2: The study area in relation to the Mitchell (2002) landscapes.



4.3 HYDROLOGY

The closest major water source to the study area is the Wollombi Brook located approximately 3 km to the west of the study area. Monkey Place Creek, a tributary to Wollombi Brook, is located approximately 780 metres (m) south of the study area (**Figure 4-3**).

Nine Mile Creek is located approximately 150 m east of the eastern portion of the additional disturbance study area. The study area is now separated from the creek by the realigned Broke Road, however, this does place this portion of the study area within 200 m of semi-permanent water; a landform often recognised as having a heightened archaeological sensitivity.

Prior to recent disturbances in the area, minor tributaries to the Wollombi Brook once intersected with the infrastructure study area (**Figure 4-4**). However, these drainage lines in proximity to the study area are no longer apparent as they have been channelled beneath the former Broke Road alignment or have been modified by other approved mining activities.

Thus, apart from very small areas within the eastern portion of the additional disturbance study area, most unmodified landforms within the study area are distant to water. No portion of the study area is associated with perennial water sources and there are no hydrological features, such as terracing, within the study area.

Figure 4-3: Map showing the waterways surrounding the study area.

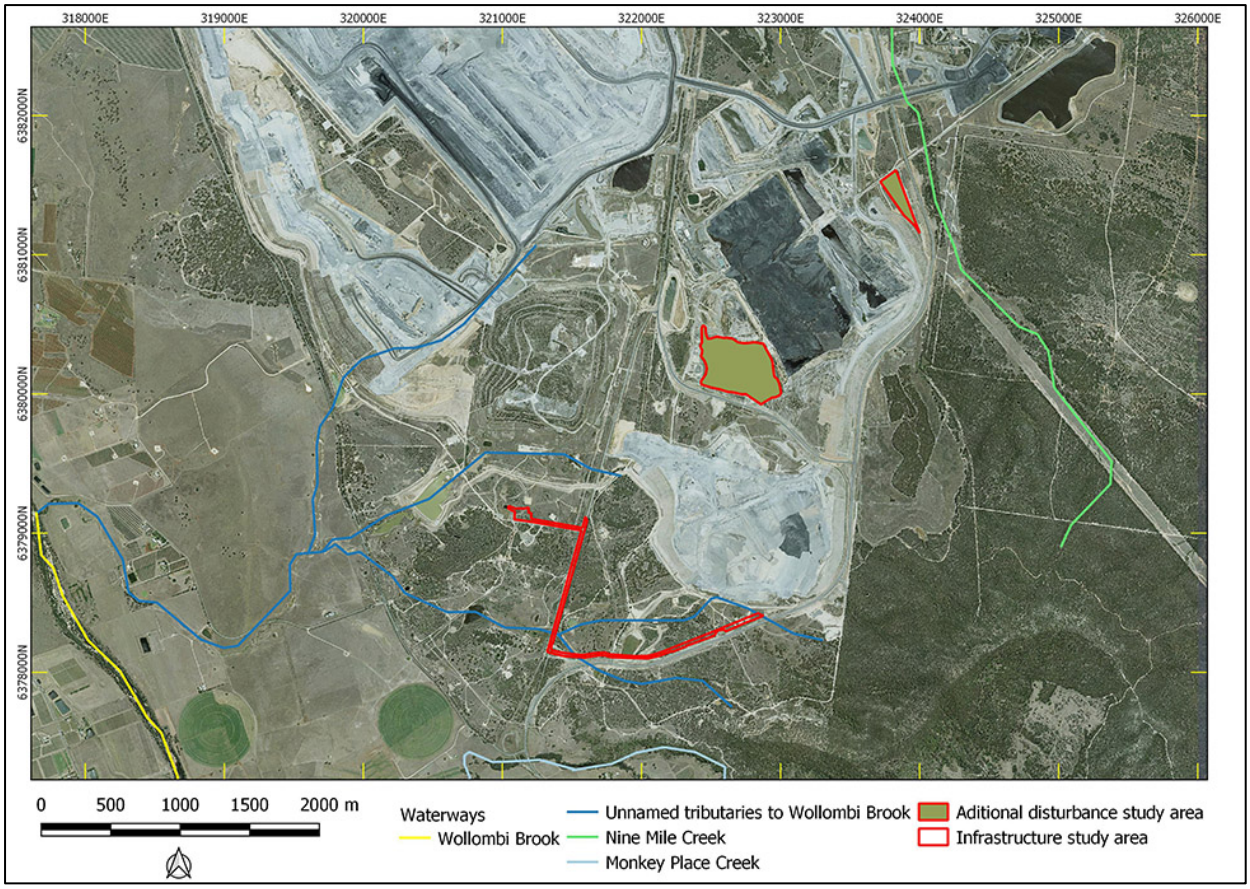
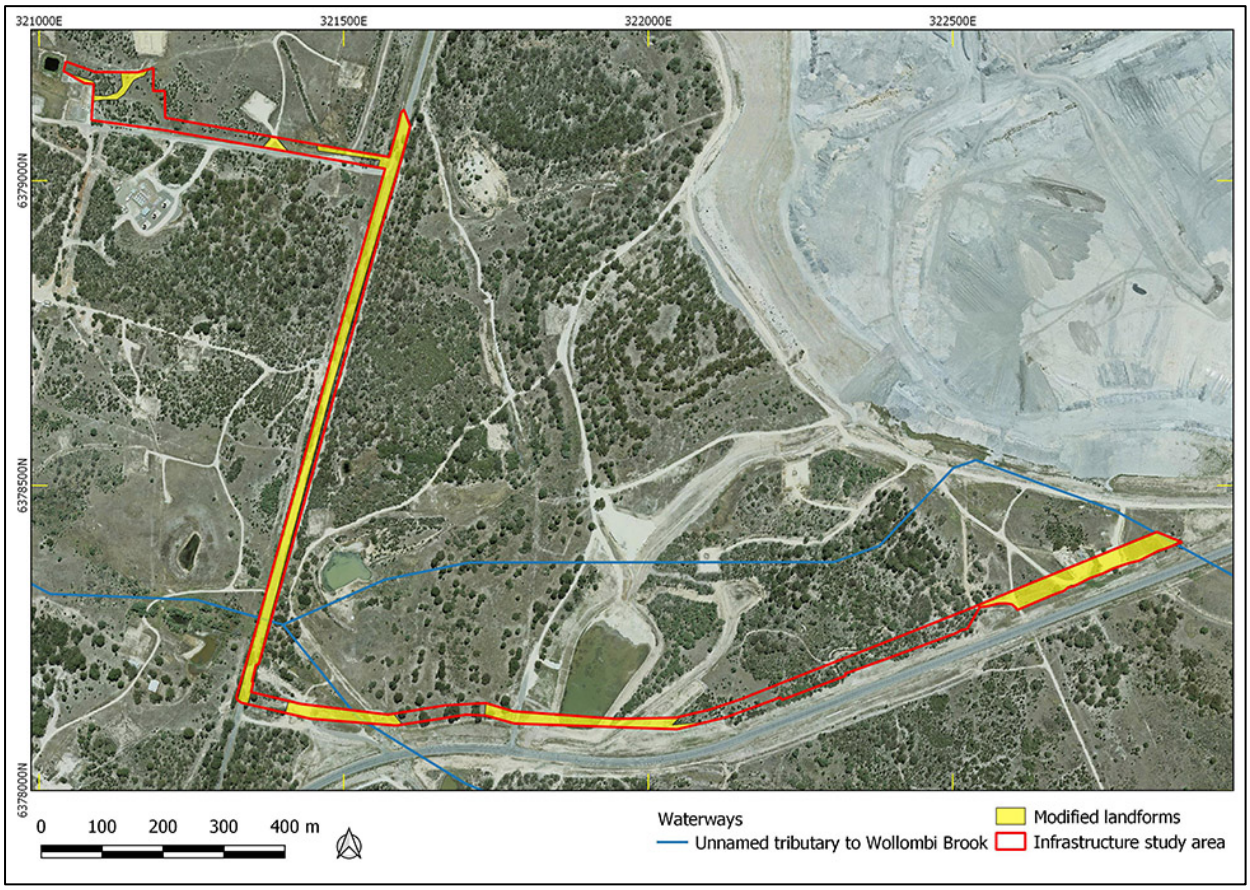


Figure 4-4: Map showing the waterways in relation to modified landforms.



4.4 VEGETATION

In the past, Aboriginal people would have encountered a variety of vegetation communities in the region of the study area. However, extensive areas of native vegetation have been cleared since European settlement.

At the time of European settlement, the Central Hunter Foothills landscape consisted of woodlands to open forest of spotted gum, forest red gum, narrow-leaved ironbark, red ironbark, white box, slaty gum, rough-barked apple, with kangaroo and wallaby grass (Mitchell 2002: 112).

The vegetation of the study area has been heavily modified from its natural state. In the western portion of the additional disturbance study area, vegetation consists of paper bark (Melaleuca), Casuarina and iron bark species. Generally, the soils in the area appear sandy and nutrient poor, and as the majority of the trees are regrowth, indicating that the entire area was once cleared. The implication is that certain Aboriginal site types, specifically culturally modified trees, will be extremely unlikely to occur in the area due to the intensive land clearance in the past.

In the eastern portion of the additional disturbance study area the existing vegetation consists of regrowth Eucalyptus woodland. Being associated with Nine Mile Creek, this portion of the additional disturbance study area would have been cleared early in the history of European farming in the area and has likely suffered widespread soil loss.

The infrastructure study area remains largely cleared and consist of paddock grasses and scattered stands of regrowth trees (primarily Casuarina and iron bark). Scattered mature trees were noted along the road verge of the former Broke Road. However, none appear mature enough to contain cultural modification.

4.5 CLIMATE

The nearest Bureau of Meteorology (BOM) record station to the study area is located at Cessnock Airport (BOM, 2018). Climate statistic from Cessnock Airport indicate that the region experiences a mostly temperate climate will temperatures above zero during the cooler months. The climate statistics show that the highest mean monthly temperatures are in January (30.3°) and the lowest mean monthly temperatures are in July (4.1°). Rainfall is greatest in February (mean rainfall: 98.1 millimetres [mm]) and the lowest in July (mean rainfall: 28.1 mm). The annual average rainfall is 739.3 mm.

4.6 LAND–USE HISTORY AND EXISTING LEVELS OF DISTURBANCE

The study area has generally been impacted to a high degree during the agricultural phase of the area's history. This includes the previously noted vegetation clearance that has led to widespread soil loss as evidenced by the generally nutrient-poor, thin topsoil across the study area.

Additionally, the area has been subject to intensive approved mining activities over recent years with roads, tracks, drainage bunds and fences being constructed. The result is that very little of the study area can be regarded as unmodified and most portions display disturbances either from agricultural land uses or approved mining associated activities.

4.7 CONCLUSION

In general, the study area's climate and topography would have allowed year-round occupation and access by Aboriginal people.

However, a review of the environment of the study area and surrounding landforms presents a landscape that has been extensively disturbed and modified; both as a result of agricultural practices and approved mining associated activities. As such, the study area presents a landscape unlikely to retain any form of structural integrity.

As the study area is located away from permanent water sources in undifferentiated landforms, the likelihood of the study area containing large, complex sites is dramatically lowered. In the region, landform units away from water, such as ridgelines, can contain sites, however, these are absent from the study area.

While smaller, more transient sites may have once existed in the study area, it is likely, due to the widespread disturbances from both agriculture and infrastructure construction, that these sites have either been previously destroyed or dispersed.

5 ABORIGINAL ARCHAEOLOGY BACKGROUND

5.1 ETHNO-HISTORIC SOURCES OF REGIONAL ABORIGINAL CULTURE

The study area is located in the Wonnarua tribal area of the upper Hunter Valley.

Using ethno-historic sources, Brayshaw (1986) has shown that the Wonnarua people lived in an environment rich in food resources. A diverse diet was obtained by eating freshwater fish, shellfish, retiles, mammals, birds and plant food. Brayshaw (1986: 82) suggests that inland groups visited the coast during the summer when marine resources were plentiful, and coastal groups travelled inland to participate in the winter kangaroo hunts. Trade and/or exchange also occurred between the coastal and inland groups. Reed spears and shells were traded inland for possum skin rugs and fur cord (Brayshaw 1986: 41). Social gatherings were a feature of Aboriginal life in this area.

5.2 REGIONAL ARCHAEOLOGICAL CONTEXT

Within the upper Hunter Valley, Aboriginal site types such as isolated finds and artefact scatters are the most common. They are generally identified through erosional processes, which also act to remove the stratified and datable context of archaeological sites. Where datable materials such as charcoal are identified at an archaeological site, the association between the dated sample and cultural materials may not be provable, unless the features comprises an intact feature such as a hearth (Dean-Jones and Mitchell 1993). Although, very few archaeological sites within the Hunter Valley have been directly dated by either radiocarbon or thermoluminescence dating, the erosional nature of many of the open sites means there are limitations in applying this technology.

Stone artefacts exposed on the ground surface may result from a single visit or from discard events from repeated visits. Such visits could span time periods from 10s to 1000s of years. Notable archaeological investigations in the Hunter Valley have provided dates of occupation for a number of sites that contribute to our understanding of the antiquity of Aboriginal occupation of the region, these include:

- Glennies Creek (Falbrook) north of Singleton, where a hearth located on a burial alluvial terrace provided radiocarbon dates between 13020±360 BP (years before present) and 34580±650 BP (Koettig 1986); and
- Wollombi Brook (west of Singleton), where artefacts identified on a terrace in a clay Horizon were dated to late Pleistocene (between 18,000 and 30,000 BP) by a geomorphologist (reported in Kuskie and Kamminga 2000: 215).

A number of studies and theories have been surmised regarding how Aboriginal people used the landscape in which they lived. These theories attempt to explain or interpret the location and nature of the archaeological record in any region. It is generally assumed that the environment, and implicitly resource distribution, was a major factor influencing patterns of occupation.

5.2.1 Previous archaeological investigations and assessments

The large number of archaeological studies undertaken within the vicinity of the study area provides information to obtain a sound understanding of the nature and distribution of archaeological sites within the area. Although there is some conjecture about the relationship between stream order, site numbers and densities, the general pattern is that the majority of sites are present within 30 m of watercourses (Dean-Jones 1992: 26–27; AMBS 1997: 29). Although sites are present in locations at a greater distance from water, these sites are limited in terms of both number and size, constituting a lower density scatter than is found along the creek lines (Dean-Jones 1992: 24; ERM 1999: 22–23). The majority of sites are small, with larger sites typically found in association with permanent watercourses. Reduced visibility has been proffered as an explanation for the higher number of sites and artefacts present along the more heavily eroded and less vegetated minor watercourses as compared to major creeks (Umwelt 2004: 7.7; ERM 1999: 84).

An investigation undertaken in the vicinity of the study area has been summarised below.

5.2.1.1 Salvage of Aboriginal Sites within Beltana No.1 Mine, near Broke, NSW (Umwelt 2005, 2007)

This project spanned over several years, with several different AHIPs. The objectives of the survey was to identify archaeological sites associated with the traditional Aboriginal occupation of the study area, to assess any potential impacts to the identified sites from the mining proposal and to advise BCM on the appropriate management of the Aboriginal sites. The survey results led Umwelt to a conclusion that traditional Aboriginal people frequented the project area and a salvage of surface artefacts was proposed.

A total of 205 artefacts were collected in the first phase of salvage that yielded the following conclusions:

- Majority of the artefacts collected were manufactured from mudstone at 68% with the second most popular material collected being silcrete (23%). Other raw materials included tuff, chert, volcanic rock, quartzite, chalcedony, glass and fine grained siliceous;
- The raw material found were in line with expected sources known in the geology of the area;
- Majority of the artefacts were made by a knapping technique known as freehand percussion resulting in flakes;
- The higher order tributary systems were subject to more intensive occupation than other landforms in the area;
- The high portion of heat shattered artefacts from bushfires suggests that the artefacts may have been exposed on the surface for an extended period of time;
- The Hunter River was the source of a variety of raw materials found during the collection;

- One of the sites (BMU19; a minor tributary of Wollombi Brook, approximately 250 m west of Charlton Road and 1.9 km from the study area) was still occupied after European settlement of the area and perhaps as much as 20 years after occupation. This conclusion was made from the finding of a base of a hand blown glass bottle. This type of bottle was commonly used in 1860s, it also displayed multiple flake scars; and
- Camping appeared to focus near a tributary of Wollombi Brook that once flowed to the north east of the study area.

The next surface collection spanned over four days and occurred seven months later in November 2003. A total of 20 areas beside the unnamed tributary of Wollombi Brook (the northern drainage located 4 km northeast of the study area) were known to have artefacts. A total of 2,223 artefacts were salvaged. The following are the field results and conclusions:

- 39 grinding grooves were located sandstone on a creek bed of a the northern drainage (BMU1);
- It was also noted that many artefacts would have been lost in the area through creek bank instability and flooding events;
- Majority of the sites found were located within 200m of the northern drainage near sandstone outcrops or on the tributary confluence, with isolated finds appearing on other landforms such as ridge crests or gentle slopes within close proximity to a road or gully erosions; and
- Grader scrapes at BMU2 were used to test areas with low ground surface visibility as results of the finding of surface artefacts was biased towards larger more visible artefacts. The scrapes yielded the following results and conclusions:
    - 47 artefacts were recovered in total, with the majority of the distribution being in the area with the gentlest gradient near the tributary channel; and
    - Hearths and ovens are almost certain to be present, however, due to geomorphic processes, they would have been destroyed. Other evidences of Aboriginal occupation may have been lost as well due to channel widening.

In total, flakes and broken flakes make up the bulk (78.6%) of the total assemblage. The artefacts were mainly manufactured from mudstone, with silcrete being the next most popular material used. Other raw materials included tuff, chert and quartz. Various types of artefacts found came to several conclusions:

- The recovery and location of bondi points, backed blades, geometric microliths and an elouera indicate that a portion of the assemblage was in the Holocene age. This could date anywhere from 7000 BP;
- Grindstones and anvils were located mainly on the main channel of the northern drainage. This suggests food processing and the presence of women;
- Raw materials located at the site would have been sourced from the Hunter River. The raw materials found at the site were not uncommon of the previous findings in the Hunter River; and

- Some artefacts were found to be heat treated, however, due to the lack of evidence to suggest that thermal pre-treatment was occurring on site, the artefacts was probably subject to the heat post-discard.

5.2.2 Bulga Optimisation Project

5.2.2.1 Assessment for the BOP

The assessment area for the BOP covered approximately 3615 ha and portions of the assessment area were located directly adjacent to portions of the current study area.

Connect for Effect Pty Limited (Connect for Effect) were engaged by BCM to undertake Aboriginal community consultation for the BOP assessment and to author the ACHAR (Connect for Effect 2013) to which OzArk 2013 contributed. Also contributing to the ACHAR were confidential cultural values assessments authored by two Wonnarua Knowledge Holder groups, the PCWP and the WNAC. The Connect for Effect ACHAR appeared as Appendix 13a (Parts 1 and 2) of the BOP *Environmental Impact Statement* (EIS) (Umwelt 2013). Connect for Effect 2013 contains the cultural, aesthetic and historic values of the area, while OzArk 2013 contains an examination of the scientific values of the area.

5.2.2.2 Cultural values

Key cultural values identified during consultation for the BOP are detailed in **Section 3.1**.

Umwelt 2013: 193 summarises the cultural values of the BOP Project Area in which the Proposed Modification is located:

> *RAPs identified the* [BOP] *Project Area to be of high social, cultural and spiritual significance to Traditional Owners*[2] *and Knowledge Holders and other RAPs, because it has spiritual and ceremonial associations to extremely high value sacred Creation and ceremonial places located within the region.*
>
> *The* [BOP] *Project Area contains a number of specific archaeological sites of high cultural significance to RAPs including Traditional Owners and Knowledge Holders. The* [BOP] *Project Area was also identified as an area of continuing traditional and historic association for local Aboriginal families, which has been described as significant, although it is noted that the* [BOP] *Project Area has been subject to mining activity for the past 30 years.*

Key cultural values identified in the cultural values assessment included the Loders Creek grinding grooves and the significance of items in the cultural landscape located outside of the BOP Project Area such as Baiame Cave and Lizard Rock.

[2] The use of the terms 'traditional owner' and 'knowledge holder' were used generically in the 2013 EIS and was not based on documented research to identify the individuals these terms may apply to.

5.2.2.3 Historic values

The historic narrative presented in Connect for Effect 2013 identified that the BOP Project Area is associated with a range of historic persons, phases, activities and events, with written records, oral histories and archaeology all contributing to a holistic and multi-faceted understanding of the Aboriginal histories of the area (Umwelt 2013: 194). RAPs who identified Traditional Owner connections shared direct historical experiences of their attachment to the BOP Project Area and also throughout the local area of Broke, Bulga, The Vere and Jerrys Plains; which add cultural meaning to the place and was expressed as having high cultural values.

5.2.2.4 Aesthetic values

RAPs expressed a range of sensory perceptions in relation to the BOP Project Area. It was acknowledged that past land use and current mining has contributed to the loss of over 2000 hectares of land, and has contributed to the loss of connectivity and pathways, disruptions to waterways, and disruption to the spiritual meanings and symbolism contained in the landscape. However, RAPs identified and retained heightened emotional cultural connection and concern for the BOP Project Area and its cultural and archaeological values, which was described by some RAPs as being located within a place where there are the spirits of their ancestors, the memories of ancestors and the footprints (archaeological sites) of their ancestors (family) ceremonial and societal ways of life (Umwelt 2013: 194).

5.2.2.5 Scientific values (OzArk 2013)

A number of previous surveys had identified discrete sites, predominately located along drainage lines within the BOP Project Area. The approach taken by OzArk to site recording was that individual sites considered to be linked by geographical proximity were grouped into a broader site complex. The site complexes generally consisted of amalgamations of stone artefact sites, apart from two complexes that also contained grinding groove sites. Most of the site complexes included sites which had been previously recorded as individual sites. The survey undertaken for the BOP identified 14 site complexes covering an area of approximately 198 ha, nine open sites and six isolated finds within the BOP disturbance area. The two grinding groove sites at Loders Creek and BMU1 were included within the site complexes.

A further 42 previously recorded sites were located outside these areas but within the BOP disturbance area making, in total, 71 sites that were partially or totally impacted by the BOP. The majority of these sites were low density artefact scatters or isolated finds.

Sites recorded by the BOP assessment that are closest to the current study area include BOP OS-9 (37-6-2843; recorded just south of the western portion of the additional disturbance study area) and BOP OS-10 (37-6-2844; recoded within the infrastructure study area).

BOP OS-9 was described as:

> *BOP OS-9 is located on the edge of a remnant patch of regenerating woodland surrounded by heavy disturbance from mining activities in the southwest of the Project Area. The site is located in an area adjacent to where a drainage diversion channel has been built. Although the site is free of invasive disturbances, the general area has been heavily affected by past agricultural land uses and general mining activity including revegetation programmes. Most of the A Horizon soils have been removed by sheet wash erosion from the area of BOP OS-9 and most artefacts were recorded resting on the gravel lag on top of the B Horizon clay. As a result, most artefacts recorded have been displaced (probably from within the vicinity) and there is little possibility of further subsurface archaeological deposits.*
>
> OzArk 2013: 262.

Approximately 10 artefacts were recorded at BOP OS-9 during the assessment.

BOP OS-10 was described as:

> *BOP OS-10 is located in the very southwest of the Project Area and will be impacted by the proposed Broke Road Realignment. BOP OS-10 is a low density artefact scatter located on a bench in mid slope topography. The site is located about 50m from an ephemeral drainage line. A Horizon soils across the site are thin and there is little possibility for further subsurface archaeological deposits at the site.*
>
> OzArk 2013: 263.

Approximately 10 artefacts were recorded at BOP OS-10 during the assessment.

5.2.2.6 Test Excavation Program (OzArk 2013)

The test excavation program for the BOP undertaken by OzArk in 2012 included the excavation of 196 0.5 m x 0.5 m excavation squares (or 49 m^2) resulting in an assemblage of 235 artefacts recovered from BOP SC-1 with PAD, BOP SC-6 with PAD and BOP SC-10 with PAD; all located at least 1 km north of the study area.

Analysis of the soils and stratigraphy recorded showed that all sites had a very shallow A-Horizon soil profile that was lacking in archaeological stratigraphy. At BOP SC-6 with PAD on Nine Mile Creek, soil profiles indicated that some of the present A-Horizon soils had been redeposited, probably at some time in the modern period. At BOP SC-10 with PAD (on 'Swan Lake'), the A-Horizon soils were very thin in the areas investigated. At BOP SC-1 with PAD (on the northeast drainage 5 km north of the study area), A-Horizon soil loss and riparian erosion had previously affected the area, however, the A-Horizon soil depth was deeper and evidence of disturbance was less.

The distribution of artefacts showed the following features from each site:

- BOP SC-1 with PAD. In several instances it was seen that exposed artefact scatters on the current erosion edge of the northeast drainage did not extend with any sort of artefact density into the non-eroded portions of the site. However, at several locations, clusters of artefacts were recorded up to 50 m from the erosion edge and so there remained the possibility of further undetected clusters within 50 m of the creek, particularly on the western bank. Some of these clusters, such as at TP23, showed evidence of being *in situ* knapping floors with possibly associated features (a cracked stone feature). No artefacts were recorded in any of the test excavation squares on the eastern bank.

- BOP SC-6 with PAD. Artefacts in the area investigated did not display any observable patterning but were present on both banks of Nine Mile Creek without any evidence of substantial clustering. As noted above, some of the A-Horizon soils at this site had been redeposited and any observed distribution could be entirely coincidental.

- BOP SC-10 with PAD. In several instances it was seen that exposed artefact scatters on the current erosion edge of Swan Lake did not extend with any sort of artefact density into the non-eroded portions of the site (on the eastern bank). Very low artefact densities were recorded in the non-eroded portions of the site on the eastern bank of Swan Lake.

The majority of artefacts at all sites were recorded in spits 2 and 3 (5 centimetres [cm] to 15 cm) and no artefact was recorded at depths greater than 30 cm.

Artefact analysis of the excavation assemblage showed:

- There is no real differentiation between the three sites in terms of artefact types or of raw materials used;

- Locations rarely recorded artefact types or size ranges to indicate that knapping was taking place in the areas investigated, although one possible knapping floor was identified (BOP SC-1 with PAD, TP 23);

- No location recorded an artefact density or variety that would indicate a long-term occupation site;

- Retouched tools were infrequent and consisted, in the main, of backed flakes, geometric microliths and end scrapers;

- The reduction technique of artefacts shows that, in general, they were:

    - Constructed from silcrete or mudstone;

    - Detached from non-cortical cores;

    - Detached from cores using a single flaking platform or opposed flaking platforms. Only a minority of flakes showed core rotation or a large number of previous flake scars on their dorsal surface;

    - Detached by indirect or soft-hammer percussion resulting in small platform areas; and

- Detached from non-exhausted cores as flakes display, in the majority, feather termination.

- Artefacts were generally small with the majority being less than 5 cm;
- Artefacts generally displayed moderately raised profiles and asymmetrical forms indicating more opportunistic knapping rather than tool production;
- The test excavation program demonstrated that there were subsurface artefacts at all sites, although the artefact density is very low at BOP SC-10 with PAD, low and possibly disturbed at BOP SC-6 with PAD, and low at BOP SC-1 with PAD;
- The artefact type and artefact distribution indicated that none of the locations investigated could be considered a long-term occupation camp but rather the artefacts are either displaced from the original positions through slope wash or represent small, one-off hunting or knapping events;
- The results of the test excavation program was also in basic agreement with the results of other archaeological excavations within the project area; and
- No artefact, feature or deposit was recorded that is any way unique to the general archaeological context for the project area that has been established.

5.2.2.7 The BOP salvage program (OzArk 2017a)

The BOP salvage program involved the salvage of Aboriginal cultural heritage sites at the BCC during the period 2014–2016. The salvage was undertaken under the auspices of the BCC 2014 ACHMP that was approved by the Department of Planning and Environment (DP&E) in 2014. The development of the ACHMP followed the issuing of SSD-4960 for the BOP.

During the salvage program, 21 artefacts were collected from BOP OS-9. Of the 21 artefacts salvaged, 16 were mudstone while the remaining five were silcrete. BOP OS-9 was listed as ‘destroyed’ with AHIMS following the salvage and the area where the site once existed is now under the new Bulga Underground site access road.

At BOP OS-10, four artefacts were recovered from the site during the salvage program, three of them at the junction of a track and a cable easement. The site was only partially salvaged as the southern portions were to be impacted by the new Broke Road alignment leaving the northern portions intact.

5.2.3 Constraints and Opportunities assessment (OzArk 2017)

In 2017 OzArk was commissioned to undertake a constraints and opportunities assessment of the study area (OzArk 2017).

The study noted that the known Aboriginal cultural heritage constraints within the study area are limited to four previously recorded sites and that all of these sites have a low scientific significance and none are associated with further, subsurface archaeological deposits. In terms of

opportunities, the study noted that the additional disturbance area associated with the Proposed Modification is relatively small and is in an area of generally high previous disturbance. As such, it is unlikely that impacts to Aboriginal cultural heritage will be significant. In light of this, the Proposed Modification is not likely to significantly impact inter-generational outcomes or impact significantly on the cumulative loss of cultural heritage sites in the region.

5.3 LOCAL ARCHAEOLOGICAL CONTEXT

5.3.1 Desktop database searches conducted

A desktop search was conducted on the following databases to identify any potential previously-recorded heritage within the study area. The results of this search are summarised in **Table 5-1** and presented in **Appendix 7**.

Table 5-1: Aboriginal heritage: desktop-database search results.

Name of Database Searched	Date of Search	Type of Search	Comment
Commonwealth Heritage Listings	31/5/2018	Singleton LGA	No places listed on either the National or Commonwealth heritage lists are located within the Study Area
National Native Title Claims Search	31/5/2018	NSW	NC2013/006 – registered claim – includes the study area.
OEH AHIMS	24 August 2018	GDA Zone 56 Eastings: 320816 to 324355 Northings: 6377960 to 6381716	The search returned 49 sites including 29 destroyed or partially destroyed sites and 20 valid sites. The 49 sites include two recorded as part of this assessment (see **Section 6.4**).
Local Environment Plan (LEP)	31/5/2018	Singleton LEP of 2013	None of the Aboriginal places noted occur near the study area.

As per **Table 5-1**, it is noted that the study area is within the boundary of Native Title Claim (*NC2013/006, NSD 1680/2013, Scott Franks and Anor on behalf of the Plains of the Wonnarua People*).

As noted in **Table 5-1**, a search of the OEH administered AHIMS was undertaken and previously recorded Aboriginal sites in the vicinity of the study area are illustrated on **Figure 5-1**.

The AHIMS search shows that there is one previously recorded Aboriginal site within the additional disturbance study area likely to be impacted (**Figure 5-2**):

- AHIMS #37-6-3763 (Bulga IF-2), an isolated mudstone flake located adjacent to a track. The site was identified by a BCC contractor and recorded by OzArk in 2016.

The infrastructure study area contains three previously recorded Aboriginal sites (**Figure 5-2**):

- AHIMS #37-6-2844 (BOP OS-10), an artefact scatter recorded by OzArk in 2012 as part of the Aboriginal Archaeological Values Assessment for the BOP. The site was partially

salvaged in 2015 during the BOP salvage program (see **Section 5.2.2.7**). The new alignment for Broke Road has now been built within the former site's extent;

- AHIMS #37-6-1659 (BP L5), an artefact scatter consisting of a pink chert flake and a pink core; and
- AHIMS #37-6-1660 (BP L6), an isolated chert core.

BP L5 and BP L6 were previously recorded by Insite Heritage (2005) as part of an assessment for the installation of the Broke water pipeline. Currently AHIMS locates both sites adjacent to, although outside of the infrastructure study area, and on the western side of the former alignment of Broke Road. There is uncertainty over the exact location of these sites as the coordinates provided by the site cards place both sites to the east of the former Broke Road and outside of the study area, yet sketch maps provided with the site card clearly show the sites to the west of Broke Road. Attempts were made during the field survey to relocate and ground-truth these sites (**Figure 5-2**).

Figure 5-1: Map showing the previously recorded sites in the vicinity of the study area.

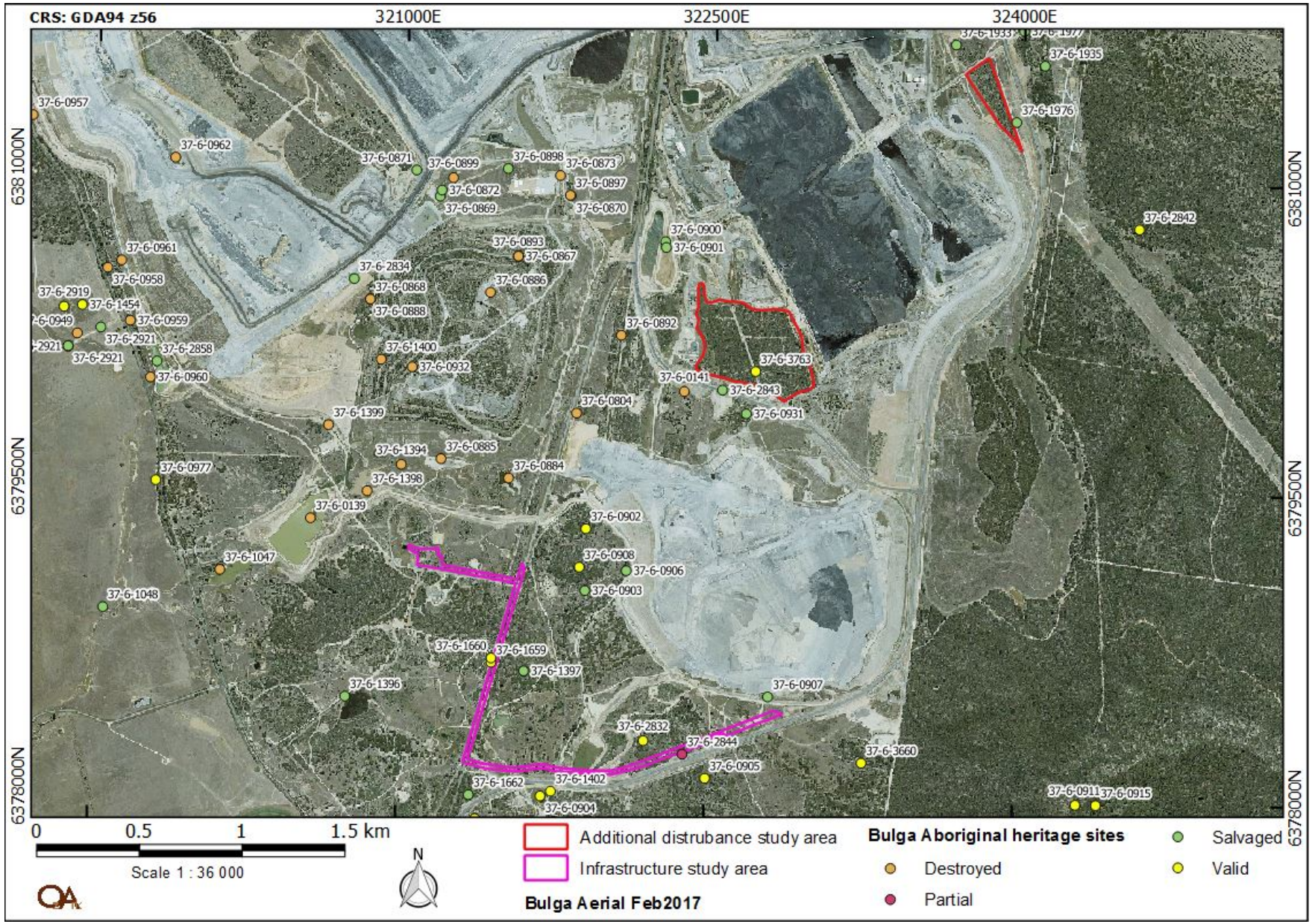
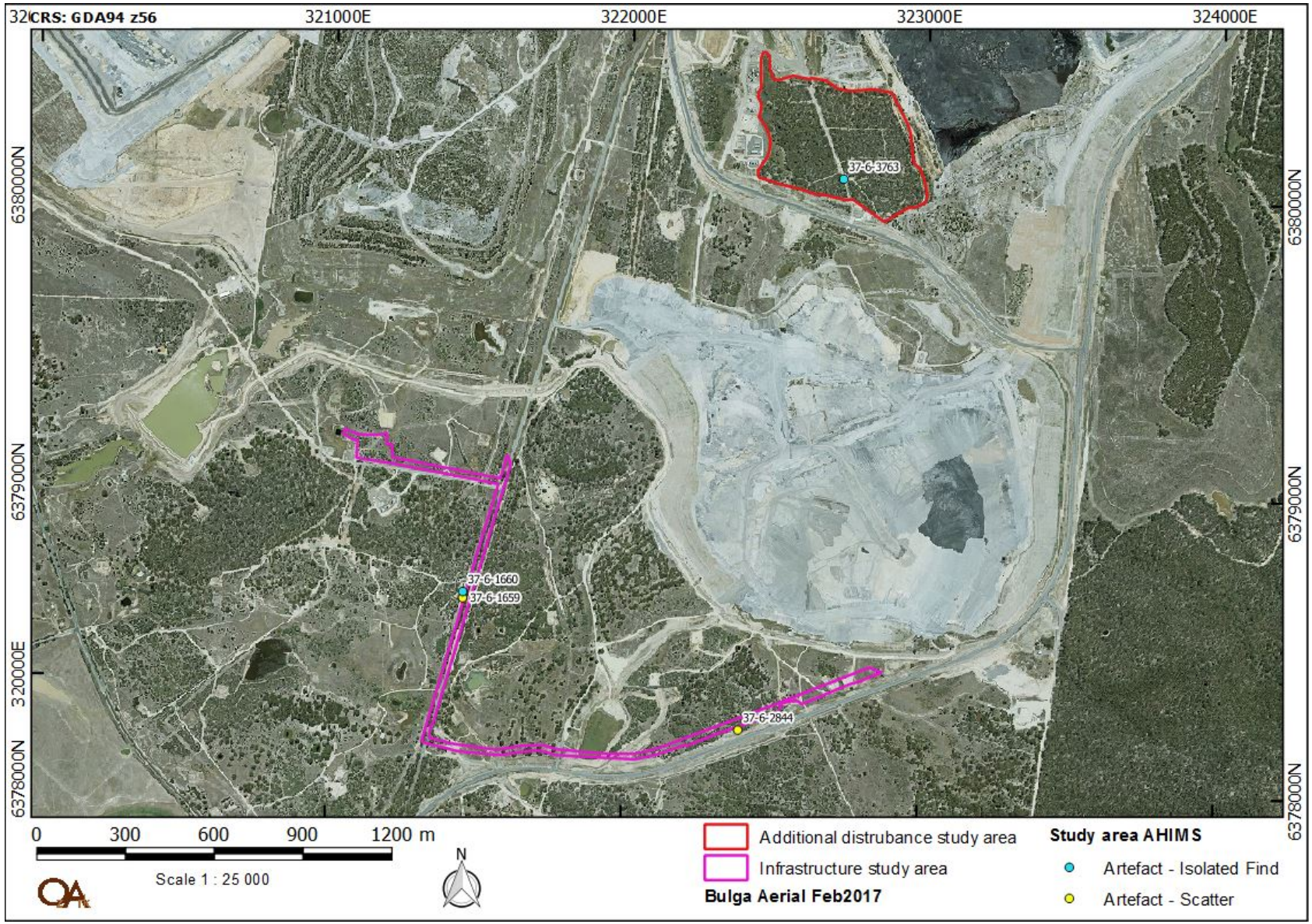


Figure 5-2: Map showing the current AHIMS sites locations in association with the study area.



5.4 PREDICTIVE MODEL FOR SITE LOCATION

Across Australia numerous archaeological studies in widely varying environmental zones and contexts have demonstrated a high correlation between the permanence of a water source and the permanence and/or complexity of Aboriginal occupation. Site location is also affected by the availability of and/or accessibility to a range of other natural resources including: plant and animal foods; stone and ochre resources and rock shelters; as well as by their general proximity to other sites/places of cultural/mythological significance. Consequently sites tend to be found along permanent and ephemeral water sources, along access or trade routes or in areas that have good flora/fauna resources and appropriate shelter.

In formulating a predictive model for Aboriginal archaeological site location within any landscape it is also necessary to consider post-depositional influences on Aboriginal material culture. In all but the best preservation conditions very little of the organic material culture remains of ancestral Aboriginal communities survives to the present. Generally it is the more durable materials such as stone artefacts, stone hearths, shell, and some bones that remain preserved in the current landscape. Even these, however, may not be found in their original depositional context since these may be subject to either (a) the effects of wind and water erosion/transport over both short and long time scales or (b) the historical impacts associated with the introduction of European farming practices leading to land degradation and soil loss. Scarred trees, by their nature, may survive for up to several hundred years but rarely beyond.

Previous archaeological studies in the region have demonstrated the close correlation between Aboriginal site location and the distance to permanent water with larger, more complex sites most often being associated with the larger drainage systems (see **Section 5.2**). As these systems are generally distant to the study area the implication is that it is unlikely that the study area contains, or even once contained, large, complex sites.

Knowledge of the environmental contexts of the study area and a desktop review of the known local and regional archaeological record, the following predictions are made concerning the probability of those site types being recorded within the study area:

- Isolated finds may be indicative of: random loss or deliberate discard of a single artefact, the remnant of a now dispersed and disturbed artefact scatter, or an otherwise obscured or sub-surface artefact scatter. They may occur anywhere within the landscape but are more likely to occur in topographies where open artefact scatters typically occur.
    - As isolated finds can occur anywhere, particularly within disturbed contexts, it is predicted that this site type could be recorded within the study area. Isolated finds are also known to exist within the study area so this site type is already represented in the landforms comprising the study area.
- Open artefact scatters are defined as two or more artefacts, not located within a rock shelter, and located no more than 50 m away from any other constituent artefact. This site

type may occur almost anywhere that Aboriginal people have travelled and may be associated with hunting and gathering activities, short or long term camps, and the manufacture and maintenance of stone tools. Artefact scatters typically consist of surface scatters or sub-surface distributions of flaked stone discarded during the manufacture of tools, but may also include other artefactual rock types such as hearth and anvil stones. Less commonly, artefact scatters may include archaeological stratigraphic features such as hearths and artefact concentrations which relate to activity areas. Artefact density can vary considerably between and across individual sites. Small ground exposures revealing low density scatters may be indicative of background scatter rather than a spatially or temporally distinct artefact assemblage. These sites are classed as 'open', that is, occurring on the land surface unprotected by rock overhangs, and are sometimes referred to as 'open camp sites'.

Artefact scatters are most likely to occur on level or low gradient contexts, along the crests of ridgelines and spurs, and elevated areas fringing watercourses or wetlands. Larger sites may be expected in association with permanent water sources.

Topographies which afford effective through-access across, and relative to, the surrounding landscape, such as the open basal valley slopes and the valleys of creeks, will tend to contain more and larger sites; mostly camp sites evidenced by open artefact scatters.

  - As the study area is within flat or gently sloping landforms distant to permanent water, this site type is not predicted to be common. The moderate degree of disturbance in the study area will probably mean that the scatter has become displaced. It is likely that any sites associated with the landforms of the study area are likely to have a low artefact density and a low complexity of tool types as the sites are either one-off events or only infrequently used. It is noted that the study area already has recorded two artefact scatters (BOP OS-10 [#37-6-2844] and BP L5 [#37-6-1659]) and this raises the possibility that the area contains further sites of this type.

- Aboriginal scarred trees contain evidence of the removal of bark (and sometimes wood) in the past by Aboriginal people, in the form of a scar. Bark was removed from trees for a wide range of reasons. It was a raw material used in the manufacture of various tools, vessels and commodities such as string, water containers, roofing for shelters, shields and canoes. Bark was also removed as a consequence of gathering food, such as collecting wood boring grubs or creating footholds to climb a tree for possum hunting or bark removal. Due to the multiplicity of uses and the continuous process of occlusion (or healing) following removal, it is difficult to accurately determine the intended purpose for any particular example of bark removal. Scarred trees may occur anywhere old growth trees survive. The identification of scars as Aboriginal cultural heritage items can be problematical because some forms of natural trauma and European bark extraction create similar scars. Many remaining scarred trees probably date to the historic period when bark was removed by Aboriginal people for both their own purposes and for roofing on early European houses. Consequently the distinction between European and Aboriginal scarred trees may not be clear.

  - Due to the near-total clearance of trees from within the study area, this site type is predicted to be very rare. It is also noted that this site type is very rare at a regional level.

- Quarry sites and stone procurement sites typically consist of exposures of stone material where evidence for human collection, extraction and/or preliminary processing has survived. Typically these involve the extraction of siliceous or fine grained igneous and meta-sedimentary rock types for the manufacture of artefacts. The presence of quarry/extraction sites is dependent on the availability of suitable rock formations.
    - This site type could be recorded within the study area should suitable rock outcroppings be available.
- Burials are generally found in soft sediments such as aeolian sand, alluvial silts and rock shelter deposits. In valley floor and plains contexts, burials may occur in locally elevated topographies rather than poorly drained sedimentary contexts. Burials are also known to have occurred on rocky hilltops in some limited areas. Burials are generally only visible where there has been some disturbance of sub-surface sediments or where some erosional process has exposed them.
    - Although it is possible that this site type could be found within the study area, it is considered a rare site type especially given the disturbance that has occurred within the study area.

6 RESULTS OF ABORIGINAL ARCHAEOLOGICAL ASSESSMENT

6.1 SAMPLING STRATEGY AND FIELD METHODS

Standard archaeological field survey and recording methods were employed in this study (Burke & Smith 2004). The field survey was undertaken over the additional disturbance study area and the infrastructure study area. The field survey included re-visiting and ground-truthing the previously recorded Aboriginal sites in and within 100 m of the study area, to determine the extent of the site boundaries.

The field survey methods comprised pedestrian transects of 100 m intervals with the surveyors spaced evenly apart (at least 10 m within transects). In instances where field conditions were poor and hampered by dense vegetation and/or associated mine works, opportunistic survey methods were applied.

RAPs assisted the field effort by identifying objects/features of interest and by placing flags at artefact and/or feature locations. Previously recorded sites associated with the study area were inspected and the site features and artefacts flagged (where identified) and photographs taken. For newly recorded sites, all artefacts were recorded using digital photography, a handheld GPS receiver with site attributes and field notes taken.

6.2 PROJECT CONSTRAINTS

There were no significant constraints in completing the archaeological assessment within the given timeframe.

6.3 EFFECTIVE SURVEY COVERAGE

Two of the key factors influencing the effectiveness of archaeological survey are ground surface visibility (GSV) and ground surface exposure (GSE). These factors are quantified in order to ensure that the survey data provides adequate evidence for the evaluation of the archaeological materials across the landscape. For the purposes of the current assessment, these terms are used in accordance with the definitions provided in the *Code of Practice* (DECCW 2010a).

GSV is defined as:

> *… the amount of bare ground (or visibility) on the exposures which might reveal artefacts or other archaeological materials. It is important to note that visibility, on its own, is not a reliable indicator of the detectability of buried archaeological material. Things like vegetation, plant or leaf litter, loose sand, stone ground or introduced materials will affect the visibility. Put another way, visibility refers to 'what conceals'* (DECCW 2010a: 39).

GSE is defined as:

> *…different to visibility because it estimates the area with a likelihood of revealing buried artefacts or deposits rather than just being an observation of the amount of bare ground. It is the percentage of land for which erosion and exposure was sufficient to reveal archaeological evidence on the surface of the ground. Put another way, exposure refers to 'what reveals'* (DECCW 2010a: 37).

The GSE and GSV within available exposures varied substantially in the additional disturbance study area and the infrastructure study area. The variable exposures were generally a result of: previous clearing; landform modification; farming and mining infrastructure development; sheet wash and other forms of erosion. In most instances, GSE within these areas was moderate to high, although GSV was lowered in placed due to dense ground cover. The calculation of effective survey within the study area is shown in **Table 6-1**, with the new and previously recorded Aboriginal sites detailed in **Table 6-2**. The survey effort is illustrated on **Figure 6-1**.

Additional disturbance study area: western portion – Area 1

Area 1 is situated to the southwest of the Deep Pit TSF on a lower slope within a generally undulating landform with a slight rise trending to the north. Area 1 is distant to water with both the former channel of Loders Creek and Nine Mile Creek being over 1.5 km away from the study area. The landforms surrounding Area 1 are so modified by approved mining activities it is difficult to determine if Area 1 was ever associated with lower order tributaries but no trace of former waterways were observed within Area 1. Within Area 1 GSE was moderate at approximately 55% with a GSV at 85%. Soils generally consist of light, silty loamy clay and sandy redeposit. A B-Horizon base was common in exposures as soils comprise a shallow deposit. Surface stone was in the form of conglomerate and quartz pebbles, and shale fragments. No suitable raw material for stone artefact manufacture was observed. Vegetation was predominantly a closed forest landscape with dense clusters of shrubs and a relatively even distribution of grass. Melaleuca species were dominant in the east of the area indicating a tendency for waterlogged soils. Disturbances include previously clearing, formed tracks, electricity infrastructure, fencing, some minor modifications, and erosion. See **Plates 1** to **5**.

Additional disturbance study area: eastern portion – Area 2

Area 2 is situated to the northeast of the Deep Pit TSF on a generally low gradient, lower slope landform. The closest permanent water source is Nine Mile Creek approximately 150 m to the east. The GSE was approximately 60% with a GSV at 90%. Soils in Area 2 generally consist of shallow redeposited sandy loam with a highly exposed B-Horizon base. Surface stone was relatively minimal and mostly contained quartz and shale fragments. No suitable raw material was identified. Vegetation appeared to be quite young growth dominated by casuarina species,

scattered eucalypts and grass. Disturbances include vegetation clearing around the perimeter of the area, past farming activities, tree planting, and erosion. See **Plates 6** to **9**.

Infrastructure study area – Area 3

Area 3 is situated immediately north of the Broke Road realignment, along the former Broke Road alignment and to the west of the former alignment. Area 3 comprises modified and disturbed land from approved mining activities. The general landscape comprises a lower slope landform with low to moderate undulations. The closest permanent water source is Monkey Place Creek approximately 750 m to the south, although some ephemeral tributaries to the Wollombi Brook once crossed Area 3. GSE was approximately 50% with a GSV at 75%. Soils are predominantly a sandy loam redeposit with a compacted clayey B-Horizon base. Surface stone included conglomerate pebbles and shale fragments; though no raw material suitable for stone artefact manufacture was identified. Native Vegetation was largely cleared in modified areas and comprised only grass and weeds while other areas contained pockets of open forest with scattered shrubs. There are some more-mature trees along the former Broke Road alignment. Disturbances include: landform modification; vegetation clearing; formed access tracks; fencing; dam construction; road construction; underground infrastructure installation; and sheet wash and other forms of erosion. See **Plates 10** to **18**.

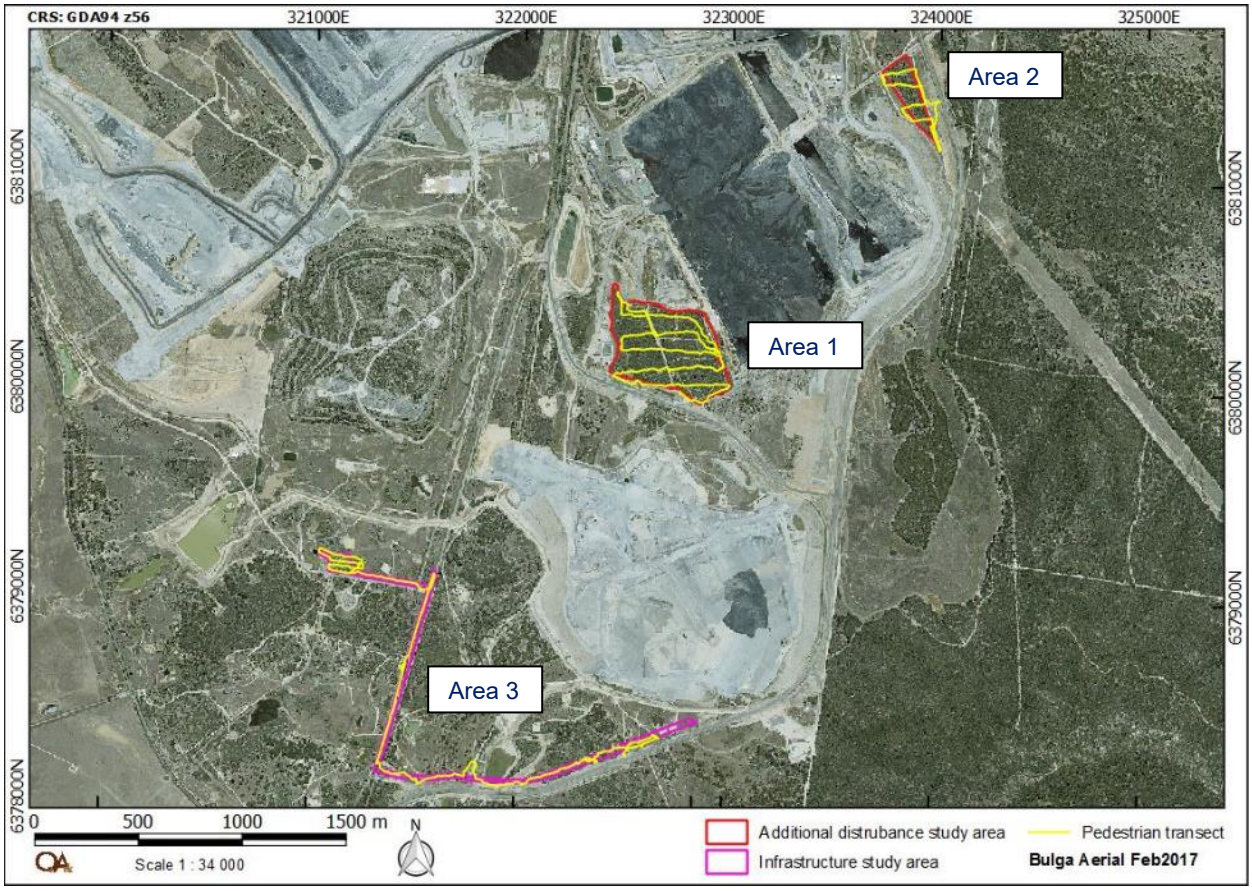
Table 6-1: Survey coverage data.

Study area	Landform	Survey Unit Area (sq m)	Visibility %	Exposure %	Effective Coverage Area (sq m) (= Survey Unit Area x Visibility % x Exposure %)	Effective Coverage % (= Effective Coverage Area / Survey Unit Area x 100)
Additional disturbance study area (Areas 1 & 2)	Low, undulating slope	202,000	85	55	94,435	46.75%
Infrastructure study (Area 3)	Low with low-moderate undulations	70,500	75	50	26,437	37.5%

Table 6-2: Aboriginal sites associated with each portion of the study area.

Survey area	Name	Previously recorded AHIMS sites	New Aboriginal sites	Number of Sites	Artefact types or Features
Area 1	Additional disturbance study area	AHIMS #37-6-3763 Bulga IF-2	-	1	Isolated find
Area 2	Additional disturbance study area	-	Bulga IF3 and Bulga IF4	2	Two isolated finds
Area 3	Infrastructure study area	AHIMS #37-6-1659 BPL5 AHIMS #37-6-1660 BPL6 AHIMS #37-6-2844 BOP-OS10	-	3	One isolated find Two artefact scatters

Figure 6-1: Map showing survey effort within the study area.



6.4 ABORIGINAL SITES RECORDED

Two new Aboriginal cultural heritage sites were identified during the survey (**Figure 6-4**). Further details including the GPS locations, site type and size have been recorded for each site (**Table 6-3**). The significance assessment and impact assessment for the new sites, and previously recorded sites, has been undertaken in **Sections 6.8.3** and **6.9**.

Table 6-3: Survey results.

Site Number	Site name	Site type	GDA Zone 56 Easting	GDA Zone 56 Northing	Site dimensions (m)
37-6-3880	Bulga IF3	Isolated find	323713	6381510	5 x 5
37-6-3881	Bulga IF4	Isolated find	323828	6381332	5 x 5

Bulga IF3

Site Type: Isolated find

GPS Coordinates: GDA Zone 56, 323713E; 6381510N

Location of Site: The site is situated on a lower slope landform with a south facing aspect (**Figure 6-4**). The site is approximately 390 m west of Nine Mile Creek and 290 m west of Broke Road on BCM owned land.

Description of Site: The site consists of a single mudstone core, located on a recently formed gravel access road associated with the BCM mine workings (**Table 6-4**; **Figure 6-2**). The core has evidence of machine damage likely associated with the formation of the road. GSE at the site was moderate at approximately 50% with a GSV at 75%. Soils consist of clayey loam, slightly sandy with a minimal natural stone content. Surrounding vegetation comprised grasses and weeds, with trees in the wider area. Disturbances include previous vegetation and land clearing associated with the ongoing operations of BCM. It is also expected that agricultural activities would have previously occurred in the area. The area has also been subject to heavy water wash and erosion. The site is identified as being within a disturbed context without associated subsurface deposits.

Table 6-4: Artefact recorded at Bulga IF3.

Type	Material	Integrity	Size (mm)	# Flake scars	Cortex %	Core features
Core	Mudstone	Complete	41	5	51-75	Secondary stage of reduction

Figure 6-2: Bulga IF3. View of site and the recorded artefact.



1. View north to Bulga IF3 site location.



2. View south to Bulga IF3 site location.

	
3. View of the mudstone core and the surface that was exposed on the track surface.	4. View of the mudstone core.

Bulga IF4

Site Type: Isolated find

GPS Coordinates: GDA Zone 56, 323828E; 6381332N

Location of Site: The site is situated on the lower slope landform with a south facing aspect (**Figure 5-4**). The site is approximately 290 m west of Nine Mile Creek and 225 m west of Broke Road, on BCM owned land.

Description of Site: The site consists of a single red silcrete flake, located within a highly exposed, cleared and modified landform (**Table 6-5**; **Figure 6-3**). GSE at the site was high at approximately 80% with a GSV of 95%. Soils consist of highly eroded redeposited sand, with surface stone of gravel and quartz fragments. No raw materials for stone tool manufacture were identified. Vegetation in the site area comprised grass, weeds and natural tree regrowth. Disturbances include vegetation clearing and mine associated activities, heavy sheet wash and erosion. The site is identified as being within a disturbed context without associated subsurface deposits.

Table 6-5: Artefact recorded at Bulga IF4.

Type	Material	Integrity	Reduction	Size Class (cm)
Flake	Silcrete	Complete	Tertiary	2 (2–4cm)

Figure 6-3: Bulga IF4. View of site and the recorded artefact.

<table>
<tr><td></td><td></td></tr>
<tr><td>1. View northwest to Bulga IF4 site location.</td><td>2. View southwest to Bulga IF4 site location.</td></tr>
<tr><td>
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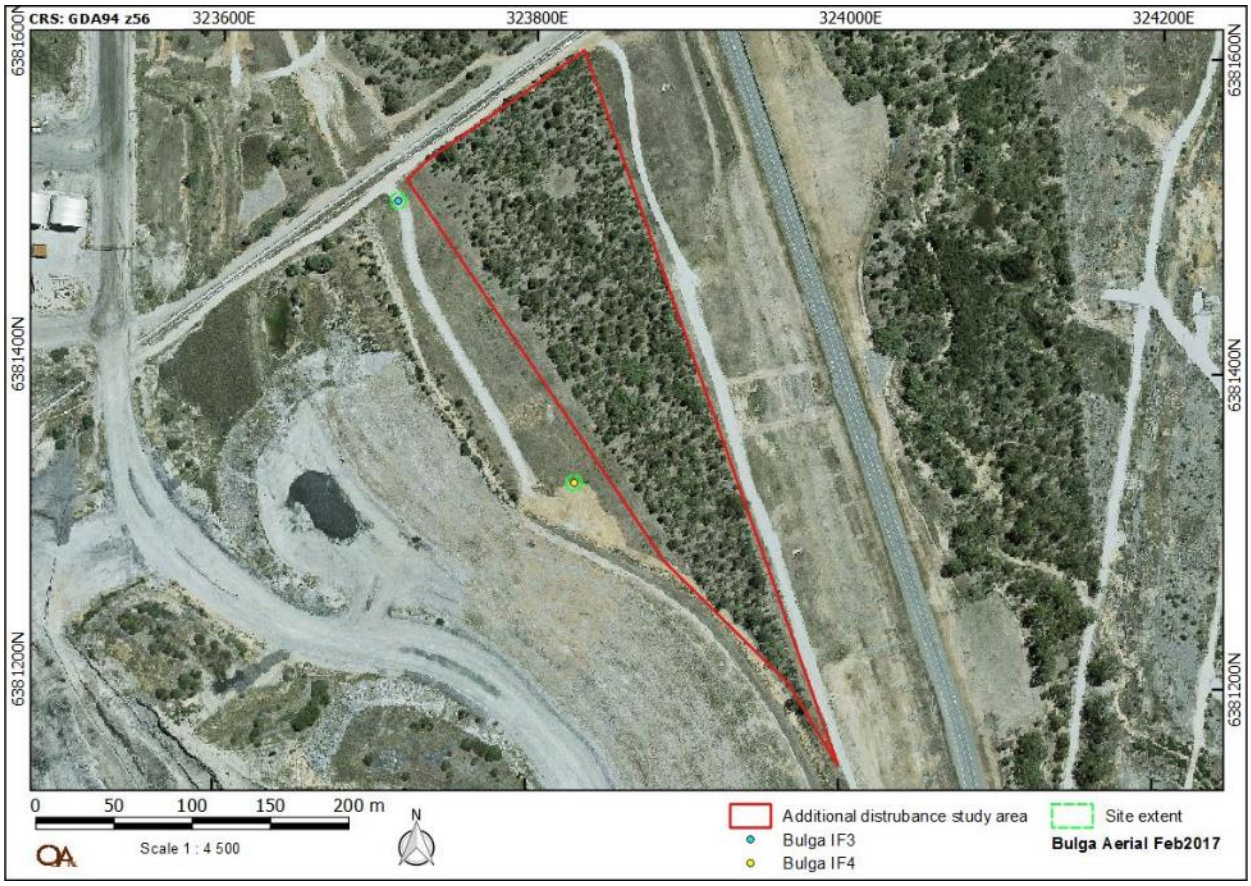
</td></tr>
<tr><td>3. Dorsal surface of Bulga IF4.</td><td>4. Ventral surface of Bulga IF4.</td></tr>
</table>

Figure 6-4: Map showing the location of the newly recorded Aboriginal sites – Bulga IF3 and Bulga IF4.



6.5 PREVIOUSLY RECORDED ABORIGINAL SITES LOCATED

There are four previously recorded Aboriginal sites situated within the study area. These sites were all ground-truthed during the field survey as they are proposed to be impacted by the Proposed Modification. The previously recorded sites within the study area are summarised below.

AHIMS #37-6-1659 (BPL5)

Artefact Scatter

The site comprises two artefacts recorded by Insite Heritage in 2005: a pink chert core and pink mottled chert flake. There is some uncertainty over the exact location of BPL5 as the original coordinates provided on the site card place the site to east of the former Broke Road (and outside of the study area). However, the sketched maps provided with the site card clearly show that the site lies to the west of Broke Road. In 2015 OzArk submitted an updated site card to correct the AHIMS coordinates[3], however, no surface artefacts were visible at the corrected coordinates at the time of the 2015 OzArk inspection. The updated artefact scatter site extent is 10 m by 10 m.

[3] The site card has "AMG' ticked alongside the coordinates but it is suspected that the coordinates were taken in GDA as this agrees with the sketch drawing of the site's location. However, the exact location of the original find remains unclear.

The location of the site is within a moderately disturbed context being within a fire-break and adjacent to the former Broke Road (which was diverted in 2015). The current AHIMS coordinates place the site on the western boundary of the infrastructure study area and on the western side of the former Broke Road alignment.

No artefacts were visible at the time of the 2018 inspection at BPL5 (**Plate 16**).

AHIMS #37-6-1660 (BPL6)

Isolated Find

Comprises one chert core recorded by Insite Heritage in 2005. In 2015 OzArk did an updated recording of the site and identified only a single distal silcrete flake and the chert core was not located. OzArk also amended the site's coordinates for the same reason as that set out for BPL5 above. The updated isolated find site extent is 10 m by 10 m. The location of the site is within a moderately disturbed context being within a fire-break and adjacent to the former Broke Road (which was diverted in 2015). The current AHIMS coordinates place the site on the western boundary of the infrastructure study area and on the western side of the former Broke Road alignment.

No artefacts were visible at the time of the 2018 inspection at BPL6 (**Plate 16**).

AHIMS #37-6-3763 (Bulga IF-2)

Isolated Find

Comprises a single mudstone flake adjacent to a formed access track. The isolated find site extent is 5 m by 5 m. The artefact was reported to Bulga Coal complex by a contractor and OzArk was supplied the location information and photographs of the site in order to submit a site card. The site has been fenced and the recorded artefact remains visible (**Figure 6-5**).

Figure 6-5: Bulga IF2. View of site and the recorded artefact.



1. View north to Bulga IF2 site location.



2. View of the Bulga IF2 artefact.

AHIMS #37-6-2844 (BOP-OS10)

Artefact Scatter

Comprises a low density artefact scatter in a mid-slope landform, where more than ten artefacts were originally recorded (**Section 5.2.2.5**). During the BOP salvage program (2014–2016), four artefacts were recovered from the site, three of them at the junction of a track and a cable easement (**Section 5.2.2.7**). The site was partially salvaged as the southern portions were to be impacted by the new Broke Road alignment leaving the northern portions of the site intact.

Artefacts remain visible at the site (**Figure 6-6**).

Figure 6-6: BOP-OS10. View of site and visible artefacts.



1. View northeast to BOP-OS10 site location.



2. View of artefacts visible at BOP-OS10.

6.6 ABORIGINAL COMMUNITY INPUT

No cultural specific information was offered by the Aboriginal community representatives during the field survey of the study area.

6.7 DISCUSSION

The survey of the study area recorded two previously unrecorded Aboriginal sites and located four previously recorded AHIMS sites. The newly recorded sites are isolated finds and are recorded associated with Area 2 (eastern portion of the additional disturbance study area). The predictive model (**Section 5.4**) suggested that the study area's distance from a permanent water source would indicate that stone artefact sites would be sparse and of low density. Additionally, the area's long agricultural history and the recent impact of mining have resulted in disturbances including: vegetation clearance; grazing; cultivation; service corridor and infrastructure installation; erosion; and mining related activities such as bunds and dams. These have combined to create landform modifications that have affected the integrity and density of Aboriginal sites. Likewise, the absence of scarred trees is due to a lack of endemic trees of sufficient age for Aboriginal cultural scarring throughout the study area due to land clearance.

Given that only a low number of new Aboriginal sites with a low artefact density were recorded, and that a high degree of land use and landform modification was noted, there is a low likelihood that intact subsurface archaeological deposits are present within the study area.

6.8 ASSESSMENT OF SIGNIFICANCE

6.8.1 Introduction

The appropriate management of cultural heritage items is usually determined on the basis of their assessed significance as well as the likely impacts of any proposed developments. Scientific, cultural and public significance are identified as baseline elements of significance assessment, and it is through the combination of these elements that the overall cultural heritage values of a site, place or area are resolved.

Social or Cultural Value

This area of assessment concerns the importance of a site or features to the relevant cultural group: in this case the Aboriginal community. Aspects of social value include assessment of sites, items, and landscapes that are traditionally significant or that have contemporary importance to the Aboriginal community. This importance involves both traditional links with specific areas, as well as an overall concern by Aboriginal people for their sites generally and the continued protection of these. This type of value may not be in accord with interpretations made by the archaeologist: a site may have low archaeological value but high social value, or vice versa.

Archaeological/Scientific Value

Assessing a site in this context involves placing it into a broader regional framework, as well as assessing the site's individual merits in view of current archaeological discourse. This type of value relates to the ability of a site to answer current research questions and is also based on a site's condition (integrity), content and representativeness.

The overriding aim of cultural heritage management is to preserve a representative sample of the archaeological resource. This will ensure that future research within the discipline can be based on a valid sample of the past. Establishing whether or not a site can contribute to current research also involves defining 'research potential' and 'representativeness'. Questions regularly asked when determining significance are: can this site contribute information that no other site can? Is this site representative of other sites in the region?

Aesthetic Value

This refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with the social values. It may consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use (Australia ICOMOS 2013).

Historic Value

Historic value refers to the associations of a place with a historically important person, event, phase or activity in an Aboriginal community. Historic places do not always have physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). They may have 'shared' historic values with other (non-Aboriginal) communities.

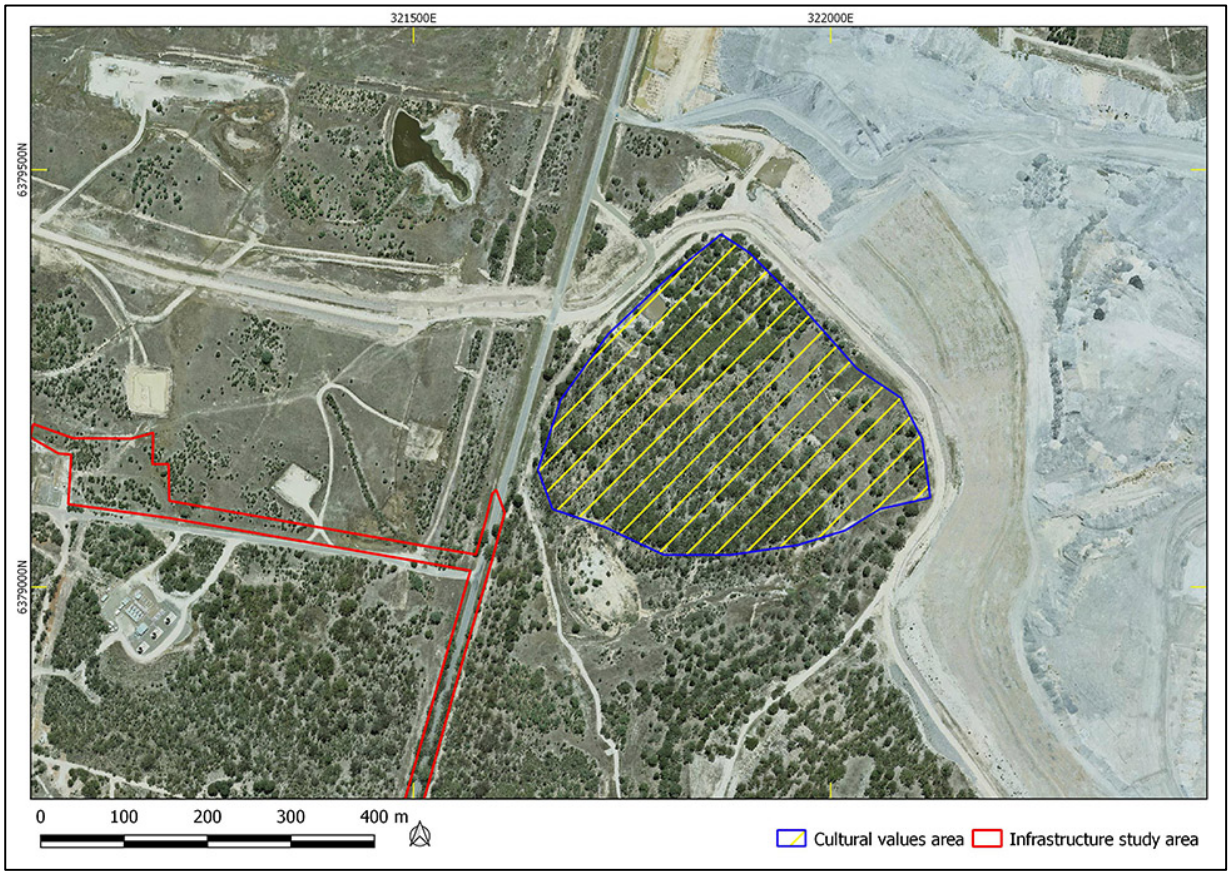
Places of post-contact Aboriginal history have generally been poorly recognised in investigations of Aboriginal heritage. Consequently the Aboriginal involvement and contribution to important regional historical themes is often missing from accepted historical narratives. This means it is often necessary to collect oral histories along with archival or documentary research to gain a sufficient understanding of historic values.

6.8.2 Identified cultural values in the vicinity of the study area

The BOP consultation recorded a number of cultural values associated with the immediate area surrounding the study area. These are summarised in **Section 3.1**.

An area of cultural sensitivity surrounding sites SBU3 (37-6-0902) and SBU9 (37-6-0908) (Harmony Hill) is located, at its closest, 50 m outside of the infrastructure study area. This area is not in the disturbance footprint for the Proposed Modification (**Figure 6-7**) and will not be impacted by the Proposed Modification.

Figure 6-7: Location of the cultural values area in relation to the study area.



Responses from the WLALC to both the draft ACHAR (**Appendix 5**), as well as the survey methodology (**Appendix 6**), make it clear that the WLALC holds that the entire landscape has cultural values:

> *The evidence shows that this area and landscape was a place that historically housed, fed, clothed, educated and entertained Aboriginal people. So the only conclusion that could be reached is that this landscape is culturally significant. As more and more of it is destroyed by mining impact the remaining areas increase in their significance and need for protection.*
>
> Noel Downs, 25 January 2019.

6.8.3 Assessed significance of the recorded sites

The Aboriginal sites identified during the field survey have been assessed for significance, as detailed below. The significance assessment is based on the criteria outlined in **Section 6.8.1**, with the results summarised in **Table 6-6**.

The significance assessment undertaken for the previously recorded Aboriginal sites connected with the study area, is based on revisiting the sites during the recent field survey, and details on their site cards.

Social or Cultural Value

The social value of Aboriginal sites is determined by the Aboriginal community. Aboriginal sites have high significance to the local Aboriginal community, as they demonstrate the occupation and use of the land by their ancestors.

No cultural specific information was offered by the Aboriginal community representatives during the field survey of the study area.

In response to a review of the survey methodology for the Proposed Modification, as well as their review of the draft ACHAR, the WLALC provided comment on the cultural values of the study area. This is presented in **Appendix 5** and **Appendix 6**.

Based on previous assessments in the region, it is understood that all sites recorded in the study area would be considered to hold social value by the Aboriginal community. As such, all sites have been assessed as having **high social/cultural value**.

Archaeological/Scientific Value

The isolated find sites (Bulga IF3, Bulga IF4, AHIMS #37-6-1660 and #37-6-3763) are represented by a single stone artefact. Isolated artefacts can be found anywhere in the landscape, and are often recorded in disturbed contexts. Unless an isolated find is a rare or unusual object, either as the individual piece or for the location, this site type offers limited

information relating to the Aboriginal occupation of an area. For the current assessment, the four isolated finds are not rare or unusual and hence have **low archaeological/scientific values**.

The artefact scatters (AHIMS #37-6-1659 and #37-6-2844) are recorded as low density scatters with little variation in the artefact assemblage. No other features (i.e. hearth features) were identified at these sites to suggest they have been an area favoured for periods of Aboriginal occupation. Additionally, these sites are situated within disturbed context and are unlikely to contain intact subsurface deposits, and therefore have been assessed to have **low archaeological/scientific values.**

Aesthetic Value

The isolated find sites (Bulga IF3, Bulga IF4, AHIMS #37-6-1660 and #37-6-3763) have all been recorded in disturbed contexts and are only represented by a single, common artefact type. They are therefore assessed as having **low aesthetic value**.

The artefact scatters (AHIMS #37-6-1659 and #37-6-2844) are situated within lower slope landforms and in previously disturbed contexts, as such, only the surface manifestations of these site assemblages can be assessed for the sites' aesthetic values. Also these sites are low density scatters with no potential for intact subsurface material. Therefore, they have been assessed as having **low aesthetic value**.

Historic Value

The recorded Aboriginal sites have been assessed as having **low historic values** as there are no known historical associations related to these sites.

Table 6-6: Significance assessment of sites within the study area.

Site ID	Site name	Social or Cultural Value	Archaeological / Scientific Value	Aesthetic Value	Historic Value
37-6-1659	BPL5	High	Low	Low	Low
37-6-1660	BPL6	High	Low	Low	Low
37-6-2844	BOP-OS10	High	Low	Low	Low
37-6-3763	Bulga IF-2	High	Low	Low	Low
37-6-3880	Bulga IF3	High	Low	Low	Low
37-6-3881	Bulga IF4	High	Low	Low	Low

6.9 DISTURBANCE OF 37-6-3880 AND 37-6-3881

During the Aboriginal heritage survey undertaken for the Proposed Modification, two isolated finds were recorded: Bulga IF3 (37-6-3880) and Bulga IF4 (37-6-3881) (see **Section 6.4**). These artefacts were located in the buffer zone of the survey area in an area approved for disturbance under the SSD 4960 consent. As stated in the survey methodology Section 5.1.1 (**Appendix 6**): *the assessment will include a buffer of at least 50 m around the outside of the survey area*. The intention of this methodology being that a site located just outside of the study area would be

taken into consideration as to whether it would be impacted or conserved by the Proposed Modification.

While the sites were recorded in early April 2018, OzArk did not complete the site cards for the sites until late June 2018 and did not gain approval for the sites until early July 2018 when the site cards were passed on to the BCC for inclusion on their GIS heritage database.

However, in mid-June 2018, a Ground Disturbance Permit (GDP) was issued by the Bulga Coal Operations team to allow for an approved laydown pad to be constructed which included the area where 37-6-3880 and 37-6-3881 were located. The locations of sites 37-6-3880 and 37-3-3881 had not been input into the Bulga Coal Operations GIS system when the GDP had been issued as the BCC had not been supplied with the site cards by OzArk.

This resulted in the sites being unintentionally destroyed by the construction of the laydown pad.

When reviewing a draft of this report, BCC Environment and Community Officer, Sarah Moore, was organising for the sites to be fenced off when she realised that sites Bulga IF3 (37-6-3880) and Bulga IF4 (37-6-3881) had most likely been disturbed by the construction of the laydown area. This was confirmed by a site inspection the next morning (6 September 2018).

On 6 September 2018, OEH and the Department of Planning and Environment were notified via email and phone call from Ralph Northey (BCC Environment and Community Manager), and this was followed up with a detailed explanation in a letter to OEH dated 12 September 2018.

In response to this breakdown of communication, the BCC undertook to revise the BCC ACHMP and distribute the draft for RAP consultation and regulatory approval by the end of September 2018. RAPs were provided the proposed ACHMP changes along with notification of the incident on 20 September 2018. The revised ACHMP now includes a form that must be filled out upon the identification of a new archaeological site that will include but not limited to:

a) Site coordinates to be put into the GIS database before the end of the next working day
b) Temporary demarcation and fencing be put in place immediately if the new sites are located within an area approved for disturbance
c) Copies of the form must be on hand when any Aboriginal heritage survey is being undertaken and those conducting the survey are fully aware of the requirements.

With this safeguard now in place, the BCC Environment and Community team will now be made aware of any new finds on the day that they are recorded so that new recorded sites can be appropriately managed.

6.10 LIKELY IMPACTS TO ABORIGINAL HERITAGE FROM THE PROPOSED MODIFICATION

Two newly recorded Aboriginal isolated find sites were recorded in the study area, however, these were unintentionally destroyed subsequent to the survey (see **Section 6.9**). A further four

previously recorded Aboriginal sites are also located in the study area: two isolated finds (AHIMS #37-6-1660 and #37-6-3763) and two artefact scatters (AHIMS #37-6-1659 and #37-6-5844).

It is likely that all four sites known to exist in the study area will be harmed by the Proposed Modification. All sites are not considered to be associated with intact subsurface deposits and all have been assessed as having low archaeological values. **Table 6-7** summarises the assessment of impact to recorded Aboriginal sites in the study area.

Table 6-7: Impact assessment to recorded Aboriginal sites.

Site Name	Type of Harm (Direct/Indirect / None)	Degree of Harm (Total/Partial / None)	Consequence of Harm (Total/Partial/No Loss of Value)	Potential impact
#37-6-1659 BPL5	Direct	Total	Total	The site and previously recorded artefacts are located west and within 10 m of Area 3 (infrastructure study area). It is anticipated that this site will be at risk of impact by the Proposed Modification.
#37-6-1660 BPL6	Direct	Total	Total	The site and artefact is located west and within 12 m of Area 3 (infrastructure study area). It is anticipated that this site will be at risk of impact by the Proposed Modification.
#37-6-2844 BOP-OS10	Direct	Total	Total	This site has been partially salvaged under the BOP Salvage Program. The portion of the site within Area 3 (infrastructure study area), is anticipated to be totally impacted by the Proposed Modification.
#37-6-3763 Bulga IF-2	Direct	Total	Total	The site and artefact is located within the boundaries of Area 1 (additional disturbance study area). This site will be totally impacted by the Proposed Modification.
#37-6-3880 Bulga IF3	N/A	N/A	N/A	The site is destroyed (see **Section 6.9**).
#37-6-3881 Bulga IF4	N/A	N/A	N/A	The site is destroyed (see **Section 6.9**).

6.11 ECOLOGICALLY SUSTAINABLE DEVELOPMENT AND CUMULATIVE IMPACT FOR THE PROPOSED MODIFICATION

Australia's *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee 1992) defines ecologically sustainable development (ESD) 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.*

The management and mitigation of Aboriginal sites involves consideration of ESD principles including cumulative impacts, the precautionary principle and the principle of intergenerational equity (OEH 2011: 12–13).

With regards to cultural heritage, the most important aspect of ESD is inter-generational equity whereby the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. Similarly inter-generational equity maintains that places and items of cultural heritage value should be preserved for the education, enjoyment and use of future generations.

The Proposed Modification adds to the cumulative impact on the region's Aboriginal cultural heritage as four sites will be harmed. However, the heritage impact value of this loss is low as

the sites consist of low density artefact scatters or isolated finds in disturbed contexts. Therefore, the loss has a negligible cumulative impact on the region's Aboriginal cultural heritage resource.

It is noted that the WLALC do not agree that the cumulative loss of Aboriginal cultural heritage values is 'minimal' or 'negligible' (**Appendix 5**):

> *So to assess the cultural value of an area you actually need to look at that area as part of a landscape. However as usual the consultant has only looked at the area of direct impact. This not only neglects the impact this will cause to the holistic landscape, it also fails to consider the cumulative impacts… How convenient for the proponent. Not only is this disappointing but it is a failure to adequately assess the area.*
>
> *The report continues on about how much disturbance there has been because of agriculture. Our response is SO WHAT? There has been ground disturbance and yes the archaeological record has been damaged. That does not affect the cultural value of the land. Yes there has been ploughing, tree removal and erosion, but that has not radically changed the landscape. It is still the same valley with the same waterways and evidence of past occupation. People could still walk, fish, hunt, gather and conduct ceremony here, and with rehabilitation the land could be returned to a state similar to that pre settlement. Open Cut Mining however WILL radically change the landscape it will destroy much of the cultural values of the landscape.*
>
> Noel Downs, 25 January 2019.

While the views of the WLALC are respected and understood, due to the relatively small size of the disturbance area, and the nature of the small number of sites to be impacted, it is still felt that the cumulative impacts of the Proposed Modification on Aboriginal cultural heritage values will be negligible. As the study area is completely surrounded by active and past mining landscapes, the study area *has* been radically changed, and while people could 'walk' there, there is little opportunity for this landscape to return to its pre-1788 form. As the landscape is irrevocably changed (mostly as a result of soil loss during the agricultural land use of the area) and is surrounded by highly modified landforms, its ability to contribute to a wider cultural landscape is greatly diminished.

7 MANAGEMENT AND MITIGATION: ABORIGINAL HERITAGE

7.1 GENERAL PRINCIPLES FOR THE MANAGEMENT OF ABORIGINAL SITES

Appropriate management of cultural heritage items is primarily determined on the basis of their assessed significance as well as the likely impacts of the proposal. **Section 6.8.3** and **Section 6.9** describe, respectively, the significance / potential of the recorded sites and the likely impacts of the proposal. **Section 6.11** concludes that the loss of the four sites liable to be harmed by the Proposed Modification will have a low impact on the region's Aboriginal cultural heritage resource.

The following management options are general principles, in terms of best practice and desired outcomes, rather than mitigation measures against individual site disturbance.

- Avoid impact: this could be achieved by altering the Proposed Modification which would subsequently avoid impact to the recorded Aboriginal sites. If this can be done, then a suitable curtilage around the site must be provided to ensure its protection both during the short-term construction phase of the proposal and in the long-term use of the area. If plans are altered, care must be taken to ensure that impacts do not occur to areas not previously assessed.

- If impact is unavoidable: the disturbance of the Aboriginal sites prior to the proposal commencing will need to be undertaken in accordance with an approved ACHMP.

7.2 MANAGEMENT AND MITIGATION OF RECORDED ABORIGINAL SITES

The complete impact avoidance of newly recorded Aboriginal sites and the previously recorded AHIMS sites by the Proposed Modification is not considered feasible. The BCC ACHMP will be updated to include all additional components of the study area (additional disturbance study area and infrastructure study area), and will include conditions for the management of the surface artefacts prior to the commencement of the Proposed Modification. Management and mitigation of the Aboriginal sites associated with the Proposed Modification will be undertaken in consultation with the Aboriginal community as per Section 3 of the ACHMP.

7.2.1 Recommended mitigation

Should the Proposed Modification be consented, it has been determined that four sites will be harmed as the sites are either within the study area, or closely adjacent to the study area. As all sites are surface manifestations without a subsurface component, the recommended mitigation is to undertake a surface collection of all visible artefacts under the protocol established in Section 6.3.1.1.1 of the BCC ACHMP.

8 RECOMMENDATIONS

Under Section 89A of the NPW Act it is mandatory that all newly-recorded Aboriginal sites be registered with OEH AHIMS. As a professional in the field of cultural heritage management it is the responsibility of OzArk to ensure this process is undertaken.

To this end it is noted that **two Aboriginal sites** were recorded during the assessment.

The following recommendations are made on the basis of proposed impacts arising from the Proposed Modification and with regard to:

- Legal requirements under Section 4.41 of the EP&A Act where actions on a state significant development do not require an AHIP but are rather managed under an ACHMP;
- The legal protection afforded Aboriginal objects under the NPW Act;
- The findings of the current investigations undertaken within the study area; and
- The interests of the Aboriginal community.

Recommendations concerning the study area are as follows:

1. This assessment has noted that the Proposed Modification is likely to harm four Aboriginal sites (Bulga IF-2, BPL5, BPL6 and BOP OS-10). It is recommended that an appropriate mitigation is to salvage all sites through a collection of surface artefacts.
2. The surface collection of all visible artefacts should be undertaken under the protocol established in Section 6.3.1.1.1 of the BCC ACHMP.
3. The BCC ACHMP should be revised in consultation with the Aboriginal community to include the impacts associated with the Proposed Modification.
4. The revised BCC ACHMP that includes the Proposed Modification is to be approved by DP&E before harm occurs at any site associated with the Proposed Modification.
5. Section 6.3.3 of the BCC ACHMP will be followed should human skeletal material be noted either during the salvage of the sites or during the construction of the Proposed Modification.

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PLATES



Plate 1: Area 1. View of the southern extent facing east, predominantly cleared for infrastructure installation.



Plate 2: Area 1. Typical ground surface view showing predominately B-Horizon soils with a light surface cover of conglomerate pebbles.



Plate 3: Area 1. Sample of the vegetation type identified in the eastern portion of the study area.



Plate 4: Area 1. View of recent land clearing in the northern portion of the area.



Plate 5: Area 1. View north along the existing electricity easement and the fenced-off location of Bulga-IF2.



Plate 6: Area 2. View to the south showing the existing vegetation which comprises Area 2.



Plate 7: Area 2. Typical view of the sandy clay soils and ground cover in the area.



Plate 8: Area 2. Sample of the typical vegetation identified in the area.



Plate 9: Area 2. View south of land clearing and disturbance on the western boundary of the area.



Plate 10: Area 3. View east into an existing cleared and modified portion of the area.



Plate 11: Area 3. View of the type of erosion which has occurred in drainage lines in the area.



Plate 12: Area 3. View east showing the remaining vegetation in portions of the area that have not been previously modified.



Plate 13: Area 3. View east, north of the Broke Road realignment, showing recent landform modifications and dam construction.



Plate 14: Area 3. View of ground disturbance and landform modification, with good ground surface visibility.



Plate 15: Area 3. View north along the former Broke Road alignment.



Plate 16: Area 3. View south the locations of Aboriginal site BPL5 and BPL6.



Plate 17: Area 3. View west towards the proposed location for the electricity infrastructure substation.



Plate 18: Area 3. View in the northwest of the proposed electricity infrastructure substation, showing previous disturbance from existing underground infrastructure, ground disturbance and erosion.

APPENDIX 1: ABORIGINAL COMMUNITY CONSULTATION: LOG (STAGES 1–3)

Aboriginal Consultation Log - BOP Modification 3			
Date	**Organisation**	**Comment**	**Method**
16.1.18	Awabakal Traditional Owners Aboriginal Corporation	Expression of Interest (EOI) to be a RAP letters sent by Sheridan Baker (SB)	email
16.1.18	DFTV Enterprises	EOI to be a RAP letters sent by SB	email
16.1.18	Guringai Tribal Link Elders Corporation	EOI to be a RAP letters sent by SB	email
16.1.18	Hunters & Collectors	EOI to be a RAP letters sent by SB	email
16.1.18	Jumbunna Traffic Management Group Pty Ltd	EOI to be a RAP letters sent by SB	email
16.1.18	Kawul Cultural Services	EOI to be a RAP letters sent by SB	email
16.1.18	Lower Wonnaruah Tribal Consultancy Pty Ltd	EOI to be a RAP letters sent by SB	mail
16.1.18	Murra Bidgee Mullangari Aboriginal Corporation	EOI to be a RAP letters sent by SB	email
16.1.18	Carol Ridgeway-Bissett	EOI to be a RAP letters sent by SB	mail
16.1.18	Didge Ngunawal Clan	EOI to be a RAP letters sent by SB	email
16.1.18	Independent Learning	EOI to be a RAP letters sent by SB	email
16.1.18	Independent Learning	SB received automated message that it could not be received.	email
16.1.18	Independent Learning	EOI to be a RAP letters sent by SB	mail
16.1.18	Didge Ngunawal Clan	EOI received to be a RAP	email
17.1.18	JT Management	EOI received to be a RAP	email
24.1.18	Murra Bidgee Mullangari Aboriginal Corporation	EOI received to be a RAP	email
29.1.18	DFTV Enterprises	EOI received to be a RAP	email
26.2.18	Lower Hunter Aboriginal Incorporated	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Jarban and Mugrebea	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	JLC Cultural Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wanaruah Local Aboriginal Land Council	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	DRM Cultural Management	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wonn 1 Contracting	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Tocomwall Pty Ltd	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Aliera French Trading	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Ka-u-ma Pondee Inc.	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wonnarua Cultural Heritage;	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	T&G Cultural Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	T & G Culture Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Widescope Indigenous Group P/L	SB sent cover sheet and stage 2/3 methodology	email

Aboriginal Consultation Log - BOP Modification 3			
Date	**Organisation**	**Comment**	**Method**
26.2.18	Gidawaa Walang Cultural Heritage Consultancy	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wattaka Wonnarua Cultural Consultants Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Hunter Valley Cultural Surveying	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Kayaway Eco Cultural and Heritage Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Muswellbrook Cultural Consultants	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Gomery Cultural Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Waabi Gabinya Cultural Consultancy	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Bunda Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Wonnarua Culture & Heritage	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Mingga Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Deslee Talbott Consultant	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Crimson-Rosie	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Carrawonga Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Aboriginal Native Title Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Giwiirr Consultants	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Breeza Plains Culture & Heritage Consultants	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Wunda Cultural Consultants	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Divine Diggers Aboriginal Cultural Consultants;	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Lower Hunter Wonnarua Council Inc	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Ungooroo Aboriginal Corporation;	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Hunter Valley Aboriginal Corporation	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wonnarua Nation Aboriginal Corporation	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Upper Hunter Wonnarua Council; Wonnarua Elders Council	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Upper Hunter Wonnarua Council Inc; Junburra Aboriginal Consultancy Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Hunter Traditional Owners	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	AGA Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Cacatua Culture Consultants	SB sent cover sheet and stage 2/3 methodology	email

Aboriginal Consultation Log - BOP Modification 3			
Date	**Organisation**	**Comment**	**Method**
26.2.18	Bawurra Consultants;	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Myland Cultural & Heritage Group	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Culturally Aware	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Warragil Cultural Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wurrumay Consultants	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Huckada Dreaming Heritage Group	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Smith Dhagaans Cultural Group	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Yinarr Culture Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Kevin and Laurell Taggart	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Warren Taggart	SB sent cover sheet and stage 2/3 methodology	mail
26.2.18	Ungooroo Cultural & Community Services Inc	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Wallangan Cultural Services	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Ngarramang- Kuri Aboriginal Cultural & Heritage Group	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	JT Management	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Didge Ngunawal Clan	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Murra Bidgee Mullangari Aboriginal Corporation	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	DFTV Enterprises	SB sent cover sheet and stage 2/3 methodology	email
26.2.18	Roger Noel Matthews	SB called, went straight to message bank. Left a message but no reply.	phone
26.2.18	Galamaay Consultant	SB called, said that the call was unable to be completed, and to try again later. Was unable to leave a message.	phone
26.2.18	Cheryl Moodie Consulting	SB there are no contact details available.	
26.2.18	Tocomwall Pty Ltd	SB received an email from Scott Franks: *I have read the attached draft and need clarification on statements made with in the document.* *Section 3 makes the statement: Traditional Owners and Knowledge Holders. Could you please explain how this was confirmed and provide the anthropological researched that was u*sed to come to this conclusion please.	email
27.2.18	Wonnarua Nation Aboriginal Corporation	SB received email from Laurie stating*: Thank You WNAC will reply before the 28 day period.....and supply one worker*	email
27.2.18	Tocomwall Pty Ltd	BS sent response to Scott	email
27.2.18	Roger Noel Matthews	SB second call, went straight to message bank. Left a message but no reply.	phone

Aboriginal Consultation Log - BOP Modification 3			
Date	**Organisation**	**Comment**	**Method**
27.2.18	Galamaay Consultant	SB second call, said that the call was unable to be completed, and to try again later. Was unable to leave a message.	phone
6.3.18	Bunda Consultants	Return To Sender	mail
7.3.18	Divine Diggers Aboriginal Cultural Consultants;	SB received email from Deidre: *Hi ....all seems good to me.* *Thanks Deidre*	email
26.2.18	Didge Ngunawal Clan	SB received an email from Paul and Lilly stating: *Didge Ngunawal Clan agrees to all proposals of survey of methodology*	email

APPENDIX 2: ABORIGINAL COMMUNITY CONSULTATION: STAGE 1

Letter sent to OEH advising of the RAPs for the Proposed Modification

OzArk Environmental & Heritage Management Pty Ltd
ABN: 59 104 582 354

21st June 2018

Office of Environment and Heritage
Hunter Central Coast Region
Locked Bag 1002
Newcastle West 2300
P: 02 4927 3152
E: rog.hcc@environment.nsw.gov.au

Aboriginal Archaeological Impact Assessment - Bulga Coal Complex Modification 2

As you are aware OzArk is currently undertaking Aboriginal heritage consultation as per the OEH "Aboriginal cultural heritage consultation requirements for proponents 2010", for the proposed Bulga Coal Complex Modification 2. As per condition 4.1.6 of the ACHCR's, we would like to advise OEH that the following groups / individuals registered an interest in this project.

1. Lower Hunter Aboriginal Incorporated
2. Jarban and Mugrebea
3. JLC Cultural Services
4. Wanaruah Local Aboriginal Land Council
5. DRM Cultural Management
6. Wonn 1 Contracting
7. Tocomwall Pty Ltd
8. Aliera French Trading
9. Ka-u-ma Pondee Inc.
10. Wonnarua Cultural Heritage
11. T&G Cultural Consultants
12. Widescope Indigenous Group P/L
13. Gidawaa Walang Cultural Heritage Consultancy
14. Wattaka Wonnarua Cultural Consultants Services
15. Hunter Valley Cultural Surveying
16. Kayaway Eco Cultural and Heritage Services
17. Muswellbrook Cultural Consultants
18. Gomery Cultural Consultants
19. Waabi Gabinya Cultural Consultancy
20. Wonnarua Culture & Heritage
21. Mingga Consultants
22. Deslee Talbott Consultant

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23. Crimson-Rosie
24. Carrawonga Consultants
25. Aboriginal Native Title Consultants
26. Giwiirr Consultants
27. Breeza Plains Culture & Heritage Consultants
28. Wunda Cultural Consultants
29. Divine Diggers Aboriginal Cultural Consultants
30. Lower Hunter Wonnarua Council Inc
31. Ungooroo Aboriginal Corporation
32. Hunter Valley Aboriginal Corporation
33. Wonnarua Nation Aboriginal Corporation
34. Upper Hunter Wonnarua Council; Wonnarua Elders Council
35. Upper Hunter Wonnarua Council Inc; Junburra Aboriginal Consultancy Services
36. Hunter Traditional Owners
37. AGA Services
38. Cacatua Culture Consultants
39. Bawurra Consultants
40. Myland Cultural & Heritage Group
41. Culturally Aware
42. Warragil Cultural Services
43. Wurrumay Consultants
44. Huckada Dreamin Heritage Group
45. Smith Dhagaans Cultural Group
46. Yinarr Culture Services
47. Kevin and Laurell Taggart
48. Warren Taggart
49. Ungooroo Cultural & Community Services Inc
50. Wallangan Cultural Services
51. Ngarramang- Kuri Aboriginal Cultural & Heritage Group

Please also be advised the following groups / individuals registered an interest in this project additional to previous correspondence since January 2018:

52. JT Management
53. Didge Ngunawal Clan
54. Murra Bidgee Mullangari Aboriginal Corporation
55. DFTV Enterprises

OzArk Environmental & Heritage Management Pty Ltd
ABN: 59 104 582 354

Please also find attached a sample copy of the notification which was sent to each relevant Aboriginal organisation / individual who may have an interest in the proposed project area.

Do not hesitate to contact our office if you have any queries regarding this matter.

Kind regards,



Sheridan Baker
Consultation Officer

APPENDIX 3: ABORIGINAL COMMUNITY CONSULTATION: STAGE 2

Sample letter sent to the PCWP and the WNAC

BULGA
COAL
GLENCORE

13 December 2017

Chief Executive Officer
Wonnarua Nation Aboriginal Corporation
PO Box 3066
SINGLETON, NSW 2330

Attention: Mr Laurie Perry

Dear Laurie

Bulga Coal Complex:
Modification to SSD – 4960 for extension of mining

As you know, Bulga Coal Management Pty Ltd (BCM) was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014, which related to ongoing operation of the Bulga Surface Operations until 31 December 2035.

During the assessment work for the Environmental Impact Statement (EIS) for the Bulga Optimisation Project (BOP) a detailed cultural values assessment was undertaken from 2012 to 2014. The WNAC provided BCM with a detailed report on your Cultural Heritage Values and recommendations, which was included in the Aboriginal Cultural Heritage Values Assessment Report for that EIS. The Report highlighted values inside the Project Area (such as BMU1 and Loders Creek Grinding Grooves) and those outside the Project Area and included recommendations for mitigation and management.

BCM is now seeking to modify the Open Cut approval (SSD 4960) to access additional coal reserves, including reserves under a tailing storage facility contained within a previously mined open cut area known as Deep Pit. In brief, this modification would entail the extension of the currently approved mining area to the south into the Deep Pit area with minimal additional disturbance being undertaken.

Figure 1 illustrates the proposed mine plan layout in relation to currently approved open cut mining operations. The proposed mine plan will remain within the existing approved Project Area that was assessed in the Values Report. However disturbance for this modification will increase by approximately 21 Ha.

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Bulga Coal Management Pty Ltd ABN 48 055 534 391
For and on behalf of the Bulga Joint Venture

GLENCORE

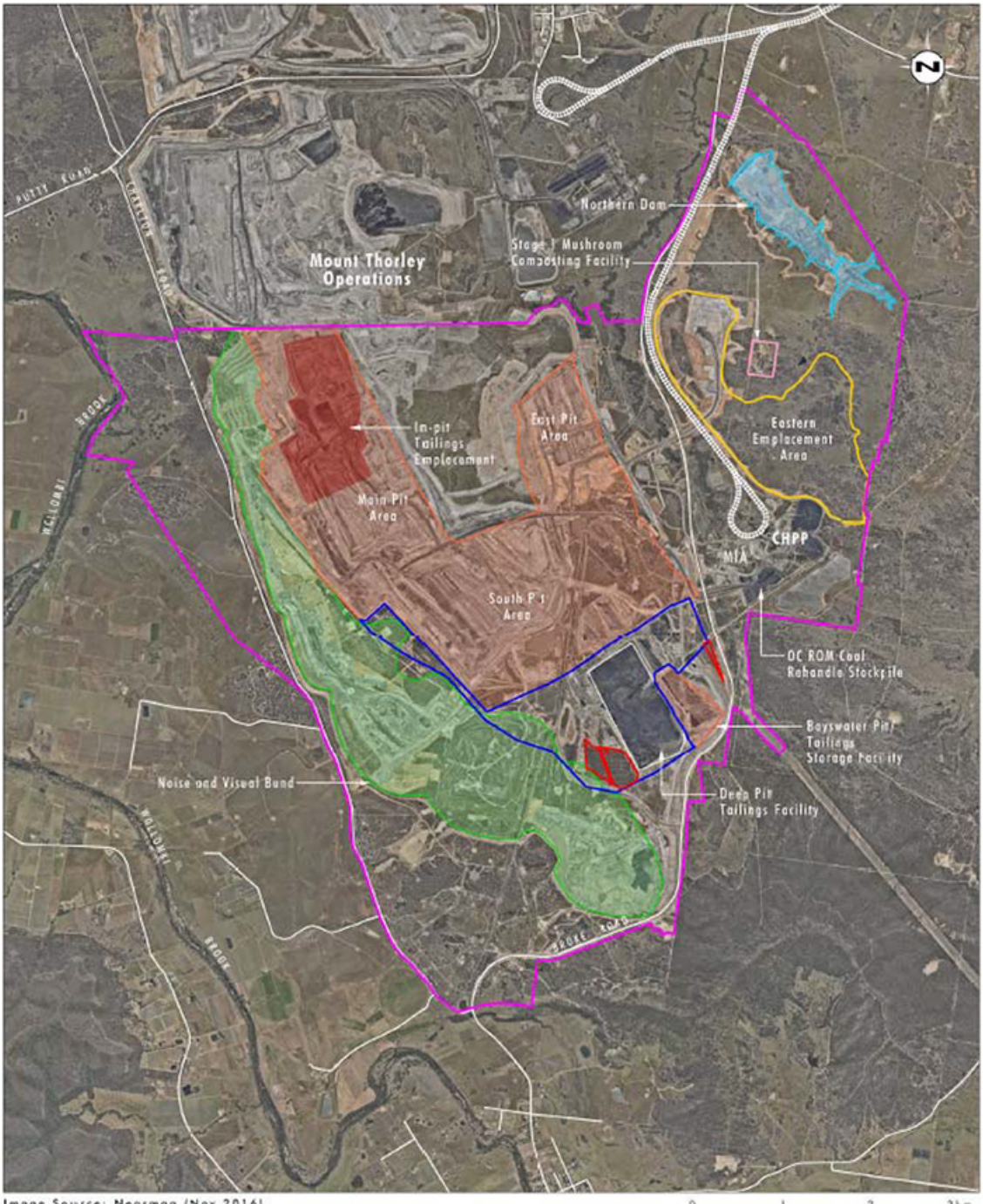


Image Source: Nearmap (Nov 2016)
Data Source: Bulga (2017)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Modification Additional Disturbance Area
- Modification Additional Coal Extraction Area
- BOP Approved Mining Area
- Noise and Visual Bund
- Eastern Emplacement Area
- In-pit Tailings Emplacement
- Northern Dam
- Rail Line

FIGURE 1

Bulga Optimistation Project Modification - Key Features

Page 2 of 3

GLENCORE

Whilst this disturbance area was covered in the previous assessments, the disturbance of this area was not included in the BOP Application.
Two sites, an isolated find and an artefact scatter are known to exist in the proposed area of additional disturbance. Table 1 below lists the identified sites.

Table No.1 Identified Artefact Sites

AHIMS Id.	Bulga EIS Id.	Site Description	Current Status
37-6-3763	Bulga IF-2	An isolated mudstone flake located adajacent to a track	Site was not salvaged as part of BOP salvage program. Would require salvage as part of the proposed Modification.
37-6-2844	BOP OS-10	Low desnisty artefact scatter located in in a mid slope landform, more than 10 artefacts recorded.	The site was partially salvaged in 2015 during BOP salvage program. Would require salvage as part of the proposed Modification.

As part of the assessment for the proposed Modifcation a small additional survey will be required of the additional disturbance area.

In recognition of your considerable input into the BOP Assessment we would like to meet with you to provide an overview of the proposed Modification and discuss any specific recommendations for this area. This could be at the site or at your offices at an agreeable time.

Please contact me on 0439 462416 to arrange a meeting or if you wish to discuss the proposed Modification further.

Kind Regards,

Greg Newton
Approvals Manager

Page 3 of 3

Newsletter produced for community information



Application to change Bulga Open Cut development consent

Bulga Open Cut is currently preparing an application to make changes to our development consent. This proposed modification is entirely within the approved project boundary (limit of activities) as shown on the figure over the page. The key aspects of the modification include relocating tailings so we can mine the coal beneath our tailings storage. The mine life will also be extended by 4 years to 2039. The modification will require the clearing of an additional 21 hectares of Endangered Ecological Community that is currently surrounded by mining activity. Noise and air quality impacts and the final void will be similar to our current approval.

There will be no change to the coal mined every year.

The modification includes:

- Mining will be within our approved current project boundary as shown on the figure on page 2;
- Relocation of approximately 30 million cubic metres of tailings within the existing tailings storage facilities to allow mining of underlying coal;
- Mining additional 64 million tonnes of coal over the life of the mine;
- Extension of the open cut mine life by 4 years to 2039;
- Clearing of additional 21 hectares of Narrow-leaved Ironbark – Bull Oak – Grey Box Shrub Endangered Ecological Community. This clearing will be offset;
- Similar noise and air quality impacts;
- The final void will move slightly to the south and be similar in size to what is already approved. It is predicted that the revised final void will have similar hydrological outcomes (filling and potential spilling).





Environmental assessments

We are preparing the following environmental studies and will update you once we have the results. The studies will include noise, air quality, biodiversity, surface and groundwater, final landform and void, heritage, visual and social impacts.

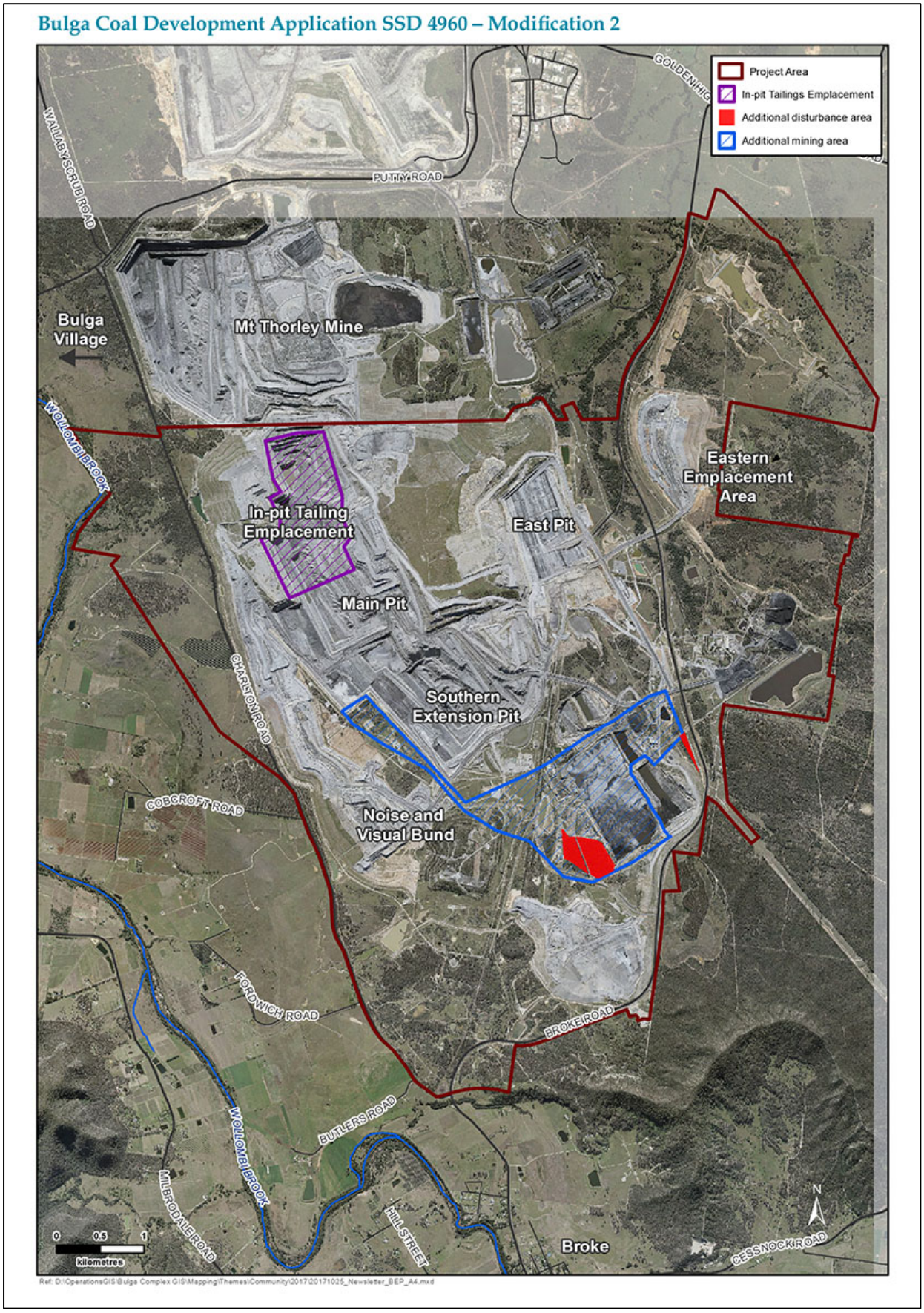
Timeframe

We plan to submit a Statement of Environmental Effects to the Department of Planning and Environment by mid-2018. Before we do this we will provide the results of the studies to our stakeholders.



For more information about the proposed modification, please contact:

Ralph Northey
Environment and Community Manager
(02) 6570 2539 or 0418 439 874
ralph.northey@glencore.com.au


Bulga Coal Development Application SSD 4960 – Modification 2
Project Area
In-pit Tailings Emplacement
Additional disturbance area
Additional mining area
WALLABY SCRUB ROAD
PUTTY ROAD
GOLDEN HIG
Bulga Village
Mt Thorley Mine
WOLLOMBI BROOK
In-pit Tailing Emplacement
East Pit
Eastern Emplacement Area
Main Pit
CHARLTON ROAD
Southern Extension Pit
COBCROFT ROAD
Noise and Visual Bund
FORDWICH ROAD
BROKE ROAD
BUTLERS ROAD
WOLLOMBI BROOK
MILEROAD LE ROAD
HILL STREET
Broke
CESSNOCK ROAD
N
0
0.5
1
kilometres

APPENDIX 4: ABORIGINAL COMMUNITY CONSULTATION: STAGE 3

Letter sent at all RAPs 26 February 2018

OzArk Environmental & Heritage Management Pty Ltd
ABN: 59 104 582 354

26 February 2018

Members

[redacted]

Dear Members,

Re: Aboriginal Archaeological Impact Assessment - Bulga Optimisation Project Modification

Thank-you for your registration of interest to become a Registered Aboriginal Party (RAP) to be consulted over an Aboriginal Archaeological Impact Assessment associated with the Bulga Optimisation Project Modification located within the Bulga Coal Complex in the Singleton Local Government Area. Further information on the location and nature of this proposed modification is contained in the attached document.

The purpose of this letter is to invite you to comment on the enclosed draft Aboriginal Cultural Heritage Assessment Methodology enclosed with this letter. This survey methodology has been sent to you as part of Stages 2 and 3 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*.

In addition to comments on the draft document, if you can share any Aboriginal cultural heritage knowledge relevant to the proposed impact area we welcome this input so as to ensure Aboriginal cultural values are considered. OzArk is required to give you twenty eight (28) days to supply feedback on the attached documents. This period closes on **Wednesday 28th March 2018.** Should you need any help supplying feedback please do not hesitate to contact our office.

Should you have any queries in relation to the enclosed information please do not hesitate to contact our office.

Kind regards,

Sheridan Baker

Consultation Officer

Dubbo | Queanbeyan
HEAD OFFICE: 145 Wingewarra St/PO Box 2069 DUBBO NSW 2830
ph 02 6882 0118 | enquiry@ozarkehm.com.au | www.ozarkehm.com.au

Letter sent at all RAPs 22 March 2018

BULGA
COAL
GLENCORE

22 March 2018

«First_Name» «Last_Name»
«RAP»
«Address_1»
«Address_2»

Dear «First_Name»

Bulga Coal Complex:
Modification to SSD – 4960 for extension of mining

Bulga Coal Management Pty Ltd (BCM) was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014, which related to ongoing operation of the Bulga Surface Operations until 31 December 2035.

During the assessment work for the Environmental Impact Statement (EIS) for the Bulga Optimisation Project (BOP) a detailed cultural values assessment was undertaken from 2012 to 2014. A detailed report on the Cultural Heritage Values and recommendations, was included in the Aboriginal Cultural Heritage Values Assessment Report for that EIS. The Report highlighted values inside the Project Area and those outside the Project Area and included recommendations for mitigation and management.

BCM is now seeking to modify the Open Cut approval (SSD 4960) to access additional coal reserves, including reserves under a tailing storage facility contained within a previously mined open cut area known as the Deep Pit. In brief, this modification would entail an extension within the currently approved mining area with minimal additional disturbance being undertaken. This additional area was within the area surveyed for BOP and covered in the subsequent values report. However, as it is now proposed to be disturbed it is being included in theAboriginal Cultural Heritage assessment for the modification.

On the 26 February 2018 a copy of the *Aboriginal Cultural Heritage Survey Methodlogy – Bulga Optimisation Project Modification February 2018* in relation to this area, was provided for comment. We would like to remind you that comments on this methodology are due back with Ozark by the 28 march 2018.

During your review of the survey methodology you would have realised that this area is approximatley 21 hectares, and therefore the survey is small (2 days of fieldwork 4 an 5 April.. With over 80 Partites registered for Bulga Coal not every Registered Aboriginal Party (RAP) will have an opportunity to be part of the survey fieldwork.

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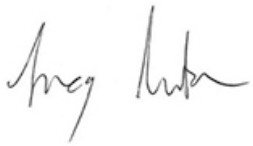
Bulga Coal Management Pty Ltd ABN 48 055 534 391
For and on behalf of the Bulga Joint Venture

GLENCORE

In recognition of this, as part of the ongoing consultation for the Project, if you feel that as part of your connection to country that you would like to visit the study area or discuss the Project further, please contact me on 0439 462416 or at Greg.Newton@glencore.com.au to arrange for a site visit/ meeting.

Kind Regards,



Greg Newton
Project Approvals Manager
Bulga Coal – A Glencore managed company

Page 2 of 2

Letter sent at all Umbrella Service Providers 19 March 2018

BULGA
COAL
GLENCORE

19 March 2018

Ross Pahuru
Hunter Valley Aboriginal Corporation
PO Box 579
Muswellbrook NSW 2333

Dear Ross

Re: Bulga Optimisation Project Modification Archaeological Survey – Umbrella Agreement

Introduction

Further to our recent discussions I have attached a copy of the revised Umbrella Agreement - Supply of Field Workers (October 2016) for your review. This Umbrella Agreement includes updated Schedule of Terms specific to the Modification of Bulga Optimisation Project (in particular Schedule 2 – Form of Project Terms). Other aspects of the Umbrella Agreement remain unchanged.

Further, I would like to confirm that the Aboriginal Archaeological Assessment – field survey component is now scheduled to occur on **Wednesday 4th April** and **Thursday 5th April 2018**. Further details are provided below.

Can you please provide a Registered Aboriginal Parties (RAPs) whom have elected to participate in the Bulga Modification Project fieldwork activities and have indicated they would like to be engaged through the Hunter Valley Aboriginal Corporation, ideally this representative would have the Glencore generic induction and also been involved in the Bulga Optoimisation Project survey and field work (2012 – 2014).

The Project will require one fieldworker for each of the survey field work days.

In addition to the fieldwork, ongoing consultation will continue for the duration of the Project. The offer to all knowledge holders remains that if you would like to visit the Project Area or provide information associated with Aboriginal objects or places of cultural value at any stage, to please contact me to arrange a visit.

Fieldwork Details

General

Work Period: Wednesday 4th April and Thursday 5th April 2018 (weather dependent)

Work Hours: 8:00 am to 3pm (on both days)

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567 Broke Road, Singleton, NSW 2330
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Bulga Coal Management Pty Ltd ABN 48 055 534 391
For and on behalf of the Bulga Joint Venture

GLENCORE

Meeting Location:	Bulga Open Cut Temporary Mine Infrastructure Area (TMIA) (old BOP Construction Offices), transport to survey site will be provided.
Access to Site:	All fieldwork particpants are required to complete an Induction at the Bulga TMIA. All fieldwork particpants are required to sign on and off daily at the Bulga TMIA.

GLENCORE

Safety Requirements

All fieldwork participants must ensure they have the following personal protective equipment and personal items:

- Hi-Vis long sleeved shirt and trousers
- Protective eyewear/sunglasses
- Boots with ankle support
- Gloves
- Wide brimmed hat and sunscreen
- Drinking Water (additional bottled water will be available)
- Lunch and morning/afternoon tea

Site Restrictions and Expectations

Bulga is a Glencore managed site and all fieldwork participants should note:

- Smoking is not permitted anywhere on site or within the Bulga Project Area
- Bulga is a zero alcohol site and all employees and contractors maybe required to complete a BAC prior to entry.
- Mobile phones or other electronic devices are not permitted onsite. If required, and subject to a genuine reason, a Mobile Phone and Portable Electronic Device Authorisation should be completed and signed by an appropriate Bulga representative prior to use.

Way Forward

In accordance with the Terms of the Umbrella Agreement and recent discussions, we ask that the HVAC provide a ratified copy of the Umbrella Agreement - Supply of Field Workers (October 2016) including completed Schedule 4 – Suppliers Declaration and return to me by **23 March 2018.**

If you have any questions in relation to the Umbrella Agreement or upcoming fieldwork, please contact me via the details provide below.

Regards,

Greg Newton
Project Approvals Manager
Bulga Coal – A Glencore managed company

Mob: +61 439 462 416

Page 3 of 3

APPENDIX 5: ABORIGINAL COMMUNITY CONSULTATION: STAGE 4

Letter sent at all RAPs 21 December 2018

OzArk Environmental & Heritage Management Pty Ltd
ABN: 59 104 582 354

21st December 2018

Members
[redacted]

Dear Members,

RE: DRAFT Aboriginal Cultural Heritage Assessment - Bulga Optimisation Project Modification 3

Thank-you for your continued participation as a Registered Aboriginal Party (RAP) and involvement in the above mentioned project.

Bulga Coal Management Pty Limited (the Proponent) would like to offer you the opportunity to provide feedback on the draft report that has been undertaken in accordance with stage four (4) of the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (ACHCR).

As per the ACHCRs we are required to give you twenty-eight (28) days to supply feedback on the attached documents. This period closes on the **Thursday 31st January 2019.** Should our office not be contacted within this time frame, we will presume that you are satisfied with the contents of the report as it stands.

Should you need any help supplying feedback or have any queries, please do not hesitate to contact our office.

Kind regards,

Rebecca Hardman
Consultation Officer

Dubbo | Queanbeyan
HEAD OFFICE: 145 Wingewarra St/PO Box 2069 DUBBO NSW 2830
ph 02 6882 0118 | enquiry@ozarkehm.com.au | www.ozarkehm.com.au

Letter received from the Wanaruah Local Aboriginal Land Council 25 January 2019

Re: Wanaruah Local Aboriginal Land Council response to the Aboriginal Cultural Heritage Survey Methodology for the Bulga Optimisation Project Modification Report.

To whom it may concern.

The response by OZARK to our response to the methodology is an excellent example of our complaint in the first paragraph of our initial response.

It is always disappointing to read reports that are grossly inaccurate in their representation of facts. Not unsurprisingly this report is no less disappointing than most others produced for Glencore. Why many of the consultants who are employed by Glencore are unable to accurately reflect or communicate in an effective way the Aboriginal Cultural Heritage for the areas studied, brings in to question the honesty, and integrity (and/ or the capability) of both Glencore and the consultants.

Yes we called it a report instead of a methodology. That does not make our comments any less valid. And no we did not comment on the methodology itself because the information supporting it was so inaccurate and shoddy that it was not worth commenting on and nor should Aboriginal people be expected to make decisions or comments ABOUT ANYTHING including methodologies if the supporting documentation cannot allow for informed decisions. As pointed out in our original comments,

This misinformation prevents Aboriginal people and others making informed decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.

The responses to our issues have been fobbed off as irrelevant with statements like "They did not understand" if they actually thought that OZARK would have made contact with us to clarify. Nor were we given any opportunity to respond to their criticisms. Instead they chose to pretend we are at fault and they have done nothing wrong. How convenient for them. Again as we put in our letter

This is this kind of shoddy reporting is usually presented to minimise any opposition to the activity and minimise any offset or compensation for destruction of Aboriginal cultural sites and values.

It would also appear (based on what has been written in the report) the consultant has confused or does not know the difference between a "Native Title Claimant Group" and a "Knowledge Holder". Although there may be knowledge holders in those groups, they are not THE knowledge holders. Nor are they the only groups with knowledge holders, and not all knowledge holders are part of a group. Some choose not to share their knowledge for fear of its misuse by others claiming it as their own and profiteering from it. The practice of falsely claiming community or family knowledge as personal knowledge is one the LALC has seen occur in the Hunter by unscrupulous individuals trying to bolster their claim and assertion of rights to country that is not theirs to claim solely.

Wanaruah LALC reiterates that we believe both the methodology and this report should have to be redone from scratch with a new consultant as the current one does not seem to be able to grasp what it is they are supposed to be doing, instead only paying lip service to the requirements.

Aboriginal Cultural Values are embedded in the landscape. Although spiritual value may be part of the cultural value of an area it is not the only indicator of Cultural Value. As we stated in our response to the methodology,

When discussing Cultural Values and Cultural Land Scape Values it is important to remember that the types of historical things culturally important to non-Aboriginal people are the same types of things culturally important to Aboriginal people. Often when discussing Aboriginal Heritage Cultural Value is applied incorrectly only to those areas of "spiritual significance" ignoring all of the other landscapes and sites with "Cultural Value". You only need look to see that the majority of the culturally significant places to all communities are those that historically housed, fed, clothed, educated and entertained people, not just churches and other places of ceremony or worship. The evidence shows that this area and landscape was a place that historically housed, fed, clothed, educated and entertained Aboriginal people. So the only conclusion that could be reached is that this landscape is culturally significant. As more and more of it is destroyed by mining impact the remaining areas increase in their significance and need for protection. This misinformation prevents Aboriginal people and others making informed decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.

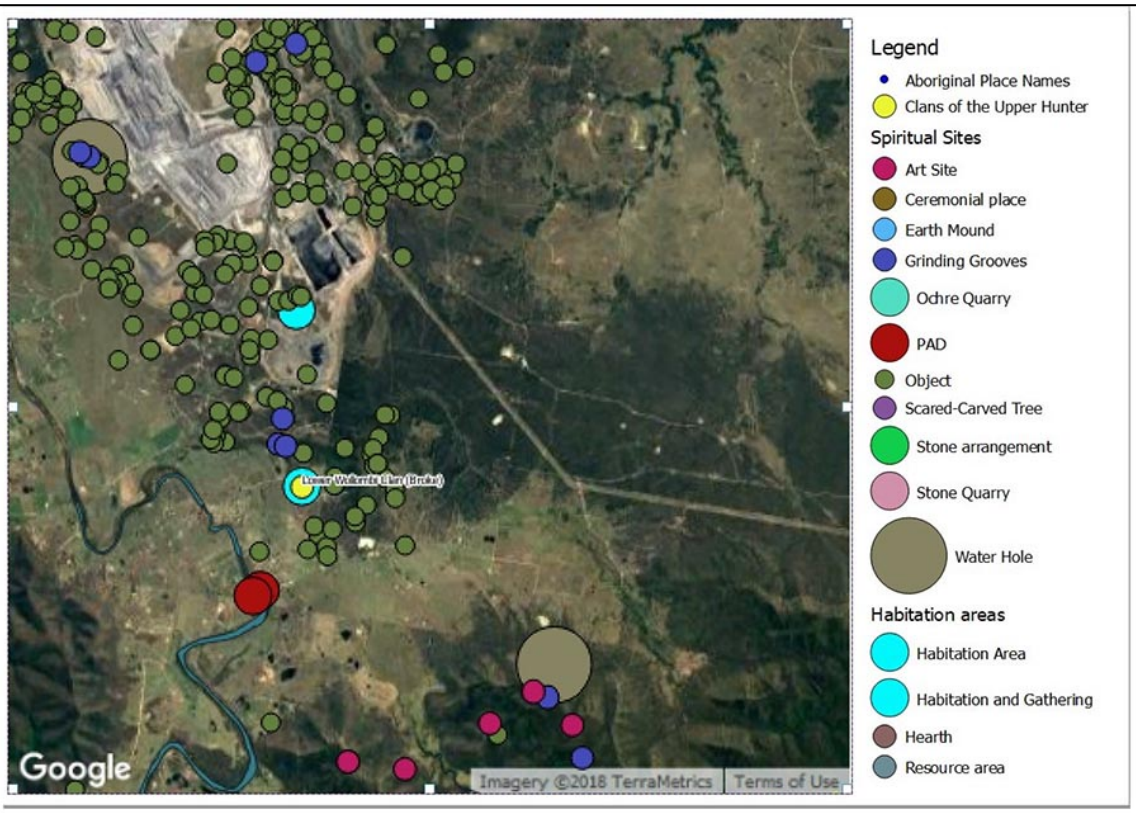
So to assess the cultural value of an area you actually need to look at that area as part of a landscape. However as usual the consultant has only looked at the area of direct impact. This not only neglects the impact this will cause to the holistic landscape, it also fails to consider the cumulative impacts… How convenient for the proponent. Not only is this disappointing but it is a failure to adequately assess the area. If people and companies do not want to do the job properly then they should not put their hand up to do them.

The report continues on about how much disturbance there has been because of agriculture. Our response is SO WHAT? There has been ground disturbance and yes the archaeological record has been damaged. That does not affect the cultural value of the land. Yes there has been ploughing, tree removal and erosion, but that has not radically changed the landscape. It is still the same valley with the same waterways and evidence of past occupation. People could still walk, fish, hunt, gather and conduct ceremony here, and with rehabilitation the land could be returned to a state similar to that pre settlement. Open Cut Mining however WILL radically change the landscape it will destroy much of the cultural values of the landscape.

This resource rich area fed people and supplied pretty much all they needed. It was traditionally (to the Baelpin) and is still today (to the local community) a very culturally significant place.

As we shared earlier

The area is close to a known junction of two Aboriginal transit ways (song lines), it is not far from where there were once grinding grooves and other sites of significance. There were also waterways which had permanent flow (though some of that was, and may still exist, underground). In 1842, some 10 Aboriginal people of the Lower Wollombi clan (Kineland/ Ellalong Clan part of the Baelpin dialect group) were still residing in the area and there are numerous recorded sites of significance in the near vicinity. The number of recorded objects found shows that in short an area that would have been utilised by the local people for millennia prior to colonisation.



Wanaruah LALC does not believe this report is compliant with the legislation. We do not support the conclusions reached. Nor do we support the mitigation offered. And will not until the report has considered the landscape beyond the area to be impacted, to enable proper assessment of the cultural value of the area to be impacted. Otherwise you are doing the equivalent of a safety check on a car by checking only one of its tyres. Business' that do that when caught are fined or lose their licence.

As we wrote in our original response to the methodology,

Wanaruah is severely disappointed with Bulga Coal and its consultant over this report. If the people responsible worked for the LALC they would find they had seven days to explain why they should continue to be employed and what steps they intend to take to rectify wasting so many people's time and resources.

Yours truly

Noel Downs
CEO

APPENDIX 6: ARCHAEOLOGICAL SURVEY METHODOLOGY

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Environmental and Heritage Management P/L

View across a portion of the study area adjacent to Broke Road.

ABORIGINAL CULTURAL HERITAGE SURVEY METHODOLOGY

Bulga Optimisation Project Modification

Singleton LGA

March 2018

OzArk EHM
145 Wingewarra St
(PO Box 2069)
Dubbo NSW 2830

Phone: (02) 6882 0118
Fax: (02) 6882 0630
enquiry@ozarkehm.com.au
www.ozarkehm.com.au

Prepared by
OzArk Environmental & Heritage Management Pty Ltd
for
Bulga Coal Management Pty Ltd

DOCUMENT CONTROLS

Proponent	Bulga Coal Management Pty Limited		
Client	Umwelt (Australia) Pty Limited		
Project No / Purchase Order No			
Document Description	*Aboriginal Cultural Heritage Survey Methodology. Bulga Optimisation Project Modification*		
	Name	Signed	Date
Clients Reviewing Officer			
Clients Representative Managing this Document		OzArk Person(s) Managing this Document	
		Ben Churcher	
Location		OzArk Job No.	
		1777	
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FINAL V3._once latest version of draft approved by client		V3.0 BC adds RAP responses 28/3/18	
Prepared For		Prepared By	
Kirsty Davies Senior Environmental Consultant Umwelt (Australia) Pty Limited 75 York Street Teralba, NSW 2284		Ben Churcher Principal Archaeologist OzArk Environmental & Heritage Management Pty. Limited 145 Wingewarra Street (PO Box 2069) Dubbo NSW 2830 P: 02 6882 0118 F: 02 6882 6030 ben@ozarkehm.com.au	

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Enquiries should be addressed to OzArk Environmental & Heritage Management Pty Ltd.

Acknowledgement

OzArk acknowledge Traditional Owners of the area on which this assessment will take place and pay respect to their beliefs, cultural heritage and continuing connection with the land. We also acknowledge and pay respect to the post-contact experiences of Aboriginal people with attachment to the area and to the elders, past and present, as the next generation of role models and vessels for memories, traditions, culture and hopes of local Aboriginal people.

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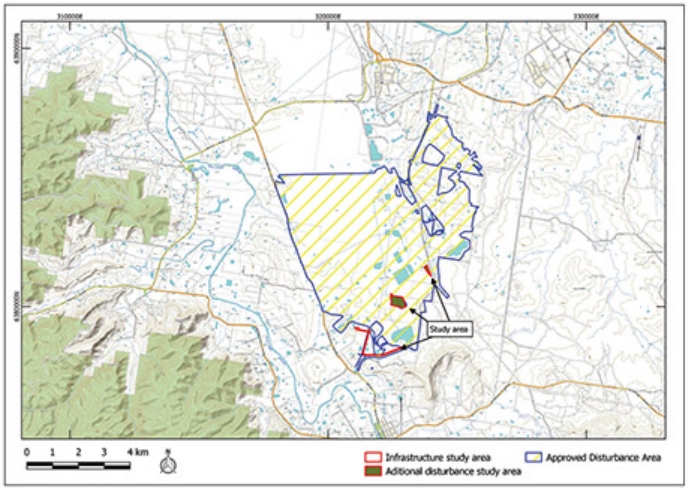
1 INTRODUCTION

1.1 BRIEF DESCRIPTION OF THE PROPOSED MODIFICATION

OzArk Environmental & Heritage Management (OzArk) has been engaged by Umwelt (Australia) Pty Limited (Umwelt) on behalf of Bulga Coal Management Pty Limited (BCM; the proponent) to complete a field survey methodology regarding Aboriginal cultural heritage values associated with the Bulga Optimisation Project Modification (Proposed Modification) located within the Bulga Coal Complex (BCC) in the Singleton Local Government Area (LGA) (**Figure 1-1**).

Figure 1-1: Location map of the study area in relation to the approved BOP Disturbance Area.



1.2 BACKGROUND

BCM was granted approval for the Bulga Optimisation Project (BOP) on 1 December 2014 (SSD 4960), which related to ongoing operation of the Bulga Surface Operations until 31 December 2035. The approval was granted by the Planning Assessment Commission (under the delegation from the Minister for Planning). SSD 4960 was subsequently modified (SSD 4960 Mod 1) in January 2017 to facilitate a revised Eastern Emplacement Area design and a revised tailing management strategy.

BCM is seeking to modify SSD 4960 to access additional coal reserves under a tailing storage facility contained within a previously mined open cut area known as the Deep Pit Tailings Storage

Facility (Deep Pit). The Proposed Modification would entail the extension of the currently approved mining area to the south into the Deep Pit area with minimal additional disturbance being undertaken.

1.3 PROPOSED WORK

The overall BOP Project Area has been previously extensively assessed, including a detailed cultural heritage assessment. There are, however, small areas within the BOP Project Area that were not previously proposed for disturbance which will now be part of the Proposed Modification disturbance area. These small areas were not assessed for the BOP and have therefore not been recently assessed for Aboriginal cultural heritage values.

It is assumed in this methodology that all areas assessed will be impacted by activities associated with the Proposed Modification. These activities are associated with the proposed extension of open cut mining and from the installation of electricity infrastructure and the construction of access roads.

1.4 STUDY AREA

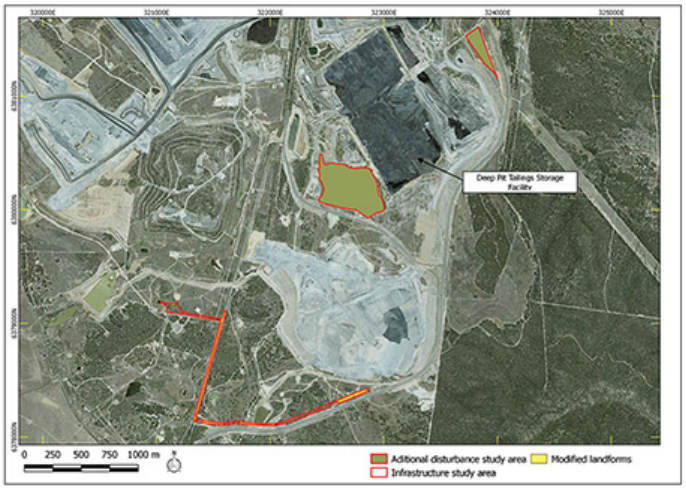
This methodology will concentrate on those landforms within the Proposed Modification that have been minimally impacted by approved mining activities and have not previously been approved for disturbance as part of the BOP. These include an area termed here as the 'additional disturbance area' which includes two non-contiguous areas to the southwest and to the east the current Deep Pit, and the 'infrastructure study area' that includes the route of a power line and the footprint of a power station. The additional disturbance area is approximately 21 hectares in size and the infrastructure study area is approximately 7.5 hectares in size. This equates to a total assessment area of approximately 28.5 hectares (**Figure 1-2**).

Figure 1-2 only shows those portions of the Proposed Modification that are occurring in relatively unmodified landforms. However, even within this area there are approximately 3.8 hectares of highly modified landforms as shown on **Figure 1-2**. These areas include a waste emplacement, a dam, the former Broke Road and its verges, and other areas of tracks and laydown areas. The remaining approximate 24.7 hectares has been impacted by past agricultural practices, minor tracks and drill pads but is less disturbed than the 3.8 hectares of 'modified landforms' that are highlighted on **Figure 1-2**.

1.5 ASSESSMENT APPROACH

The Aboriginal cultural heritage assessment of the study area will follow the *Code of Practice for the Investigation of Aboriginal Objects in New South Wales* (Code of Practice; DECCW 2010). The field inspection will follow the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales* (OEH 2011).

Figure 1-2: Aerial showing the Proposed Modification study area.



1.6 CONSULTATION FOR THIS SURVEY METHODOLOGY

A draft of this methodology was sent to all Registered Aboriginal Parties (RAPs) for the Proposed Modification on 26 February 2018. As set out in the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, RAPs were provided with 28 days in which to review the draft and offer any comment on the proposed survey methodology (a sample Stage 3 cover letter is provided in **Appendix 1**). The closing date for comment was Wednesday 28 March 2018. At the conclusion of the review period, a number of responses had been received (**Table 1-1**), however, only the response from Scott Franks (Tocomwall) necessitated an addition to the survey methodology (Footnote 1 added to **Section 3.3.2**).

Table 1-1: RAP responses to the draft of this survey methodology.

Date	RAP	Comment
26.2.18	Tocomwall Pty Ltd	Sheridan Baker (SB) received an email from Scott Franks: *I have read the attached draft and need clarification on statements made with in the document.* *Section 3 makes the statement: Traditional Owners and Knowledge Holders. Could you please explain how this was confirmed and provide the anthropological researched that was used* to come to this conclusion please.
27.2.18	Wonnarua Nation Aboriginal Corporation	SB received email from Laurie stating: *Thank You WNAC will reply before the 28 day period.....and supply one worker*
27.2.18	Tocomwall Pty Ltd	Ben Churcher (BC) sent response to Scott Franks (Tocomwall): Hi Scott, Sheridan passed on you question for me to respond to.

Date	RAP	Comment
		The use of the terms 'Traditional Owners' and 'Knowledge Holder' in Section 3.3.2.1 is a direct quote from the 2013 BOP EIS. The use of the term 'Traditional Owner' in Section 3.3.2.2 has also been taken from the 2013 BOP EIS. We both know that these terms were bandied about without too much thought in the BOP ACHAR by Jane (I don't think Jane even defines who she is talking about when she mentions 'traditional owners'). Our use of the terms is not us agreeing with Jane's designations/terms but just quoting the 2013 document which will inevitably be drawn on for this assessment. I could put in a footnote to say something like: *The use of the terms 'traditional owner' and 'knowledge holder' were used generically in the 2013 EIS and was not based on documented research to identify the individuals these terms may apply to.* Thoughts? Ben To date no further response from Scott Franks has been received.
7.3.18	Divine Diggers Aboriginal Cultural Consultants;	SB received email from Deidre: Hi ....all seems good to me. Thanks Deidre
19.3.18	Hunter Traditional Owners	SB received email from Paulette: PAULETTE RYAN here I would like to put in a expression of interest in the upcoming of work Kind Regards Paulette Ryan HTO
26.3.18	Didge Ngunawal Clan	SB received an email from Paul and Lilly stating: Didge Ngunawal Clan agrees to all proposals of survey of methodology.
29.3.18	Wanaruah Local Aboriginal Land Council	SB received a response from the Wanaruah Local Aboriginal Land Council. This is presented in **Appendix 2**.

1.6.1 Wanaruah Local Aboriginal Land Council response

On 29 March 2018 OzArk received a response to the draft survey methodology from the Wanaruah Local Aboriginal Land Council (Wanaruah LALC; **Appendix 2**).

It would appear that the Wanaruah LALC have misunderstood the document as it is not an assessment report as is implied in the Wanaruah LALC response, but rather a survey methodology. As such, the Wanaruah LALC do not comment on the proposed survey methodology but rather concentrate on the background information that has been used to inform the formulation of the predictive model for site location within the study area.

While respecting the views of the Wanaruah LALC, the following points are made:

- Comment on **Figure 3-2** as presented in this methodology: this is purely a product of scale and **Figure 3-2** accurately shows all previously recorded sites within the vicinity of the study area. OzArk is aware that there are more sites beyond the limit of **Figure 3-2** but these are not directly associated with the current study area.
- Comment on landform assessment: OzArk has accurately portrayed the landforms associated with the study area. OzArk is aware of the changes to landscape features that have occurred in the past 200 years and this is taken into account in the assessment of landforms associated with the study area.
- Comment on the association of the study area to areas of known cultural values. OzArk accepts the views of the Wanaruah LALC on the cultural values of the study area and will

include this information in the assessment report. During the survey, a focus of the assessment will be to determine, in consultation with the attending Aboriginal community, whether specific cultural values exist within the study area.

- Comment on disturbances within the study area: OzArk does not state that previous disturbances have removed all evidence of Aboriginal cultural heritage material culture from the study area. Rather, previous disturbances are noted to predict that should Aboriginal sites such as artefact scatters be recorded in the study area that they are likely to lack integrity. Full survey of the study area will take place to test this prediction.

2 LANDSCAPE CONTEXT

An understanding of the environmental contexts of a study area is a requisite in any Aboriginal archaeological investigation (DECCW 2010). It is a particularly important consideration in the development and implementation of survey strategies for the detection of archaeological sites. In addition, natural geomorphic processes of erosion and/or deposition, as well as humanly activated landscape processes, influence the degree to which these material culture remains are retained in the landscape as archaeological sites; and the degree to which they are preserved, revealed and/or conserved in present environmental settings.

2.1 TOPOGRAPHY AND HYDROLOGY

The study area is located in flat and gently sloping landforms distant to permanent or semi-permanent water (**Figure 2-1**).

The closest major source of water to the study area is the Wollombi Brook located approximately three kilometres to the west of the study area. Monkey Place Creek, a tributary to the Wollombi Brook, is located approximately 780 metres south of the study area.

Prior to recent disturbances, minor tributaries to the Wollombi Brook once intersected with the infrastructure study area (**Figure 2-2**). However, these drainages, in the vicinity of the study area, are no longer evident as they have been channelled beneath the former Broke Road alignment. Nine Mile Creek is located approximately 150 metres east of the additional disturbance study area that is located to the east of the Deep Pit. Although now separated from the creek by the realigned Broke Road, some landforms within the additional disturbance study area are within 200 metres of semi-permanent water. Such landforms that are generally recognised as having a heightened archaeological sensitivity.

Previous archaeological studies in the region have demonstrated the close correlation between Aboriginal site location and the distance to permanent water with larger, more complex sites most often being associated with the larger drainage systems (see **Section 3.3.1**). As these systems are generally distant to the study area the implication is that it is unlikely that the study area contained, or even once contained, large, complex sites.

Figure 2-1: Topography of the study area.

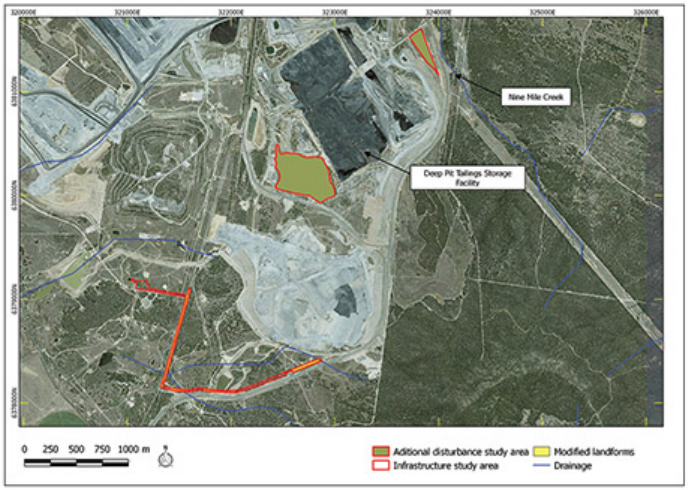


1. View of the flat landform within the additional disturbance study area to the west of the Deep Pit.



2. View of the flat landform in the west of the infrastructure study area.

Figure 2-2: Hydrology in the vicinity of the study area.



2.2 VEGETATION

The vegetation of the study area has been heavily modified from its natural state. In the additional disturbance study area to the west of the Deep Pit, vegetation consists of paper barks (Melaleuca), Casuarina and iron bark species. However, the soils appear sandy and nutrient poor, and as the majority of trees are regrowth, the indication is that the entire area was cleared in the

past. The implication is that certain site types, such as culturally modified trees, will be extremely unlikely in this area because, if they ever existed, they would have been removed during the land clearance phase of the area's history.

In the additional disturbance study area to the east of the Deep Pit, vegetation consists of regrowth Eucalyptus woodland. Being associated with Nine Mile Creek, this portion of the additional disturbance study area would have been cleared early in the history of European farming in the area and has probably suffered from widespread soil loss.

Other portions of the study area remain largely cleared and consist of paddock grasses and scattered stands of regrowth trees (primarily Casuarina and iron bark).

Some more-mature trees were noted along the road verge of the former Broke Road. However, none appear mature enough to contain cultural modification.

2.3 LAND USE HISTORY AND EXISTING LEVELS OF DISTURBANCE

The study area has generally been impacted to a high degree during the agricultural phase of the area's history. This includes the previously noted vegetation clearance that has led to widespread soil loss as evidenced by the generally nutrient-poor, thin topsoil across the study area.

In addition, the area has been subject to intensive approved mining activities over recent years with roads, tracks, drainage bunds and fences being constructed.

The result is that very little of the study area can be regarded as unmodified and most portions display disturbances either from agricultural land uses or approved mining associated activities.

2.4 CONCLUSION

The study area presents a landscape unlikely to contain large, complex sites that would retain any form of structural integrity.

As the study area is located away from permanent water sources in undifferentiated landforms, the likelihood of the study area containing sites is dramatically lowered. In the region, landform units away from water, such as ridgelines, can contain sites, however, these are absent from the study area.

While smaller, more ephemeral sites may have once existed in the study area, it is likely, due to the widespread disturbances from both agriculture and mining, that these sites have either been previously destroyed or dispersed.

3 ARCHAEOLOGICAL CONTEXT

3.1 INTRODUCTION

The study area is located in an area where the archaeological values are largely known due to the high amount of previous assessment either within the study area or in immediately adjacent landforms.

This survey methodology will limit itself to those studies that are directly applicable to the study area although the predictive model for site location will consider the broader archaeological context of the district.

3.2 ANTIQUITY OF ABORIGINAL OCCUPATION

The Aboriginal occupation of Australia begins prior to 40,000 BP (years before present) and possibly earlier than 50,000 BP. Dates exceeding 20,000 years occur in almost all parts of Australia resulting in the expectation that most areas should have a Pleistocene (>12,000 BP) occupational signature. However, such dates remain relatively rare due to a range of factors, both behavioural and post-depositional. These factors include a possible low density of occupation in the Pleistocene period, poor preservation of archaeological materials (particularly dateable organic materials) and significant coastline change over the past 18,000 years.

In 1986, Koettig undertook an archaeological survey between Glennies Creek and Singleton (cited in Umwelt 2003). Following that survey, Koettig carried out several excavations at six locations along Glennies Creek. Koettig considered artefacts found in Site SGCD 16 (about one metre deep in Unit B of on an old alluvial terrace) were 'markedly different' to artefacts recovered from the artefacts in Unit A. Her conclusion was formed on the basis of the raw material used, large number of cores, the large percentage of cortex remaining on artefacts and larger sizes of artefacts. Artefacts from Unit B were from volcanic rocks while those in Unit A were predominantly mudstone and silcrete. Later, a date of >20,200 BP was obtained from a hearth associated with the artefacts placing the site well into the Pleistocene.

3.3 PREVIOUS ASSESSMENTS WITHIN OR NEAR THE STUDY AREA

3.3.1 Background

The large number of archaeological studies undertaken within the vicinity of the study area provides information to obtain a sound understanding of the nature and distribution of archaeological sites within the area. Although there is some conjecture about the relationship between stream order, site numbers and densities, the general pattern is that the majority of sites are present within 30 metres of watercourses (Dean-Jones 1992: 26–27; AMBS 1997: 29). Although sites are present in locations at a greater distance from water, these sites are limited in terms of both number and size, constituting a lower density scatter than is found along the creek

lines (Dean-Jones 1992: 24; ERM 1999: 22–23). The majority of sites are small, with larger sites typically found in association with permanent watercourses. Reduced visibility has been proffered as an explanation for the higher number of sites and artefacts present along the more heavily eroded and less vegetated minor watercourses as compared to major creeks (Umwelt 2004: 7.7; ERM 1999: 84).

3.3.2 Assessment for the BOP

The assessment area for the BOP covered approximately 3615 hectares and portions of the assessment area are located directly adjacent to portions of the current study area.

Connect for Effect Pty Limited (Connect for Effect) were engaged by BCM to undertake Aboriginal community consultation for the BOP assessment and to author the Aboriginal Cultural Heritage Assessment Report (ACHAR) to which OzArk 2013 contributed (Connect for Effect 2013). Also contributing to the ACHAR were confidential cultural values assessments authored by two Wonnarua Knowledge Holder groups, the Plains Clans of the Wonnarua People and the Wonnarua Nation Aboriginal Corporation. The Connect for Effect ACHAR appeared as Appendix 13a (Parts 1 and 2) of the BOP *Environmental Impact Statement* (EIS) (Umwelt 2013). Connect for Effect 2013 contains the cultural, aesthetic and historic values of the area, while OzArk 2013 contains an examination of the scientific values of the area.

3.3.2.1 Cultural values

Umwelt 2013: 193 summarises the cultural values of the BOP Project Area in which the study area is located:

> *RAPs identified the* [BOP] *Project Area to be of high social, cultural and spiritual significance to Traditional Owners*[1] *and Knowledge Holders and other RAPs, because it has spiritual and ceremonial associations to extremely high value sacred Creation and ceremonial places located within the region.*
>
> *The* [BOP] *Project Area contains a number of specific archaeological sites of high cultural significance to RAPs including Traditional Owners and Knowledge Holders. The* [BOP] *Project Area was also identified as an area of continuing traditional and historic association for local Aboriginal families, which has been described as significant, although it is noted that the* [BOP] *Project Area has been subject to mining activity for the past 30 years.*

[1] The use of the terms 'traditional owner' and 'knowledge holder' were used generically in the 2013 EIS and was not based on documented research to identify the individuals these terms may apply to.

Key cultural values identified in the cultural values assessment included the Loders Creek grinding grooves and the significance of items in the cultural landscape located outside of the BOP Project Area such as Baiame Cave and Lizard Rock.

In response to a review of the survey methodology the Wanaruah LALC provided comment on the cultural values of the study area. These are presented in **Appendix 2**.

3.3.2.2 Historic values

The historic narrative presented in Connect for Effect 2013 identified that the BOP Project Area is associated with a range of historic persons, phases, activities and events, with written records, oral histories and archaeology all contributing to a holistic and multi-faceted understanding of the Aboriginal histories of the area (Umwelt 2013: 194). RAPs who identified Traditional Owner connections shared direct historical experiences of their attachment to the BOP Project Area and also throughout the local area of Broke, Bulga, The Vere and Jerry's Plains; which add cultural meaning to the place and was expressed as having high cultural values.

3.3.2.3 Aesthetic values

RAPs expressed a range of sensory perceptions in relation to the BOP Project Area. It was acknowledged that past land use and current mining has contributed to the loss of over 2000 hectares of land, and has contributed to the loss of connectivity and pathways, disruptions to waterways, and disruption to the spiritual meanings and symbolism contained in the landscape. However, RAPs identified and retained heightened emotional cultural connection and concern for the BOP Project Area and its cultural and archaeological values, which was described by some RAPs as being located within a place where there are the spirits of their ancestors, the memories of ancestors and the footprints (archaeological sites) of their ancestors (family) ceremonial and societal ways of life (Umwelt 2013: 194).

3.3.2.4 Scientific values

A number of previous surveys had identified discrete sites, predominately located along drainage lines within the BOP Project Area. The approach taken by OzArk to site recording was that individual sites considered to be linked by geographical proximity were grouped into a broader site complex. The site complexes generally consisted of amalgamations of stone artefact sites, apart from two complexes that also contained grinding groove sites. Most of the site complexes included sites which had been previously recorded as individual sites. The survey undertaken for the BOP identified 14 site complexes covering an area of approximately 198 hectares, nine open sites and six isolated finds within the BOP disturbance area. The two grinding groove sites at Loders Creek and BMU1 were included within the site complexes.

A further 42 previously recorded sites were located outside these areas but within the BOP disturbance area making, in total, 71 sites that were partially or totally impacted by the BOP. The majority of these sites were low density artefact scatters or isolated finds.

Sites recorded by the BOP assessment that are closest to the current study area include BOP OS-9 (37-6-2843; recorded just south of the treed area in the current assessment) and BOP OS-10 (37-6-2844; recoded within the proposed electricity line easement in the south of the current study area).

BOP OS-9 was described as:

> *BOP OS-9 is located on the edge of a remnant patch of regenerating woodland surrounded by heavy disturbance from mining activities in the southwest of the Project Area. The site is located in an area adjacent to where a drainage diversion channel has been built. Although the site is free of invasive disturbances, the general area has been heavily affected by past agricultural land uses and general mining activity including revegetation programmes. Most of the A Horizon soils have been removed by sheet wash erosion from the area of BOP OS-9 and most artefacts were recorded resting on the gravel lag on top of the B Horizon clay. As a result, most artefacts recorded have been displaced (probably from within the vicinity) and there is little possibility of further subsurface archaeological deposits.*
>
> OzArk 2013: 262.

Approximately 10 artefacts were recorded at BOP OS-9 during the assessment.

BOP OS-10 was described as:

> *BOP OS-10 is located in the very southwest of the Project Area and will be impacted by the proposed Broke Road Realignment. BOP OS-10 is a low density artefact scatter located on a bench in mid slope topography. The site is located about 50m from an ephemeral drainage line. A Horizon soils across the site are thin and there is little possibility for further subsurface archaeological deposits at the site.*
>
> OzArk 2013: 263.

Approximately 10 artefacts were recorded at BOP OS-10 during the assessment.

3.3.3 The BOP salvage program

The BOP salvage program involved the salvage of Aboriginal cultural heritage sites at the BCC during the period 2014–2016. The salvage was undertaken under the auspices of the BCC 2014 *Aboriginal Cultural Heritage Management Plan* (ACHMP) that was approved by the Department of Planning and Environment in 2014. The development of the ACHMP followed the issuing of Development Consent SSD 4960 for the BOP.

During the salvage program, 21 artefacts were collected from BOP OS-9. Of the 21 artefacts salvaged, 16 were mudstone while the remaining five were silcrete. BOP OS-9 was listed as 'destroyed' with the Aboriginal Heritage Information Management System (AHIMS) following the salvage and the area where the site once existed is now under the new Bulga Underground site access road.

At BOP OS-10, four artefacts were recovered from the site during the salvage program, three of them at the junction of a track and a cable easement. The site was only partially salvaged as the southern portions were to be impacted by the new Broke Road alignment leaving the northern portions intact.

3.3.4 2017 Constraints and Opportunities assessment

In 2017 OzArk was commissioned to undertake a constraints and opportunities assessment of the study area (OzArk 2017).

The study noted that the known Aboriginal cultural heritage constraints within the study area are limited to four previously recorded sites and that all of these sites have a low scientific significance and none are associated with further, subsurface archaeological deposits (these sites are discussed further in **Section 3.4**).

In terms of opportunities, the study noted that the Proposed Modification disturbance area is relatively small and is in an area of generally high previous disturbance. As such, it is unlikely that impacts to Aboriginal cultural heritage will be significant. In light of this, the Proposed Modification is not likely to significantly impact inter-generational outcomes or impact significantly on the cumulative loss of cultural heritage sites in the region.

3.4 Other sites in the study area

Apart from BOP OS-10, three further sites are associated with the study area and all remain extant within the landscape: BP L5 (37-6-1659); BP L6 (37-6-1660); and Bulga IF-2 (37-6-3763).

BPL5 and BPL6 were recorded in 2005 by Insite Heritage as part of an assessment for the installation of the Broke water pipeline. Currently AHIMS locates both sites just outside the infrastructure study area on the western side of the former alignment of Broke Road (**Figure 3-1**). However, there is considerable uncertainty over the exact location of these sites as the coordinates provided by the site card place both sites to the east of the former Broke Road and outside of the study area (shown as 'former site location' on **Figure 3-1**)[2], yet sketch maps provided with the site card clearly show the sites to the west of Broke Road. As both sites have

[2] It is suspected that the discrepancy has arisen because although the coordinates are in GDA they have been listed on AHIMS as AGD (and therefore when converted to GDA the site has been erroneously shifted 220m to the northeast and to the other side of Broke Road).

a very low artefact density (BP L5 recorded two artefacts and BP L6 recorded a single artefact) they will be difficult to locate in the current landscape.

Bulga IF-2 is an isolated mudstone flake noted by a BCC contractor and recorded by OzArk in 2016. The site remains extant and is fenced.

These sites, along with all other currently extant sites that have been previously recorded in the vicinity of the study area, are shown on **Figure 3-2**.

All extant sites that remain within the study area are illustrated on **Figure 3-3**.

3.5 Cultural values area

During the BOP cultural values assessment, members of the Aboriginal community identified an area within the BCC as having cultural landscape values. This area, shown on **Figure 3-2**, is outside of the study area but is in close proximity.

Figure 3-1: Aerial showing the current and former locations for sites BP L5 and BP L6.

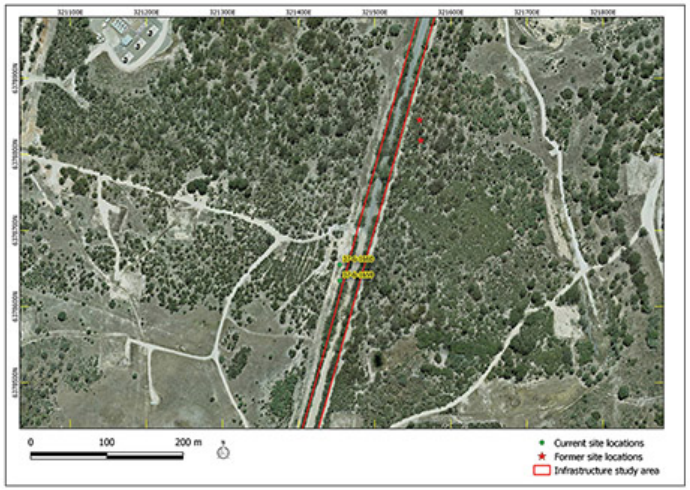


Figure 3-2: Previously recorded sites in the vicinity of the study area.

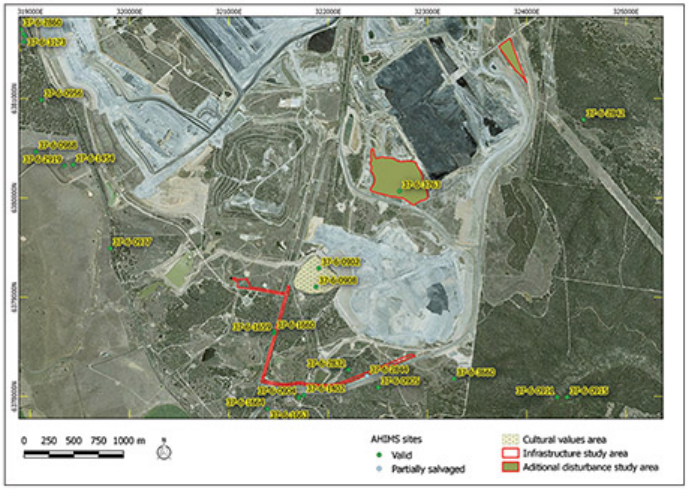


Figure 3-3: Views of the valid sites remaining in or near the study area.



1. View of Bulga IF-2 that remains fenced beside an access track.



2. View of the artefact at Bulga IF-2.



3. View of the now-disused track along which BOP OS-10 was recorded.



4. View of artefacts at BOP OS-10.



5. View of the area in which BP L5 was recorded. No artefacts have been noted at this location during recent inspections during the BCC site monitoring program.

No photograph as no artefacts have been noted recently at BP L5.



6. View of the area in which BP L6 was recorded.



7. View of an artefact recorded recently at BP L6.

4 PREDICTIVE MODEL

4.1 SETTLEMENT STRATEGIES

It has been noted that as a result of past archaeological investigations that there is an established correlation between site location and the proximity to water (see **Section 3.3.1**). As the study area is devoid of any permanent water bodies, it is expected that large and complex sites will be absent from the study area.

4.2 PAST LAND USE

Crucial for the preservation of archaeological deposits is the history of past land use in a particular area. In particular, the European history of the Hunter Valley lowlands, where the study area is located, is a stark example of land mismanagement leading to wide-spread erosion as the dispersible soils were exposed to rain.

Such widespread impacts have undoubtedly affected the archaeological landscape in that many tens of centimetres of topsoils have been removed from areas such as the study area, along with any archaeological deposits they may have contained. With such widespread soil movement it is also important to remember that accumulations of artefacts that may be termed a 'site' today may have, in fact, been washed into that location during the historic period and bear no relationship to past Aboriginal occupation patterns in the area.

4.3 LANDFORM MODELLING

The study area is largely contained within flat or gently sloping landforms. Generally the land is sloping towards the east and is part of the Wollombi Brook catchment.

There are few topographic features within the study area that would have encouraged or hindered past Aboriginal occupation.

The greatest determinant in the likelihood of locating Aboriginal sites in the study area is the distance to permanent water with the majority of the study area being greater than 200 metres from water.

4.4 PREDICTIVE MODEL

Across Australia, numerous archaeological studies in widely varying environmental zones and contexts have demonstrated a high correlation between the permanence of a water source and the permanence and/or complexity of Aboriginal occupation. Site location is also affected by the availability of and/or accessibility to a range of other natural resources including: plant and animal foods; stone and ochre resources and rock shelters; as well as by their general proximity to other sites/places of cultural/mythological significance. Consequently sites tend to be found along permanent and ephemeral water sources, along access or trade routes or in areas that have

good flora/fauna resources and appropriate shelter. In addition, in formulating a predictive model for Aboriginal archaeological site location within any landscape, it is also necessary to consider post-depositional influences on Aboriginal material culture. Generally it is the more durable materials such as stone artefacts, stone hearths, shell, and some bones that remain preserved in the current landscape. Even these, however, may not be found in their original depositional context since these may be subject to either (a) the effects of wind and water erosion/transport - both over short and long time scales or (b) the historical impacts associated with the introduction of European farming practices.

Based on knowledge of the environmental contexts of the study area and a desktop review of the known local and regional archaeological record, the following predictions are made concerning the probability of those site types being recorded within the study area:

- Isolated finds may be indicative of: random loss or deliberate discard of a single artefact, the remnant of a now dispersed and disturbed artefact scatter, or an otherwise obscured or sub-surface artefact scatter. They may occur anywhere within the landscape but are more likely to occur in topographies where open artefact scatters typically occur.
    - As isolated finds can occur anywhere, particularly within disturbed contexts, it is predicted that this site type could be recorded within the study area. Two isolated finds (Bulga IF-2 and BP L6) are known to exist within the study area and this site type is already represented in the landforms comprising the study area.
- Open artefact scatters are defined as two or more artefacts, not located within a rock shelter, and located no more than 50 metres away from any other constituent artefact. This site type may occur almost anywhere that Aboriginal people have travelled and may be associated with hunting and gathering activities, short or long term camps, and the manufacture and maintenance of stone tools. Artefact scatters typically consist of surface scatters or sub-surface distributions of flaked stone discarded during the manufacture of tools, but may also include other artefactual rock types such as hearth and anvil stones. Less commonly, artefact scatters may include archaeological stratigraphic features such as hearths and artefact concentrations which relate to activity areas. Artefact density can vary considerably between and across individual sites. Small ground exposures revealing low density scatters may be indicative of background scatter rather than a spatially or temporally distinct artefact assemblage. These sites are classed as 'open', that is, occurring on the land surface unprotected by rock overhangs, and are sometimes referred to as 'open camp sites'.

  Artefact scatters are most likely to occur on level or low gradient contexts, along the crests of ridgelines and spurs, and elevated areas fringing watercourses or wetlands. Larger sites may be expected in association with permanent water sources.

  Topographies which afford effective through-access across, and relative to, the surrounding landscape, such as the open basal valley slopes and the valleys of creeks, will tend to contain more and larger sites, mostly camp sites evidenced by open artefact scatters.

    - As the study area is within flat or gently sloping landforms distant to permanent water, this site type is not predicted to be common. The moderate degree of

disturbance in the study area will probably mean that the scatter has become displaced. It is likely that any sites associated with the landforms of the study area are likely to have a low artefact density and a low complexity of tool types as the sites are either one-off events or only infrequently used. It is noted that the study area already has recorded two artefact scatters (BOP OS-10 and BP L5) and this raises the possibility that the study area may contain further low density artefact scatters consisting of artefacts manufactured from mudstone and silcrete.

- Aboriginal scarred trees contain evidence of the removal of bark (and sometimes wood) in the past by Aboriginal people, in the form of a scar. Bark was removed from trees for a wide range of reasons. It was a raw material used in the manufacture of various tools, vessels and commodities such as string, water containers, roofing for shelters, shields and canoes. Bark was also removed as a consequence of gathering food, such as collecting wood boring grubs or creating footholds to climb a tree for possum hunting or bark removal. Due to the multiplicity of uses and the continuous process of occlusion (or healing) following removal, it is difficult to accurately determine the intended purpose for any particular example of bark removal. Scarred trees may occur anywhere old growth trees survive. The identification of scars as Aboriginal cultural heritage items can be problematical because some forms of natural trauma and European bark extraction create similar scars. Many remaining scarred trees probably date to the historic period when bark was removed by Aboriginal people for both their own purposes and for roofing on early European houses. Consequently the distinction between European and Aboriginal scarred trees may not be clear.
    - Due to the near-total clearance of trees from within the study area, this site type is predicted to be very rare. It is also noted that this site type is very rare at a regional level.
- Quarry sites and stone procurement sites typically consist of exposures of stone material where evidence for human collection, extraction and/or preliminary processing has survived. Typically these involve the extraction of siliceous or fine grained igneous and meta-sedimentary rock types for the manufacture of artefacts. The presence of quarry/extraction sites is dependent on the availability of suitable rock formations.
    - This site type could be recorded within the study area should suitable rock outcroppings be available.
- Burials are generally found in soft sediments such as aeolian sand, alluvial silts and rock shelter deposits. In valley floor and plains contexts, burials may occur in locally elevated topographies rather than poorly drained sedimentary contexts. Burials are also known to have occurred on rocky hilltops in some limited areas. Burials are generally only visible where there has been some disturbance of sub-surface sediments or where some erosional process has exposed them.
    - Although it is possible that this site type could be found within the study area, it is considered a rare site type especially given the disturbance that has occurred within the study area.

An examination of the landforms within the study area (**Section 2.3**) indicate that the study area is in a degrading environment where soils have been moved from landforms in the study area.

This would have the effect of displacing or impacting archaeological deposits had they existed in the study area.

4.5 Conclusion

In conclusion it can be noted that:

- The landforms of the study area are located at a distance to permanent water sources and this generally precludes the existence of larger Aboriginal sites in the study area;
- There have been a generally high degree of past land disturbance within the study area stemming from long-term agricultural use of the area. This is evidenced by thin, nutrient-poor soils across the study area. Archaeologically this has the effect of removing or dispersing sites had they existed in the study area;
- Large areas of the Proposed Modification disturbance area have been previously modified by approved mining activities. Such activities include waste emplacements, dams, drainage bunds and road/track construction. Archaeologically this indicates that Aboriginal sites are unlikely to be located in these areas;
- There are four known sites within or immediately adjacent to the Proposed Modification disturbance area: two isolated finds, one low density artefact scatter and one partially destroyed low density artefact scatter. The nature of these sites confirm the predictive model that sites in the study area are likely to display low artefact numbers and low site complexity; and
- The study area is located close to, but not within, an area with recognised cultural values although, due to past disturbances, it is unlikely that landforms within the study area will have similar cultural landscape values.

The 2017 site inspection of the study area undertaken by OzArk (OzArk 2017) concluded that non-artefact site types are predicted to be extremely rare and/or non-existent; specifically:

- Culturally modified trees (scarred or carved) are predicted to be extremely rare due to the regrowth nature of the trees within the study area;
- Quarry sites are predicted to be extremely rare as no suitable rock outcropping was noted in the study area;
- Axe grinding groove sites are predicted to be extremely rare as no suitable rock outcropping was noted in the study area and the study area does not contain drainage lines which are often (but not always) associated with this site type;
- Burial sites are predicted to be extremely rare as suitable soils (such as sandy dunefield landforms) are not present in the study area; and
- Other site types such as stone arrangements, are predicted to be extremely rare as the previous agricultural disturbances in the study area are likely to have dispersed any such sites.

5 Survey Methodology

5.1 Background

The following archaeological methodology is based on the understanding that portions of the study area have been previously surveyed and, in some areas, salvaged as a result of past archaeological assessments and works related to mining approvals. In addition, sizeable portions of the study area have been heavily modified by approved mining activities.

For much of the study area there is, therefore, significant knowledge about the location and likelihood of further unidentified Aboriginal objects or sites in many of these previously surveyed areas. As such, from an archaeological perspective, the appropriate survey level is lower in these assessed areas than may be the case in less studied areas. In these areas, data from previous reports, site cards and permits will be used to interpret the landscape if visibility is poor.

All survey will be undertaken with the assistance of Registered Aboriginal Parties (RAP)/ Wonnarua Knowledge Holder representatives. Apart from their valuable experience in recognising and recording archaeological sites, the RAP/Wonnarua Knowledge Holder representatives will be able to acquaint themselves with the study area in order to inform their cultural value assessment of the study area. Any cultural values relating to the study area will be captured by the OzArk archaeologist (either during the survey or subsequently) and included in the ACHAR that will be produced following the survey.

The broader cultural heritage values of the study area and surrounds have been captured as part of the BOP ACHAR (Connect for Effect 2013) and based on the location and nature of the study area the cultural, historic and aesthetic values captured in this document can also be applied to the current study area.

5.1.1 Survey methodology

Standard archaeological field survey and recording methods will be employed in this assessment (Burke & Smith 2004).

The field assessment will be undertaken over the additional disturbance study area and the infrastructure study area. This assessment will include a buffer of at least 50 metres around the outside of the study area (where possible and warranted) and will include the re-visiting and re-recording of any previously recorded sites within 100 metres of the additional disturbance study area and the infrastructure study area to ensure that the site does not extend into areas where proposed impacts are to occur.

Field survey will, wherever possible, be conducted in transects of 100 metre intervals with field surveyors spaced 10 metres apart within each transect. If field conditions do not allow straight

transects some areas may be investigated more opportunistically where exposures and/or vegetation allow. This will be to assess this previously unassessed area in detail.

If areas have significant levels of ground cover and pedestrian survey is considered by the archaeologist to yield no results, then assessment will be made, based in part on knowledge gained from past archaeological research in the area, of the potential of the area to have Aboriginal artefacts present.

As the location of BP L5 and BP L6 is uncertain, the entire length of the study area to the west of the Broke Road boundary fence will be inspected to try to ascertain where these sites may be located. Particularly the area around the current AHIMS location and landforms to the north will be closely inspected for any sign of these, or other, sites.

It is envisioned that fieldwork for the survey would be completed in two days given the areas of modified landforms within the study area, and the previous archaeological investigations that have taken place both within and near to the study area. It is envisioned that the survey team will consist of one archaeologist and up to four RAP/Wonnarua Knowledge Holder representatives.

5.1.2 Test excavation

Although it is considered unlikely given the nature of the landforms in the study area, it is possible that the survey may identify landforms where test excavation under the Code of Practice is required. Should such landforms be identified during the survey, the test excavation methodology will be prepared as a separate document.

6 REFERENCES

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OEH 2011 — Office of Environment and Heritage. 2011. *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales.* Department of Environment, Climate Change and Water, Sydney.

OzArk 2013 — OzArk Environmental & Heritage Management Pty Limited. *Aboriginal Archaeological Values Assessment. Bulga Optimisation Project.* Report for Bulga Coal Management Pty Ltd.

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Umwelt 2003 — Umwelt (Australia) Pty Limited. *Survey and Assessment of Impact on Aboriginal Cultural Heritage and Archaeological Values, Main Creek, Hunter Valley, NSW.* Report for Glennies Creek Coal Management Pty Limited.

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APPENDIX 1: RAP COMMUNICATION

Sample Stage 3 letter inviting comment on a draft of this survey methodology.

OzArk Environmental & Heritage Management Pty Ltd
ABN: 59 104 582 354

26 February 2018

Members
[redacted]

Dear Members,

Re: Aboriginal Archaeological Impact Assessment - Bulga Optimisation Project Modification

Thank-you for your registration of interest to become a Registered Aboriginal Party (RAP) to be consulted over an Aboriginal Archaeological Impact Assessment associated with the Bulga Optimisation Project Modification located within the Bulga Coal Complex in the Singleton Local Government Area. Further information on the location and nature of this proposed modification is contained in the attached document.

The purpose of this letter is to invite you to comment on the enclosed draft Aboriginal Cultural Heritage Assessment Methodology enclosed with this letter. This survey methodology has been sent to you as part of Stages 2 and 3 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*.

In addition to comments on the draft document, if you can share any Aboriginal cultural heritage knowledge relevant to the proposed impact area we welcome this input so as to ensure Aboriginal cultural values are considered. OzArk is required to give you twenty eight (28) days to supply feedback on the attached documents. This period closes on **Wednesday 28 March 2018.** Should you need any help supplying feedback please do not hesitate to contact our office.

Should you have any queries in relation to the enclosed information please do not hesitate to contact our office.

Kind regards,

Sheridan Baker
Consultation Officer

Dubbo | Queanbeyan
HEAD OFFICE: 145 Wingewarra St/PO Box 2069 DUBBO NSW 2830
ph 02 6882 0118 | enquiry@ozarkehm.com.au | www.ozarkehm.com.au

APPENDIX 2: WANARUAH LOCAL ABORIGINAL LAND COUNCIL RESPONSE

(Received at OzArk on 29 March 2018)

Re: Wanaruah Local Aboriginal Land Council response to the Aboriginal Cultural Heritage Survey Methodology for the Bulga Optimisation Project Modification Report.

To whom it may concern.

It is always disappointing to read reports that are grossly inaccurate in their representation of facts. Not unsurprisingly this report is no less disappointing than most others produced for Glencore. Why many of the consultants who are employed by Glencore are unable to accurately reflect or communicate in an effective way the Aboriginal Cultural Heritage for the areas studied, brings in to question the honesty, and integrity (and/ or the capability) of both Glencore and the consultants.

This kind of shoddy reporting is usually presented to minimise any opposition to the activity and minimise any offset or compensation for destruction of Aboriginal cultural sites and values.

We believe this report should have to be redone from scratch with a new consultant.

I will not waste my time on the introductory waffle that makes up the greater part of the report.

The first easily demonstrable omission (misrepresentation of fact?) is on page 13 Figure 3.2.This picture shows the area with 24 registered sites marked. Of note some of the sites marked on page 13 are NOT on the image below as they are more recent finds not available when the image below was produced, yet the image below shows more than one hundred cultural sites/ objects.



Supported by this (deliberate?) omission on Page 18 Section 4.5, Conclusion, dot point 4 reads;

There are four known sites within or immediately adjacent to the Proposed Modification disturbance area: two isolated finds, one low density artefact scatter and one partially destroyed low density artefact scatter. The nature of these sites confirm the predictive model that sites in the study area are likely to display low artefact numbers and low site complexity;

Which is clearly not correct as there are (or were) more than 4 sites in the vicinity. This misinformation prevents Aboriginal people and others making informed decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.

Recommendation:

That Figure 3.2 on page 13 be corrected and all conclusions based on this incorrect information be rewritten to accurately reflect the truth.

Also on page 18 Section 4.5, Conclusion, dot point 1 reads;

The landforms of the study area are located at a distance to permanent water sources and this generally precludes the existence of larger Aboriginal sites in the study area;

The assessment totally ignores (since settlement) changes in the nearby waterways, once easily recognisable by the remanent plants that indicated a good supply of water year round was available and it also ignores mining activities have removed or backfilled and buried most that were there. It does not change that they were there once. The inaccuracy of the first part of the dot point makes the conclusion reached questionable. It also prevents Aboriginal people and others making informed decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.

Recommendation:

That Dot point 1 on page 13 be corrected and all conclusions based on this incorrect information be rewritten to accurately reflect the truth.

Also on page 18 Section 4.5, Conclusion, dot point 5 reads;

The study area is located close to, but not within, an area with recognised cultural values although, due to past disturbances, it is unlikely that landforms within the study area will have similar cultural landscape values.

When discussing Cultural Values and Cultural Land Scape Values it is important to remember that the types of historical things culturally important to non-Aboriginal people are the same types of things culturally important to Aboriginal people. Often when discussing Aboriginal Heritage Cultural Value is applied incorrectly only to those areas of "spiritual significance" ignoring all of the other landscapes and sites with "Cultural Value". You only need look to see that the majority of the culturally significant places to all communities are those that historically housed, fed, clothed, educated and entertained people, not just churches and other places of ceremony or worship. The evidence shows that this area and landscape was a place that historically housed, fed, clothed, educated and entertained Aboriginal people. So the only conclusion that could be reached is that this landscape is culturally significant. As more and more of it is destroyed by mining impact the remaining areas increase in their significance and need for protection. This misinformation prevents Aboriginal people and others making

informed decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.
The following is a statement from our community:

Like most of the Hunter Valley, the area in question has great cultural and social significance to Aboriginal peoples of this area as it is within easy walking distance of several VERY significant sites and ceremonial grounds. In this area there are representations of a variety of tribal interactions. Yet as quickly as we begin to understand something about how our people lived, (the activities they partook in and the time lines showing when, "history" that was not passed on because of the savage impact of European settlement), it is lost because of development. Many of the people still living in this area cannot speak the language of their tribe, we cannot sing the songs, and we cannot tell our children the stories of all creation. This was lost because these things were considered "Evil" by the missionaries. What little is still known is closely guarded by those entrusted with it who pass it on as "need to know" on those occasions when something vital to the dreamtime is endangered. All that is left is to the majority is the few markers that remain of a once full and harmonious society and culture. These markers along with the snippets allowed to us by those entrusted, is all we have to link us to our mother the earth. Culturally, these places give us an insight to our forbearers. The level of occupation and the length of occupation give us insight to what the landscape was like and the activities the conducted. With no culture of writing, history has been passed by word of mouth. To aid the telling, many of the creation stories incorporated the land forms. This included how they came to be. No amount of written language can adequately describe or replace the value and meaning of being in touch with the living remnants of our dreamtime. On a social level these remnants and markers give hope to a displaced people. No longer is it "Shame" to be Aboriginal. We have for many years been told that our culture was "Bad, Heathen, Satanical, Backward, Uncivilised and generally unacceptable". Employment, education, and health issues can be directly linked to ones vision of one's self and community. We still suffer from stereotyping and bigotry. We need something that is ours to take pride in. All we have is tied to the land in the remnants and markers.

The area is close to a known junction of two Aboriginal transit ways (song lines), it is not far from where there were once grinding grooves and other sites of significance. There were also waterways which had permanent flow (though some of that was, and may still exist, underground). In 1842, some 10 Aboriginal people of the Lower Wollombi clan (Kineland/ Ellalong Clan?) were still residing in the area and there are numerous recorded sites of significance in the near vicinity. The number of recorded objects found shows that in short an area that would have been utilised by the local people for millennia prior to colonisation.

Recommendation:

That Dot point 5 on page 13 be corrected and all conclusions based on this incorrect information be rewritten to accurately reflect the truth.

Also on page 18 Section 4.5, Conclusion, dot point 2 and dot point 3 read;

There have been a generally high degree of past land disturbance within the study area stemming from long-term agricultural use of the area. This is evidenced by thin, nutrient poor soils across the study area. Archaeologically this has the effect of removing or dispersing sites had they existed in the study area;

Large areas of the Proposed Modification disturbance area have been previously modified by approved mining activities. Such activities include waste emplacements, dams, drainage bunds and road/track construction. Archaeologically this indicates that Aboriginal sites are unlikely to be located in these areas;

Although there has been a large amount of disturbance, it is not correct to assume all Archaeology is gone. The areas have never been 100% cleansed of all cultural objects. There have been surface salvages and subsurface excavations, yet even in spoil heaps and dam walls Aboriginal Cultural Objects often find their way to the surface to be exposed for those who know what to look for to find, record and report. Also the amount of disturbance does not lessen the protection against further disturbance without and AHIP or management plan. That there are objects nearby would clearly indicate a potential for further objects to be located within the study area. This misinformation prevents Aboriginal people and others making informed

decisions about Aboriginal Culture and denies Aboriginal people their rights to self-determination.

Recommendation:

That Dot points 2 and 3 on page 13 be corrected and all conclusions based on this incorrect information be rewritten to accurately reflect the truth.

Wanaruah is severely disappointed with Bulga Coal and its consultant over this report. If the people responsible worked for the LALC they would find they had seven days to explain why they should continue to be employed and what steps they intend to take to rectify wasting so many people's time and resources.

Cheers

Noel Downs

CEO

APPENDIX 7: AHIMS SEARCH

Office of Environment & Heritage NSW GOVERNMENT

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1777
Client Service ID : 366273

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
37-6-0886	Bulga Ope Cut ISF4 (A1)	GDA	56	321420	6380428	Open site	Valid	Artefact : -	Isolated Find	102074,10207 5,102170
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0873	Bulga Open Cut site 10 (A1)	AGD	56	321645	6380810	Open site	Destroyed	Artefact : -	Open Camp Site	102074
	Contact	Recorders	Megan Mebberson,Environmental Resources Management Pty Ltd - Sydney					Permits	3301	
37-6-0884	Bulga Open Cut IF1 (A1)	GDA	56	321524	6379529	Open site	Destroyed	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0885	Bulga Open Cut IF2 (a1)	GDA	56	321193	6379617	Open site	Destroyed	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0804	Broke Rd 1	GDA	56	321850	6379850	Open site	Valid	Artefact : 3	Open Camp Site	
	Contact	Recorders	Mrs.Angela Besant,OzArk Environmental and Heritage Management,Mr.Ben Churcl					Permits	3301	
37-6-0931	SBU35	AGD	56	322677	6379861	Open site	Destroyed	Artefact : -	Open Camp Site	
	Contact	Recorders	Megan Mebberson					Permits	3301	
37-6-0932	BOC IF 7(A1)	GDA	56	321045	6380060	Open site	Valid	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant,OzArk Environmental and Heritage Management,Mr.Ben Churcl					Permits		
37-6-0911	sbu14	AGD	56	324200	6377800	Open site	Valid	Artefact : -	Isolated Find	
	Contact	Recorders	Megan Mebberson					Permits		
37-6-0888	Bulga Open Cut IF6 (a1)	GDA	56	320835	6380385	Open site	Destroyed	Artefact : -	Isolated Find	102075
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0892	Bulga Open Cut Site 1 (a1) - duplicate of 37-6-804	AGD	56	321955	6380040	Open site	Destroyed	Artefact : 3	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant,Environmental Resources Management Pty Ltd - Sydney					Permits	3301	
37-6-0893	Buga Open Cut site 2 (a1)	GDA	56	321553	6380606	Open site	Valid	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant					Permits	3301	
37-6-0897	Bulga Open Cut Site 5 (a1).	GDA	56	321804	6380903	Open site	Destroyed	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant,Environmental Resources Management Pty Ltd - Sydney					Permits	3301	
37-6-0898	Bulga Open Cut Site 6 (a1)	GDA	56	321496	6381030	Open site	Destroyed	Artefact : 7	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant,Mr.NICHOLAS HARROP					Permits		
37-6-0899	Bulga Open Cut Site 7 (a1)	GDA	56	321230	6380981	Open site	Destroyed	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0900	SBU1	GDA	56	322269	6380689	Open site	Destroyed	Artefact : -	Open Camp Site	

Report generated by AHIMS Web Service on 24/08/2018 for Stephanie Rusden for the following area at Datum :GDA, Zone : 56, Eastings : 320816 - 324355, Northings : 6377960 - 6381716 with a Buffer of 0 meters. Additional Info : Survey. Number of Aboriginal sites and Aboriginal objects found is 49

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Office of Environment & Heritage NSW GOVERNMENT

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1777
Client Service ID : 366273

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited,ERM Australia Pty Ltd- Sydney CBD					Permits		
37-6-0901	SBU2	GDA	56	322273	6380661	Open site	Destroyed	Artefact : -	Isolated Find	
	Contact	Recorders	Umwelt (Australia) Pty Limited,ERM Australia Pty Ltd- Sydney CBD,Mr.Ben Church					Permits		
37-6-0902	SBU3	AGD	56	321800	6379100	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	Unknown Author					Permits	3301	
37-6-0903	SBU4	GDA	56	321905	6378990	Open site	Destroyed	Artefact : -	Isolated Find	
	Contact	Recorders	Unknown Author,OzArk Environmental and Heritage Management,Mr.Ben Churche					Permits	3301	
37-6-0904	SBU5	GDA	56	321705	6377990	Open site	Destroyed	Artefact : -	Open Camp Site	
	Contact	Recorders	Unknown Author,OzArk Environmental and Heritage Management,Mr.Ben Churche					Permits	3301	
37-6-0905	SBU6	AGD	56	322400	6377900	Open site	Valid	Artefact : -	Isolated Find	
	Contact	Recorders	Unknown Author					Permits	3301	
37-6-0906	SBU8	AGD	56	322105	6379090	Open site	Destroyed	Artefact : -	Isolated Find	
	Contact	Recorders	Unknown Author,Ms.Morgan Wilcox					Permits	3301	
37-6-0907	SBU7	AGD	56	322805	6378490	Open site	Destroyed	Artefact : -	Open Camp Site	
	Contact	Recorders	Unknown Author,Ms.Morgan Wilcox					Permits	3301	
37-6-0908	SBU9	GDA	56	321876	6379103	Open site	Valid	Artefact : -	Isolated Find	
	Contact	Recorders	Unknown Author,OzArk Environmental and Heritage Management,Mr.Ben Churche					Permits	3301	
37-6-0867	Bulga Open Cut Site 2 (A1)	GDA	56	321553	6380606	Open site	Valid	Artefact : -	Open Camp Site	102074
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0868	Bulga Open Cut IF 6 (A1)	AGD	56	320788	6380154	Open site	Destroyed	Artefact : -	Isolated Find	102074,10207 5
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0869	Bulga Open Cut ISF 8 (A1)	AGD	56	321174	6380883	Open site	Destroyed	Artefact : -	Isolated Find	102074
	Contact	Recorders	Megan Mebberson					Permits		
37-6-0870	Bulga Open Cut Site 5 (A1)	AGD	56	321730	6380450	Open site	Valid	Artefact : -	Open Camp Site	102074
	Contact	Recorders	Mrs.Angela Besant					Permits		
37-6-0871	Bulga Open Cut Site 8 (A1)	AGD	56	320945	6380825	Open site	Destroyed	Artefact : -	Open Camp Site	102074
	Contact	Recorders	Megan Mebberson					Permits		
37-6-0872	Bulga Open Cut Site 9 (A1)	AGD	56	321182	6380913	Open site	Destroyed	Artefact : -	Open Camp Site	102074
	Contact	Recorders	Megan Mebberson					Permits		
37-6-1394	BCO 1	AGD	56	320894	6379395	Open site	Destroyed	Artefact : -		102076
	Contact	Recorders	Umwelt (Australia) Pty Limited,Leila McAdam					Permits	3301	
37-6-1397	BCO5	GDA	56	321614	6378595	Open site	Valid	Artefact : -		102076
	Contact	Recorders	Lower Wonnarua Tribal Council,OzArk Environmental and Heritage Management,I					Permits	3301	
37-6-1398	BCO7	AGD	56	320730	6379264	Open site	Destroyed	Artefact : -		102076

Report generated by AHIMS Web Service on 24/08/2018 for Stephanie Rusden for the following area at Datum :GDA, Zone : 56, Eastings : 320816 - 324355, Northings : 6377960 - 6381716 with a Buffer of 0 meters. Additional Info : Survey. Number of Aboriginal sites and Aboriginal objects found is 49

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Office of Environment & Heritage

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1777
Client Service ID : 366273

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited,Wanaruah LALC,Lower Wonnarua Tribal Council,U					Permits	3301	
37-6-1400	BCO9	AGD	56	320787	6379903	Open site	Destroyed	Artefact : -		102076
	Contact	Recorders	Umwelt (Australia) Pty Limited,Lower Wonnarua Tribal Council					Permits	3301	
37-6-1402	BCO6	GDA	56	321755	6378014	Open site	Valid	Artefact : -		102076
	Contact	Recorders	Janice Wilson,OzArk Environmental and Heritage Management,John Mathews,Mr.B					Permits	3301	
37-6-1933	BDS2	AGD	56	323564	6381478	Open site	Valid	Artefact : 1		101207,102170
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
37-6-1935	BDS4	AGD	56	323992	6381390	Open site	Destroyed	Artefact : 14		101207,102170
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
37-6-1976	BDS13	AGD	56	323970	6381297	Open site	Destroyed	Artefact : 1		102170
	Contact	Recorders	Umwelt (Australia) Pty Limited,Mr.Ben Churcher					Permits		
37-6-2832	BOP - IF5	GDA	56	322196	6378274	Open site	Valid	Artefact : 1		
	Contact	Recorders	OzArk Environmental and Heritage Management,Mr.Ben Churcher					Permits		
37-6-2843	BOP-OS9	GDA	56	322559	6379974	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	OzArk Environmental and Heritage Management,Mr.Ben Churcher					Permits		
37-6-2844	BOP-OS10	GDA	56	322393	6378205	Open site	Partially Destroyed	Artefact : 1		
	Contact	Recorders	OzArk Environmental and Heritage Management,Mr.Ben Churcher					Permits		
37-6-3074	Bulga Open Cut ISF8 (B)	GDA	56	321064	6380896	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Mr.Malcolm Harrop,Mr.NICHOLAS HARROP					Permits		
37-6-3880	Bulga IF3	GDA	56	323713	6381510	Open site	Valid	Artefact : -		
	Contact	Recorders	OzArk Environmental and Heritage Management,Miss.Philippa Sokol					Permits		
37-6-3881	Bulga IF4	GDA	56	323828	6381332	Open site	Valid	Artefact : -		
	Contact	Recorders	OzArk Environmental and Heritage Management,Miss.Philippa Sokol					Permits		
37-6-0141	Saxonvale ;	GDA	56	322373	6379964	Open site	Destroyed	Artefact : -	Open Camp Site	311,1357,1978,2121,102170
	Contact	Recorders	Helen Brayshaw					Permits	252	
37-6-1659	BPL5	GDA	56	321454	6378634	Open site	Valid	Artefact : 6		100153
	Contact Searle	Recorders	Mrs.Angela Besant,OzArk Environmental and Heritage Management,Mr.Ben Churcl					Permits	2575,3301	
37-6-1660	BPL6	GDA	56	321454	6378655	Open site	Valid	Artefact : 6		100153
	Contact Searle	Recorders	Mrs.Angela Besant,OzArk Environmental and Heritage Management,Mr.Ben Churcl					Permits	2575,3301	
37-6-1662	BPL1	GDA	56	321355	6377990	Open site	Destroyed	Artefact : 26		100153
	Contact Searle	Recorders	Mrs.Angela Besant,OzArk Environmental and Heritage Management,Mr.Ben Churcl					Permits	2575,3301	
37-6-3763	Bulga IF-2	GDA	56	322719	6380067	Open site	Valid	Artefact : -		

Report generated by AHIMS Web Service on 24/08/2018 for Stephanie Rusden for the following area at Datum :GDA, Zone : 56, Eastings : 320816 - 324355, Northings : 6377960 - 6381716 with a Buffer of 0 meters. Additional Info : Survey. Number of Aboriginal sites and Aboriginal objects found is 49

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1777
Client Service ID : 366273

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	OzArk Environmental and Heritage Management,Mr.Ben Churcher					Permits		
37-6-3660	Bulga IF1	GDA	56	323266	6378177	Open site	Valid	Artefact : -		
	Contact	Recorders	OzArk Environmental and Heritage Management,Mr.Ben Churcher					Permits		

Report generated by AHIMS Web Service on 24/08/2018 for Stephanie Rusden for the following area at Datum :GDA, Zone : 56, Eastings : 320816 - 324355, Northings : 6377960 - 6381716 with a Buffer of 0 meters. Additional Info : Survey. Number of Aboriginal sites and Aboriginal objects found is 49

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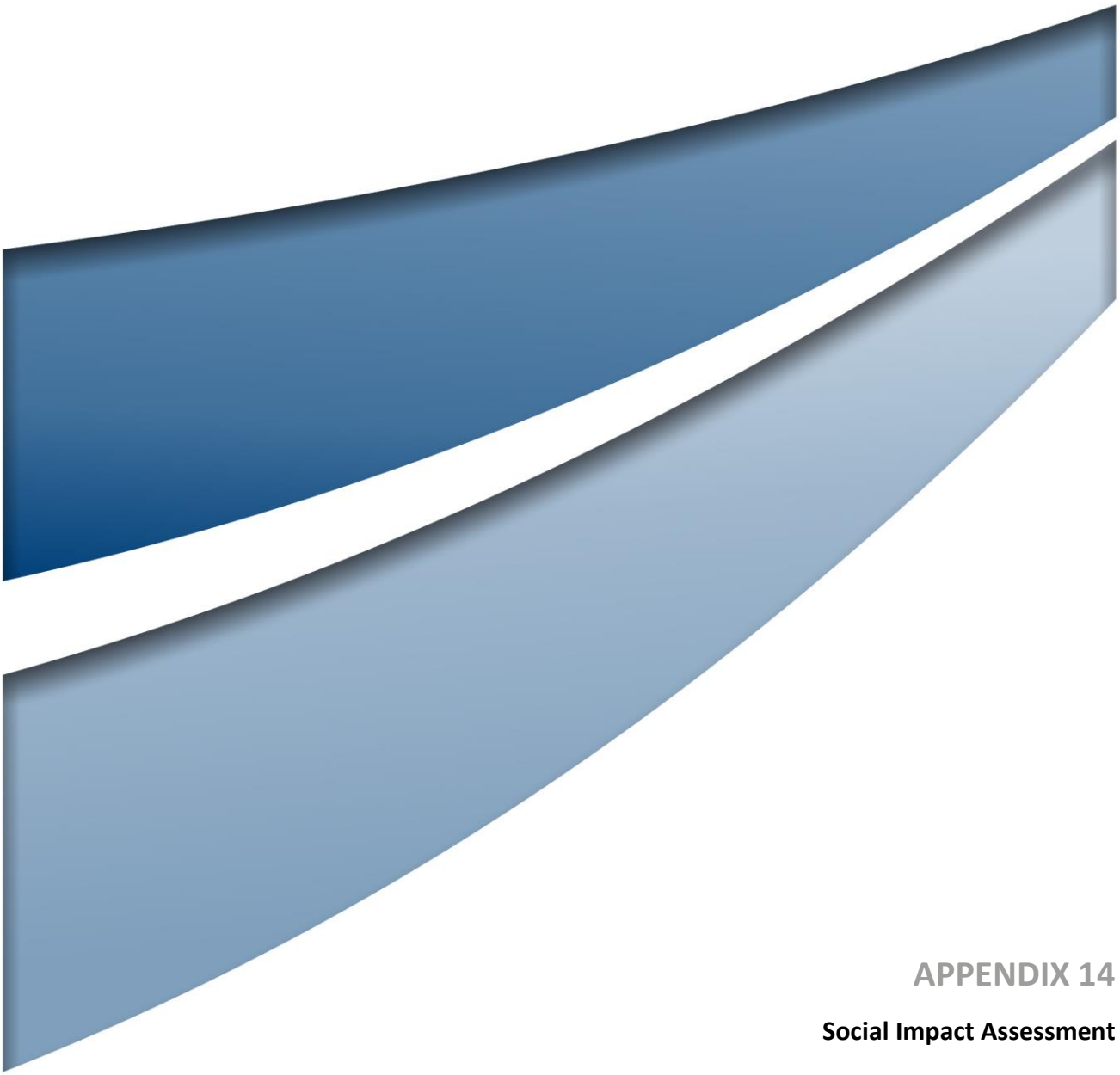

APPENDIX 14

Social Impact Assessment

umwelt
Environmental & Social Consultants

GLENCORE

BULGA OPTIMISATION PROJECT MODIFICATION 3

Social Impact Assessment

FINAL

June 2019

GLENCORE

BULGA OPTIMISATION PROJECT MODIFICATION 3

Social Impact Assessment

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Bulga Coal Management Pty Limited

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
FINAL	Dr Sheridan Coakes	13 June 2019	Bret Jenkins	13 June 2019

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1.0 Introduction

The Bulga Coal Complex (BCC) is an open cut and underground coal mining operation located approximately 12 kilometres (km) south-west of Singleton in the Hunter Valley, NSW (refer to **Figure 1.1**). The BCC is located approximately 4 km to the south-east of Bulga village, approximately 4 km to the north of Broke village, and approximately 12 km south-west of the township of Singleton.

Bulga Coal Management Pty Ltd (BCM) operates the BCC, on behalf of the Bulga Joint Venture, with mining operations having occurred at the site for over 35 years. The BCC consists of open cut operations (Bulga Surface Operations) and underground operations (Bulga Underground Operations) that use shared coal washing and rail loading infrastructure, as well as having an integrated water management system.

On 1 December 2014 BCM was granted approval for the Bulga Optimisation Project (BOP) (SSD 4960), which related to the ongoing operation of the Bulga Surface Operations until 31 December 2035. The approval was granted by the Planning and Assessment Commission (under delegation from the Minister for Planning). The SSD 4960 has been modified twice since it was initially approved:

- SSD 4960 Mod 1: in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy
- SSD 4960 Mod 2: in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

The underground operations at the BCC operate under a separate development consent (DA 376-8-2003) granted in 2004 (Bulga Underground Consent). The Bulga Underground Operations suspended mining in May 2018 and the mine was sealed in July 2018. While underground mining is currently suspended, pre-drainage of the Blakefield North mining area is still being undertaken and supplies the 9-megawatt (MW) gas fired power station. The Bulga Underground Operations approvals are being retained and the BCM is actively evaluating opportunities to recommence underground operations in the future.

BCM is proposing a modification to maximise resource recovery within the approved Bulga Optimisation Project Area (Project Area). The modification proposes an extension of the open cut operations to the south east. Proposed mining will extend into a former open cut area occupied by the current Tailings Storage Facilities (TSFs), known as Deep Pit and Bayswater Pit. A revised mining sequence also allows the extraction of deeper coal resources beneath the floor of parts of the currently approved open cut mine (the Proposed Modification). The Proposed Modification also requires changes to infrastructure to accommodate the proposed extension to the mining area.

The Proposed Modification requires approval under Part 4.55 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The development application will be lodged with the Planning Secretary of the NSW Department of Planning and Environment (DPE). The Minister for Planning is the consent authority for the Proposed Modification.

This Social Impact Assessment (SIA) has been prepared by Umwelt Environmental and Social Consultants (Umwelt) as part of a Statement of Environmental Effects (SEE) on behalf of BCM.

1.1 Report Structure

This SIA has been prepared by Umwelt as part of the Statement of Environmental Effects (SEE) to assess the environmental and social impacts of the Proposed Modification.

The SIA section of the report has been structured according to key sections as detailed below:

- **Section 2.0** - Background to the Proposed Modification, including a summary of key project components.
- **Section 3.0** - Methodology employed as part of the SIA and an overview of community involvement in the SIA, including mechanisms used by the company and the consultants to gather community feedback on the Proposed Modification.
- **Section 4.0** - Assessment of the socio-economic links between BCC and communities in the region using a technique known as Town Resource Cluster (TRC) Analysis. This section also outlines current perceptions of the existing operations through a review of complaints and perception survey outcomes.
- **Section 5.0** - Development of a social profile for the relevant study communities, including an assessment of five key community capital areas. This section also identifies regional issues and aspirations as identified through a review of local media and local and regional strategic plans.
- **Section 6.0** - Identification of the perceived positive and negative social impacts associated with the Proposed Modification, as identified through engagement activities with proximal landholders, key stakeholders and the wider community.
- **Section 7.0** - Prediction of the likely social impacts that may result due to the Proposed Modification and identified strategies to manage negative impacts and enhance positive impacts.
- **Section 8.0** - Outline of how social impacts will be monitored should the Proposed Modification be approved.

A comprehensive Social Impact and Opportunities Assessment was undertaken for the BOP (Coakes Consulting, 2013). The current SIA for the Proposed Modification will build on this previous work, with DPE confirming this to be an acceptable approach (as documented in a letter dated 17 October 2017).

However, it has also been requested that the current SIA have regard to the DPE's *Social Impact Assessment Guideline for State Significant mining, petroleum production and extractive industry development* (DPE, 2017). In regards to a Proposed Modification, the DPE SIA guideline (2017, p.50) requests the applicant to consider whether "*the social impacts associated with the modification are expected to be new or different (in terms of scale and/or intensity) to those that were approved under the original consent?"* If yes, then the SIA review questions need to be applied.

2.0 Proposed Modification Overview

The Proposed Modification relates to the extension of open cut mining within the approved Project Area (refer to **Figure 2.1**). The Proposed Modification will maximise resource recovery by extending the open cut operations approved under the BOP development consent (SSD 4960) to the south-east into a former open cut mining area currently occupied by two of the three approved TSFs known as Deep Pit and Bayswater Pit. The extension of the open cut pit to the southeast enables extraction of additional deeper coal resources both below parts of the currently approved BCC open cut, and also below the Deep Pit and Bayswater Pit TSFs. The Proposed Modification will maintain the currently approved open cut coal extraction rate of up to 12.2 Million tonnes per annum (Mtpa) run-of-mine (ROM) and will afford extraction of approximately 64 Mt additional of coal and extend the mine life for an additional four years.

The Proposed Modification includes the removal and relocation of the tailings material currently stored in the Deep Pit and Bayswater Pit TSFs to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings from the Deep Pit and Bayswater Pit TSFs.

To allow for the proposed extension of the open cut pit, the Proposed Modification includes changes to infrastructure associated with the separately approved adjacent Bulga Underground Operations (DA 376-8-2003), including a power station and associated infrastructure. The Proposed Modification does not prohibit the ability to access and mine approved underground mining resources to the south and west of the proposed pit in the future, or the future use of the Coal Handling and Processing Plant (CHPP) and train loading facilities, for the beneficiation and transportation of coal from potential Bulga Underground Operations.

The Proposed Modification generally comprises:

- extension of mining areas to the south and east to access an additional 64 Mt of coal by accessing deeper resources within the approved open cut pit and in the proposed extension area
- realignment of the western highwall to achieve a more stable long term highwall
- an additional disturbance of 20.2 hectares to accommodate the proposed extension of the mining areas to the south and east
- removal and relocation of the tailings material currently stored in the existing TSF's to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure
- relocation and removal of infrastructure servicing the open cut and underground operations including workshops, gas infrastructure and power station, fuel and oil storage
- continued use of the East Pit Muster Area
- construction of new water management facilities to manage changes to the site surface water catchments
- the use of all existing or approved infrastructure and equipment with some additions to the existing mobile equipment fleet over the life of Proposed Modification.

A summary of the key modifications is provided in **Table 2.1.**

Table 2.1 Comparison of Approved Development and Proposed Modification

Project Component	Approved Development (SSD 4960) (as Modified)	Proposed Modification
Extraction Rate Limit	Extraction limit of 12. Mtpa ROM coal	No change
Total Recoverable Resource (ROM)	162 Mt	An additional 64 Mt
Project Life	Mining operations until 31 December 2035	Extension to the life of mine until 31 December 2039 (an additional four years)
Project Boundary / Schedule of Lands	Per SSD_4960 Appendix 1	No change to approved Project Area or Schedule of Lands, subject to any land title changes in the interim
Mining Areas	Mining areas as approved – Main Pit, East Pit and South Pit Mining undertaken within existing ML1547, CL224, ML1717 and MLA525.	Extension of mining areas to the south and west. Accessing deeper resources within the approved pit and the proposed extension area Mining undertaken within existing ML1547, CL224, ML1717 and MLA525
Disturbance Areas	Approved mining disturbance footprint (3,786 hectares)	Additional disturbance area of approximately 20.2 hectares not currently part of the approved mining disturbance footprint
Key Infrastructure	Realignment of Broke Road (Complete) Relocation of 330 kV transmission lines (Complete) Construction of new water storage dam (Complete) Upgrade to CHPP to improve yield and plant efficiency (Ongoing) Relocation of sections of Broke-Fordwich Private Irrigation District pipeline, Broke potable water supply pipeline and Telstra infrastructure (Complete)	Relocation of some mine owned open cut infrastructure Demolishing of some open cut infrastructure to accommodate proposed mining Replacement / relocation of some infrastructure to service open cut operations including the construction of a lube station and light vehicle workshop Installation of tailings relocation infrastructure (pumps and pipelines, power lines and access tracks)
Coal Handling And Processing	Upgrade of existing CHPP infrastructure in the current location. No change to approved CHPP throughput	Potential upgrade of CHPP to reprocess additional tailings No changes to CHPP throughput, ROM or product stockpiles
Coal Transport	20 million tonnes of product coal transported in any calendar year	No change

Project Component	Approved Development (SSD 4960) (as Modified)	Proposed Modification
Equipment Fleet	Mining fleet as per BOP Amended Project Application Assessment (Umwelt 2013)	Minor changes to fleet numbers to provide flexibility for mining operations
Overburden, Coarse Reject	Overburden placed in-pit	No change to overburden and coarse reject management
Tailings Management	Ongoing use of Deep Pit and Bayswater TSF Main Pit TSF approved in SSD 4960 Mod 1	Additional tailings relocation equipment will be required to remove tailings from the Bayswater and Deep Pit TSF prior to mining Increased capacity of Main Pit TSF from approximately 7.5 Mm^3 to approximately 62 Mm^3 to cater for relocated tailings and ongoing tailings production
Final Void	One void at the end of mining operations	One void proposed to be of similar size to the approved void
Rehabilitation and Final Landform	Conceptual final landform is shown in SSD 4960 and includes a final void and areas for a range of vegetation communities and habitat types, wildlife corridors, and potential for some ongoing grazing use	No change to approved rehabilitation methods. Revised mining schedule will require revised rehabilitation sequencing Increases to typical overburden emplacement heights from 150 mAHD to 160 mAHD with some areas to 175 m RL to provide topographical relief Revised conceptual final landform includes 1 final void as per approved
Employee Numbers	Approximately 700 FTE employees	No change
Construction Workforce	Approximately 300 (Previously approved construction workforce; Construction complete)	Peak of approximately 150 construction workforce in 2021 (year 2)



FIGURE 2.1

Locality Plan

3.0 SIA Methodology

3.1 Social Impact Assessment Framework

The SIA program has been designed to:

- profile key communities, both in proximity to and, associated with the Proposed Modification, with an emphasis on any changes that may have occurred across the assessment period (2013-2019)
- scope and assess the potential social issues/impacts and opportunities associated with Proposed Modification
- develop strategies to address identified issues/impacts and enhance any opportunities, and monitor and manage social impacts associated with the Proposed Modification.

As previously noted, the SIA for the Proposed Modification will build on the previous Social Impact and Opportunities Assessment undertaken for the BOP (Coakes Consulting, 2013), in identifying whether the social impacts associated with the Proposed Modification differ (in scale and/or intensity) from those that were approved under the original consent.

SIA is an approach to predicting and assessing the likely consequences of a proposed action in social terms and developing options and opportunities to improve social outcomes. Best practice SIA is participatory and involves understanding impacts from the perspectives of those involved in a personal, community, social or cultural sense, to provide a complete picture of potential impacts, their context and meaning.

The generally agreed international principles relating to SIA (Vanclay, 2003) identify social impacts as the matters affecting, directly or indirectly:

- people's way of life, that is: how they live, work, play and interact with one another on a day to day basis
- their community, that is: its cohesion, stability, character, services and facilities
- access to and use of infrastructure, services and facilities, whether provided by local, state, or federal governments, or by for-profit or not-for-profit organisations or volunteer groups
- their culture, that is: their shared beliefs, customs, values and language or dialect
- their health and wellbeing: health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity
- their surroundings, such as: the quality of the air and water people use, the availability and quality of the food they eat, the level of hazard or risk, dust and noise they are exposed to, the adequacy of sanitation, their physical safety, and their access to and control over resources
- their personal and property rights, particularly whether people are economically affected or experience personal disadvantage which may include a violation of their civil liberties
- their political and decision-making system, such as the extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place, and the resources provided for this purpose

- their fears and aspirations, that is: their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children.

As is the case with any type of change, some individuals or groups within the community may benefit, while others may experience negative impacts. If negative impacts are predicted, it is the role of the SIA to determine how such impacts may be addressed effectively to reduce the degree of social disruption to those affected. If positive impacts are predicted, the aim of the SIA is to maximise these opportunities and identify how they might be further enhanced.

Monitoring and evaluation are also key components of an SIA process to identify any unanticipated impacts that may arise in the future as a result of the Proposed Modification.

3.2 Social Impact Assessment Guidelines

In September 2017, DPE released the SIA guideline *Social Impact Assessment Guideline for State Significant mining, petroleum production and extractive industry development* (DPE, 2017) (the SIA Guideline).

A comprehensive Social Impact and Opportunities Assessment SIOA was undertaken as part of the BOP in 2013 (Coakes Consulting , 2013), which is largely consistent with the current requirements of the SIA Guideline. Given the nature and scale of the Proposed Modification and the extent of the previous SIOA for the BOP (Coakes Consulting , 2013), a more refined and targeted SIA assessment has been undertaken for the Proposed Modification. This approach, and the proposed scope of works, was confirmed through consultation with DPE, refer to **Appendix A.**

The SIA has been prepared by a suitably qualified and experienced lead author and team of social impact practitioners. The lead author is Dr Sheridan Coakes, Practice Lead – Social Impact Assessment and Community Engagement at Umwelt. As the principal technical specialist, Dr Coakes' *Curriculum Vitae* is provided in **Appendix B,** and a signed declaration certifying that the SIA does not contain false or misleading information is provided at **Appendix C**.

3.3 SIA Approach and Methodology

A best practice approach to SIA has been adopted for the Proposed Modification, that integrates international and NSW social guideline requirements.

In line with best practice, the SIA has involved key phases of work that include:

- preparatory planning - undertaking appropriate planning for the Proposed Modification and the development of a Stakeholder Engagement Strategy, including a review of the previous SIOA undertaken for the operation in 2013
- profiling - updating the baseline social context in which the Proposed Modification is based
- scoping - identifying key social impacts/issues relevant to the Proposed Modification
- assessment and prediction of impacts - evaluating and predicting positive and negative social impacts associated with The Proposed Modification
- strategy development - identifying any relevant strategies to minimise significant negative impacts and enhance positive impacts associated with the Proposed Modification

- monitoring and evaluation – development of a framework outlining how social impacts should be monitored and evaluated should the Proposed Modification proceed.

Engagement with the community has been a key component of the SIA program at key phases of the assessment, to afford a participatory approach to assessment. Since late 2017, the BCM Project team and Umwelt have been engaging with both the local and wider community to identify their issues, concerns and aspirations through a variety of mechanisms including personal meetings, telephone liaison, community barbecues and project briefings.

The BCM team has strong existing relationships within their respective proximal communities – Broke, Milbrodale and Bulga - as clearly evidenced in the previous SIA for the BOP. Since gaining approval for the BOP in 2014, BCM has continued to build on, and further develop, these relationships with proximal landholders and community members through their continuing engagement efforts. Outcomes of this engagement have been used to inform the SIA.

Commissioning of the SIA early in the Proposed Modification and regular meetings with the BCM Project team throughout the assessment program, has also provided opportunities to effectively align assessment outcomes with the wider SEE process, undertaken by Umwelt, and inform project planning and mine plan design.

3.4 Participants/Stakeholders in the SIA

Social impact assessment involves the cooperation and coordination of a number of "social partners" or "stakeholders". As Burdge (2004) outlines, stakeholder may be affected groups or individuals that:

- live nearby the resource/project
- have an interest in the proposed action or change
- use or value a resource
- are interested in its use and/or
- may be required to relocate as a result of the Proposed Modification.

As part of the SIA Proposed Modification, a range of stakeholders have been identified and involved in the Project. These stakeholders have been grouped as follows:

- **Proximal landholders and residents** – landholders and residents residing in proximity to the current mining operations in the state suburbs (ABS, 2016) of Bulga, Broke and Milbrodale and Fordwich.
- **Indigenous stakeholders** - including registered Aboriginal parties and Indigenous service and groups (note that this refers specifically to those Indigenous stakeholders consulted as part of the SIA regarding social issues, not those consulted as part of the Aboriginal cultural heritage assessment program regarding cultural heritage issues which is further discussed in the SEE).
- **Community stakeholders and residents** - in the wider Singleton LGA (local government, business, community groups and residents).

To track community attitudes and perceptions in relation to its operations, Glencore also undertakes a community perceptions survey (hereafter referred to as the survey) every three years, which affords the tracking of a number of key indicators relating to the company's social and environmental performance; and provides an evaluation of the approach the operations have adopted in relation to stakeholder engagement and consultation. This survey is undertaken across Glencore assets, including the Bulga Coal Mine, and involves proximal landholders and key stakeholders (government (local and state), community, business, indigenous, and not for profit organisations) relevant to each of the company's operations, as identified through Glencore's operational stakeholder databases. The most recent survey was undertaken in 2018 by Umwelt on behalf of Glencore Coal Assets Australia (GCAA). The 2018 survey builds upon previous surveys implemented for GCAA since 2010, with the previous survey undertaken in 2015.

The Proposed Modification commenced in 2017 and given the timing of the survey (August, 2018), relevant outcomes to the Bulga Coal Mine have been included in the SIA for the Proposed Modification, particularly the views of the wider Singleton community sample. Survey outcomes are further discussed in **Section 4.2.**

Table 3.1 provides a summary of the number of key stakeholders consulted, including proximal landholders, Indigenous and community stakeholders and residents of the wider Singleton LGA. Excluding government agency representatives, approximately 122 stakeholders have participated in the SIA engagement program. A total of 11 participants also attended the community information sessions for the Proposed Modification held in Broke. The majority of these participants had also participated in the SIA engagement program through other mechanisms.

Table 3.1 Stakeholder Participation in SIA Program

Stakeholder Category	Number of Participants
Proximal landholders	106*
Indigenous stakeholders (RAPs and service providers)	15
Community stakeholders (meetings with groups)	1**
Subtotal	**122**
Wider community (as per the GCAA survey)	37 and 149

*Note: 86 landholders contributed as part of the project survey, 20 nearby neighbours were engaged directly by BCM of which six took part in individual SIA surveys.
**Note: There was one community stakeholder meeting for Broke Fordwich Wine and Tourism Association Committee 3/06. Meetings were offered to Bulga Milbrodale Progress Association and Hunter Valley Protection Alliance, however no meetings were required.

Source: Umwelt 2019

3.5 Social Assessment and Engagement Mechanisms

Table 3.2 provides a summary of the assessment and engagement mechanisms that have been utilised during each phase of the SIA program. This consultation has been further complimented by engagement undertaken by the broader team with Government agencies and other key stakeholders in the course of operational and assessment activities. Further detail of the extent of consultation undertaken for the Proposed Modification is summarised in Section 4.0 of the SEE.

BCM has predominantly utilised its established communication channels that are well known by their communities. Consultation with community stakeholders has included community newsletters, community barbeques, personal telephone calls, personal meetings, targeted briefings, emails and the distribution of project information sheets.

Table 3.2 Summary of Social Assessment and Community Methods

Method	Description
Phase 1	**Community Profiling**
Township Resource Cluster (TRC) Analysis	Documentation of the social and economic linkages/associations between BCM and communities within the region through analysis of employee, supplier/vendor and community investment data.
Community Capitals Analysis	Assessment and analysis of changes in ABS Census data and other relevant social and community indicators and data sets to update a social baseline profile of the communities of interest – Bulga, Broke, Milbrodale and the Singleton LGA. Areas of existing community resilience and vulnerability have been identified through application of a community assets/capitals approach.
Post Impact Studies Analysis	Review and analysis of secondary data (including local histories, local government strategic plans and assessment studies, local media, previous SEE/EIS/SIA studies, operational complaints) and primary data collected through stakeholder interviews, to understand historical, existing and emerging issues and opportunities within the community.
Indigenous Profile and Issues Analysis	Socio-economic statistics relevant to the aboriginal community incorporated in the profile section (**Section 5.0**). Personal and telephone interviews undertaken with RAPs and Indigenous groups and service providers in the Singleton LGA. This consultation is in addition to the consultation undertaken as part of the Aboriginal cultural heritage assessment discussed in the SEE.
Phase 2	**Scoping of Issues and Opportunities**
Key Stakeholder Issues Analysis	Review of previous SIOA undertaken for the BOP (Coakes Consulting , 2013) and survey of proximal landholders and residents residing in proximity to the BCC, to identify both existing operational concerns and perceived issues and opportunities relating to the Proposed Modification. Review of community survey data undertaken in the Singleton LGA relevant to the Proposed Modification (GCAA Community Survey 2018).
Review and Analysis of Existing Company Consultation Mechanisms	Review and analysis of company engagement data including meetings, phone calls, newsletter and community complaints.
Phase 3	**Assessment and Impact Prediction**
Key Stakeholder Issues Analysis - Impacts and Opportunities	Survey of proximal landholders and residents residing in proximity to the BCC, to identify perceived issues and opportunities relating to an overview of the Proposed Modification (prior to completion of technical assessments). Ranking of perceived issues and opportunities by relative frequency. Personal meetings with 20 stakeholders and BCM to further discuss the Proposed Modification and mitigation and enhancement measures. Personal SIA interviews with six proximal landholders to collect information and identify perceived social impacts of the Proposed Modification Community BBQs in Broke and Bulga, and a community information session facilitated to allow input from proximal landholders and the wider community on the impacts and opportunities relating to the Proposed Modification.

Method	Description
	One community stakeholder meeting for Broke Fordwich Wine and Tourism Association Committee. Meetings were offered to Bulga Milbrodale Progress Association and Hunter Valley Protection Alliance, however no meetings were required.
Phase 4	**Mitigation and Management**
Social Risk Matrix	Categorisation of impacts by social impact category and theme.
Social Impact Management and Residual Risk Ranking	Identification and development of appropriate strategies (mitigation and enhancement) to address significant predicted impacts from the Proposed Modification. Minimisation of high and moderate social impacts through commitment to relevant management and enhancement strategies.
Engagement Methods	
Proximal Landholder Meetings	Personal meetings with proximal landholders to collect information and identify perceived social impacts of the Proposed Modification.
Telephone Interviews with Indigenous Services Providers	Telephone interviews with 15 RAPs and service providers to identify issues in relation to mining more generally within the community; and to explore potential opportunities for impact management and enhancement (note that this refers specifically to those Indigenous stakeholders consulted as part of the SIA, not to those RAPs consulted separately as part of the Aboriginal cultural heritage assessment program which is discussed in the SEE).
Community BBQ Program	The bi-annual Community BBQ Program developed to provide opportunity for the community to meet staff from the BCM operations in an informal setting. It provides a forum for BCM to update the community on their mining operations and activities, as well as answer any questions. The community barbeques also provide a social opportunity for community members to come together and network, with the mechanisms becoming a significant event in the local communities of Bulga and Broke.
Community Information Session	Drop-in session to share information about the Proposed Modification, and the SEE/SIA process, and to receive community feedback.
Glencore Community Perceptions Survey	Review and analysis of outcomes of a community perception survey undertaken by Umwelt on behalf of GCAA in July and August 2018, with the purpose of providing Glencore with a greater understanding of stakeholder issues and needs relating to company activities, past and present; and to assist in driving business improvement in the areas of environmental performance, stakeholder engagement and community development across neighbouring and regional communities associated with GCAA's operations in both NSW and QLD. Glencore operations within the Hunter Valley include the Mangoola Coal Mine, Bulga, HVO Joint Venture, United, Ravensworth, Liddell, Mt Owen Complex and Integra. The 2018 survey builds upon previous surveys implemented for GCAA since 2010 across its NSW and QLD operations, with the most recent previous survey being undertaken in 2015. For the purpose of the SIA, data from the perception survey involving landholders, local business, community groups, indigenous groups, local and state government and NGOs, and residents residing in the broader Hunter Valley, has been reviewed and incorporated where relevant.

Method	Description
Government Briefings and Consultation	Briefings and personal meetings with relevant government representatives (local and state) to present various stages of the assessment and obtain feedback on Proposed Modification aspects.
Community Consultative Committee Meetings	Project briefings to the local CCC to share information about the Proposed Modification and obtain committee member feedback on the project.
Community Information Sheets	Development and distribution of two project information sheets to near neighbours and key stakeholders at key stages: • Project and Process Overview – to describe Proposed Modification and the SEE/SIA process (as part of regular BCM newsletter) • SEE Project Summary – summary of the key outcomes of the environmental and social impact specialist studies undertaken as part of the assessment program and proposed management approaches. Each information sheet also provided contact details for the BCM Environment and Community Manager for further information and/or to request a personal project briefing.
Email and Phone Correspondence	Phone calls and emails relating to the SIA process to landholders, as required, to organise meetings, provide information and/or respond to questions relating to the SEE and SIA process.
Bulga Coal Mine Website	Provision of information on the BCC website relating to the Proposed Modification including information sheets and newsletters

4.0 Bulga Coal - Operational Context and Analysis

This section provides an overview of the existing operations at BCC to provide an operational context for the Proposed Modification. Information has been sourced from secondary data relating to employee residential location and household expenditure and supplier business location and total contract amounts, as provided by BCM. This data has been compared to data obtained as part of the SIA for the BOP (Coakes Consulting, 2013).

4.1 Social-economic Contribution of the Bulga Coal Complex

The analysis for this section utilises a technique known as Township Resource Cluster analysis (TRC analysis) (Fenton, Coakes and Marshall, 2003). This technique assists in identifying the direct and indirect socio-economic linkages/associations that exist between the BCC and communities both within and outside the region.

As part of the BOP SIOA in 2013, Coakes Consulting conducted a detailed TRC analysis of the links between the BCC operations and its surrounding communities. This study involved surveys of employees, contractors, and businesses that had a supplier relationship with the BCC operations, in order to determine residential location, expenditure estimates, use of local services and participation in community life.

In the current study, secondary data relating to employee residential location and household expenditure has been reviewed and updated, where available. Current supplier data has also been sourced from BCM that focuses on business location and expenditure.

Specifically, the results of the current TRC analysis include:

- demographic comparison between the BCC workforces and local community populations
- consideration of the residential location of the workforce
- analysis of workforce household income and expenditure
- analysis of locations of BCC suppliers and their expenditure.

Calculations for employee expenditure are based on workforce income data provided by BCM and aligned with expenditure scales developed from the ABS Household income and expenditure survey 2009-2010 (utilising income quintiles and proportion spent on goods and services). Estimated expenditure amounts per employee have been aggregated by assessment location and rounded to the nearest thousand in order to determine the approximate employee expenditure within each township.

Supplier goods and services expenditure has been conservatively estimated at 20 per cent (%) of total supplier contract amounts, consistent with wider industry practice and based on a review of the range of cost and expense benchmarks provided by the ATO.

The townships and locations reported by employees and businesses have been grouped according to the relevant LGA's proximate to the BCC operations, as well as the greater Hunter and Central Coast Region, including Port Stephens.

The following limitations should be noted when reviewing the TRC analysis outcomes, namely that:

- Inputs relating to employees are based on data provided by BCM which have not been externally validated and are *exclusive* of subcontractors.
- Whilst the earlier TRC study undertaken by Coakes Consulting (2013) asked participating employees and businesses where they spent their income, no data has been obtained in the current study that relates to the specific location of workforce expenditure. In the absence of this primary survey data, it is assumed that all expenditure occurs within the employee town of residence (as supplied by Bulga Coal, 2018) and is therefore likely to be an overestimate of expenditure in these localities. However, where possible, data obtained in the Coakes Consulting (2013) SIA has been compared as relevant.
- Data in relation to supplier contract amounts, by location, is based on internal records provided by BCC and has not been externally verified. Expenditure/supplier expenses have also been assumed to be within the location of each supplier's business address, as provided.

4.1.1 Bulga Coal Complex Employees and Subcontractors

BCM utilises two different types of employment within its workforce. Direct employment is where a person is directly employed by BCM and for the purpose of this report such a person will be referred to as an 'employee'. The other type of employment is through a third-party company, with the individual fulfilling a role as if they were a direct employee, with such a person referred to as a 'contractor'.

Table 4.1 summarises the LGA where BCM employees and contractors reside and estimates of annual household expenditure within these localities. Key characteristics of the BCC operations workforce, suppliers and partners are noted below.

4.1.1.1 Employees

- Existing workforce income data provided by BCM for the SIA has been used to determine the socio-economic benefits that are generated by direct employment at BCC. Based on average FTE employee numbers provided by BCM at the end of the 2017/2018 financial year, there were approximately 500 employees at BCC. Consistent with the BOP SIOA undertaken by Coakes Consulting (2013), the average total workforce including contractors is approximately 700.
- The average annual salary was $119,637.32, which was higher than the average annual salary of employees in NSW ($83,517 as at 2018 seasonally adjusted figures, ABS).
- The majority of employees reside in the local government areas of Maitland/Cessnock (57%) followed by Singleton (22%), with approximately 19% of the workforce residing in the local government areas of Newcastle, Central Coast, Port Stephens and Lake Macquarie, approximately one hour's drive from the mine site as shown in **Table 4.1.**

The outcomes of the TRC analysis for the current operations are broadly consistent with the more detailed findings of the BOP SIOA in relation to the communities estimated to have received the most socio-economic benefit (Coakes Consulting, 2013). Consistent with the findings of the BOP SIOA, household expenditure by employees was highest in Maitland, Singleton, Cessnock, and Newcastle (refer to **Table 4.1**). Expenditure estimates however differ between the reports, largely due to differences in methodology and assumptions.

Given the use of employee and business surveys in the BOP SIOA, the following factors are likely to account for the difference:

- estimation of total workforce spending based on a sample of employees and contractors
- employee responses indicating areas of expenditure outside of locations of residence
- employees own estimates of spending on goods and services, compared to the scales derived from the ABS Household income and expenditure survey (2015-2016), the later having been used solely in the current analysis.

Table 4.1 2018 BCC Workforce LGA of Residence and Expenditure

Locality	Number of employees*Employees	Annual Household Expenditure (Estimated)
Maitland/Branxton	277	$16,973,000
Singleton	155	$9,505,000
Cessnock/Kurri Kurri	119	$7,298,000
Newcastle	80	$4,922,000
Lake Macquarie	36	$2,206,000
Muswellbrook	18	$1,103,000
Central Coast	7	$424,000
Port Stephens	7	$424,000
Total	**700**	**$42,856,000**

Source: Umwelt, 2019

Note: Data has been sourced from Bulga Coal Management (Pty Ltd), 2018

**Employee numbers and expenditure has been extrapolated from internal HR records of 505 employees to a workforce of 700, inclusive of contractors*

The prior study by Coakes Consulting (2013) also collected employee and contractor demographic data and information on community involvement and use of local community services. Given the similarity in distribution of employees within the surrounding communities, it is likely that current employee use of services and community engagement levels are equivalent. In this regard, specifically, the BOP SIOA TRC analysis found that:

- 5% of the sampled employees/contractors identified themselves as being of Aboriginal or Torres Strait Islander descent
- the majority of employees/contractors were in a couple (73%), with just over half having children
- 66% of employees said they had children attending school, the majority of which were located in Maitland, Singleton and Cessnock (67%)
- similarly, the majority of employees/contractors identified Maitland, Singleton and Cessnock as their primary health care service destinations (70%), with 8% indicating they attended medical centres in Newcastle

4.1.1.2 BCC Suppliers

As noted in **Section 4.1,** the supplier data presented below has been provided BCM. **Table 4.3** provides a summary of supplier locations and relative contract amounts.

In summary:

- Of the 620 suppliers to BCC, the most common supplier business locations included Singleton (19%), Newcastle (15%), Sydney (14%), Queensland (14%) and Maitland (9%).
- Around $77.5 million (24%) of the total supplier contract spend was made through businesses with head offices in the Sydney area, with expenditure on suppliers in the Singleton LGA comprising around $58.1 million (18%) and Port Stephens $50.7 million (16%). These areas were followed by Newcastle ($26.8 million), Cessnock ($26.6 million) and Queensland ($26.4 million), with approximately 8% vendor-spend respectively. Collectively these areas receive 83% of the overall vendor spend from BCC, as illustrated in **Table 4.2**.
- Despite differences in methodology with the BOP SIOA survey report conducted by Coakes Consulting (2013) (as above), the locations of business expenditure were approximately equivalent. Sydney, Singleton and Newcastle were represented in the top four locations in both analyses. In the current study, these locations, with Port Stephens, accounted for $212 million or 66% of total business spend. Queensland was also high on the list, accounting for 8% of business expenditure overall.

Table 4.2 2018 BCC Total Business Spend

Location	Total Business Contract Amount ($)	% of Total Business Spend
Total Suppliers	**$317,360,820.40**	
Local Suppliers	$84,714,590.25	**27%**
Singleton LGA	$58,129,134.20	18%
Singleton, Singleton Heights	$29,346,006.00	9%
Broke	$353,347.30	< 0.5%
Branxton	$329,726.25	< 0.5%
Bulga	$24,925.00	< 0.5%
Other Singleton Shire	$57,421,135.65	18%
Cessnock LGA	$26,585,456.05	8%
Kurri Kurri	$25,166,716.90	8%
Branxton	$720,161.25	< 0.5%
Cessnock	$382,608.95	< 0.5%
Greta	$301,800.25	< 0.5%
Other Cessnock Shire	$14,168.70	< 0.5%
Hunter (other) Expenditure	**$106,581,452.65**	**34%**
Port Stephens	$50,721,022.80	16%
Newcastle	$26,840,981.45	8%
Maitland	$12,499,093.25	4%
Muswellbrook	$11,069,382.80	3%

Location	Total Business Contract Amount ($)	% of Total Business Spend
Lake Macquarie	$5,353,885.05	2%
Mid-Coast	$69,020.00	< 0.5%
Other Hunter Region	$23,138.80	< 0.5%
Upper Hunter Shire	$4,928.50	< 0.5%
NSW Expenditure	**$84,445,884.55**	**27%**
Sydney	$77,493,592.45	24%
South East and Tablelands	$4,699,429.15	1%
Central Coast	$1,457,199.10	< 0.5%
Central West	$260,453.95	< 0.5%
Dubbo	$113,313.60	< 0.5%
New England North West	$61,061.00	< 0.5%
Mid-North Coast	$56,976.40	< 0.5%
Illawarra Shoalhaven	$26,221.70	< 0.5%
Interstate Expenditure	**$41,615,460.80**	**13%**
Queensland	$26,357,008.70	8%
Victoria	$11,924,941.45	4%
Western Australia	$2,370,694.90	1%
South Australia	$15,639.75	< 0.5%
ACT	$13,456.75	< 0.5%
Tasmania	$933,719.25	< 0.5%
International	**$332,158.40**	**< 0.5%**
Not specified	**$1,000.00**	**< 0.5%**

Source: Umwelt, 2019. Note: Data has been sourced from Bulga Coal Management (Pty Ltd), 2018

For the most part, the amount of business spend is closely linked with the number of suppliers in each location. A breakdown of number of suppliers by location can be found in **Table 4.3**. Notably, over 50% of suppliers were based in the Hunter, with nearly 45% of total supplier expenditure estimated to be spent on suppliers based within the region.

Table 4.3 2018 BCC Location of Suppliers

Location	Number of Suppliers	% of Suppliers
Total Suppliers	**620**	
Local Suppliers	**148**	**24%**
Singleton	**129**	**21%**
Singleton, Singleton Heights	94	15%
Broke	8	1%
Bulga	3	< 0.5%

Location	Number of Suppliers	% of Suppliers
Branxton	2	< 0.5%
Other Singleton Shire	22	4%
Cessnock	19	3%
Cessnock	9	1%
Branxton	2	< 0.5%
Greta	2	< 0.5%
Kurri Kurri	2	< 0.5%
Other Cessnock Shire	4	1%
Hunter (other)	**221**	**36%**
Newcastle	88	14%
Maitland	53	9%
Lake Macquarie	37	6%
Muswellbrook	25	4%
Port Stephens	14	2%
Mid-Coast	2	< 0.5%
Upper Hunter Shire	1	< 0.5%
Other Hunter Region	1	< 0.5%
NSW Expenditure	**108**	**17%**
Sydney	86	14%
Central Coast	5	1%
Central West	5	1%
Illawarra Shoalhaven	4	1%
Dubbo	2	< 0.5%
New England North West	2	< 0.5%
Mid-North Coast	2	< 0.5%
South East and Tablelands	2	< 0.5%
Interstate Expenditure	**141**	**23%**
Queensland	86	14%
Victoria	35	6%
Western Australia	15	2%
ACT	2	< 0.5%
Tasmania	2	< 0.5%
South Australia	1	< 0.5%
International	**2**	**< 0.5%**
Not specified	**1**	**< 0.5%**

Source: Umwelt, 2019

Note: Data has been sourced from Bulga Coal Management (Pty Ltd), 2018

The BOP SIOA report (Coakes Consulting, 2013) also asked participating suppliers to estimate the level of business dependence on a) the mining industry and b) BCC specifically. Average dependence on the mining industry was estimated on average to be around 70%, with 9.3% of income dependent on BCC. Based on this proportion, it was estimated that approximately $3.6 million of total sampled business expenditure was directly reliant on income from the BCC. It should be noted that as the BOP SIOA business analysis did not utilise data from BCM on total business expenditure, estimates of supplier expenditure were based on data obtained from the supplying companies themselves (refer to Coakes Consulting, 2013). This resulted in an estimated $30 million of business expenditure, compared to the current estimate of $63 million (refer to **Table 4.2**).

4.1.2 Bulga Coal Complex - Community investment

BCC, as a Glencore operation, has a comprehensive Community Investment program, supporting a range of organisations delivering services and initiatives in key investment areas of health, environment and capacity building (including education/training), enterprise development and economic diversity.

BCM supports a number of projects, events and organisations in the local community including the Broke Fordwich Wine and Tourism Association, Broke Public School, Broke Village Fair, and Broke Bulga Landcare.

Over 2017 and 2018, BCC spent approximately $126K on community investments, with $54k spent in 2017 and $74k in 2018. **Table 4.4** provides a breakdown of the social investment contributions made in 2017 and 2018.

Table 4.4 Bulga Coal Complex Social Investment

Community Partner/Organisation	Name of Project/Activity	Focus Area	Financial Commitment (AUD)	Year
Singleton Council	Singleton Library Summer Reading Program	Education	$5,000.00	2018
School and P&C partnership program	VPA: Broke School Future focused furniture	Education	$10,600.00	2018
Broke Fordwich Wine and Tourism Association (BFWTA) Projects	VPA: A Little Bit of Italy and in kind traffic control	Economic Diversification	$6,368.00	2018
Broke Fordwich Wine and Tourism Association (BFWTA) Projects	VPA: Smoke in Broke	Economic Diversification	$6,620.90	2018
Broke Fair Committee	VPA: Broke Fair and Vintage Car Display and in kind traffic control	Community	$6,046.84	2018
Bulga Milbrodale Progress Association	Letter Delivery	Community	$500.00	2018
Broke Bulga Landcare	Cool burn, weed spraying, traffic control McNamara Park	Environment	$7485.82	2018
Hunter Valley Off Road Racing Club	Milbrodale Mountain Classic	Recreation	$3,000.00	2018
Singleton Council	Broke Road Adopt-a-Spot Clean up	Environment	$10,000.00	2018

Community Partner/Organisation	Name of Project/Activity	Focus Area	Financial Commitment (AUD)	Year
Small donations through workforce	One off donations	Community	$2,183.62	2018
Bulga Hall	In kind: Delivery and remove boards	Community	$360.00	2018
Broke Hall	Remove and grind 7 trees	Community	$4,200.00	2018
Singleton Scout Group	Donations for Broke Village Fair	Community	$500.00	2018
CWA	In Kind and Sponsorship of Baiame Cave Picnic Event	Community	$1,676.64	2018
Hunter Valley Local Health Network	Cessnock Hospital: Nox Gas unit donation	Health	$9,000.00	2018
		Total 2018	**$73,791.82**	**2018**
School and P&C partnership program	VPA: Broke School teacher's aide sponsorship	Education	$10,400.00	2017
Broke Fordwich Wine and Tourism Association (BFWTA) Projects	VPA: A Little Bit of Italy	Economic Diversification	$5,200.00	2017
Broke Fordwich Wine and Tourism Association (BFWTA) Projects	VPA: Meet the Maker	Economic Diversification	$5,250.00	2017
Broke Fair Committee	VPA: Broke Fair and Vintage Car Display	Community	$5,081.96	2017
Bulga Fire Brigade	Family open day	Community	$2,500.00	2017
Bulga Milbrodale Progress Association	Bulga Beats Festival	Community	$5,000.00	2017
Broke Bulga Landcare	In kind Landcare: Weed spray McNamara Park and Cool Burn	Environment	$3384.00	2017
Hunter Valley Off Road Racing Club	Milbrodale Mountain Classic	Recreation	$3,000.00	2017
Singleton Council	Broke Road Adopt-a-Spot Clean up	Environment	$3,181.82	2017
Small donations through workforce	One off donation requests	Community	$2,625.44	2017
Westpac Rescue Charity Match	Rugby League team sponsorship	Health	$1,409.09	2017
Maitland Neighbourhood Centre	Christmas Hampers	Community	$6,500.00	2017
Singleton Scout Group	In Kind Broke Village Fair	Community	$500.00	2017
		Total 2017	**$ 54,032.31**	**2017**
		Total Overall	**$127,824.13**	**2017-18**

Figure 4.1 shows the proportion of spending in 2018 allocated to each investment category. The majority of contributions were accounted for by projects relating to community (24%), environment (23%), education (20%) and economic diversification (17%).

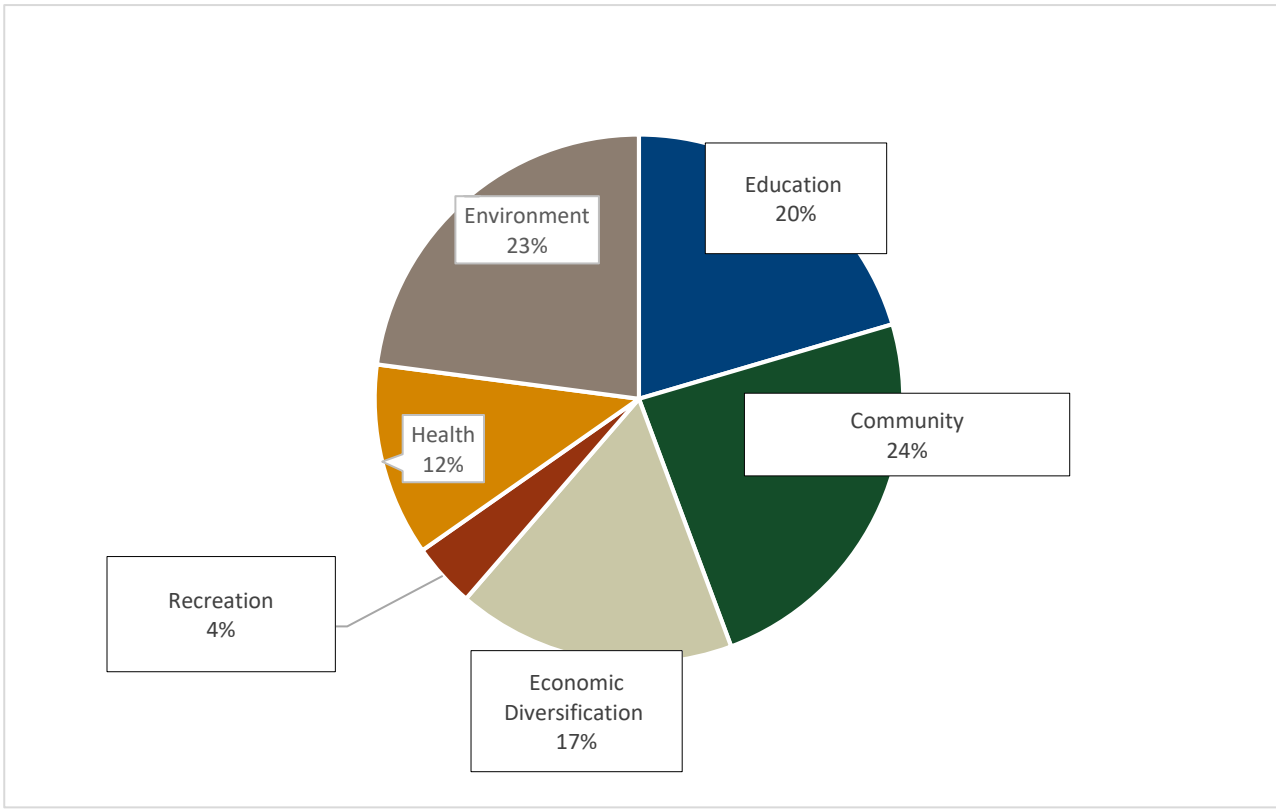

Figure 4.1 Summary of 2018 Investments by Type

© Umwelt, 2019

data sourced from BCM, 2019

As part of the BOP approval, BCM has a Voluntary Planning Agreement (VPA) in place with the Singleton Council which includes approximately $985,000 of funding towards local community projects in Broke and Bulga and $985,000 for projects in Singleton.

To help inform consultation and allocation of funding with Singleton Council on the VPA, BCM utilised outcomes of the BOP SIOA and key findings of a community visioning project, undertaken with stakeholders across the villages of Bulga, Milbrodale and Broke. The objectives of the visioning project were to:

- identify community views for the future of the villages and create momentum to realise a shared community vision
- support community development and future planning
- ensure alignment with Singleton Council's Community Strategic Plan and other regional planning efforts.

Of the $126k in community contributions made in 2017 and 2018, approximately $50k was contributed, as part of the VPA, to the sponsorship of community events held by the Broke Fordwich Wine and Tourism Association, the funding of teacher training, teacher's aide and future focused furniture at the Broke School and sponsorship of the Broke Fair (see **Table 4.4**).

Other projects funded in Bulga, under Part A: Implementation of the Village Master Plan of the VPA, include upgrades to the Bulga Hall and funding for community events in Bulga. The remaining funds (approximately $200K) have been earmarked for the Bulga Recreation Ground (playground shade sail, soft fall, picnic tables and shelters, clubhouse maintenance) and cemetery restoration.

Projects funded in Broke, under Part A: Implementation of the Village Master Plan of the VPA, include upgrades to the Broke Hall, funding for community events in Broke and restoration of Anglican church. Remaining funds have been earmarked for a skate park, tables with shelters and barbeque at McTaggart Park.

4.1.3 Summary of findings

Major resource projects can make significant social and economic contributions to communities that extend far beyond the location in which an operation is based. For instance, the presence of an operation provides economic contributions to communities through indirect impacts such as employees' household expenditure. Furthermore, employees (and their families) that are supported by their employment on a project may contribute to communities through their participation in community groups and activities, or through their use of local and regional services. Likewise, indirect benefits may be experienced in communities where suppliers' head offices are located or where suppliers' business expenditure is undertaken.

This section has provided an indication of the direct and indirect economic contributions of BCC, through analysis of employees' location of residence, wages, and an estimate of employee annual household expenditure. Further analysis of the expenditure on suppliers and estimation of the suppliers spend in their local area describes the direct and indirect contributions of BCC to the region more generally.

Contributions were assessed as wages, residential patterns of employee household expenditure, and supplier business locations and estimated spend on suppliers. Comparison with the earlier TRC analysis, conducted by Coakes Consulting for the BOP SIOA (2013), has also provided an opportunity to triangulate results and assess levels of general similarity in workforce/supplier locations and expenditure across the two periods of analysis.

Consistent with the analysis in the BOP SIOA (2013), the current TRC identified several key towns that appeared to be significantly associated with BCC's operations – these include Maitland, Singleton and Cessnock. Large numbers of employees reported living in these locations, and consequently it was assumed that most employee household expenditure and use of local services would take place in these communities. As the earlier study had specifically asked where employees/contractors spend their money, the similarity in locations of expenditure supports the findings of the current report. Where differences were evident, this was usually in communities that lack access to services.

Similarly, supplier locations and expenditure were found to be spread across equivalent communities, with Singleton, Newcastle, Sydney, Cessnock and Queensland (Brisbane) receiving the highest flow of expenditure in both instances. Estimates of supplier business reliance on BCC, collected in the earlier study, indicated that most businesses still have significant reliance on the operations.

Overall, BCC spent an estimated total of approximately $176 million on salaries and supply contracts within the communities of Singleton, Muswellbrook, Maitland/Branxton and Cessnock Shire Councils, and $274 million in the Hunter Region.

Approximately $84 million was spent on employee salaries and supplies over the course of a year, with $68 million going to employees and suppliers in the local government areas mentioned above, and a total of $83 million in the Hunter Region more broadly. Additionally, BCC pledged a total of $985,000 of investment for the communities of Broke and Bulga, and an equivalent amount for Singleton, over the life of the BOP – the majority of these funds has been used or is currently allocated to specific projects.

Given that the Proposed Modification would prolong the life of the mine for a further four years, it can be inferred that the social and economic linkages discussed would be sustained for this additional period should the project proceed. The economic benefits of the Proposed Modification have been assessed and are further discussed in the SEE.

4.2 Perceptions of the Company

This section analyses existing data to provide an overview of community perceptions of BCC and has sourced data from the 2018 GCAA Community Perception Survey and the BCC complaints register.

4.2.1 Community Perception Survey

As previously noted every three years, GCAA conducts a community perception survey of stakeholders and community residents relevant to their NSW and QLD operations. This survey is designed to obtain a greater understanding of stakeholder issues and needs relating to company activities, past and present; and to assist in driving business improvement in the areas of environmental performance, stakeholder engagement and community development across neighbouring and regional communities.

To inform this section, data from the 2018 perception survey relating to Glencore, involving landholders, local businesses, community groups, Indigenous groups, local and State government and NGOs and residents residing in the wider Hunter Valley, has been reviewed and incorporated as relevant. Glencore operations within the Hunter Valley include the Bulga Coal Complex, Mangoola Coal Mine, HVO Joint Venture, United, Ravensworth, Liddell, Mt Owen Complex and Integra in relation to stakeholder perceptions of BCC:

- proximal landholders and Singleton resident attitudes towards Glencore resulted in an average rating of 5.69 out of 10, where 0 was extremely negative and 10 extremely positive
- of proximal landholders surveyed, 64% felt that their attitude towards Glencore had remained the same over the past year, while 22% indicated it had become more negative
- when asked whether they, their family, or the organisation which they represent, had concerns in relation to Glencore's activities in the area, around half of those consulted, relevant to the Bulga operations, noted that they did have some concerns (49%)
- for the 49% who noted that they did have concerns, these concerns related to air quality – dust (22.6%) followed by noise (12.9%). Community members within the LGA of Singleton noted dust from blasting as their key concern and general environmental impacts
- when prompted with a list of potential impacts that may occur from mining, landholders and key stakeholders' highest level of concern was obtained in relation to air quality (65% rated as high), groundwater (62% rated as high), health and well-being (61%), mine voids (58%), dust from blasting (58%), property rights and future land use planning (57%).

The top priorities for community investment included:

- environment/rehabilitation (17.1%) – strategies including culling of pests, in particular kangaroos; provision of further bush corridors to provide connection between rehabilitated sites for wildlife; beautification of local recreation areas for the community to enjoy and to facilitate tourism

- infrastructure and utilities (9.8%) – strategies included the need for footpaths and cycleways through, and connecting, the local villages e.g. Broke, Bulga, to improve safety for children on roads used by mining vehicles and to facilitate recreational activities for the local community and visitors to the area.

- community sustainability (8.7%) - in relation to community sustainability, some respondents identified the need to undertake a further planning study for the community to facilitate economic diversification in the local communities and reduce dependence on mining, akin to the original visioning study undertaken in 2013 (Coakes Consulting , 2013). It was suggested that community engagement should be a key component, with involvement from key groups such as the Bulga Progress Association. There was also a desire to see local events e.g. Broke Fair, Little Bit of Italy continue to be supported.

4.2.2 Complaints Analysis

BCM maintains a Complaints Register to record all community complaints, investigations and outcomes in relation to their operations. The Complaints Register is available to the public via the BCC website at http://www.bulgacoal.com.au. A review of the complaints register from January 2013 to January 2019 has been undertaken to provide some operational context to issues identified by landholders during the SIA.

It is important to note that BCM records all relevant contact with the community via the complaints line. All complaints are recorded, even if an incident investigation outlines that the operation has been compliant and within their development consent conditions. Across the period from January 2013 to January 2019, BCC received, investigated and recorded a total of 140 complaints. As shown in **Figure 4.2,** the most complaints were received in 2014, with complaints gradually decreasing to 16 complaints in 2017 but increasing slightly in 2018.

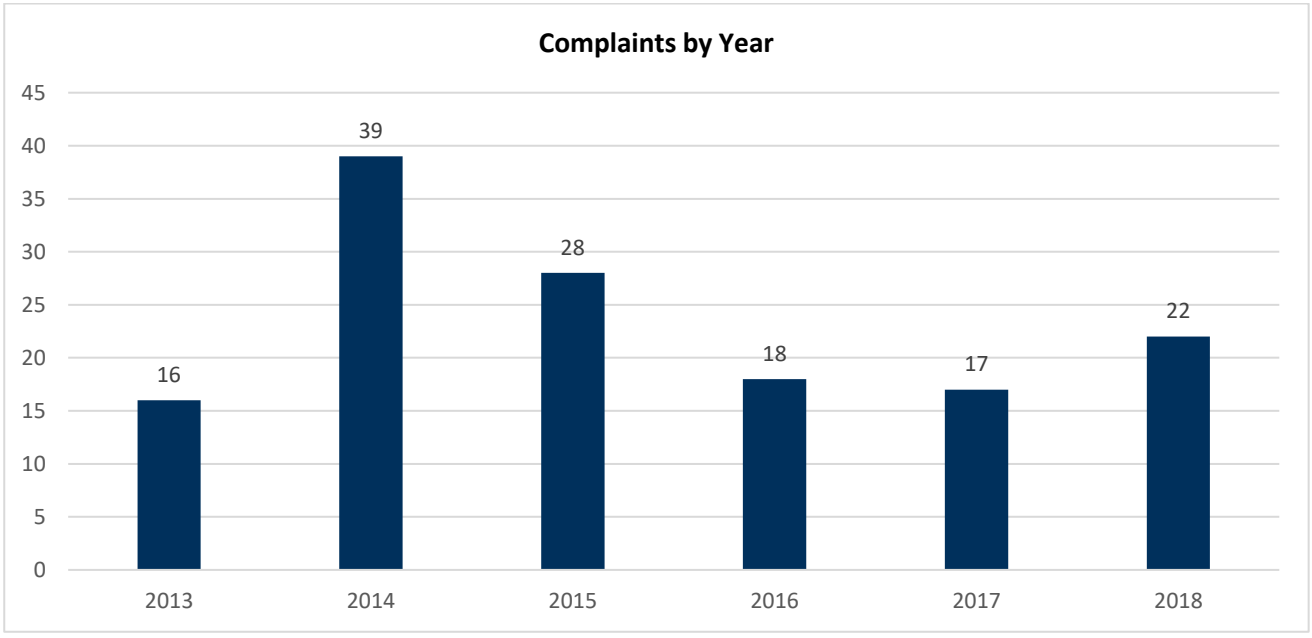

Figure 4.2 Complaints Received by Bulga Coal January 2013 – January 2019 (N=140)

Source: Bulga Coal Complaints database (2019)

Figure 4.3 illustrates the themes of the complaints received by BCM for this period. The most common topics of complaint included noise and lighting, together accounting for 75% of all complaints received across this period. Of the lighting complaints, 96% came from two stakeholders.

In relation to noise, complaints received related to general noise from site machinery, typically during night-time activities, and noise from excavation, loading and hauling and dumping activities. The lighting complaints generally related to the positioning of lighting towers during night-time activity.

Blasting complaints accounted for 15% of complaints received and mainly for vibration, with only 1% of complaints relating to the dust created from blasting activities.

All complaints were investigated by relevant Bulga Coal personnel. Where required, additional management measures were put in place, in response to the complaint e.g. repositioning of lights to address lighting impacts at night; purchasing new lighting systems, relocation of real time monitors to address noise impacts, shutting down of machinery and training of OCEs, supervisors and employees in noise, lighting and air quality aspects.

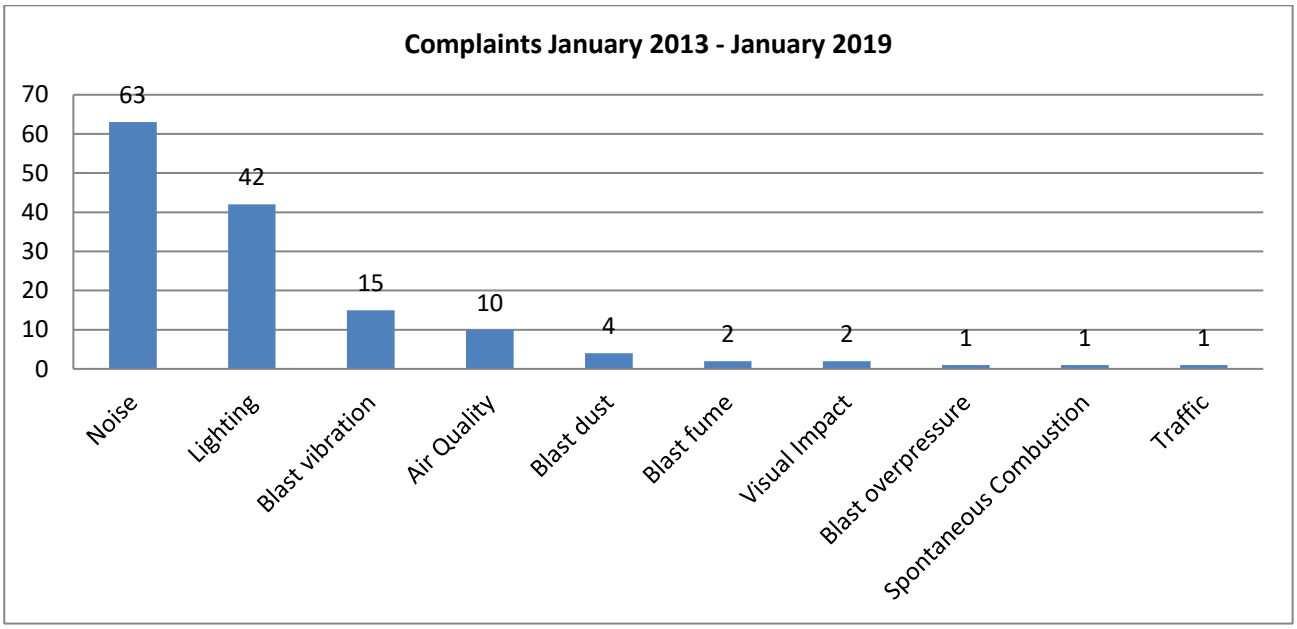

Figure 4.3 Complaint Themes for Bulga Coal January 2013 – January 2019 (N=140)

Source: Bulga Coal Complaints database (2019)

As can be seen in **Figure 4.4** there were 39 complaints received between January 2017 and January 2019, with 17 complaints received in 2017 and 22 in 2018. These complaints were received from a total of 12 complainants, with four anonymous complaints recorded, and over 65% of complaints being lodged by five residents living within the operational management zone.

Over this two-year period, noise was the predominant complaint (59% of all complaints received) followed by lighting (15% of all complaints received). Complaints in relation to blasting were less than in previous years.

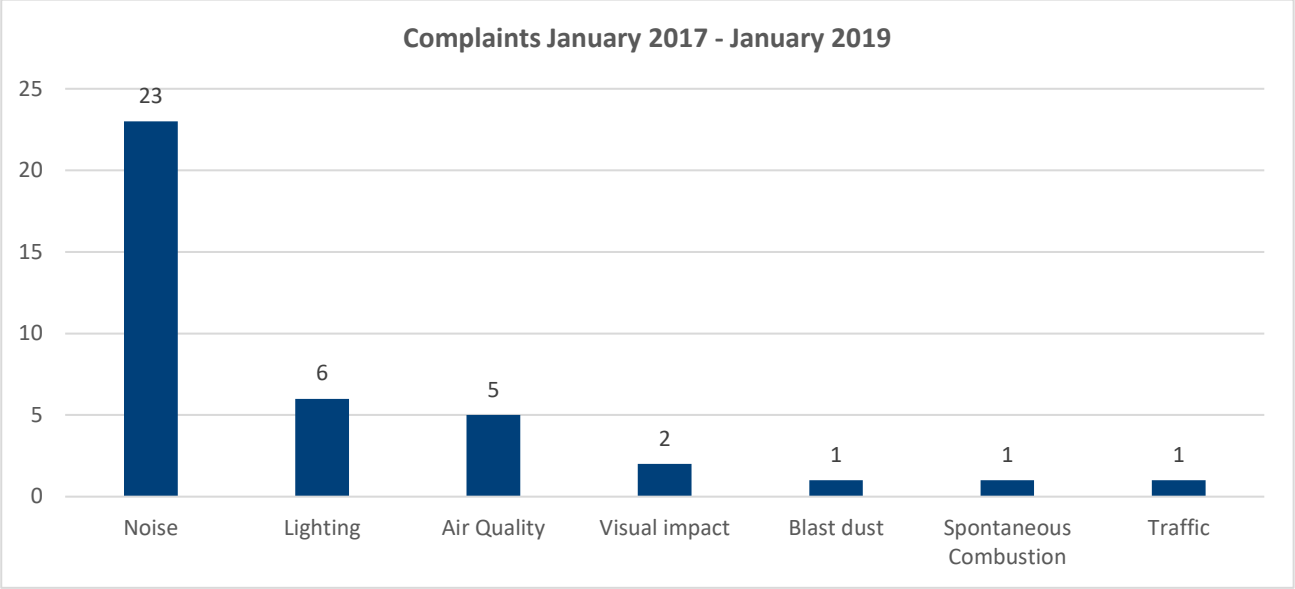

Figure 4.4 Complaint Themes for Bulga Coal January 2017 – January 2019 (N=39)

Source: Bulga Coal Complaints database (2019)

5.0 Social Profile

A baseline social profile gathers knowledge of primary and secondary sources to increase understanding of the existing social environment in which a project is proposed and to provide a foundation from which impacts associated with Proposed Modification may be predicted.

According to the DPE's SIA Guideline (September 2017) a social baseline study should:

> *"document the existing social environment, conditions and trends relevant to each of the social impacts identified during scoping … [and provide] a crucial benchmark against which direct, indirect and cumulative impacts can be predicted and analysed, and to understand the relevant pre-existing social pressures"*

As outlined earlier, an extensive social profile was undertaken to support the SIA for the BOP (Coakes Consulting , 2013). As such, the current SIA study provides an updated social baseline, building on the research undertaken as part of the previous assessment, including:

- **Geographic and historical context** – description of the context and identification of the communities of interest relevant to the current assessment, including a review of the history of the local area and communities, and the culture and values of local residents.
- **Community capitals/assets** – assessment of the areas of vulnerability and resilience across the communities of interest in line with the community capitals/assets approach.
- **Key community values, issues and aspirations** – documentation of current community issues in the Singleton LGA and Upper Hunter Region as a whole, as identified in key planning documents, regional studies, the previous BOP SIA, and media review.

Data sources used in the preparation of this baseline Profile include:

- ABS Census data (ABS, 2001; 2006; 2011; 2016)
- Social Health Atlas (PHIDU, 2018) and other social indicators
- Local and State Government Reports
- existing EIS and SIA reports (relevant to the Project Area)
- review of relevant media.

5.1 Geographic and Historical Context

The Proposed Modification is located within the Singleton LGA in the Hunter Valley Region of NSW. The BCC neighbours the villages of Broke, Milbrodale and Bulga and is located approximately 12 km south of the township of Singleton.

The BCC is one of several mines in the area including the Mount Thorley Warkworth (Yancoal) and Wambo (Peabody Energy) mines, which are located further west and north of the village of Bulga.

The geographical local communities of interest for the Proposed Modification and SIA are outlined below and include the ABS state suburb communities (SSC) of Broke and Bulga. Data relating to the Singleton LGA and NSW are also included for comparative purposes. The data specifically considers time series data from 2011 and 2016 and identifies the demographics where notable change has occurred (changes that have occurred since the BOP SIA was undertaken in 2013).

Due to significant boundary changes to the ABS locality of Milbrodale since the 2011 Census where it was measured as party of Putty, only 2016 data is available for this locality and therefore no time series analysis for this locality has been undertaken. Given that the 2011 boundaries for the Broke SSC included the 2016 SSC of Fordwich; the 2016 data for Broke combines figures from both localities, unless stated otherwise.

The primary state suburbs of interest (or communities) as defined by the ABS (2016) are listed below and include:

- Broke
- Bulga
- Milbrodale
- Singleton (LGA)
- the state of NSW (for comparative purpose).

The Hunter Region has an abundant Aboriginal history which precedes the arrival and colonisation of the area by European immigrants. A cultural heritage assessment has been undertaken as part of the Proposed Modification and can be found in the SEE.

In brief, the Traditional Owners of the Singleton region are the Wonnarua people (also known as Wanaruah and Wonnaruah), whose traditional lands span the Singleton, Muswellbrook and Upper Hunter LGAs (NSW Aboriginal Land Council, 2009).

The Hunter Region also has an extensive European history, with the first free European immigrants leaving Newcastle to explore the Hunter Region in 1793, with the objective of creating further settlements. European settlers were initially drawn to the Singleton area due to the quantity and the quality of viable land. The area has comprised many different forms of industry throughout its history, which have driven the growth of the region. Key industries have included agriculture, dairy, manufacturing, military operations (i.e. Singleton Military Area) and the mining and energy industries.

Dairy farming was one of the dominant industries during the 1900s and grew rapidly as a result of technical advancements in the late 1880s, that included road transportation, refrigeration and cream separators. In more recent times, the Broke region has become well known for viticulture and winemaking, with the Hunter Valley widely acknowledged as one of the oldest wine regions in Australia (Hunter History Consultants, 2013).

One of the other key industries which have played an important part in Singleton's history is mining. Coal was first discovered in the area in 1850, with mining commencing in the 1860s. By the start of the 20th Century there were approximately 16 mines in the area. Post-World War II saw the demand for coal increase, as did demand for energy and electrical power (NSW Minerals Council, 2001). Broken Hill Propriety (BHP) began operation of the Saxonvale Mine outside of Broke in 1982. In 1989, Xstrata Coal purchased the mine from BHP and renamed it the BCC.

A significant event in the Hunter Valley over the past 5 to 10 years, was the collapse in the world coal price in late 2012, and the subsequent downturn in the coal industry. During this period contractors and subsequently employees were laid off from a number of coal mining operations throughout the Hunter Valley. During this period there was a negative impact on the property market and increasing unemployment in the region. Associated sectors were also seen to feel the impacts, with local real estate agents reporting a 25% drop in rental accommodation prices and an estimated 240 rental properties vacant. Hotel/motel and club owners also reported 30-40% reductions in occupancy and patronage of their establishments (ABC Rural, 2014). The downturn lasted for a number of years, with cautious confidence returning to the coal sector in 2016 on the back of improved world coal prices.

The Hunter Valley Coal Chain, as it is now described, contains 35 separate mines, owned by 11 coal producers (HVCCC, 2019). In 2017, these Hunter Valley mines contributed over 159 million tonnes of coal exports from the Newcastle Port (NPC, 2017).

In examining historical changes in the Singleton community, it can be concluded that Singleton strongly identifies with primary and extractive industry sectors (e.g. agriculture/dairying and mining), and holds values traditionally associated with these sectors (e.g. connection to the land, physical labour). However, in more recent times, viticulture and tourism have also become key economic sectors, contributing to the economic diversity of the region.

5.2 Community Capitals Assessment

In developing the social baseline for this SIA, the sustainable livelihoods approach (DFID, 1999) has been utilised, to provide a comprehensive understanding of the relevant communities proximal to the BCC.

The Department for International Development (DFID, 1999) approach draws on broad categories of community capitals as a fundamental basis to identifying and further enhancing community capacity and resilience. According to DFID, a livelihood includes the capabilities, assets (including both material and social resources) and activities required for people to meet their basic needs and support their well-being.

The study has involved profiling communities according to five 'community capitals' or 'capital assets – economic, physical, social, human and natural capital; and has involved the selection and collation of indicators for each capital.

For example, **human capital** refers to the health and welfare of human beings, their knowledge and skills, as well as their overall capacities to contribute to ongoing community sustainability. A community that is heavily dependent on a particular industry, but which exhibits low levels of human capital, is likely to face greater challenges in embracing socio-economic change as a result of disruption.

S**ocial capital** relates to how individuals, groups, organisations and institutions within a community interact and cooperate; and can be broadly defined as a multifaceted concept that can broadly be defined as the dynamics and strength of relationships and/or interactions within a given community; this includes the degree of social cohesion and interconnectedness between community members.

Economic capital is defined as the extent of financial or economic resources within a town or community, including access to credit. For instance, a town lacking in economic capital, but predominantly reliant on a specific industry sector such as mining, is likely to be more vulnerable to change and consequently more likely to experience greater difficulties in adapting to change given this dependence, particularly once an industry declines or as a result of industry closure.

Physical capital is broadly defined as a town or community's built infrastructure and services, including hospitals, schools as well as social service provision e.g. health care, aged care, childcare. For example, a highly remote community that lacks access to basic facilities and social services may lack the capacity to enhance its local human skills base and is likely to be more disadvantaged in capitalising on opportunities for further industry development and economic capital growth.

Lastly, **Natural capital** is defined as the stock of natural resources e.g. minerals, oil and gas, agricultural lands, oceans, forests etc. that provide natural beauty, generate sustainable economic and commercial activities and which provide ecosystem services.

Elements of each capital area are further outlined in **Figure 5.1**.



Figure 5.1 Capital Framework

Source: Adapted from Coakes and Sadler (2011)

Table 5.1 provides a summary of the demographic statistics for SSC of Broke and Bulga, the Singleton LGA and NSW. The data specifically considers time series data from 2011 and 2016 and identifies the demographics where notable change has occurred (changes that have occurred since the BOP SIA was undertaken in 2013).

Due to significant boundary changes to the ABS locality of Milbrodale, since the 2011 Census, only 2016 data is available for this locality and therefore no time series analysis for this locality has been undertaken. Given that the 2011 boundaries of the Broke SSC included the 2016 SSC of Fordwich; the 2016 data for Broke combines figures from both localities, unless stated otherwise.

Table 5.2 provides a summary of key demographic statistics for the localities of interest.

Table 5.1 Demographic Summary Statistics of Milbrodale, Broke, Bulga, Singleton LGA and NSW by Capital Area

	Milbrodale (SCC)	Broke (SSC)			Bulga (SSC)			Singleton (LGA)			NSW		
	2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016
Economic Capital													
Employed full-time (%)	56.6	60.7	53.4	↓	62.4	57.6	↓	65.0	59.5	↓	60.2	59.2	-
Employed part-time (%)	32.1	26.5	35.4	↑	21.0	27.3	↑	25.4	29.0	↑	28.2	29.7	-
Unemployed (%)	5.7	4.5	4.5	-	4.8	6.1	↑	3.3	6.1	↑	5.9	6.3	-
Top industry of Employment (%)	21.2 Mining	18.3 Mining	20.2 Mining	↑	22.5 Mining	25.7 Mining	↑	24.5 Mining	23.4 Mining	-	12.0 Healthcare & social assistance	12.5 Healthcare & social assistance	-
Median household income ($/weekly)*	$1,125	$1,537	$1,662	↑	$1,882	$1,553	↓	$1,663	$1,682	-	$1,233	$1482	↑
Median rent ($/weekly)*	-	$265	$350	↑	$200	$325	↑	$260	$280	-	$300	$380	↑
Median mortgage repayment ($/month)*	$1,820	$1,950	$1,734	↓	$2,200	$1,733	↓	$2,000	$1950	-	$1,993	$1986	-
Human Capital													
Population size (persons)	119	636	671	↑	358	354	-	22,694	22,987	↑	6,917,658	7,480,228	↑
Indigenous population (%)	7	0.8	6.1	↑	7.3	9.8	↑	3.9	6.1	↑	2.6	3.1	-

	Milbrodale (SCC)	Broke (SSC)			Bulga (SSC)			Singleton (LGA)			NSW		
	2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016
Family household (%)	83.3	78.4	75.2	↓	95.5	84.8	↓	72.9	70.0	↓	68.4	68.6	-
Lone person household (%)	16.7	16.8	21.8	↑	5.5	9.8	↑	20.6	22.2	↑	24.2	23.8	-
Group household (%)	0	4.2	2.4	↓	0.0	0.0	-	2.6	2.1	-	3.8	4.2	-
Left school at Year 10 or below, or did not go to school (%)*	41.2	49.4	48.0	↑	63.5	57.8	↓	55.9	52.3	↓	40.6	35.5	↓
Highest year of schooling – Year 12 (people aged 15 yrs and over) (%)*	30.6	44.9	45.3	-	27.5	37.5	↑	35.6	38.9	↑	53.9	59.1	↑
Highest post-school qualification – Bachelor Degree (people aged 15 yrs and over) (%)*	8.3	24.8	19.6	↓	21.6	27.1	↑	17.8	17.0	-	30.8	31.8	↑
Highest post-school qualification – Certificate and/or Diploma (people aged 15 yrs and over) (%)*	51.7	70.7	72.3	↑	72.1	66.9	↓	77.6	77.5	-	56.6	53.6	↓
Physical Capital													
Housing - Fully owned (%)	47.2	34.3	33.5	↓	30.6	33.3	↑	31.1	30.6	-	34.1	32.2	↓

	Milbrodale (SCC)	Broke (SSC)			Bulga (SSC)			Singleton (LGA)			NSW		
	2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016
Housing - Being purchased (%)	38.9	41	45.1	↑	47	39.6	↓	39.9	38.0	↓	34.0	32.3	↓
Housing – Rented (%)	0.0	23	18.9	↓	23	23.4	-	28.5	28.4	-	31.1	31.8	-
Social Capital													
Single parent families (%)	0.0	7.1	13.8	↑	12.3	7.8	↓	13.7	14.7	↑	16.3	16.0	-
Volunteers out of population aged 15 years and above (%)	12.9	23.5	21.3	↓	23.8	32.9	↑	20.4	23.0	↑	18.4	19.7	-
Mobility – % of individuals with a different address one year ago (%)	9	13	10	↓	9	8	-	15	14	-	14	14	-
Mobility – % of individuals with a different address five years ago	28	36	31	↓	24	28	↓	38	37	-	37	39	↑
Cultural Diversity - English language – % of individuals born overseas that speak English "not well" or "not at all"*	0.0	0.0	0.0	-	0.0	0.0	-	2.9	3.1	-	12.3	13.3	-

	Milbrodale (SCC)	Broke (SSC)			Bulga (SSC)			Singleton (LGA)			NSW		
	2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016
Households where a non English language is spoken (ABS) (%)*	0.0	3.8	2.0	↓	3.5	5.6	↑	2.8	3.2	-	23.7	26.9	↑
Cultural Diversity - Immigrants – % of population not born in Australia (Overseas Born – ABS)*	2.5%	11.2	12.7	-	9.6	9.9	-	8.6	8.6	-	27.3	29.7	↑

Source: ABS (2011, 2016)

*Note: * notes where data for Fordwich has not been included. Due to Milbrodale being measured as part of Putty SSC in 2011, only data from the 2016 Census is available for this locality.*

Table 5.2 Demographic Summary – Singleton LGA and NSW

Indicator	Singleton			NSW		
	2011	2016	Change 2011 to 2016	2011	2016	Change 2011 to 2016
Housing stress – mortgage (%)	5.4	7	↑	11.1	9.6	↓
Housing stress – renters (%)	15.8	22.8	↑	26.3	27.9	↑
Rates of Respiratory Disease (ASR per 100 persons)	24.5	31.9	↑	25.4	27.4	↑
Estimated number of people aged 15 years and over with fair or poor self-assessed health (ASR per 100 persons)	14.3	14.6	↑	14.3	14.3	-
Estimated number of people aged 18 years and over who rated high or very high psychological distress (ASR Per 100 persons)	9.9	11	↑	10.5	11.9	↑
Estimated number of people aged 18 years and over with one of four risk factors (current smokers, high risk alcohol, obese, no or low exercise in the previous week) (ASR per 100 persons)	55.6	82.1	↑	56.6	76.3	↑
Residential Aged care places (per 1,000 population aged 70 years and over)	102.2	92.5	↓ 9.5%	87.5	83.4	↓ 4.7%

Source: PHIDU, 2018, 2016, 2010

5.3 Natural Capital

Natural capital refers to the natural assets and resources that contribute to community strength and sustainability. Natural capital can include resources such as minerals, productive agricultural soil, presence of oil and gas and forests which provide commercial and other benefits to the community. Natural capital can also include other environmental assets that generate tourism or provide other social, cultural, and recreational value, such as waterways or lakes. In the Upper Hunter Region, natural capital is abundant. The key natural features of the region are summarised below.

The Singleton LGA comprises a range of natural assets, including mineable resources – particularly coal, as well as natural assets such as Lake St. Clair, Mt Royal, Yengo National Park and Wollemi National Park.

Wollemi National Park is NSW's largest wilderness area and covers a total of 5,017 km^2 featuring a spectacular maze of deep canyons, rocky cliffs and undisturbed forest, including temperate rainforests. Wildlife abounds in the national park with a rich variety of diverse species including eastern grey kangaroos, brush tailed wallabies, wombats, echidnas, gliders, geckos, wedge-tailed eagles and a variety of snakes including the rare broad headed snake (Upper Hunter Country, 2018). Other significant natural areas include Mount Royal to the north, and the Putty State Forest and Yengo National Park to the south of the LGA.

The Hunter Region 2036 Plan (DPE, 2016) outlines a need to diversify the economy within the Upper Hunter but also suggests that industries such as mining, energy production, viticulture and thoroughbred horses will continue to underpin the economy and employment in the region. The Department of Primary Industries (DPI), in its development of the Upper Hunter Strategic Regional Land Use Plan (DPI, 2012) (which is to be reviewed and updated as per the Hunter Region 2036 Plan), has attempted to establish a framework to support growth and protect the environment of the region, whilst responding to competing land uses and conflicts. Approximately 12% of the Upper Hunter's regional lands is currently available for coal mining (DPI 2012) providing significant employment and economic growth in the area, while 18% of the Upper Hunter's regional lands is marked as prime agricultural area or 'strategic industry clusters' (i.e. viticulture and equine industry clusters) (DPI 2012).

Strategies around air quality, waste and wastewater recycling and reuse and managing the risks of pollution and disease have also arisen in the LGA's recent Strategy (Singleton Community Strategic Plan 2017-2027, 2017).

The local villages of Broke and Bulga also identify with a range of natural capital assets which are particularly valued in these communities. Outputs of a community visioning project, 'Our Villages Our Vision' commissioned by BCM in 2013 (see Coakes Consulting, 2013), identified several natural capital values which were important to local residents, particularly in relation to natural recreational assets. These included areas for bike riding, fishing, horse riding, swimming and walking in and around the local villages.

The diversity of natural capital within the Hunter region, and the varied land uses and values associated with this natural capital, has created many opportunities for communities but has also been the source of much debate within the region, particularly between mining, agricultural and equine industries.

5.4 Economic Capital

5.4.1 Industry and Employment

In 2016, employment across the LGA remains centred around the mining industry in general (23.4%), similarly in Bulga (25.7%), Broke (20.2%) and Milbrodale (21.2%). Employment in the mining industry increased between 2011 and 2016 in Bulga (from 22.5% to 25.7%) and Broke (18.3% to 20.2%), against a minor drop in employment in mining in the wider Singleton LGA. The cyclic nature of mining and agriculture, driven by economic and environmental circumstances, may also account for changes in population centres and industry of employment given employment opportunities increase or decrease depending upon market forces.

Employment is undergoing change across the Shire, with a rise in part-time employment and a corresponding fall in full-time employment, across all localities between 2011 and 2016. This may indicate a rising level of under-employment in the region. Broke was seen to experience the largest decrease in labour force statistics, for full-time employment, across the study areas; while decreases in Bulga and the Singleton LGA were less severe. Unemployment rates remained stable in Broke, but increased across all other study areas and NSW, with rates in Singleton LGA doubling between 2011 and 2016 (3% to 6%). In 2016, employment statistics for Milbrodale were equivalent to Bulga and Broke.

Technicians and trades workers, and machinery operators and drivers, represented the main occupations in 2016, with positions across the key industries of mining and agriculture. Current levels of educational attainment (48.5% of Singleton LGA residents leaving school at or before Year 10 in 2016) may reflect vocational training trends across the region.

5.4.2 Income, Spending and Economic Diversity

The SEIFA Index Economic Resources (IER) reflects the economic resources of households within an area and includes variables such as household income, housing expenditure (e.g. rent) and wealth (e.g. home ownership). A low score indicates a relative lack of access to economic resources in general, while a high score indicates greater access to economic resources.

Based on this index, and given that the lowest scoring 10% of areas are given a decile of 1, and the highest a 10, the data indicates a relatively robust economic capital across Broke, Bulga and the Singleton LGA, whilst Milbrodale appears to have comparatively lower levels of available economic resources (refer to **Figure 5.2**)

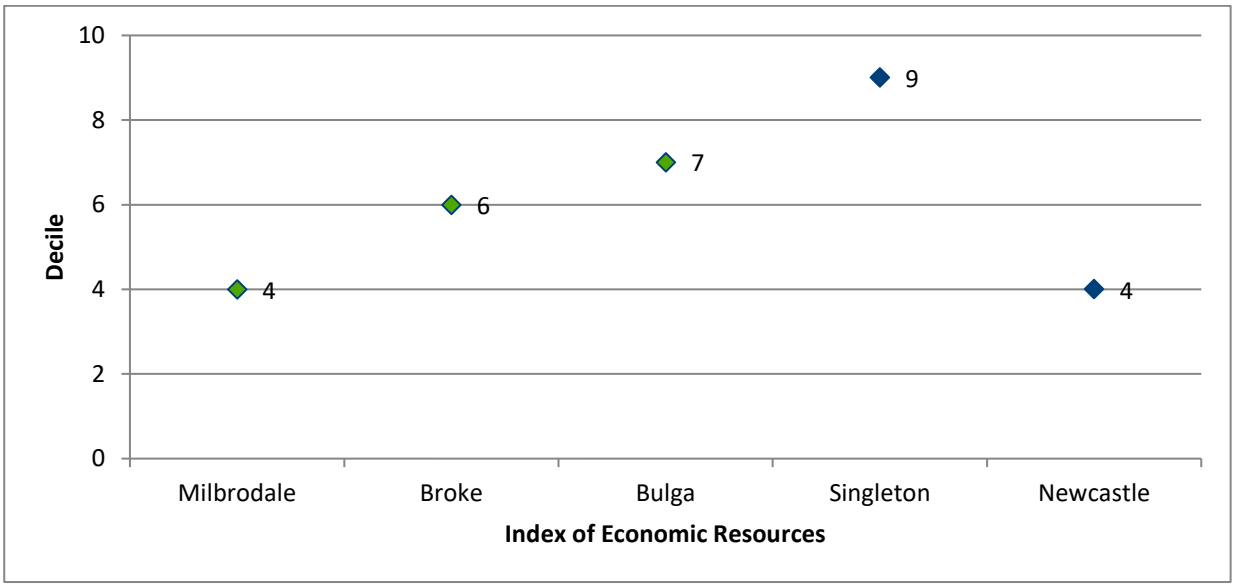

Figure 5.2 Index of Economic Resources (IER)

Source: ABS, SEIFA 2016

The Herfindahl index is a measure of homogeneity/diversity and is used to measure economic diversity. It is calculated as the sum of squares of proportional employment within detailed industry sectors, using ABS INDP4 data (with an index closer to 1 indicating less economic diversity). Not surprisingly, the Herfindahl index for Milbrodale, Bulga, Broke and the Singleton LGA experience higher levels of economic vulnerability, when compared to NSW (0.009) broadly, with Bulga demonstrating the least diverse economy with a Herfindahl score of 0.063, as outlined in **Table 5.3**.

Table 5.3 Herfindahl Index, 2016

	Milbrodale	Bulga	Broke	Singleton LGA	Upper Hunter SED	NSW
Herfindahl Index	0.059	0.063	0.050	0.059	0.031	0.009

Source (ABS 2016)

Wages and expenditure are comparatively higher than those across wider NSW, while mortgage repayments are lower in the localities of Broke and Bulga and rent is lower across the Singleton Shire. The exception to this is Milbrodale, where median household income is substantially lower than the NSW median, whilst median mortgage repayments are only slightly lower than the state.

Both the localities of Broke and Bulga appear subject to volatile conditions in their key industries, with large increases in rental prices seen in both Broke and Bulga from 2011 to 2016, and only minor decreases in median mortgage repayments in Singleton compared to a state-wide trend towards decreasing mortgage repayments. Higher rental and mortgage costs, or comparatively low household income, may indicate housing stress, and this may be evident in the decrease in homes both fully owned and being purchased, and the rise in homes being rented between 2011 and 2016.

Overall, Singleton LGA is particularly sensitive to economic and environmental changes, given its heavy reliance on its natural assets for economic sustainability and growth. The LGA's Strategy (Singleton Community Strategic Plan 2017-2027, 2017) is focused on sustaining key industries while positioning the region as an attractive tourist destination in order to build economic diversity and decrease impacts from economic changes in both mining and agriculture. Key strategies outlined in the Plan include planning for and resourcing the visitor economy, including the development of a night economy in the Shire e.g. eating, drinking, entertainment and nightlife; and further enhancing Singleton's brand. Further investment could include sponsorship of Shire or community events and festivals, which build the area's brand, enhancement of tourism opportunities and assistance in diversifying the business market.

5.5 Human Capital

A review of the data in relation to human capital highlights the following key aspects.

5.5.1 Key Population Characteristics and Trends

As shown in **Table 5.4**, population numbers for Broke have increased since the 2011 Census, while Bulga and Singleton LGA populations have remained relatively steady.

Table 5.4 Changes in Population over Time

Change in Population	2011	2016	Change (2011 - 2016)
Broke	636	672	↑ 5.5%
Bulga	358	354	↓ 1%
Singleton LGA	22,694	22,987	↑ 1%
NSW	6,917,658	7,480,231	↑ 8%

The population projections prepared by the NSW Government from 2011 to 2036 (2016 edition) for the Singleton LGA are presented in **Figure 5.3**. The projections identify growth (21.6%) for the LGA in the medium term, with a population of 28,600 expected to be reached by 2036. It should be noted, that the predicted population for 2016 was overestimated by 1,713 people (24,700 estimated compared to 22,987 counted in the 2016 ABS Census). In addition, the projected population for 2036, calculated in the previous NSW Government projections (released in 2010), was for a slightly higher increase, where Singleton was expected to have a population of 31,800 by 2036 (Coakes Consulting, 2013).

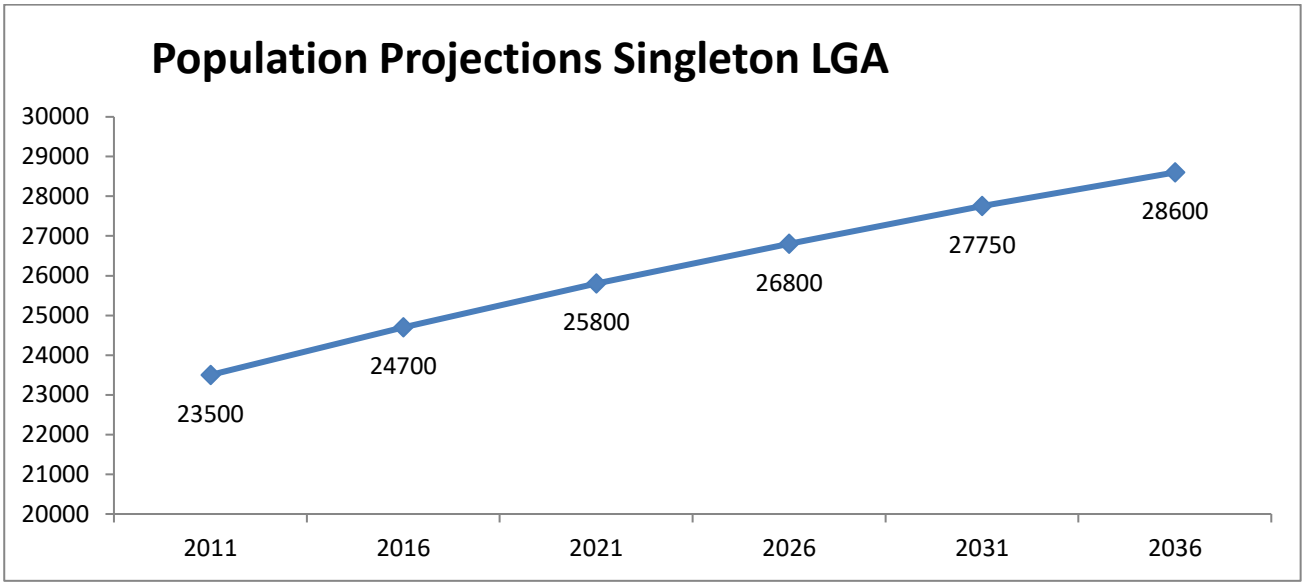

Figure 5.3 Singleton LGA Population Projections, 2011 - 2036

From 2006 to 2016, there has been a sharp rise in the number of people within the Singleton LGA who identify as Aboriginal or Torres Strait Islander, with this change being especially prominent in Broke between 2011 and 2016 (refer to **Figure 5.4**). This trend follows a steadier increase in the proportion of the population of NSW identifying as Aboriginal or Torres Strait Islander, with an increase of 3.3% in Singleton compared to 0.9% in NSW.

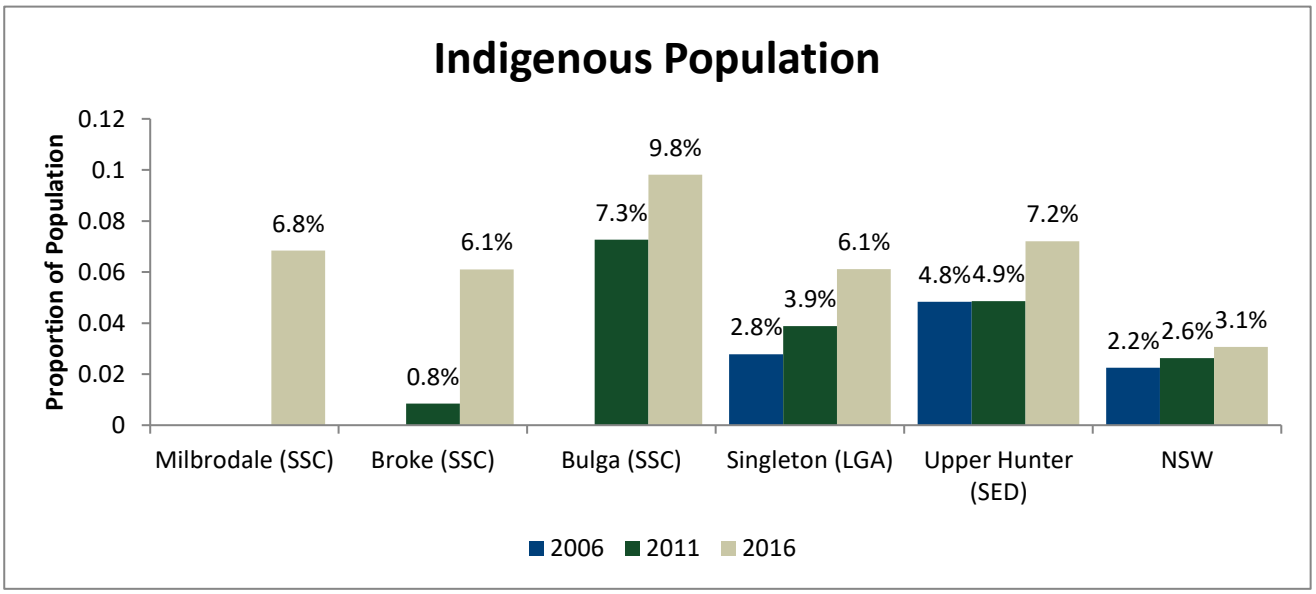

Figure 5.4 Proportion of Indigenous Population 2006-2016

Source ABS Census, 2006, 2011, 2016
Note: Due to changes in SSC boundaries, data from 2006 has been excluded for Broke and Bulga

5.5.2 Health

A community's health is determined through a review of a range of indicators including rate of premature death, status of childhood health, rates of chronic illness, levels of self-addressed and general community health as well as the extent and quality of aged care and medical services in the locality.

In relation to health risk factors, Singleton LGA is above the NSW state average on a number of health measures (i.e. obesity, smoking rates, alcohol consumption and physical inactivity) but is largely on par with rates across country NSW more broadly (refer to **Figure 5.5**).

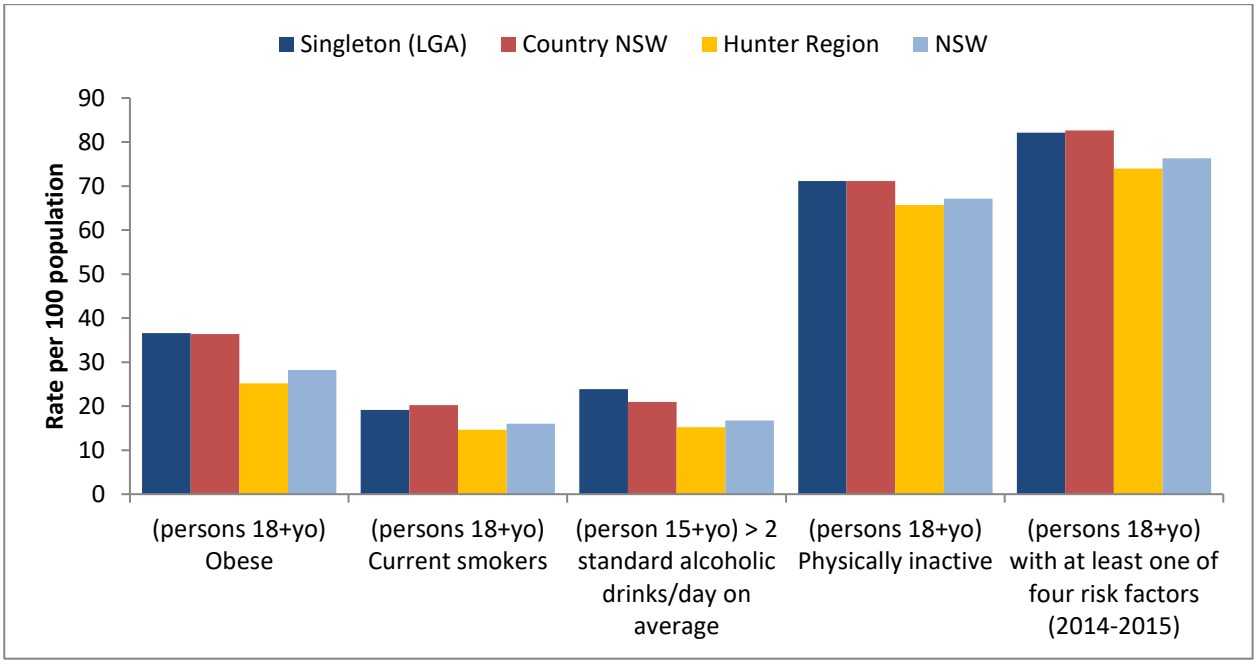

Figure 5.5 Health Risk Factors (2014-2015)

In relation to premature mortality, Singleton LGA experienced higher rates of premature mortality in relation to cancer, lung cancer; circulatory diseases and road traffic incidents over the period 2010 to 2014, when compared to NSW (refer to **Figure 5.6**). Rates of death for suicide and self-inflicted injuries, breast cancer, external causes and ischaemic heart disease were lower than the rest of the state. All other indicators were similar to NSW as a whole.

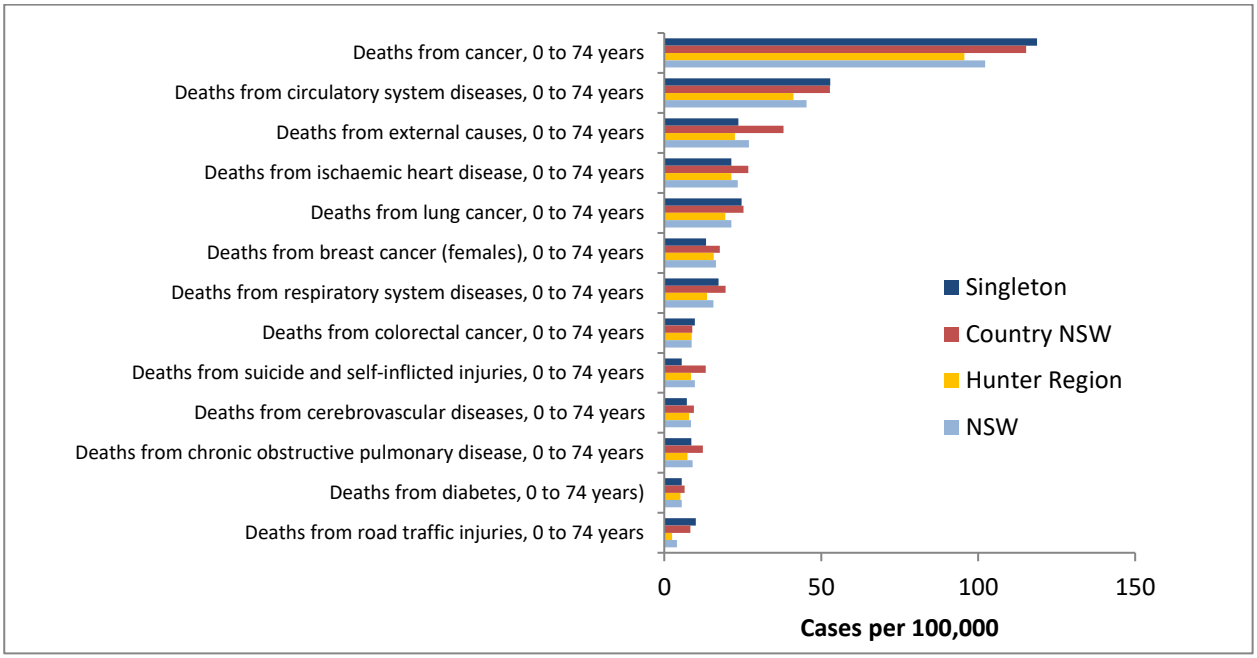

Figure 5.6 Premature Mortality Indicators (2011-2015)

Regarding key indicators of children's health, Singleton LGA fared better than NSW in relation to the percentage of low weight babies and the percentage of fully immunised children at 5 years of age. Smoking rates of mothers was above the NSW average while infant deaths were on par (refer to **Table 5.5**).

Table 5.5 Key Indicators of Children's Health

	Singleton LGA			NSW		
	2011	2017	Change 2011-2016	2011	2017	Change 2011-2016
Children fully immunised at 5 years old (%)	93.5	96.7	↑	91.4	93.5	↑
% of low birth weight babies	6.0	3.4.	↓	6.2	5.2	↓
Average Infant deaths (Rate per 1000 live births)	4.8	3.0	↓	4.7	3.5	↓
Mothers who smoked during pregnancy (%)	17.0	15.5	↓	11.5	8.7	↓

(Source: HealthStats NSW- http://www.healthstats.nsw.gov.au/IndicatorGroup/locationbased)

Mental health issues across the LGA are decreasing with suicide dropping from 8.7 to 5.6 cases per 100,000 people for the periods of 2003-2007 and 2011-2015 respectively (PHIDU 2011, 2018), with NSW experienced a corresponding reduction. However, indicators from the PHIDU showed an increase in 'high' or 'very high' psychological distress between 2007-8 and 2014-15. As can be seen in **Table 5.6**, this figure is equivalent to the current state average.

Singleton experienced a drop in the number of aged care places available, yet still offers proportionately more aged care places than across NSW.

Table 5.6 Psychological Health and Infrastructure Indicators

	Singleton LGA			NSW		
	2011	2018	Change 2011-2016	2011	2018	Change 2011-2016
Avoidable deaths by suicide and self-inflicted behaviour (rate per 100,000)	8.7	5.6	↓	9.0	9.8	↑
High or very high psychological distress (rate per 100)	10.1	11.0	↑	12.1	11.0	↓
Residential aged care places (rate per 1,000 population aged 70+)	107.4	92.5	↓	87.6	83.4	↓

Source: Phidu, 2011, 2018

In relation to the impact of air quality on health, media articles on the impact of mining in the region state that 2018 was the worst year for air-quality measurements since measuring began in 2012. This is said to be due to an increase in coarse particulate matter. The heightened measurements include a 2-week period in June where 4-6 monitors recorded higher than national standard dust levels six times overnight in the Upper Hunter. Further articles suggest that local residents are concerned about their health and wellbeing, with an article reporting a 28.6% rise in Singleton hospital admissions coinciding with a decrease in air quality from September 2016 until September 2017 (Newcastle Herald, 21 February 2018) (refer to **Appendix D**). This is not withstanding that the locality is in the grip of a significant drought and that there have been elevated dust levels during this time across the entire state, attributed to the constant and inevitable drought conditions.

The SRLUP (2012) for the Upper Hunter also acknowledges that the impact of air pollution on health and amenity is a major community issue in the region, with a decrease in health and wellbeing perceived as a result of the presence of the mining industry.

To date there is a lack of focused and conclusive government studies on health impacts of air quality in the Hunter Valley. However, an examination of health data for the Hunter New England LHD (which is inclusive of the Hunter, New England and Lower Mid North Coast regions), shows an increase in hospitalisations for respiratory diseases (which include influenza and pneumonia, other acute respiratory infections, asthma, chronic obstructive pulmonary disease, lung cancer, 'remaining respiratory disease'). Rates of hospitalisations for respiratory diseases per 100,000 persons have increased from 1441 in 2001/2002 to 1721 in 2017/2018 (refer to **Figure 5.7**).

Figure 5.8 shows the breakdown of respiratory diseases by type and illustrates that the accumulation of 'remaining respiratory diseases' accounts for the most hospitalisations. In this regard, it should be noted that there have been increased hospitalisations from 2015 to 2017 for all respiratory disease types excluding lung cancer which has been steadily declining. Furthermore, rates of 'influenza and pneumonia' and 'remaining respiratory disease' hospitalisations have continued to rise between 2016-17 and 2017-18, while all other respiratory disease hospitalisations have reduced.

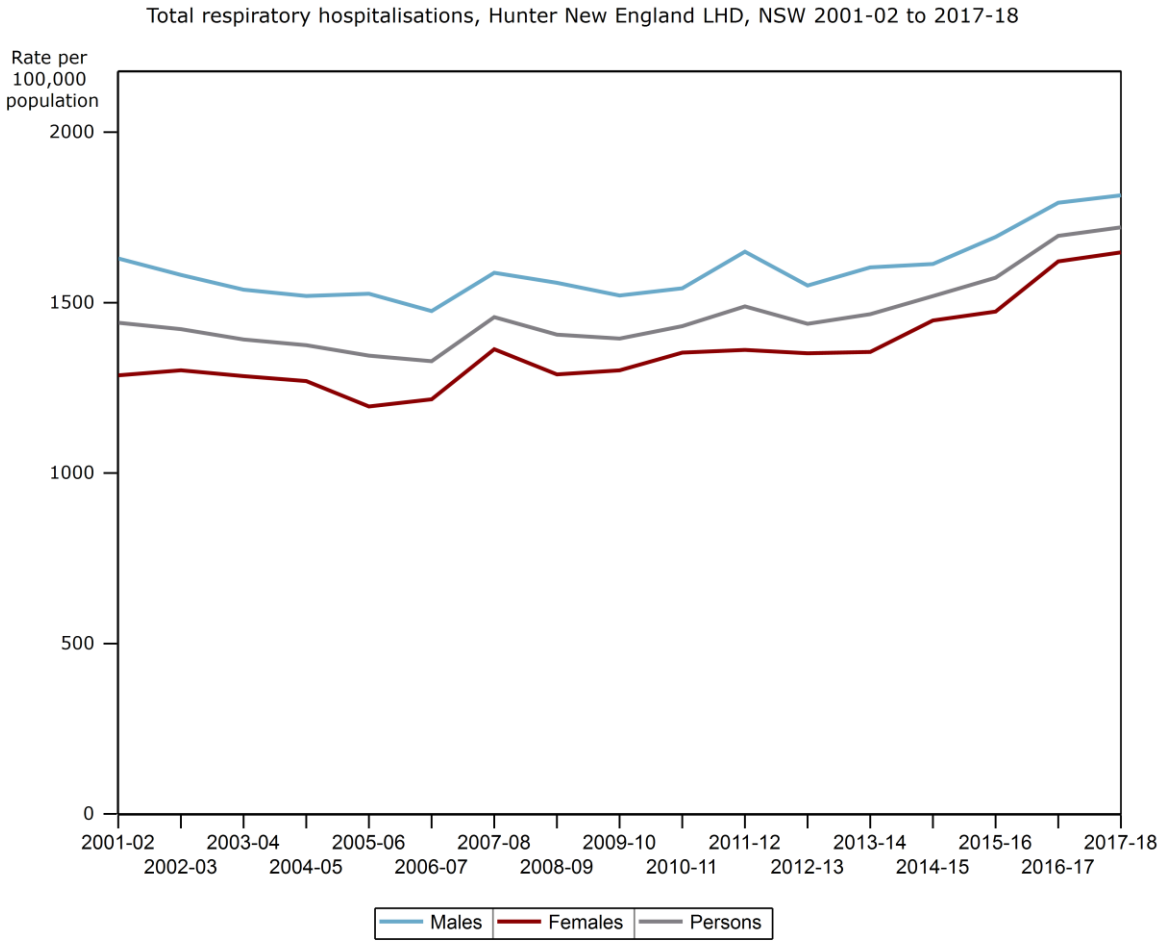

Figure 5.7 Total Respiratory Hospitalisation for Hunter New England Health (2001/2002 to 2017/2018)

Source: HealthStats NSW (2019), http://www.healthstats.nsw.gov.au/

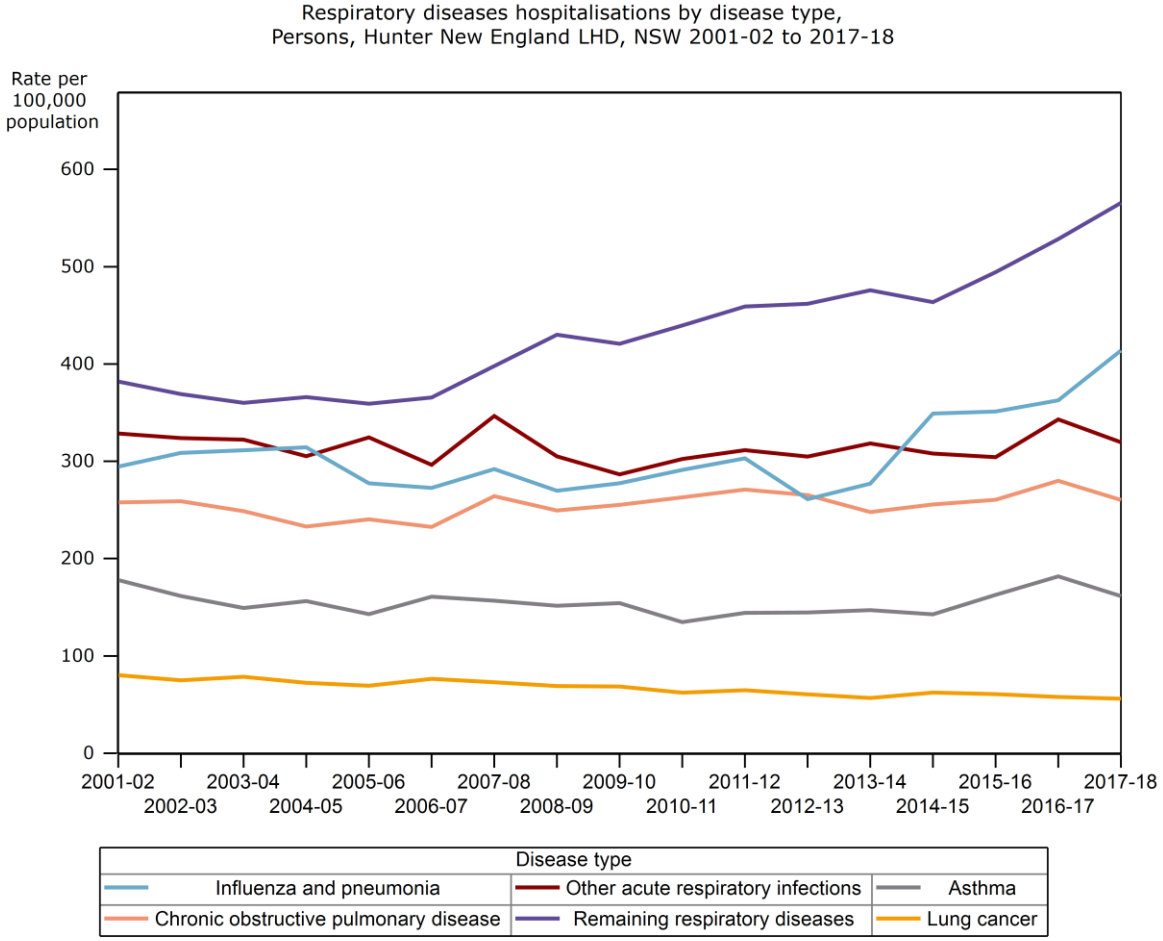

Figure 5.8 Respiratory Diseases Hospitalisations by Disease Type for Hunter New England Health (2001/2002 to 2017/2018)

Source: HealthStats NSW (2019), http://www.healthstats.nsw.gov.au/

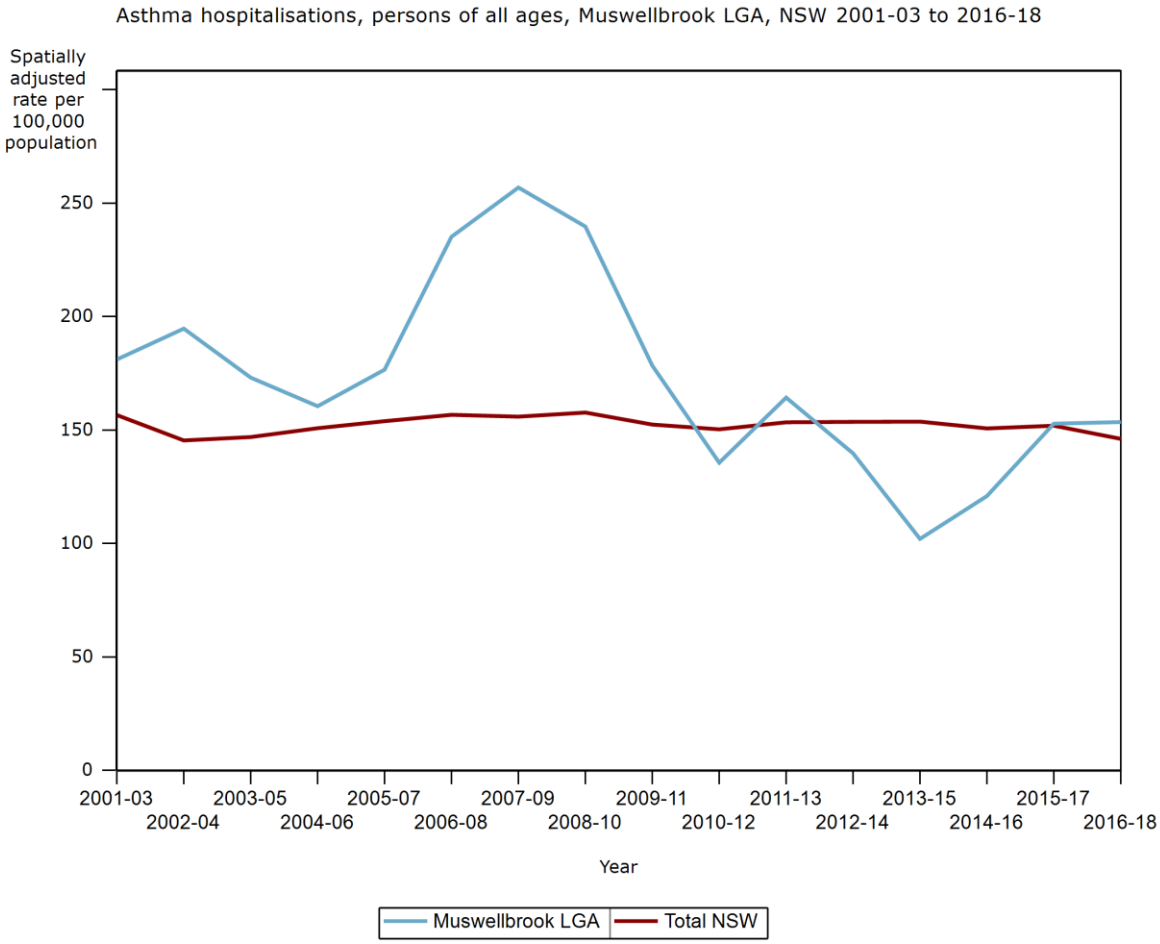

Figure 5.9 Asthma Hospitalisations for Persons Of All Ages Singleton LGA (2001-2018)

Source: NSW Health Stats, 2018

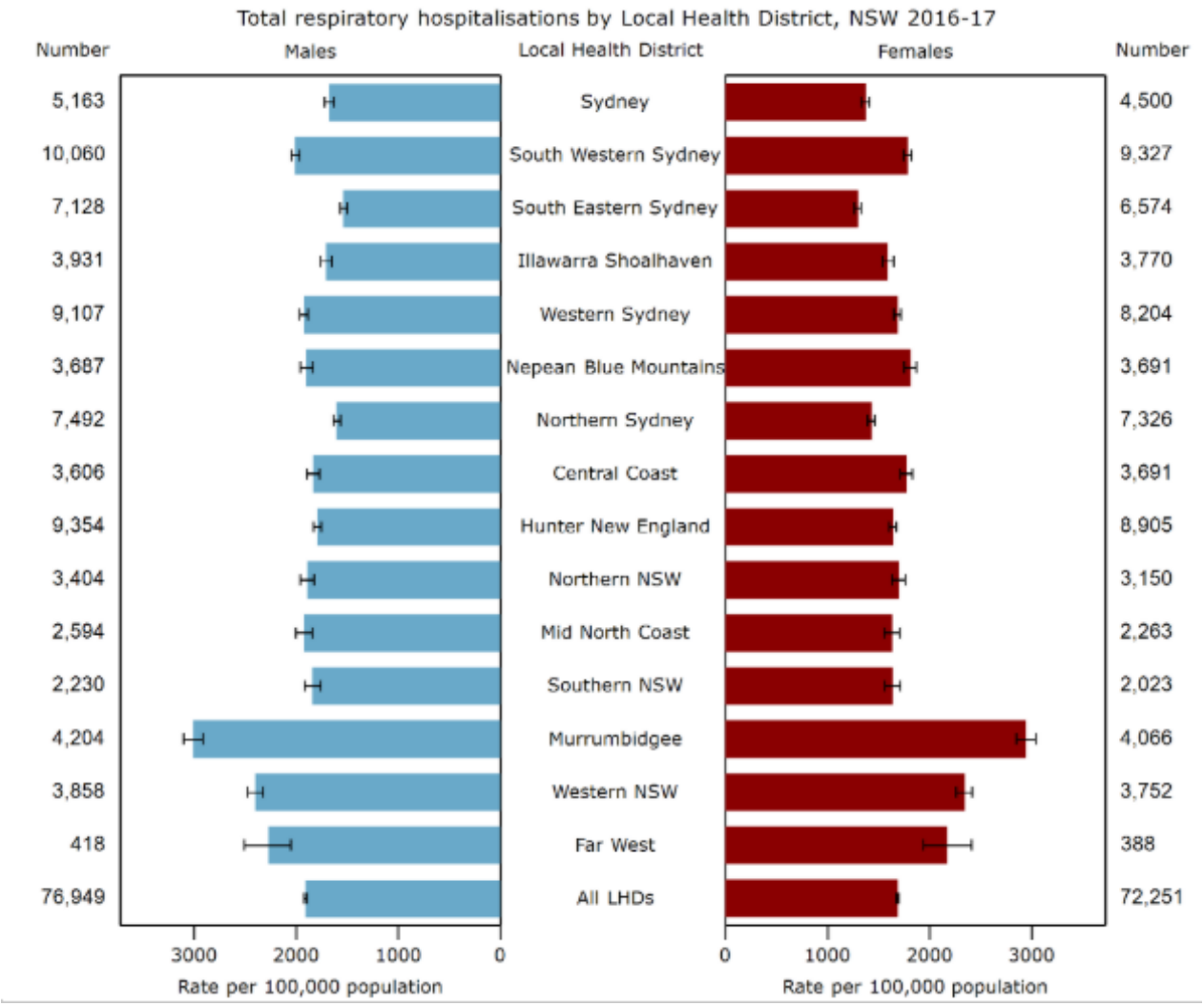

Figure 5.10 Total Respiratory Hospitalisations by LHD (2016/2017)

Source: HealthStats NSW (2018), http://www.healthstats.nsw.gov.au/

The numbers of hospitalisations for respiratory diseases in 2016-17 in the Hunter are the second highest when compared to the other local health districts in NSW, with the highest number found in the South Western Sydney Local Hospital District (LHD). However when considering the rates per 100,000 persons across the LHD, Hunter New England LHD (18,259 hospitalisations, 1707.5 rate per 100,000) is lower than Murrumbidgee (2965.2), Western NSW (2359.8), Far West (2208.3) and Mid North Coast (1767.5); and comparable to the average rate across all New South Wales LHD's, 1787.2 per 100,000 (refer to **Figure 5.10**) (HealthStats NSW, 2018).

Singleton Council's 2017 Strategy focuses on the need for greater health facilities across the LGA and increasing healthy lifestyles for residents. Environmental targets include better air quality and strategies to manage the effects of pollution and disease. Investment in health education programs, further achievement of air quality targets and development of health facilities would result in greater human capital for LGA residents.

5.5.3 Education

Levels of educational attainment increased across the LGA, between 2011 and 2016 (36 - 39%), with the highest increase in residents obtaining year 12 qualifications in Bulga (increase of 10%). Despite this, rates of year 12 completion remain substantially lower than that of the state (59% in 2016), with 48% of residents leaving school at year 10 or below. Echoing this trend of lower levels of educational attainment, the 2016 Socio-Economic Index For Areas (SEIFA) index of education and occupation shows that all three locations (Broke, Bulga and Singleton) were considered disadvantaged compared to other localities, receiving a rating of 3 (out of a possible 10).

As can be seen in **Table 5.7,** educational attainment across the LGA is weighted toward Cert. III or IV, in line with key employment industries, while attainment of Bachelor / Postgraduate degrees in Singleton LGA has remained at approximately half that of NSW from 2006 through to 2011 and 2016 (17-18% compared to 30-32%).

Higher degree education across the LGA follows the general trend for the state, with the proportion of residents with a post-school qualification increasing from 41% to 45% between 2011 and 2016 (2011, 2016 ABS Census). Greater rates of education may lead to a decrease in risky health activities and provide greater social capacity, social networks and social engagement. The Singleton Council recognise the need for flexibility in training opportunities and job-readiness as employment industries continue to transition out of traditional areas.

Investment in this capital area, could take the form of scholarships for tertiary education or funding school programs locally which enhance learning opportunities and increase the quality of education available to school age and mature age residents.

Table 5.7 Post-school Educational Attainment

	Singleton			NSW		
	2006	2011	2016	2006	2011	2016
Postgraduate Degree Level	2%	3%	3%	8%	9%	11%
Graduate Diploma and Graduate Certificate Level	2%	2%	2%	3%	3%	3%
Bachelor Degree Level	17%	18%	17%	30%	31%	32%
Advanced Diploma and Diploma Level	16%	15%	15%	18%	18%	18%
Certificate Level:	63%	63%	62%	41%	39%	36%
Certificate III & IV Level(b)	54%	54%	53%	34%	32%	29%
Certificate I & II Level(c)	4%	4%	4%	3%	3%	2%
Certificate Level, nfd	5%	4%	5%	5%	4%	4%

Source: ABS Time Series Profiles, 2016

The SEIFA Index of Education and Occupation (IEO) reflects the general level of education and occupation related skills of people within an area. The IEO SEIFA Index illustrates relatively low levels of educational and occupational capital in Milbrodale and across Broke, Bulga and the Singleton LGA (refer to **Figure 5.11**).

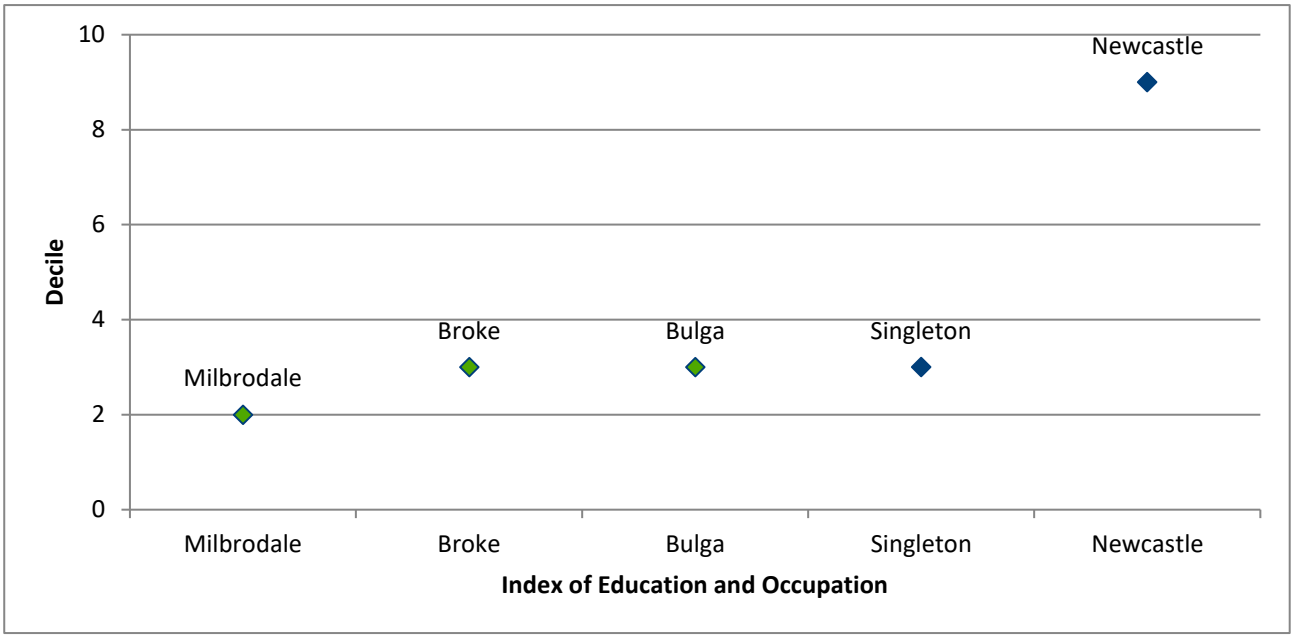

Figure 5.11Index of Education and Occupation (IEO)

Source: ABS, SEIFA 2016

5.5.4 At Risk Groups

Singleton's Community 2016 portrait shows that overall, Aboriginal residents are less well off than non-Aboriginal residents across a range of indicators, including median income (24% less than non-Aboriginal residents) and labour force participation (64% compared with 68%), with fewer Aboriginal residents attending an educational institution.

In 2016, Aboriginal residents were also more likely to live in rented dwellings than non-Aboriginal residents. However, indicators such as personal income, workforce participation, teenage education and level of educational attainment all showed positive changes between 2011 and 2016, with the exception of household income, which decreased across this period.

Broke and Bulga have ageing populations, with a median age of 40-41 years, consistent with regional and state trends. In contrast, Singleton LGA is on average younger (36 years) than the rest of NSW (38 years), however all three localities are experiencing proportionate increases in persons aged 65+ years, over time. The lower proportion of persons aged 20-34 years and those 65 years and over may be indicative of the largely rural characteristics of these areas that include more limited higher education and employment opportunities for young adults, as well as more limited local health and aged care services.

A recent media report also outlines employment as a concern in the Upper Hunter region for those with a disability, injury or mental health condition, particularly in a mining driven economy. The Australian Government's existing Disability Employment Services (DES) has taken on key changes to help individuals gain and maintain employment in the community, with job seekers now able to have greater choice in the services they receive, and how these are delivered (refer to **Appendix D**). These services involve resume/curriculum vitae assistance and identification of job opportunities but can also include ongoing support for a year after work commences to assist job seekers in remaining employed.

Singleton LGA is expected to reach a population of 28,600 by 2036, and the Singleton 2017 Community Strategy focuses, in part, on managing median house costs and population trends. Given the ageing population, there may also be a greater need for health and social services, as indicated in the rise in employment in the health care and social assistance sector since 2011.

5.6 Physical Capital

As would be expected in a regional community, much of the physical capital in the area is located in the regional centre of Singleton. Most of the public utilities are provided by Singleton Council, including waste services, potable water and sewerage; however, some rural areas, such as Bulga, are serviced by on-site water and septic tanks.

Limitations to infrastructure across Singleton LGA exist in telecommunications, with uneven coverage across the Shire, and limited public transport services connecting rural areas of the LGA. The region also still lacks an arts and cultural centre.

There is a significant network of road and rail infrastructure within the Singleton LGA and Hunter Region, which allows for transport and trade both domestically and facilitates access to global markets. The Singleton LGA is traversed by two main national highways: the New England Highway, which links Sydney to Brisbane; and the Golden Highway, which links Newcastle to the Western Region of NSW via Dubbo. The Hunter Expressway opened to traffic in 2014 which has improved travel time for motorists between Newcastle and the Upper Hunter.

The region has a large rail network servicing the coal mines, with rail passenger services also available within key towns within the region. The Australian Rail and Track Corporation (ARTC) owns significant rail infrastructure throughout the Hunter region, including within the Singleton LGA, connecting mines and other industries with the Port of Newcastle.

Over 75% of LGA residents travel to work by car. Higher than state average deaths by road traffic incidences may be linked with private vehicle usage and a high number of trucks using the roads. The Singleton 2017 Strategy seeks to increase public transport access as well as incorporate a disability and inclusion action plan to improve infrastructure across the Shire.

Singleton Shire Council released a *Singleton Bike Plan Revision* (2016) that plans to meet the current needs of the community. In the plan, a number of updates to cycle paths in Singleton and surrounds are noted, however, the Council believe the communities of Broke, Bulga and Jerrys Plains have a low demand for bike paths due to the size of the townships and the absence of 'trip generators', such as work places and commercial precincts. The document also recognises that the existing infrastructure in these towns is limited to non-existent. In the Visioning study for Broke, Bulga and Milbrodale (Our Villages Our Vision 2012 – A Future Vision for Broke, Bulga & Milbrodale, (Coakes Consulting, 2013)), the community outlined the need for a safe dual lane walk/cycleway linking Broke, Bulga and Milbrodale, that is separate from road traffic.

At a wider LGA level, the Singleton Town Centre Revitalisation Project and Singleton Roads Upgrade Program have been implemented. These large-scale projects will address mining traffic management, contribute to the attractiveness of the town centre and improve local safety and travel times (refer to **Appendix D**).

Changes to housing types across the LGA show a slight rise in semi-detached, row or townhouse living (2% in 2006, 4% in 2011 and 6% in 2016), with a corresponding decrease in the percentage of people living in separate housing (95% in 2006, 92% in 2011 to 78% in 2016), which may relate to rising mortgage costs and associated housing stress.

Singleton LGA experienced a rise in the proportion of low-income houses experiencing rental stress between 2011 and 2016 (15.8% to 22.8%), and mortgage stress over the same period (5.4% to 7.0%). For NSW, the rate of mortgage stress has decreased (11.1% to 9.6%), whilst rental stress follows the same trend (26.3% to 27.9%).

Housing stress negatively affects resident's capacity to afford basic living requirements; impacts on the number of hours worked, and leaves residents with a narrow margin for dealing with emergencies or unforeseen events. Overall, housing stress negatively impacts resilience. The trend toward higher rental stress may be attributable to a transition from home ownership to renting, in an effort to relieve mortgage stress occurring as a result of price rises between 2011 and 2013. House prices, however, currently remain lower than 2012 levels.

5.7 Social Capital

Social cohesion in Singleton appears to have remained steady between 2011 and 2016. Cultural diversity decreased slightly, while the proportion of households with two or more languages increased. There were zero to low proportions of non-English speaking residents across all communities in both the 2011 and 2016 census periods. Cultural diversity was low in Milbrodale, with no reported language diversity and only 2% of the population having immigrated in their lifetime. However, it is likely that ABS adjustments have skewed this number due to the low population size in the locality. Bulga experienced a drop in the proportion of households with two or more languages, while Broke remained steady and Singleton increased slightly.

Volunteer rates remained steady in Singleton LGA between 2011 and 2016 and increased 11 percentage points in Bulga (from 18% to 29%) in the same period, indicating a rise in participation. As with cultural diversity, volunteering in Milbrodale was markedly lower than the other areas, with 12.9% of community members over 15 years having volunteered in the last year.

Mobility across Broke, Bulga and Singleton has decreased, with lower proportions of the population living at different addresses one year ago for all localities in 2016 compared to 2011. In 2016, Broke and Bulga had lower than state average proportions of the population who lived at a different address five years ago (29% and 28% respectively, compared with 39% from NSW), while Singleton LGA (37%) has mobility rates comparable to the state average. These rates have also remained stable since 2011 across all localities.

Mobility across the LGA may relate to the mining downturn during 2012-13, and the associated migration of workers out of the area, to other parts of the LGA and region. This worker migration can be seen in the decrease in people aged 25 to 64 years in Broke, 35-54 years in Bulga, and 15 to 44 years in Singleton LGA.

In relation to safety, overall, the Singleton LGA reported increased perceptions of community safety and reduced crime rates in 2016.

5.8 Summary of Community Capital

In summary, there have been a number of changes across community capital areas in the communities of interest between 2011 and 2016, notably:

- Employment in the mining industry in Bulga has increased (2011 and 2016) – up 3.2% to 25.7%; with a small decrease in employment in mining in the wider Singleton LGA.
- A rise in part-time employment and a corresponding fall in full time employment across all localities within the LGA between 2011 and 2016 – this may indicate a rising level of under-employment in the region.

- Unemployment rates increased across all study areas, and in NSW, with rates in Singleton LGA doubling between 2011 and 2016 (3% to 6%).
- Broke has experienced a population increase from 636 in 2011 to 672 in 2016, while Bulga and Singleton populations have remained relatively stable.
- The populations of Broke and Bulga are ageing, with a median age of 40-41 years, whilst Singleton (36 years) has a slightly younger population than NSW (38 years).
- Both Broke and Bulga have seen a small rise (2%) in the proportion of the population aged over 65 years since 2011.
- Volunteer rates remained steady in Singleton LGA between 2011 and 2016 and jumped 11 percentage points in Bulga (from 18% to 29%) in the same time period.
- Mobility across Broke, Bulga and Singleton has decreased, with lower proportions of the population living at different addresses one year ago for all localities in 2016 compared to 2011. Similarly, mobility rates for people living at a different address five years previous in 2016 were lower than state average (39%) for the localities of Broke and Bulga with 29% and 28% respectively.
- Worker migration can be seen in decreases in people aged 25 to 64 years in Broke, 35-54 years in Bulga, and 15 to 44 years in Singleton LGA. Mobility across the LGA may relate to the mining downturn during 2012-13, and the migration of workers out of the area, or to other parts of the LGA and the region
- Health indicators suggest that residents of the Singleton area are particularly vulnerable across a range of health factors, with heightened rates of obesity, smoking, drinking, and cancer. Hospitalisations for respiratory diseases (including pneumonia, asthma and chronic obstructive pulmonary disease) have increased (214 cases from 2002 to 2017).
- Singleton LGA experienced a rise in rental stress concurrently with a drop-in mortgage stress between 2011 and 2016. This general trend is echoed in NSW figures for the same period.
- Increases in rental prices in both Broke and Bulga are evident from 2011 to 2016, and only minor decreases in median mortgage repayments in Singleton compared to a state-wide trend towards decreasing mortgage repayments.
- Higher rental and mortgage costs may indicate housing stress, and this may be evident in the decrease in homes both fully owned and being purchased, and the rise in homes being rented between 2011 and 2016.
- The Hunter Expressway opened to traffic in 2014 which has improved travel time for motorists between Newcastle and the Upper Hunter.

Table 5.8 summarises the findings of the capital's assessment indicating the strengths and vulnerabilities of the Singleton LGA, including where relevant, apparent differences across the villages of Broke, Bulga and Milbrodale.

Table 5.8 Community Capitals Assessment Summary – Singleton LGA

Capital Area	Strengths	Weaknesses
Natural	Diversity and abundance of natural resources	Potential for land use conflicts, particularly around the use of land post mining
Economic	Mining is a key industry of employment Higher than average household incomes	Dependency on mining – key industry of employment A rise in part-time employment across all localities, which may indicate a rising level of under-employment in the region
Human	Good performance against key health indicators when compared to NSW Relatively good access to health services, including aged care facilities Disparities between Aboriginal and non-Aboriginal residents are still apparent, this is particularly relevant given the increase in Aboriginal and Torres-Strait Islander residents in the region during the last census period, however, there has been improvements across a range of social and economic indicators, except for household income	Ageing population Lower than average school and post-school education levels, with a further drop in educational attainment across the LGA since 2011 An increase in high/ very high psychological distress between 2011 to 2016, illustrating that mental health is still a concern across the Shire Greater health issues in relation to lung cancer, cancer and a higher rate of death from road traffic incidence over the period of 2010 to 2014.
Physical	Good provision of utilities and transport networks Provision of telecommunications including an initial roll out of Telstra's NBN service providing access to a significant proportion of the less remote areas of the LGA	Reliance on private car transport with limited public transport options that coincide with working hours Increasing issues of accessibility and affordability of housing, including increase in both rental and mortgage stress.
Social	Increased perception of community safety and reduced crime rates Generally increasing rates of community participation and involvement (volunteering) Decreased mobility rates, with Bulga being the exception	Low levels of cultural diversity Higher than average population mobility rates in Bulga.

Source: Umwelt 2018

5.9 Regional and Local Issues and Aspirations

This section utilises several data sources to build a picture of community issues, values and aspirations at the Hunter regional level, the Singleton LGA level and at a local state suburb level. Data used in this section has been sourced from:

- NSW State Government and Singleton Shire Council strategic plans
- Local, regional and state media (refer to **Appendix D**)
- Outcomes of the Community Capitals Analysis (as detailed in **Section 5.2**).

Relevant regional strategic planning documents that have been sourced include:

- Singleton Community Strategic Plan 2017 – 2027
- Hunter Regional Plan 2036, NSW Government DPE (October 2016)
- The Upper Hunter Economic Diversification Project: Action Plan (2017)
- Upper Hunter Mining Dialogue (2018).

Singleton Community Strategic Plan 2017 – 2027: Singleton Council released their long-term community plan in 2017. The Plan focuses on five key pillars: people, places, environment, economy and leadership to deliver a range of visions. The current plan is a review of the existing Strategic Plan adopted in 2012, given the significant changes that have occurred in the Singleton LGA. The Plan states:

> *Reviewing the Strategy has given Council a fresh line of sight between our community's needs and aspirations, and the opportunities available for us to work together as a community to build a robust and sustainable place to live, work and play.*

In the development of the plan, consultation was undertaken with over 2000 people across the LGA through mechanisms such as:

- engagement booths at local events and public spaces
- provision of community information
- local school workshops
- customer satisfaction surveys, focus groups and phone surveys
- an online engagement hub
- social media competitions and surveys.

Community engagement identified a range of ideas and suggestions including:

- improved connectivity to the river
- diverse range of local jobs
- more creative use of mining voids
- more sporting events

- development of a performing arts centre
- more diverse night time economy
- a planned transition from a mining-based economy.

As noted, the Plan outlines that Singleton is heavily dependent on mining, with 57.9% of the economy generated from the mining industry. In comparison, the Hunter Region has greater economic diversity (with only 9% of its economy in mining). There are currently around 20 coal mines within the Singleton LGA which collectively produce approximately 57 million tonnes of coal per year. Mining employs around 36% of the local population and contributes $5.1 billion in regional outputs annually (Singleton Community Strategic Plan 2017-2027).

The Hunter Regional Plan 2036: The Hunter Regional Plan 2036 is a 20-year blueprint for the future of the Hunter Region which is intended to guide the NSW Government's land use planning priorities and decisions from 2016 to 2036. The vision for the Plan is:

The leading regional economy in Australia with a vibrant new metropolitan city at its heart

The Plan recognises that the Singleton LGA forms part of the transition between the Upper and Lower Hunter; and there are several important interchanges between State and regional roads, including the Hunter Expressway, New England Highway, Golden Highway and Putty Road, all of which intersect in the LGA.

The Plan further outlines that areas of natural capital, such as Lake St Claire and parts of the Greater Blue Mountains and Gondwana Rainforest World Heritage areas, provide significant conservation and tourism opportunities. The future of Singleton lies in growing and diversifying its industry base (including primary industries), improving its housing product mix and minimising land use conflict. The mainstays of the economy are coal mining, agriculture (with growth in viticulture and related tourism), manufacturing and retail.

Some of the key issues for the region and LGA outlined in the Plan include:

- a need to diversify the economy within the Upper Hunter, and while mining, energy production, viticulture and thoroughbred horses will continue to underpin the economy and employment in the region; growth is expected in other industries including manufacturing, creative industries and defence
- support tourism and agriculture by conducting a land use assessment across the Viticulture Critical Industry Cluster to align planning controls that balance scenic amenity with ongoing growth in tourism
- assess land use compatibility
- manage productive landscapes that sustain important agricultural sectors
- improve connectivity to major transport corridors
- protect and revitalise items of heritage significance
- improve provision of housing stock.

Upper Hunter Economic Diversification Project: The Upper Hunter Economic Diversification Project: Action Plan (2017) works within the implementation framework established by the DPE for the Hunter Regional Plan 2036 and delivers on the government's commitment in that plan to diversify the economy in the Upper Hunter.

The Upper Hunter Economic Diversification Project Action Plan was prepared by the NSW Government's Hunter Regional Leadership Executive in 2107 and sets renewed priorities for encouraging new business and employment opportunities and sustainable regional transition for the region over the next 20-25 years. This renewed economic diversification initiative for the Upper Hunter is shifting the debate from land use conflict towards regional economic priorities based on comparative and competitive advantages, leading to opportunities to strengthen industry investment.

Key directions for economic development and industry transition outlined in the Hunter Regional Plan 2036 that this plan draws from include:

- enhance connections to Asia-Pacific through global gateways
- transform the productivity of the Hunter
- protect and enhance agricultural productivity
- manage the ongoing use of natural resources
- diversify and grow the energy sector
- plan for greater land use compatibility.

Upper Hunter Mining Dialogue: The Upper Hunter Mining Dialogue was established in 2011 by the region's miners in response to community concerns about infrastructure and services, mine rehabilitation, water and water quality (NSW Minerals Council 2018).

Many communities in the Hunter Valley have been built around the economic activity generated by mining, which continues to comprise a significant part of the Hunter's economy, injecting $6 billion in wages and payments to local businesses each year. The Dialogue recognises that the growth of mining in the Upper Hunter results in economic growth but also brings with it challenges and impacts for the local community.

The Dialogue brings together local miners, community and business leaders, environment groups, residents, regulators and other industries to better understand and address these challenges together. The Dialogue is a collaborative effort addressing local community priorities by understanding its concerns and then working together to develop and implement solutions. The aim of the dialogue is to ensure that the community can have a voice in directing mine rehabilitation and mitigation efforts towards local community priorities.

Key issues that have been addressed by the dialogue process since 2013 include:

- Water Resources – to better understand the Hunter Valley's water resources a bioregional assessment, a water resource map, a water accounting framework, and a water quality assessment of the Hunter River have been undertaken.
- Social Impacts and Infrastructure – this group has worked to facilitate discussion between councils, business chambers and industry to understand infrastructure requirements and lobby for infrastructure development. This included the completion of a housing study to assess the impact of industry growth on the Upper Hunter, with a focus on social impacts.
- Land Management – the joint Working Group have undertaken a grazing study, a study of possible beneficial end uses for mine voids in the Upper Hunter, and rehabilitation principles and commitments.
- Health and Emissions - this Working Group has developed a Weather Forecasting Project and a Community Weather Forecast Notification Project.

- Other key projects include development of a school mine tours program, and a drive to review the Synoptic Plan for the final landform of the Hunter post-mining.

5.9.1 Summary of issues and opportunities – Upper Hunter Region

A summary of the issues and opportunities presented in the three key strategic documents summarised above is provided in **Table 5.9**. The issues and opportunities identified have been categorised according to the community capitals framework and align with the indicators of strength and vulnerability highlighted in the capitals profile.

Table 5.9 Summary of Issues and Opportunities – Upper Hunter Region

	Issues	Opportunities
Natural Capital	Competing land uses - agriculture, mining and residential Retaining resource base for mining, agricultural and energy industries Maintaining and enhancing opportunities for environmentally responsible mining and coal seam gas development to deliver reliable energy supplies to the state that reduce energy costs and carbon emissions and that generate economic wealth to the state Mining and coal seam gas extraction have the potential to impact on water quality in aquifers and surface water resources through their operations and treatment and disposal of their wastewater The natural environment in the region is under ongoing pressure from development including an increase in mining and coal seam gas development Approximately 13 threatened ecological communities listed under NSW legislation are known to occur in mining areas and as such are likely to be impacted Greenhouse gas emissions in the Upper Hunter are higher than the NSW average Residential and commercial development in several towns and villages in the region is already constrained by flooding	Region has significant natural resources including coal and coal seam gas and productive agricultural land The Upper Hunter region comprises just 2% of the area used for grazing and cropping in NSW but provides a much greater contribution to the NSW production of many agricultural commodities, particularly equine, viticulture, milk and beef cattle Geologically, much of the region is underlain by the Hunter coalfield, a world class coal deposit with approximately 60 coal seams containing predominantly high-quality thermal coals and lesser quantities of soft coking (steel making) coals The coal seam gas industry in the Upper Hunter Region is in its infancy, with no commercial production at this stage. However, the region contains large reserves of coal seam gas and is highly prospective for conventional gas The region contains other mineral deposits as well as numerous extractive resource operations (e.g. hard rock, gravel) The region includes a significant portion of the Hunter-Central Rivers Catchment Management area, and a smaller proportion of both the Hawkesbury Nepean and Macquarie River catchments The Upper Hunter region retains substantial natural heritage with nearly 60% of the area blanketed with native bushland

	Issues	Opportunities
Physical Capital	Growth of the mining sector will require infrastructure provision and upgrades (in particular, rail, roads, pipelines and ports) Need for more diverse housing options due to decreasing persons per household and population growth Increased activity and population growth will impact on infrastructure provision in local communities Regional cumulative impacts on infrastructure due to the growth of mining and related industries in the region Demand for social infrastructure, including health, community and social services, education and emergency facilities is likely to increase as a result of population and economic growth and any existing deficiencies are likely to be compounded	Resources for Regions: a $160 million program aimed at assisting communities to address local infrastructure issues and the local impact on mining affected communities
Economic capital	Mining (and related industries) places pressure on other industries including the thoroughbred and wine industries (in terms competition for land, labour force, wages) Persistently weak trading conditions for Upper Hunter coal industry, reflecting global energy market restructuring – jobs have fallen from 18,000 to 12,000 since 2012 Further replacement of jobs through robotics and automated production is predicted The planned closure of Liddell and Bayswater power stations in 2022 and 2035 respectively will have long term implications for land, water and jobs – one quarter of region's licenced water, 10,000 hectares of strategic land and infrastructure Open cut mining operations are fragmenting highly productive industries and lands Land use uncertainty is impacting on investment in diversified industries Uneven economic growth and distribution of economic resources (including wages) due to the mining industry	Upper Hunter dominated economically by coal mining and agriculture which contributes strongly to the regional, state and national economy The Upper Hunter region is one of the state's most fertile and productive agricultural areas. The agricultural industry is worth around $5.9 billion annually to the regional economy, with dairy, horse breeding, viticulture and beef cattle industries being major contributors Coal is NSW's most significant commodity export - worth over $14 billion in 2010/11. Approximately 60% of this coal is mined in the Upper Hunter region Tourism is an important industry for the region There is also significant employment in the region in service industries such as health care, education, retail and local administration Benefits of the mining industry include lower unemployment, higher average incomes and increased business investment Working with existing sectors to encourage further investment and growth

	Issues	Opportunities
Social Capital	Urban, regional and mining growth has the potential to further impact on known and yet to be identified cultural heritage	Upper Hunter region is rich in both Aboriginal and historic cultural heritage The current identification and protection of both Aboriginal and historic cultural heritage within the region is not comprehensive Many communities are set within and around the Hunter's natural features and open space, which are among the region's best assets. The quality of these areas and the ability to access them gives residents an array of unique experiences and the opportunity for a healthy lifestyle. Strong sense of regional identity and community
Human Capital	A perceived decrease in human health and wellbeing (physical and psychological) is one of the key impacts from coal mining in the Upper Hunter region Greater volumes of coal production mean an increase in potential air, noise and water pollution Aging population: 25% of the region's population will be over 65 years by 2036	The Government is developing a cumulative impact assessment methodology to address the challenges of cumulative impacts of the mining industry on community health and wellbeing (e.g. dust, noise and visual amenity).

6.0 Perceived Positive and Negative Social Impacts

A key component of the SIA is the process of understanding, from a community perspective, community values and uses in the assessment area, and specifically the social impacts and opportunities associated with the Proposed Modification. These impacts are then further assessed to predict impacts in relation to the Proposed Modification that are considered significant and which may require mitigation or enhancement (refer to **Sections 7.0** and **8.0**).

The aim of this section is to provide a more complete description of community perceptions of the Proposed Modification from the perspectives of those involved, in a personal, community, social and cultural sense.

This phase of the SIA program has three main objectives:

- to identify perceived issues / impacts associated with the Proposed Modification
- to identify perceived social issues / impacts associated with cumulative mining development in the region
- to identify strategies for management and opportunities of enhancement of perceived modification social impacts.

These objectives were achieved through engagement with key stakeholders, as outlined in **Section 3.0**

6.1 Issue Themes – Proximal Landholders

This section provides a review of perceived positive and negative social impacts identified through engagement with proximal landholders and the community in the villages of Broke, Milbrodale and Bulga.

The community surrounding the Proposed Modification is well informed, having lived in close proximity to mining for over 20 years. They have a good understanding of the potential impacts of mining and have been through an extensive stakeholder engagement program as part of the BOP from 2012-2013, with over 180 stakeholders engaged as part of the associated assessment process during this time. The most common perceived social impact themes identified by proximal landholders, residents and community group representatives at that time, related to the impacts of air quality (15.4%) and noise (13.3%) on social amenity, visual impacts (11.6%) and community sustainability (11.3%) (refer to **Figure 6.1**).

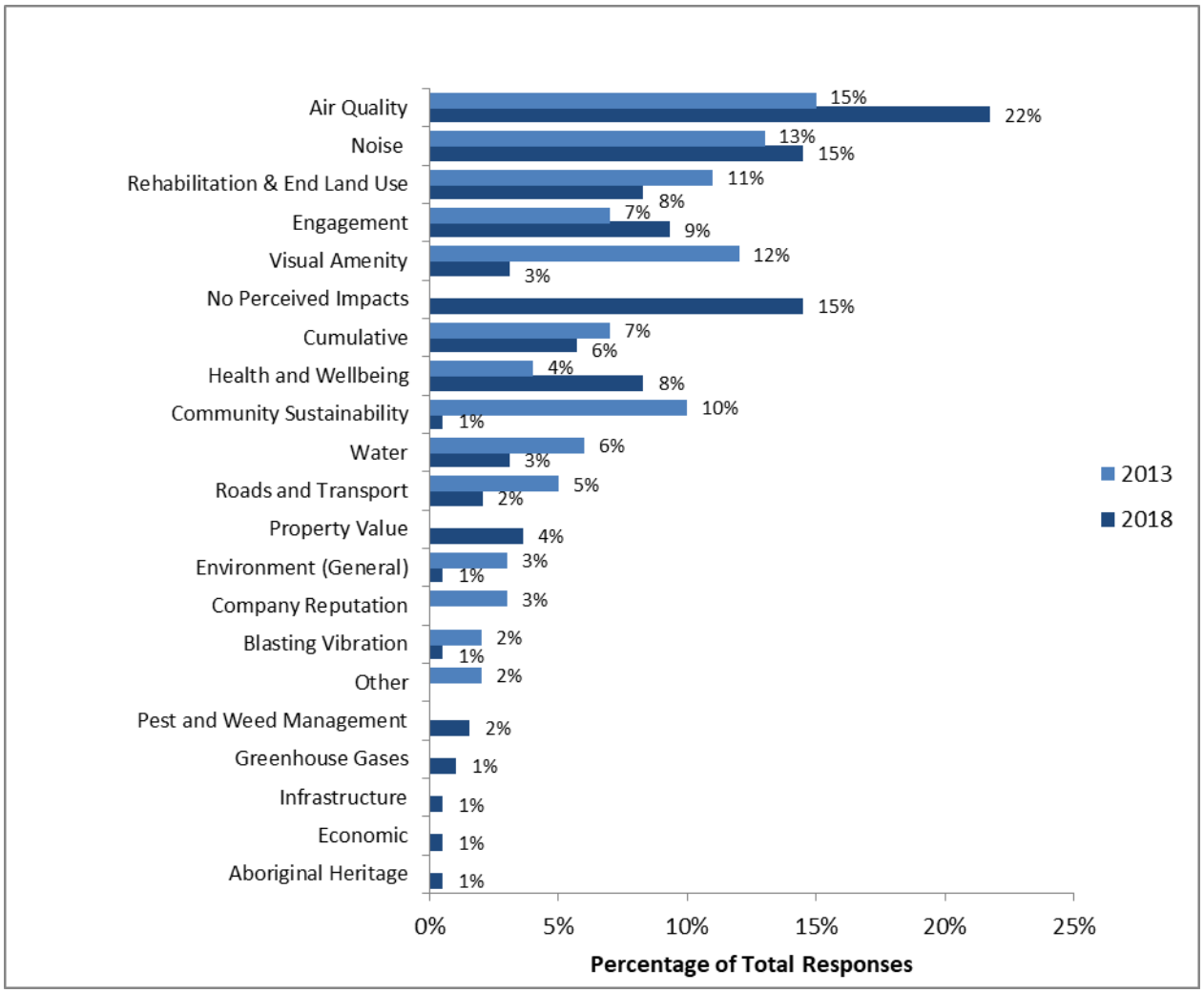

Figure 6.1 Comparison of BOP 2013 Predicted Impacts and Existing Operational Impacts

Source: Umwelt (2018)
Note: 2013 n =149; 2018 n=86, multiple responses allowed

The 2012-13 SIA study also went further and outlined the perceived importance of these issues across the various geographic locations, as issues may vary by area due to topography and proximity of residences to the Bulga Coal's operations.

As shown in **Figure 6.2,** in the previous SIA**,** the localities closest to the mine e.g. those residents located in the village of Bulga, placed greater emphasis on direct mining impacts, including air quality, visual impacts and noise. For landholders and community members of Bulga, noise (17%) was the most recurring and consistent issue of concern and for the Fordwich/Charlton Road area the main area of concern was visual impacts (19%).

For those residents located in and around the Broke Village, community engagement was the key issue (16%), with residents providing positive comments on the engagement approach of Bulga Coal. Air quality and visual impacts were also identified as issues of concern.

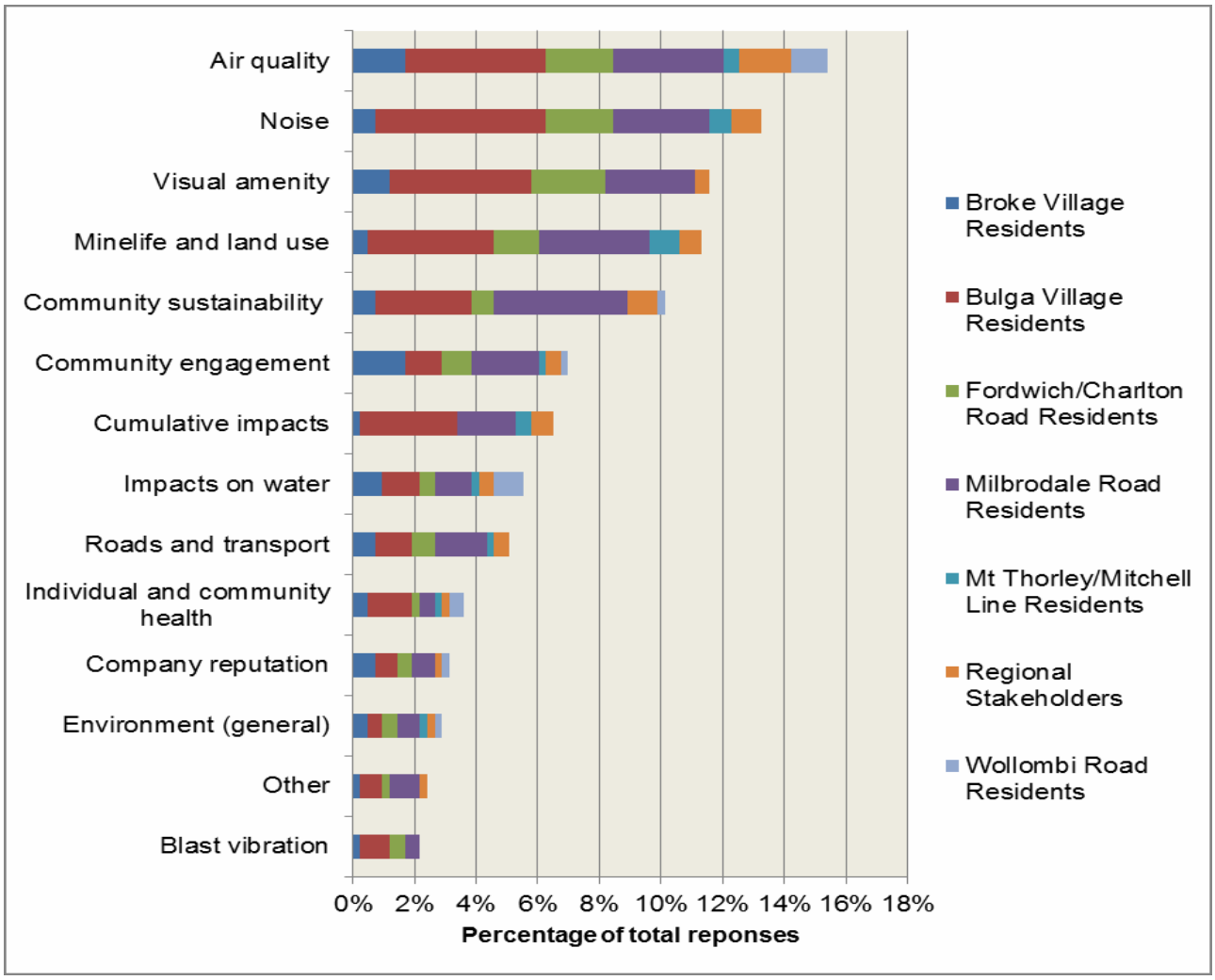

Figure 6.2 Impact Spectrum Key Issues and Opportunities by Location

Source: Coakes Consulting (2013)

More recently, a survey of near neighbours/proximal landholders to the BCC was carried out to inform the current SIA, with respondents asked to provide feedback on both existing operational issues and perceived positive or negative impacts associated with the Proposed Modification. It should be noted that while an overview of the Proposed Modification was presented, no detailed outcomes of the technical assessments were available at that time.

A total of 86 respondents (Bulga n=45 and Broke n=41) participated in the survey and an additional 11 stakeholders attended a Community Information Session held in April 2019.

In addition to these surveys, once the environmental assessments were complete, BCM also offered personal meetings with 20 proximal landholders closest to Bulga Coal's operations (those most directly affected by the Proposed Modification) throughout April and May. In May 2019, Umwelt followed these meetings with SIA phone interviews (six proximal landholders chose to participate), to better understand perceptions relating to the proposed modification and mitigation measures currently in place. These stakeholders were asked to rate the effectiveness of current mitigation strategies and to offer any potential strategies to be considered by Bulga Coal, in relation to the Proposed Modification.

Regarding perceptions relating to the **existing operation** at BCC (refer to **Figure 6.3**):

- 28 respondents (32.6%) stated they did not have any concerns in relation to BCCs existing operations
- for those that did have concerns, the greatest concerns noted were associated with the impact of air quality on social amenity (n = 42 or 22% of respondents)
- noise was the second highest negative concern, again in relation to the impact on social amenity (n=28 respondents or 15% of respondents) and was particularly noted by Bulga respondents
- trust and engagement, rehabilitation and end land use, impacts on health and wellbeing and cumulative impacts were also raised.

As can be seen in **Figure 6.1,** outcomes of the recent engagement is comparable to the predicted negative impacts identified in the BOP (2013), where impacts on social amenity from noise and air quality were also the highest perceived negative impacts at that time. Furthermore, both noise and air quality featured highly in complaints received by BCC from 2013 to 2019 in relation to their operations as detailed in **Section 4.2.2**.

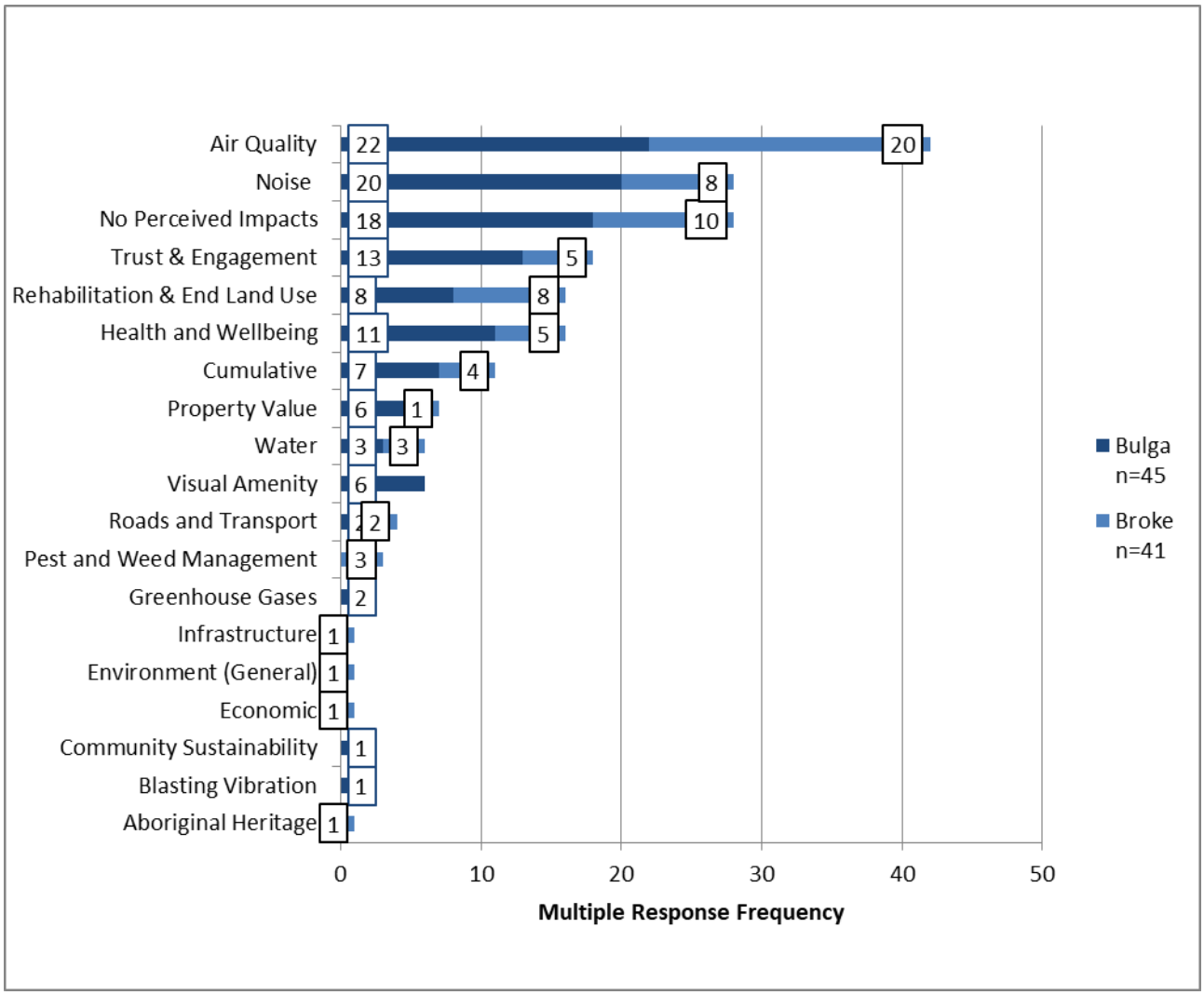

Figure 6.3 Frequency of Impacts Overall by Locality (Existing Operations)

Source: Umwelt (2018)
Note: n=86, multiple responses allowed

In regards to the perceived positive or negative impacts associated with the Proposed Modification (**Figure 6.4**):

- 37 respondents (15%) stated they did not have any concerns
- the highest social impact area noted was the positive economic impacts of the Proposed Modification (N=23)
- concerns around mine life and end land use, including rehabilitation, was the highest perceived negative impact (11), followed by impacts on social amenity due to air quality (7), noise (4) and trust and engagement (4).

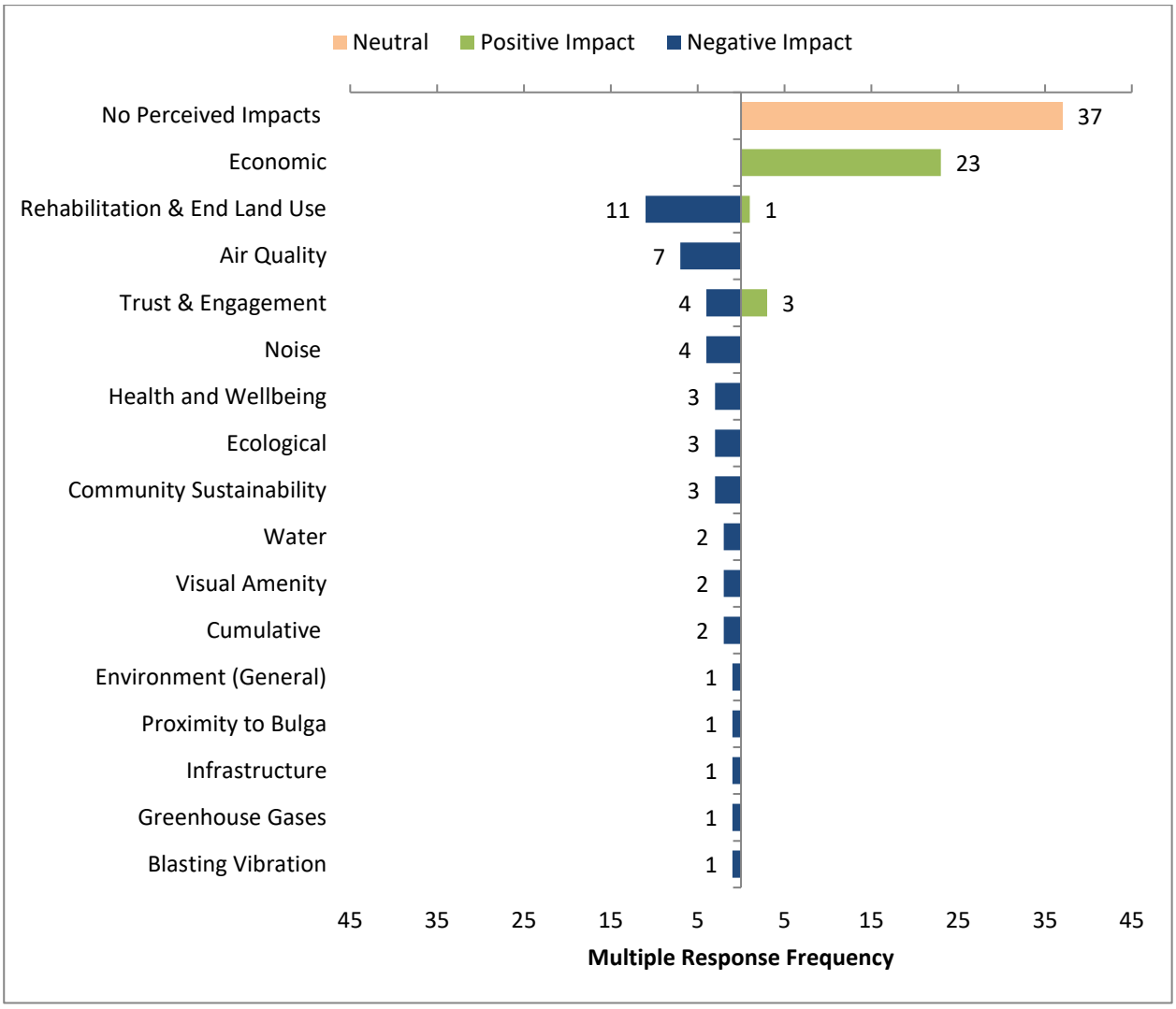

Figure 6.4 Perceived Positive and Negative Social Impacts (Proposed Modification)

Source: Umwelt (2018)
Note: n=86, multiple responses allowed

As shown in **Figure 6.5,** when comparing responses relating to the Proposed Modification by location, the Bulga locality had a higher number of neighbours/landholders with concerns across all impact categories, compared to Broke; with identified impacts relating to rehabilitation and end land use (8); impacts of air quality on social amenity (5) and health and wellbeing (3); ecological impacts (3) and impacts on community sustainability. These issues are also in line with the 2013 SIA engagement data.

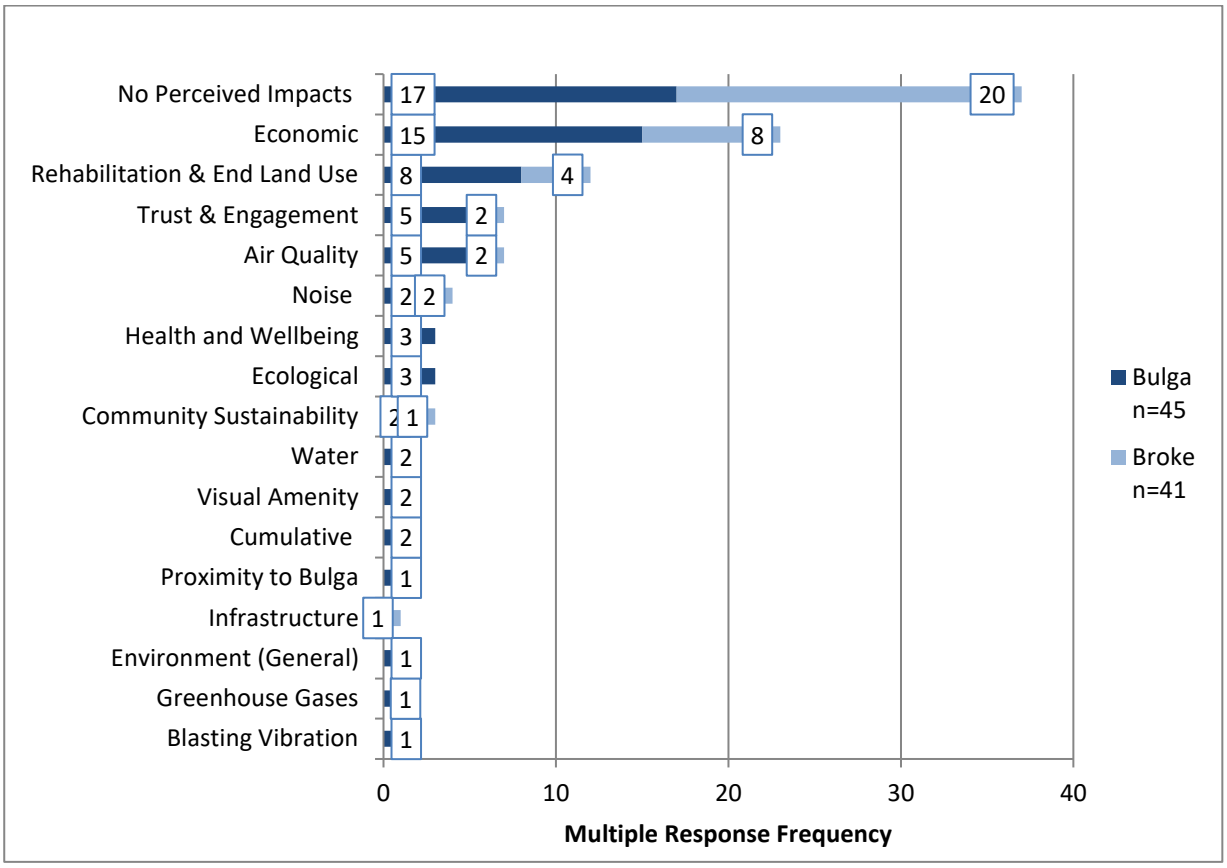

Figure 6.5 Perceived Social Impacts by Locality (Proposed Modification)

Source: Umwelt (2018)
Note: n=86, multiple responses allowed

The following sections provide further discussion of the perceived positive and/or negative impacts identified by proximal landholders in relation to the Proposed Modification.

In addition to comparative analysis undertaken with the 2013 BOP SIOA outcomes, frequencies relating to landholder perceptions of the current BCC operations have also been included, to provide additional context. Direct stakeholder quotes have been referenced to illustrate stakeholder sentiment, however for privacy reasons, no identification of source is provided.

6.1.1 Economic

Near neighbours/proximal landholders (23) from both Broke and Bulga acknowledged that the Proposed Modification will positively contribute to the community, with 21% of total responses identifying the ongoing / sustained economic benefits of the proposal as a key positive impact. The positive impacts noted included further economic growth, ongoing employment opportunities and the continued sustainability of the BCC workforce.

> *"More job opportunities."*
>
> *"Economic growth within the community."*
>
> *"Future employment."*
>
> *"More jobs and more educational classes."*
>
> *"Increasing the life of the mine and therefore extending job opportunities."*

"Sustain jobs – great for the local community."

Comparatively in the BOP SIOA (Coakes Consulting, 2013), employment was raised as a positive impact by only a small proportion of respondents (1.2%).

6.1.2 Rehabilitation and End Land Use

Mine life, end land use and rehabilitation were also identified as key issues associated with the Proposed Modification (11). Some landholders called into question the effectiveness of existing rehabilitation strategies, with such concerns raised more frequently by residents in Bulga (8) compared to Broke (3). Two stakeholders consulted, acknowledged the efforts made by Bulga Coal in their current rehabilitation practice, with some landholders requesting further information regarding land management and rehabilitation, including designation of specific offset areas.

"Rehab seems to be going well."

"I think they put in a lot of thought and are executing it really well."

"They have planted in gullies which have benefits to stop erosion and I think those sorts of efforts ought to be recognized, and it gives me comfort that the efforts on the bund will also be rehabilitated."

"They put in logs for fauna to use as refuge areas and make homes in, which is a good idea – they really think about it."

"I was unaware of the regeneration program and would love to see and hear more about this."

"Please provide information on offsets when determined."

"Even though 2038 is a long way off, they are considering options now - more community things and mountain bike rides for families."

Consistent with proximal neighbour sentiment almost half of the stakeholders (5), in attendance at the Community Information Session held in April 2019, expressed concerns regarding end land use and rehabilitation; and particularly in relation to what could be expected for the use of the final void (post mining), with one stakeholder suggesting alternative energy production should be considered, such as hydroelectric power. Final voids were of concern, with some further suggestions put forward in relation to the use of voids as landfill areas or water catchments. Overall, landholders that identified end land use as a concern also considered the suitability of land once mining ceases for future purposes, such as potential for agricultural use.

"What is planned for the void?"

"What will happen to the mined area when mining is complete?"

"Use the big hole for a dam or rubbish."

"Land regeneration after mining to restore bush habitat."

"There are sink holes."

Stakeholders also expressed a desire for rehabilitation efforts to continue, and general appreciation was expressed when BCC representatives explained that progressive rehabilitation occurs during operations, resulting in more natural undulating landforms, rather than landforms with flat profiles.

"What will happen to the trees that will be bulldozed for the modification?"

"How will the hills/visual bunds look post rehabilitation?"

Six landholders that participated in SIA phone interviews, post the information session, were asked to rate their level of concern with rehabilitation and end land use, which was identified as the most prominent area of concern for these stakeholders, with an average rating of moderately concerned obtained (3 out of 5). Consulted landholders identified the need for further strategic planning for the region of Broke and Bulga when mining operations cease.

6.1.3 Air Quality - Dust

Consistent with the issues raised in the BOP SIOA (2013), air quality/dust was the most frequent negative impact raised during the 2018 engagement (21%), with proximal landholders identifying further potential impacts associated with dust as a result of the Proposed Modification (6%). Interestingly, respondents that mentioned dust as a current operational issue did not generally raise this as a concern with regards to the Proposed Modification, suggesting that air quality and dust impacts extend more broadly to mining in general across the region (cumulative dust impacts).

Overall, landholders from Bulga were more concerned about the impacts of air quality on social amenity, as a result of the Proposed Modification, than those in Broke (7% and 5% respectively). The possibility of increased coal production and cumulative dust, during transportation via rail, as a result of the Proposed Modification, was also a concern for one stakeholder.

"Lots of dust."

"Dust noticeable at night under lights."

"On a windy day black coal dust blows all over everything – cannot keep windows and doors open."

"Daily black dust in house and on the verandah."

"More dust."

"Increased dust."

"Dust from uncovered trains."

"I think it will increase our dust problem."

Social amenity impacts relating to dust included the effective operation of solar panels, as an ongoing issue of existing operations; with landholders (2) noting the subsequent costs associated with cleaning the panels to ensure efficiency. Dust accumulating in swimming pools and an increase in domestic cleaning, as a result of dust, was also a notable social impact expressed by proximal landholders (40). These landholders expressed a sense of entrapment in their own homes by not being able to open windows or doors to enjoy the breeze, due to poor air quality.

"We have solar panels, which we have cleaned every June at a cost of $360 (approx.). Within a couple of months, the dust is significantly thick, that it is clearly visible from looking up from the ground. This is affecting the function of the panels."

"Dust seems to be increasing – amount visible on outside of house, on screens and in gutters."

"I am sick of cleaning coal dust from my pool."

"Dust is an issue, but the origin is not identifiable."

"In general, the air quality in the Hunter is a cumulative issue with all the sites in the Hunter."

"Dust (but probably from Mt Thorley)."

"It is difficult to pinpoint who is the main contributor, yourselves or Mt Thorley. I feel Mt Thorley are worse. I appreciate that you give me a call to warn of impending blasts."

"Dust impacts on my life daily, however I believe Bulga Coal manages this to the best of their ability."

While specific mitigation strategies relating to dust impacts were not suggested by any consulted landholders, two landholders noted that they had been offered water tank cleaning and filtering by the BCC and were satisfied with these measures.

"Have been offered assistance with water filters and tank cleaning."

6.1.3.1 Health and Wellbeing (Dust)

Consulted stakeholders also noted concerns regarding the potential impacts of dust on human health from existing operations (15). Health related concerns were associated with respiratory issues from air-borne particulates and dust accumulating in drinking water. One stakeholder also referred to the ongoing effects of anxiety and stress.

"It cannot be good for our health, as asthma is relevant to this area."

"Dust impacts on my asthma as well as sinus and eyes."

"Dust pollution, not only annoying, I know the health risks it imposes."

"Myself and my children both suffer from asthma and I associate this to the coal mines."

"Dust is in my water tank and pool-health reasons."

"How much slush is there in the bottom of our tanks that provide our drinking water?"

"Dust – respiratory problems – asthma."

Similar concerns were also noted in reference to the Proposed Modification, but to a much less extent (3) and related more generally to the cumulative impacts of mining in the area.

"Health risks."

"Cumulative health impacts."

Both individual and community health concerns were also raised by landholders during the previous stakeholder engagement in 2013 as part of the BOP SIOA, with 4% of total responses relating to health impacts. Community stakeholders at this time specifically recalled dust accumulating in water tanks as an issue and potential health impacts as a result of dust particles in the air. In 2013, the community of Broke were particularly concerned with existing fumes from operations; however, no landholders raised this issue during the current SIA engagement program.

6.1.4 Trust and Engagement

In relation to levels of trust and existing engagement undertaken by the company, a total of 13 responses were obtained, both positive (3) and negative (4), including one stakeholder who held a sense of distrust in the government decision making process.

Overall, proximal landholders stated that they were comfortable with the level of engagement that they had experienced to date with Bulga Coal, with many congratulating the company on their efforts to be transparent concerning operational information and/or potential impacts.

Positive sentiment pertaining to engagement was reiterated by stakeholders during consultations at the Community BBQ's held in November 2018 and the Community Information Session held in April 2019, with these stakeholders explicitly acknowledging and expressing gratitude to BCC for facilitating a community forum in which operational and social impacts could be discussed in a relaxed setting.

An additional six landholders contacted in May 2019 suggested engagement occurs frequently, with four (66%) of these explicitly outlining their positive interactions with Bulga Coal.

The regular Community BBQs were deemed a particularly successful mechanism to bring the community together and contribute to the sense of community in the area. Those consulted also often compared Bulga Coal's approach to engagement with other operations in the area, stating that BCC's engagement practices were well organised, transparent, straight forward and honest.

> *"Community sessions are well organised."*
>
> *"Open communication with transparency."*
>
> *"Like being invited to the Bulga BBQ to find out what is happening."*
>
> *"Very good feedback to the community through the BBQ dinners."*
>
> *"No concerns, we are always informed of any activity that may be cause for concern."*
>
> *"Bulga Coal's communication with the community is always straight forward and honest."*
>
> *"Appreciate the opportunity to [make] comments."*
>
> *"Compared to your neighbours – pretty good."*
>
> *"It shows they care and are listening to landholders."*

As described above, most proximal landholders and community residents were satisfied with the level of information provided by BCM. Mechanisms of engagement offered by BCM appear consistent with stakeholder preferences, these include face to face meetings, or contact by phone and email. Of all stakeholders consulted, two respondents expressed that community engagement and information provision offered in regard to the Proposed Modification, had been inadequate and requested more information on topics such as operational plans and rehabilitation measures.

"Transparency on the project."

"Appreciate the opportunity to [make] comments."

"More info required."

"Why was the modification not included in the original approval?"

The positive sentiment associated with BCC's existing company engagement is also strengthened by the fact that when asked *"Do you have any other comments you would like to make?' Over* half of the comments referred to the company's existing engagement practices, i.e.:

"Thank you for providing this night to connect with our local families."

"I would like to thank Ralph and Teegan for their ongoing support to our community and I believe they have built some lasting relationships with community members."

"Thank you for your interest in the opinions of the community."

"Local relations are near perfect."

For those landholders that expressed little to no concern with the Proposed Modification, it was noted that concerns would remain low if the company followed its current operational practices.

6.1.5 Noise

Consistent with the 2013 SIA data, the second most frequently raised impact in relation to existing operations was concern regarding noise impacts. Five of 28 respondents (17%) made specific reference to incidences of night noise and being able to hear operational machinery more at night. This aligns with the complaints analysis in **Section 4.2.2**, where the vast majority of complaints were lodged at night, and related to noise.

As with air quality above, noise impacts were primarily discussed in relation to the current operation and only a very small number of responses were linked to the Proposed Modification.

"On a hot summer night when windows are needed open, there is some noise."

"Machinery noise, trucks and track machine."

"Dust and Noise, but that goes with what a coal mine is."

"Ongoing noise impacts from machinery."

"Noise – it destroys the quiet country environment."

"The slight noise we hear from the equipment when the wind is blowing from the mines direction."

"I think the noise will increase."

"I don't know what the noise impacts will be?"

The frequency of noise as an issue was only slightly higher in 2018, when compared to the number of responses obtained in the BOP SIOA in 2013 (15% and 13% respectively), with uncertainty of the level of noise impacts as a result of the Proposed Modification expressed. Unlike the issues raised in 2013, trustworthiness of noise monitoring systems did not appear to be an issue for the respondents of Broke or Bulga in 2018/19; however there was a desire expressed by near neighbours, for the company to reduce their noise impacts as much as possible.

"I just hope the night operations don't get any louder."

"Dust and Noise is unavoidable, but please do your best to reduce."

Overall, respondents located in Bulga, placed greater emphasis on existing operational noise impacts, compared to Broke (20 and 8 responses, respectively), with some mitigation strategies proposed by proximal landholders to limit noise impacts including positioning machinery below ground level, using lower gears during operation and increasing the height of noise barriers.

6.1.6 Ecological

Ecological impacts were raised as a concern for a small number of Bulga respondents in relation to the Proposed Modification (3). The identification of offset areas as a mitigation strategy was called into question by some, with a view expressed that endangered species would not benefit from these measures.

Ecological concerns were reiterated by one stakeholder during the Community Information Session, whereby stakeholders were largely concerned that local fauna would become trapped in developing mine areas or would be unable to retreat effectively to habitat areas.

Management strategies identified included the development of vegetated land bridges erected over mine haul roads, which may act as wildlife corridors encouraging fauna methods of mobility through their natural habitat.

"Endangered species wiped out and you 'offset' with something completely different."

"Species extinction."

"I'm not sure once the landscape and endangered environment has been dug up, it can ever really be 'offset'."

"When the mine closes, we request that the two overpasses on Broke Road be left in place but be revegetated to establish two corridors for wildlife to safely move between the Army range and rehabilitated mine site."

Landholders were advised through the community information sheet and also at the information session, that the Proposed Modification will result in a small additional impact of 20.2 hectares consisting of 19.2 hectares of native vegetation communities - of which 16.4 hectares is listed as the Commonwealth Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC). As detailed in the SEE, one State listed endangered ecological community (EEC) will also be impacted, this being the Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC. This vegetation remains as an island of vegetation within areas already disturbed by mining.

To compensate for the unavoidable loss of these ecological values, BCM is committed to providing an appropriate biodiversity mitigation strategy. This may be (subject to approval) a biodiversity offset area known as the proposed Vere Offset. The proposed Vere Offset is located to the east of Broke Road to ensure a local offset can be developed which will be managed into the future. There are no predicted impacts on the Warkworth Sands Endangered Ecological Community.

Further provision of information on the proposed offset strategy may assist in increasing neighbour/landholder understanding of the company's intent in this regard.

6.1.7 Community Sustainability

A small number of landholders (3) also expressed concern that the local community would not benefit directly from the Proposed Modification, with one respondent questioning the economic viability of coal resources in the medium to long term.

> *"No benefits to the local community."*
>
> *"Long term viability – will there be demand for coal in 2038 at a sustainable price?"*
>
> *"The benefits are for the shareholders, not for local residents."*
>
> "[The benefit will be] a*n increased bonus for the CEO."*
>
> *"Given the resources are limited, it is a shame that we are willing to sell them so cheaply to other countries. Would be great if there was a balance of reserve for future use by Australia to value add in the decades to come."*

In regard to community sustainability, similar sentiment was echoed in the 2013 BOP SIOA consultations, whereby landholders relevant to the village of Bulga, suggested that differing industry sectors collaborate to facilitate the implementation of projects to ensure community economic sustainability, alongside the mining sector. Educational programs and partnering with organisations such as TAFE were also suggested to encourage youth employment.

> *"Need more TAFE classes for younger generation."*
>
> *"Support sustainable projects i.e. tourism."*
>
> *"Need to work on projects that bring all impacted communities, people, industries and residents together."*

A review of BCM's current investment program does indicate an emphasis by the company on supporting projects that build capacity and support development across other sectors e.g. tourism.

6.1.8 Additional Social Impacts

Several negative impacts that were identified less frequently by landholders included impacts on water quality, visual amenity and cumulative impacts, with the later also previously described in the relevant impact sections above.

6.1.8.1 Water

Similar to BOP, impacts on water quality as a result of mining operations was raised as a concern for proximal landholders. Respondents, who were recently surveyed, were more likely to comment on water impacts regarding existing operations (6), with 2 respondents specifically concerned about water impacts as a result of the Proposed Modification. Of most concern to those consulted, was the potential for water contamination, changes in water quality or changes to groundwater as a result of mining.

> *"Loss of well/spear water due to fracking and underground operations."*
>
> *"Water contamination."*

The intergenerational equity issue of subsequent impacts on future resource use were also identified, in terms of the water quality that will be left for future generations.

> *"What water quality will be left for future generations?"*

Specific to the Proposed Modification, one landholder was concerned with the quality and quantity of local water in the creeks and rivers, with two landholders concerned about potential pollution risks.

> *"Pollution of Wollombi Brook as that is where our kids play and swim."*

In this regard, the suggestion for further research on water quality impacts in the area was identified as a potential strategy.

> *"A genuine attempt at researching the effect on ground water as a result of mining."*

> *"Tailings and transfer risks e.g. burst pipeline."*

> *"We can see the river is not as clean or full of fish like it was when I was a kid – because the mines are taking the water from the river. They use a lot of water."*

BCM currently report on water quality as part of their annual review which is made available via the website and also send to the CCC. Information is also made available via the quarterly environment reports which are also available on the website.

6.1.8.2 Visual Amenity

The appearance of the landscape was mentioned by several proximal landholders (6) concerned with the overall visual amenity of the area as a result of mining operations. These landholders expressed concern that the Proposed Modification would contribute to further changes to their natural surrounds and vista, with 4 responses specific to existing operations and 2 identifying a further potential decline in visual amenity should the Proposed Modification be approved. All of those who identified visual amenity as an issue/impact were residents of Bulga.

> *"The slightly ugly look of the ground being dug up."*

> *"This is a beautiful part of the world and it saddens me greatly to see the ugliness produced by open cut mines."*

Light spill was identified by a small number of respondents in both Broke and Bulga (4) and was equally identified as an existing operational concern (2) and a potential impact of the Proposed Modification (2).

Interestingly, according to BCC's Complaints database (2019), light spill was the second most identified impact registered by complainants between 2017 and 2019 (refer to **Figure 4.4**), with 6 complaints registered, only slightly higher than current landholder sentiment. Visual Amenity accounted for 2 complaints during this same period.

> *"First time last year I witnessed a mining light from my driveway."*

> *"Just the dump lights of a night time shine into my window."*

The visual amenity of bunds and final landforms was raised by over half of the stakeholders (6) that attended the Community Information Session. Stakeholder concerns appeared to be addressed when BCM representatives discussed that the shaping of permanent hills will result in a natural, undulating topography for the area.

Of four landholders contacted via phone, who were unable to attend the information session, two suggested that the development of the noise and visual bund was a positive impact of the Proposed Modification and would help mitigate the activities of the Proposed Modification; whilst the other two suggested that their visual amenity would further decrease due to limited visual access to the world around them.

One landholder held concerns that the modelling of the overburden and bund heights is flawed, believing the current height of the overburden currently exceeds modelling scenarios for the Proposed Modification; and expressed that overburden heights be checked before the application to progress the Proposed Modification is finalised.

> *"Since they've built the bund they can get on and do what they need to do behind it – I think it is a good strategy."*
>
> *"I don't like the humps, I would have left the land flat, I like to see what is going on, but you just can't see over the humps."*
>
> *"It's all hidden behind the bund."*
>
> *"They need to modify their modelling because the visual impact is already past where it should be - it is so high – it's like having your own Ayers Rock."*

6.1.8.3 Cumulative Impacts

Community respondents expressed concern for the cumulative impacts of dust and noise by mining operations within the local area. As outlined in **Sections 6.1.3** and **6.1.5,** landholders were more likely to identify cumulative impacts as a concern in regards to the existing operations (11), while only two responses were specific to the Proposed Modification (it should be noted that technical assessment results were discussed at the one on one stakeholder meetings). Overall, a total of nine responses were attributed to cumulative dust impacts with four responses relating to cumulative noise, the majority of which were expressed by Bulga landholders.

Of six landholders contacted post the information session, that were asked to rate their level of concern for the community-identified impacts pertaining to the Proposed Modification, cumulative impacts were rated as the second highest level of concern, with these landholders providing an average score of 2.86 out of 5, however cumulative impacts were not top of mind for this group of landholders when asked to identify potential impacts of concern for them, with more emphasis placed upon visual amenity impacts (both negative and positive), discussed in more detail in **Section 6.1.8.2.**

Two local business owners also expressed cumulative concerns relating to dust and noise, as well as impacts to visual and rural amenity, during the community information session held in April 2019. Stakeholders identified the perceived risk of attracting clients to their establishment due to the proximity to the mine and the cumulative impacts identified. The ability to provide tourist opportunities, such as walking/cycling tracks in the area or specific program implementation for their clients was also expressed as a potential strategy.

When comparing outcomes of the BOP SIOA engagement in 2013, concerns regarding cumulative impacts have increased from 3% to 6% of total responses.

6.2 Broader Stakeholders within the Hunter Valley

As has been highlighted earlier, consultation was also undertaken with a range of stakeholders at the Singleton LGA level (233) as part of the Glencore's Community Perception Survey (2018) and residents of the wider Singleton LGA through a random survey of households.

Although not conducted specifically as a part of the engagement program for the Proposed Modification, the survey has identified community perceptions of Glencore's operations in the wider Singleton LGA, affording input from a wider range of stakeholders than only those proximal to the existing operation and the Proposed Modification.

Glencore undertakes a regular community perception survey every three years involving stakeholders relevant to their NSW and QLD operations. In general, the survey affords the tracking of a number of key indicators relating to the company's social and environmental performance and provides an evaluation of the approach the operations have adopted in relation to stakeholder engagement and consultation. The most recent survey was carried out in 2018 and included 37 proximal landholders and 10 key stakeholders across local businesses, community groups, Indigenous groups, local and state government and NGOs, relevant to Bulga Coal. In addition, a total of 149 community members were also randomly sampled from across the Singleton LGA.

The survey identified a number of issues in relation to the presence of mining in the area, but particularly impacts on social amenity as a result of air quality and dust from blasting due to the presence of numerous mines within the Shire.

Air quality impacts on social amenity were frequently cited, with stakeholders identifying the need for increased domestic cleaning of residences, swimming pools and solar panels, as well as concerns in relation to health e.g. respiratory issues, due to particulates in the air.

> *"We do have a lot of dust here. Can't pinpoint which mines. Have to clean the house."*
>
> *"We've got 4 major mines in close proximity and all of them are a problem with noise and dust."*
>
> *"Dust - because I'm breathing it in, I'm raising kids and grandkids, its filthy, the towns are filthy, the cars are filthy, the houses are filthy."*
>
> *"It's the residue, I work outdoors in Singleton and the blast residue is everywhere."*
>
> *"Because there is continuous dust, the solar panels, washing the pools, they are all always dirty."*
>
> *"Health of people - all mining companies and government have to address this."*
>
> *"Health issues, there are serious respiratory issues. We can't keep on top of the dust both inside and outside the house."*
>
> *"Because it affects your house and health, affects your breathing, people's health is affected up here."*

General environmental concerns were the second most frequently raised concern for community residents of Singleton LGA and included impacts associated with land clearing for mine development and the subsequent impacts on native flora and fauna. Although some stakeholders acknowledged rehabilitation efforts, the overall sentiment expressed was that rehabilitation would not substantially replace the original environment.

> *"Disregard for the local environment."*

"Environmental degradation."

"They are going to get rid of all the trees."

"Taking away the natural environment for wildlife."

"I know all of them rehabilitate, but they never put back what they take out."

"They take agricultural land, turn it upside down and basically destroy the ecology of the area."

To a lesser extent, respondents in the wider community of Singleton also identified operational noise as a concern, particularly sleep disruption and general impacts on social amenity and rural life-style.

> *"Country life has always been very peaceful, but it is not quiet and peaceful anymore due to the mines. There is a constant rumble and then there are point noises, if you like, that might wake you in the night."*

Community sustainability was also raised by some key stakeholders within the Shire, with concerns around the future of communities post-mining. There was a desire to see the community more actively involved in planning for the future and greater alignment with the strategic community issues of focus and relevance to local government.

"Does not provide the community with any certainty around diversification, post mining land uses and leaves a legacy for the community that the community does not have any say in."

"Lacks strategic thought as to what will be left post mining."

"The community engagement framework under the Local Government Act identifies the long-term strategic issues of concern to the community. Glencore's engagement is not aligned to this and this is a missed opportunity."

6.3 Indigenous Groups Including Local Service Providers and Community Groups

To further inform the SIA, interviews were also undertaken with local Indigenous groups and services providers in the Upper Hunter across the Shires of Singleton and Muswellbrook. A total of 15 Indigenous stakeholders participated in the interview process that held representative roles in Aboriginal service provision in government, NGOs and the private sector. This included representatives from Hunter New England Health, Hunter Valley Aboriginal Corporation and the NSW Indigenous Chamber of Commerce as well as other more locally based group representatives and service providers.

It should be noted that the comments made by the organisations were general related to mining in the Hunter Valley in general. When it came to contributions to the community, many stakeholders identified with contributions made by Glencore as an entity as opposed to individual mines.

The relationships that exist between the Indigenous service providers operating in the Upper Hunter and other partner organisations, as identified by the stakeholders interviewed, is illustrated in **Figure 6.6.** (Note: Singleton Council was not consulted as a service provider in this context but was consulted regarding the Proposed Modification).

This network analysis gives an indication of the relationships the respondents described within the local Aboriginal community, with many respondents noting poor or non-existent relationships with other surveyed organisations. It is notable that no bi-directional relationships were reported, although many nominated other surveyed organisations as partners – no two organisations identified one another as partners in service provision.

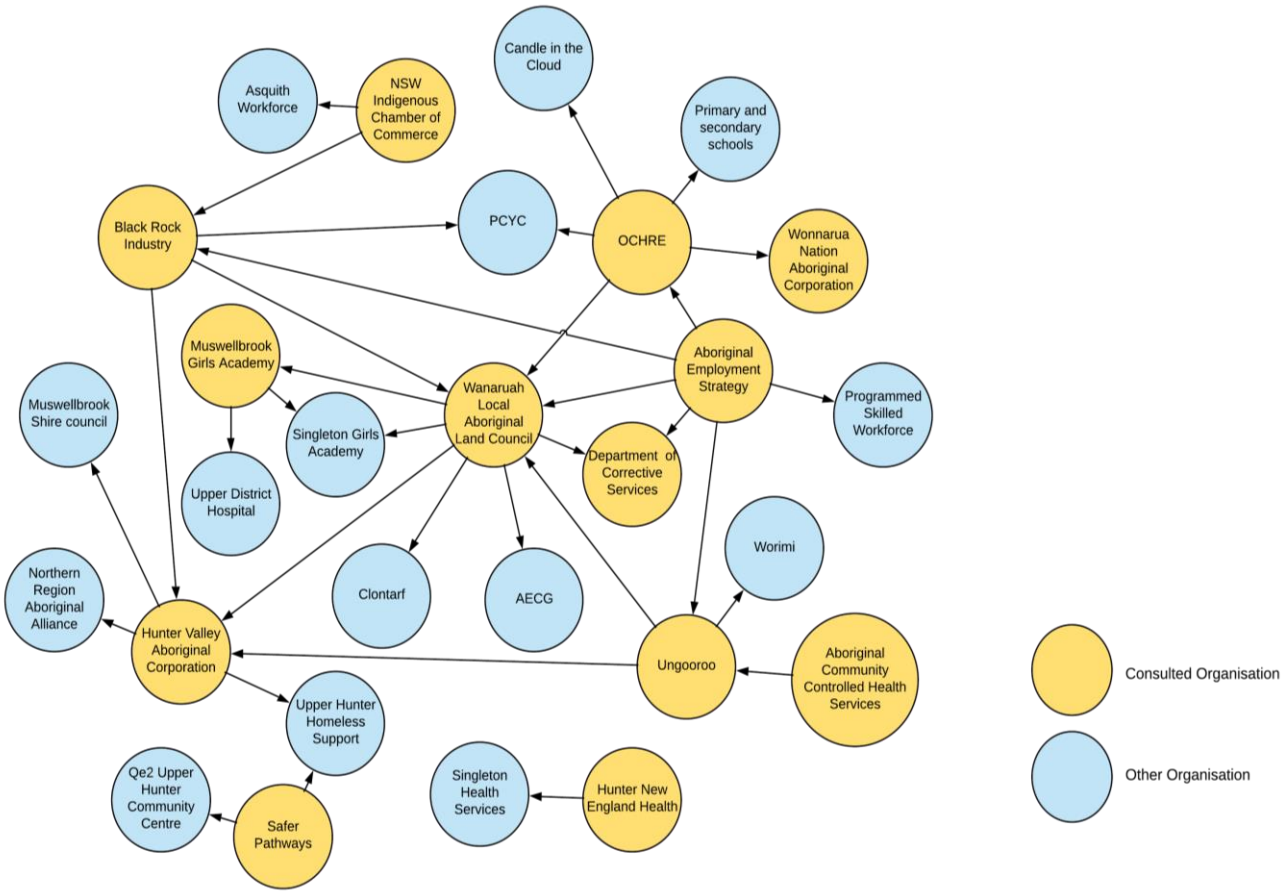

Figure 6.6 Networks Map - Upper Hunter Aboriginal and Torres Strait Islander Service Providers

Respondents were asked to provide information on their service provision within the area and to comment on the impacts (positive and negative) of mining in the region. Key themes emerging from the analysis related to:

- community sustainability – boom and bust cycles in mining
- opportunities for mine based employment and local procurement
- community investment
- environmental impacts of mining.

In general, respondents expressed an overarching concern for the future sustainability of their communities, but also optimism for the potential of mining contributions and input to effect positive social change. Future opportunities for cooperation and engagement were also welcomed.

6.3.1 Community Sustainability – Boom and Bust Cycles in Mining

Respondents identified the changes in population associated with mining sector booms and downturns were a key impact on the region. This impact was emphasised as a result of the high dependence of Upper Hunter communities on mining for employment and social funding, particularly the Aboriginal community.

> "*… Mining essentially dominates the space… Employment outcomes – using local business – petrol – food – all those things get a bit of a boost. The risk is what happens when they close and major economic downturn* [occurs]*…during downturn you will see a pinch. Local businesses closing down.*"

The impact on housing prices was a commonly noted concern for the Indigenous community. Lower rental prices during downturns were said to have temporarily afforded community members to transition from social housing into rental properties; however, in boom periods these individuals were again forced out by increased housing costs, caused by the flooding of the market by new mining employees and contractors. Respondents suggested that this in turn increased strain on social housing, leading to homelessness and movement of local Aboriginal people away from the area.

> "*Low income people rely on our services because of the really low level of houses available and what is available is too expensive.*"

> "*There are contributions from the mining community, but broader issues like rent rises are not addressed. For example, there was a downturn a few years ago, so people in social housing went to private rentals because the rent had got so cheap, then the boom came, rent went up and people had to ask for social housing back.*"

6.3.2 Opportunities for Mine Based Employment and Local Procurement

Perceptions of the impact of mining on local employment and procurement for the Aboriginal community were mixed. Some respondents were satisfied with the economic benefits of the presence of mining while others felt there was insufficient benefit to the Aboriginal community, given the high levels of mining activities in the area.

> "*Socially it has been good for the town, creating employment, contracting and economic development.*"

> "*The Aboriginal community is disappointed, in that although there has been some employment created and some of the community are employed, it is not enough. The community hasn't grown or benefited from mining as a whole – there has been no significant engagement for Aboriginal businesses.*"

> "*Mining companies aren't investing enough in local communities, there are Aboriginal people and businesses who need work, and who are not utilised by mining companies. It's important in terms of social impacts of mining, as economic development is connected to social impacts; we need economic development to help improve social impacts*."

This dissatisfaction was commonly attributed to the lack of long-term opportunities for Aboriginal jobseekers within the mining industry and extended to field work contractual arrangements associated with community participation in Cultural Heritage projects.

The prevailing feeling was a desire for Aboriginal job seekers to be given greater support to access permanent employment, and encouragement to pursue higher level positions.

"*It's about being able to transition into permanent jobs (not the lower end jobs). It's about having mentoring positions where someone can go and sit with a mining engineer and see what they do and get motivation to not only get a job, but study and become educated enough to get the engineer type jobs. It's about progressing from basic jobs to empowering people to go further to go to Uni etc. Need to find a way to have an education without debt. Need to motivate the community to progress*."

"The need to improve people's knowledge of how they can work. Teach people how they can apply for jobs. Teach people how they can tender."

One Indigenous stakeholder raised the concern in regard to the way their community service has become focussed around procurement of mining contracts, and the sustainability of these services in the absence of mining subsidies. In this regard, it was expressed that once mining ceases, many groups and organisations could potentially become 'white elephants' with no alternate sources of funding available to them.

6.3.3 Community Investment

Within the community, there was general acknowledgement of the positive contributions/investments made by the surrounding mines.

"*They are pro-active in sponsoring things like NAIDOC week, also sponsored to have a new kitchen at the* [Local Aboriginal Land Council] *LALC, and the turf out the front, they've sponsored some of the programs/events at Ungooroo, Clontarf etc.*"

However, service providers expressed frustration with a perceived lack of transparency and evaluation around allocation of work/funding to community groups and organisations.

"This perception that it has divided community members, in the sense of handing out money without the accountability - where it's gone."

"There is not the outcome given and it isn't an open and transparent process"

"It should be more performance based and there needs to be a model. Where is the money going?"

For some, the issue was not so much who was receiving funding, but rather for what purpose it was intended. Many felt that the focus on economic growth and employment came at the cost of important social assistance programs - that could address needs that had to be met, before lower income members of the community would be capable of accessing the employment opportunities provided by mining.

"*The community is missing out in relation to the issues of domestic violence, community transport and community interaction and housing. If you look at all the reports from legal aid, NSW revenue, housing, unemployment you quite clearly see the gaps which aren't properly being delivered; and to rely on the government to do that without the assistance from the mining industry isn't sustainable.*"

6.3.4 Environmental Impacts of Mining

Although the focus of most respondents was on social and cultural issues associated with mining, some also spoke to the impacts of mining on the natural environment in the region more generally. Such impacts related to the impacts of air quality/dust and the corresponding health issues, potential loss of culturally important flora, fauna, and sites for which they felt a custodial duty of care, and concern for the future rehabilitation of the region.

The primary health impact was the cumulative levels of dust produced by the mines in the area.

> *"Dust around here is absolutely ridiculous. Health wise it has an impact on the community."*

> "*For myself – the air. The dust. When you fly, you look down there is a distinct ring around the valley. You can't say it's from anything else. It's from the pits."*

The impacts from destruction of nature were seen as damaging to the fabric of the Aboriginal population's sense of community and attachment to place.

> *"[Mining has] impacted on culture and heritage and the way we live. It dictates how we do things. In Muswellbrook we are now surrounded by mines. This place isn't what it used to be and when will it end and what will it look like afterwards?"*

> *"Mining has completely impacted the area. It has brought cultural devastation in the area. There are so many people coming to the area and the mining companies still haven't got engagement with Aboriginal people right."*

Discussion in this regard, highlighted a critical conflict felt by respondents – how to find a balance between protecting their cultural heritage and the environment, and servicing the needs of their communities.

> *"I don't like it [mining], but it is a necessity. The valley is rich in coal….Don't like the way it destroys things but if I can get something for my community out of it, I'll do it. People have to live whether they are rich, poor, black or white."*

Respondents also focussed their concerns on rehabilitation and the ability of the community to access and utilise the land in the future post mining. Many were happy with how some companies were handling rehabilitation, but wanted to see more consultation with the community, so that rehabilitation could be tailored towards a preferred end-use.

7.0 Assessment and Prediction of Social Impacts

This section provides a risking of the social impacts identified in **Section 6.0**, in line with the DPE SIA Guideline requirements. The aim of the SIA is to assess the proposed changes to the current baseline social environment (of which BCC is a part), as a result of the Proposed Modification proceeding.

The SIA has utilised data from a range of sources to develop a layered picture of the potential social impacts arising from the Project. This section further assesses the social impacts associated with the Proposed Modification, providing a detailed ranking of impacts according to key criteria, as defined in the SIA Guideline (DPE, 2017). These criteria relate to:

- **extent** – the geographical area affected by the impact or number of proportion or people or population groups who are affected
- **impact timing/duration** - when in the project the potential social impacts are expected to occur and the timeframe over which the impact occurs
- **vulnerability/sensitivity** – identification of who specifically is to be affected (directly, indirectly or cumulatively), including susceptibility or vulnerability of people, receivers or the receiving environment to adverse changes caused by the impact
- **stakeholder perceived risk ranking** - the importance placed, or level of concern that, those potentially affected feel about the social matter
- **impact severity** – the potential level of social risk posed by the negative social impact and the scale or degree of change from the existing condition as a result of the impact.

In order to prioritise the identified social impacts, a risk-based framework has been adopted. Traditionally, the technical risk assessment process has not been greatly amenable to the inclusion of social impacts. One key adaptation of the approach is that both technical ratings and stakeholder perceptions of impacts are assessed. This approach is consistent with Sandman's risk equation (Risk = Hazard + Outrage) (Sandman, 1997), which acknowledges the low correlation between a risk's technical 'hazard' (how much harm it's likely to do) and its 'outrage' (how upset it's likely to make people).

Stakeholder perception of risk/impact is considered an independent and no less valid component of risk. The integration of the outcomes of technical ranking (severity) with stakeholder perceived ranking of impacts, thus affords a true integration of expert and local knowledge in SIA and enables both types of risk to be addressed in the development of impact mitigation, amelioration and enhancement strategies. Such an approach is acknowledged in the SIA Guideline in relation to estimating material effects.

Prioritising impacts in this integrated manner ensures that appropriate assessment and mitigation strategies can be developed that not only address impacts that may require more technical management but also those impacts that are perceived by stakeholders as of high risk/importance/concern. These perceived concerns are just as important to manage as they have the potential to result in elevated levels of community concerns, complaints and grievances if not addressed appropriately.

As outlined in **Section 6.0**, a range of social impacts have been identified in relation to the Proposed Modification that require prioritisation for assessment and appropriate management/enhancement. These impacts fall within the following social impact categories as outlined in **Figure 7.1** below.

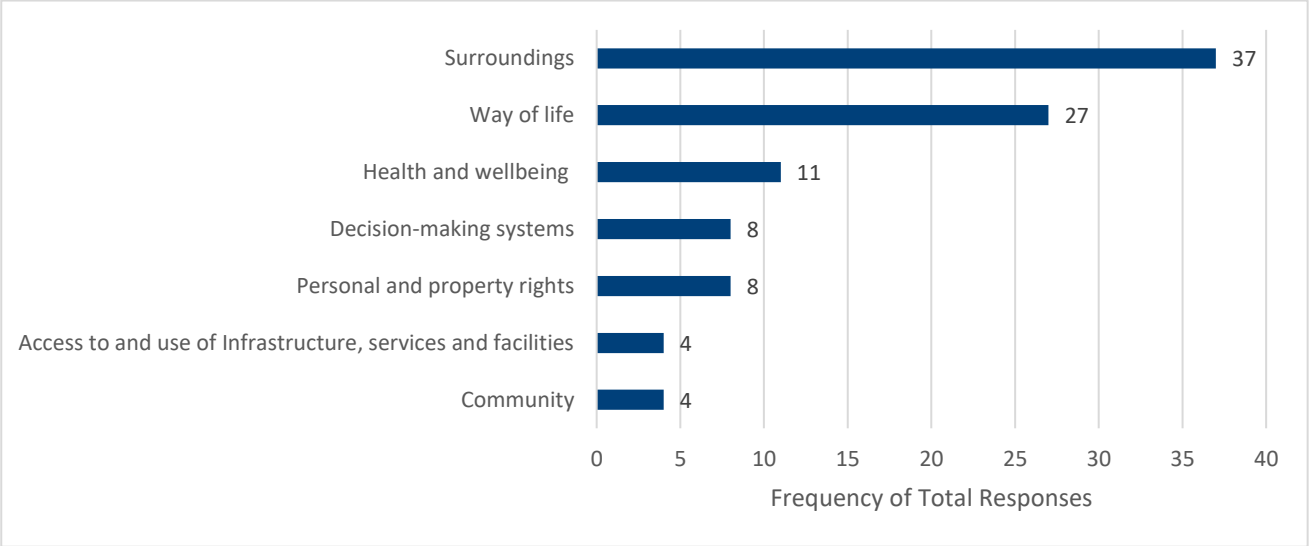

Figure 7.1 Impacts by Social Impact Category

Source: Umwelt (2019)

The impacts identified within these social impact categories are assessed in detail as part of the overarching risk-based framework in the following sub-sections. As the chart illustrates, social impacts relating to surroundings were the most common types of social impacts identified, followed by impacts on way of life – how people work, play and interact with each other.

It should also be noted that social impacts are often not mutually exclusive, with higher order impacts such as population change resulting in second order impacts such as impacts on sense of community and service provision.

7.1 Assessment of Social Risks/Impacts

This section provides an evaluation of the significance of each potential negative and positive social impact **without mitigation**. The assessment is undertaken using the criteria noted above and through the application of a consequence and likelihood framework as identified in the SIA Guideline (DPE, 2017 p.41). The impacts are then further revisited in **Section 8.0** once mitigation and enhancement strategies are considered.

The social risk matrix (refer to **Table 7.1**), that considers both the consequences of the potential social impact (minimal, minor, moderate, major and catastrophic) and the likelihood of the impact occurring (rare, unlikely, possible, likely and almost certain) is then used to determine an overall risk assessment of the social impact as 'low', 'moderate', 'high' or 'extreme'.

Both positive and negative impacts are considered in this regard, with slight adjustments made to the approach to reflect positive impacts e.g. level of concern becomes level of interest, severity becomes scale of improvement or benefit, sensitivity becomes importance of the improvement or benefit and the equity of its distribution etc.

As noted in the SIA Guideline, the definitions and scale assigned to each of the likelihood and consequence categories need to be relevant to the impact that is being evaluated, explained and justified in the SIA and where possible the consequence scale should be based on established measures and standards. Where possible and relevant, specific definitions have been developed for the consequence categories of the identified social impacts and are guided by best practice research findings (Coakes Consulting, 2012), and relevant agency guidelines (IAIA, 2015). These definitions are outlined in **Table 7.3**.

The social risk assessment process for the current SIA, has therefore involved four main steps:

1. **Determining the consequence**. The risking approach adopted for this SIA requires the determination of the worst-case (but reasonable), consequence of a Project factor. For some impacts it may be a negative consequence, while for others it may be a positive consequence (positive risk rankings are delineated in italics). These consequences are assessed against impact-specific consequences and are categorised as 'catastrophic', 'massive', 'major', 'moderate', 'minor' or 'minimal' (refer to **Table 7.1**).

2. **Determining the likelihood**. To understand the risks presented by a Project factor, the magnitude of a consequence must be cross-referenced with the likelihood of it occurring. **Table 7.2** presents the **likelihood definitions** that were used to assess the likelihood of social impact consequences associated with the Proposed Modification, categorised as 'almost certain', 'likely', 'possible', 'unlikely', or 'rare' (DPE, 2017).

3. **Assessing the technical risk.** To assess the overall social risk, the consequence determined in step one are cross-referenced with the likelihood determined in step two to determine an overall risk assessment rating (i.e. low, medium, high, or extreme) (refer to **Table 7.1**). In the case of some impacts, this risk assessment has involved referencing the respective technical reports of the SEE (e.g. economic, water, blasting, and traffic), however the associated social impacts have been assessed through the social risking process. The social risk ratings are presented as unmitigated social risks in this section and as mitigated social risks in **Section 8.0,** having considered proposed mitigation and enhancement strategies.

4. **Ranking the stakeholder perceived risk.** An important component of the SIA has been the integration of technical results with the perceived risk ranking of a project factor or impact by key stakeholders i.e. the sensitivity/susceptibility/vulnerability) of people to adverse changes caused by the impact and/or the importance placed on the relevant social matter. Consequently, stakeholder ratings of risk were determined by assessing impacts identified through the scoping phase of the SIA. The perceived ranking (i.e. *low*, *moderate*, and *high*) is determined by the frequency that an issue was raised by a stakeholder in the engagement process. The justification for each ranking is highlighted in the discussion within each respective impact section. It should be noted that community perception rankings are not 'residual risk' rankings as they do not reflect the management measures an applicant may put in place.

Table 7.1 Social Risk Matrix

		Consequence Level				
		1	2	3	4	5
		Minimal	Minor	Moderate	Major	Catastrophic
Likelihood category	A. Almost certain	HIGH	HIGH	EXTREME	EXTREME	EXTREME
	B. Likely	MODERATE	HIGH	HIGH	EXTREME	EXTREME
	C. Possible	LOW	MODERATE	HIGH	EXTREME	EXTREME
	D. Unlikely	LOW	LOW	MODERATE	HIGH	HIGH
	E. Rare	LOW	LOW	MODERATE	HIGH	HIGH

Source: NSW SIA Guidelines (DPE, 2017)

Table 7.2 Social Likelihood Definitions

Likelihood Category	Definition
Almost certain	Common repeating occurrence, ongoing Will occur in most circumstances
Likely	Will probably occur in most circumstances There is at least a 50% chance that it may happen
Possible	Might occur at some time Could occur but not often 5% chance it could happen
Unlikely	Unusual occurrence Unexpected
Rare	May occur only in exceptional circumstances Unheard of in the industry

In line with the process defined above, the following section assesses the technical and perceived social risk in relation to consequences that may be experienced by people due to anticipated impacts/changes associated with the Proposed Modification. These have been categorised in line with the Social Impact Categories and characteristics outlined in the SIA Guideline (DPE, 2017, p.5) and then further defined within impact themes and sub-impact issues, as noted in **Figure 7.1**

At the conclusion of this section a table is presented which summarises the Proposed Modification aspect, the social impact category and social impact, the extent of the impact, the affected stakeholders, the duration and/or timing of the impact, the sensitivity/vulnerability of potentially impacted stakeholders, the perceived social risk (from the perspectives of key stakeholders), and the severity of the impact (unmitigated). Relevant, existing and proposed management and enhancement strategies employed to manage the predicted risks are further described in **Section 8.0** with social risks then reassessed (mitigated) in light of the mitigation/enhancements proposed.

Table 7.3 Social Consequence Definitions

Social Impact Factors	Social Consequence Definitions				
	1	2	3	4	5
	Catastrophic	Major	Moderate	Minor	Minimal/Negligible
Population Change	Greater than 20% permanent population change in a *region or local area*	Greater than 10% permanent population change in a *local area*	Permanent population change in a *local area* of less than 5%	Temporary population change in a *local area* less than 5%	Nil population change in a *local area*
Community Infrastructure and Services	Permanent and significant reduction in the capacity of *regional* community services and infrastructure, and existing regional housing and accommodation stock	Temporary and significant reduction in the capacity of *local* community services and infrastructure, and existing local housing and accommodation stock	Temporary or permanent but marginal significant reduction in capacity of *local* community services and infrastructure, and existing local housing / accommodation stock	Temporary or permanent but insignificant reduction in the capacity of *local* community services and infrastructure, and existing local housing and accommodation stock	No measurable impacts on capacity of *local* community services and infrastructure, and existing housing and accommodation stock
Social Amenity	Permanent and significant reduction in social amenity in a *region* as a result of dust / air quality, noise, visual impacts, traffic congestion	Permanent and significant reduction in social amenity in a *local area* as a result of dust / air quality, noise, visual impacts, traffic congestion	Permanent but insignificant or temporary but significant reduction in social amenity in a *local area* as a result of dust / air quality, noise, visual impacts, traffic congestion	Temporary but insignificant reduction in social amenity in a *local area* as a result of dust / air quality, noise, visual impacts, traffic congestion	No measurable impacts on social amenity in a *local area* as a result of dust / air quality, noise, visual impacts, traffic congestion

Social Impact Factors	Social Consequence Definitions				
	1	2	3	4	5
	Catastrophic	Major	Moderate	Minor	Minimal/Negligible
Health and Well-Being	>1 fatality **or** 2-5 permanent disabilities **or** Non-permanent injuries requiring hospitalisation for 2-5% of population at risk **or** Acute health effect requiring hospitalisation for >2-5% of population at risk **or** Chronic health effect requiring medical treatment for 5-10% of population at-risk **or** >$5m - $10m of health cost due to hazard **or** Demand exceeds capacity of health services by >30-40%	No fatality and 1 permanent disability **or** Non-permanent injuries requiring hospitalisation for >2-5% of population at risk **or** Acute health effect requiring hospitalisation for >2-5% of population at risk **or** Evacuation is necessary or chronic health effect requiring medical treatment for 2-5% of population at-risk **or** >$1m - $5m of health cost due to hazard **or** Demand exceeds capacity of health services by >20-30%	No fatality and no permanent disability and non-permanent injuries requiring hospitalisation for 1-2% of population at risk **or** Acute health effect requiring hospitalisation for 1-2% of population at risk and no evacuation **or** Chronic health effect requiring medical treatment for 1-2% of population at-risk **or** >$500k - $1m of health cost due to hazard **or** Demand exceeds capacity of health services by >10-20%	No fatality and no permanent disability and non-permanent injuries requiring hospitalisation for 1-5 persons **or** No acute health effect requiring hospitalisation) and no evacuation **or** Chronic health effect requiring medical treatment for about 0-1% of population at-risk **or** $100k - $500k of health cost due to hazard **or** Demand exceeds capacity of health services by >1-10%	No fatality and no permanent disability and no non-permanent injuries requiring hospitalisation and no acute health effect requiring hospitalisation and no evacuation **or** No chronic health effect requiring medical treatment **or** < $100k of health cost due to hazard **or** Demand exceeds capacity of health services by 0-1%

Social Impact Factors	Social Consequence Definitions				
	1	2	3	4	5
	Catastrophic	Major	Moderate	Minor	Minimal/Negligible
Sense of Community	Permanent but significant reduction in sense of community due to > 12% permanent population change in a *region* **or** Serious and/or long-term impact to items and/or places of community value **or** Serious and long-term impact on other land uses– agriculture, viticulture, tourism, residential, industry, natural **or** Community members are in serious and prolonged dispute	Permanent and significant reduction in sense of community due to > 5% permanent population change in a *local area* **or** Moderate and/or medium-term impact to items and/or places of community value **or** Moderate and/or medium-term impact on other land uses– agriculture, viticulture, tourism, natural **or** Community disputes occur	Permanent but insignificant reduction in sense of community due to <5% permanent population change in a *local area* **or** Temporary but significant reduction in sense of community due to temporary but significant population change in a local area **or** Minor and/or short-term impact to items and/or places of value **or** Moderate and/or short-term impact on other land uses – agriculture, viticulture, tourism, natural **or** Possibility for community disputes	Temporary but insignificant reduction in sense of community due to temporary but insignificant population change in a *local area* **or** Very minor and/or short-term impact to items and/or places of community value **or** Minor and/or short-term impact on other land uses – agriculture, viticulture, tourism, natural **or** Community disputes unlikely	Negligible change in sense of community due to negligible population change in a *local area* **or** Negligible /no impact on items and/or places of community value **or** Negligible /no impact on other land uses– agriculture, viticulture, tourism, natural **or** Negligible community disputes

Source: Adapted from Coakes Consulting (2012)

Note: The technical assessments for economic and environmental impacts are undertaken as part of the EIS (please refer to the relevant sections of the EA for further detail).

7.2 Evaluating Social Impacts of the Proposed Modification

7.2.1 Population Change

Changes to population are fundamental impacts within SIA, given that the size, diversity and behaviours of a community are underpinned by its population and characteristics. Population change (influx and outflux) is usually described as a first order social impact which has the potential to create several second order social impacts, such as impacts on community infrastructure and services, changes in sense of community, social cohesion and networks etc.

This section will examine the potential impacts of population change as a result of the Proposed Modification, utilising established population change characteristics adapted from Burdge (2004). Burdge suggests that population change of greater than 10% in a local area is likely to have a major consequence and as a result population change consequences have been based on Burdge's assessment (refer to **Table 7.3**)

In relation to population change, it has been determined that the Proposed Modification could influence population change:

- as a result of an influx of construction workers
- extension of the operational workforce for a further four years.

No acquisition of properties is expected as part of the Proposed Modification. Consequently, the aspects that could potentially influence population change are considered further below.

7.2.1.1 Construction Workforce

The presence of a construction workforce can often have different impacts on a community than a permanent, operational workforce. Usually a construction workforce is temporary and transient in nature, residing in a location in proximity to a project, before moving on to the next project. Due to the temporary, transient nature of construction work, families may often not accompany the worker, preferring to live in one permanent location while the construction worker travels away and resides at a location in close proximity to the project.

The Proposed Modification has been designed to maximise the use of existing infrastructure with only minor construction activities required, that are associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure, and water management structures. In total, a peak construction workforce of 150 personnel is expected in year two of the Proposed Modification (2021), amounting to half of the construction workforce utilised in BOP 2013. However this may vary depending on the timing of construction of the various components of the Proposed Modification and construction laydown areas and construction workforce offices and facilities will be located within the existing project area.

To understand the potential (reasonable) worst case scenario for population change associated with the construction workforce, the following assumptions have been made:

- due to the temporary nature of the construction workforce, the families of the workforce will most likely not relocate with the worker
- all construction workers will relocate into the area for the construction period (worst case population change for the construction period)

- the workforce may wish to temporarily reside as close as possible to the Proposed Modification, i.e. within Singleton), where a range of accommodation facilities and services are available (worst case) or may live within the region more broadly and drive-in drive-out daily.
- all other factors will remain proportionally the same over the construction period.

The population change that will occur as a result of the influx of the construction workforce would be minor and temporary for the construction period. As construction activities are expected to generally be for a limited period and are not expected to require a significant additional construction workforce it is predicted that there will be a low impact (*possible* and *minimal*) of a construction workforce on the local community. The impact of a construction workforce was also not a key issue identified by stakeholders through the SIA engagement program and consequently has been rated as a *low* perceived stakeholder impact.

7.2.1.2 Operational Workforce

It is predicted that there will not be any significant change in operational workforce as a result of the Proposed Modification. The Proposed Modification, however will extend the peak operational mine life for approximately a further four years, and then gradually reduce workforce numbers towards planned closure in around 2039.

Consequently, two potentially different mine closure scenarios may be considered:

1. A no-development scenario (closure in approximately 2035)
2. Proposed Modification scenario (closure in 2039).

Should the Proposed Modification not be approved, a 'no-development' scenario would see completion of the operation around 2035, with the exhaustion of approved coal resources in the existing mining area and the withdrawal of employees likely to commence around 2035, as operational areas within the existing approved operation becomes constrained. As noted above, the second development scenario would delay this impact by approximately four years.

To understand the impacts of potential population change across these two scenarios, population modelling was undertaken.

Table 7.4 provides an analysis of the potential worst-case population change scenario, based on the following assumptions:

- each employee has a dependent or semi-dependent household, the same size as the relevant SSC or LGA household average
- as a result of losing employment at BCC, the employee and their family would need to relocate to another location to find gainful employment
- all other factors remain proportional to existing conditions.

Table 7.4 Estimated Workforce and Household Population Size for BCC

Employee Location	Number of Employees	Average Household Size by Locality	Total BCC Related Population (family no.)**	Total Population of Locality	Percentage of BBC Related Population within the Locality (%)
Maitland/ Branxton	277	2.7	749	77,305	0.97%
Singleton	155	2.7	419	22,986	1.82%
Cessnock/ Kurri Kurri	119	2.6	310	55,560	0.56%
Newcastle	80	2.4	193	155,411	0.12%
Lake Macquarie	36	2.5	90	197,371	0.05%
Muswellbrook	18	2.5	45	16,080	0.28%
Central Coast	7	2.5	17	327,736	0.01%
Port Stephens	7	2.5	17	69,556	0.02%
Total	**700**		**1,840**	**922,005**	**0.20%**

Source: ABS Community Profiles (2016), ABS QuickStats (2016), BCC (2018)
** Population and average household data sourced from QuickStats, ** Figures have been rounded to the nearest whole number.*

As highlighted in **Table 7.4**, BCC employees currently account for approximately 1.8% of the local population in the Singleton LGA, with the localities of Maitland/Branxton and Cessnock/Kurri Kurri housing collectively around 1.5% of the existing workforce. Continuation of the Proposed Modification would see continued employment for these workers for the term of the Proposed Modification, continued use of local services and participation in community life; as well as the subsequent economic flow on effects to the locality, LGA and the wider region through household expenditure of workers and their families.

Pressures on population associated with the Proposed Modification's operational workforce were not raised by stakeholders as a key perceived issue and have therefore been categorised as a '***low***' perceived stakeholder risk. Furthermore, the impacts relating to pressures of population change associated with the operational workforce are also considered ***'low*** '(*unlikely* and *minimal*) given no additional operational workforce are proposed under the Proposed Modification. However, the Proposed Modification was perceived by stakeholders to continue to provide economic benefits to the locality as a result of continued project duration.

However, population change associated with the eventual closure of the operation would result in social impacts being experienced both locally and regionally. The Proposed Modification will extend the current life of mine until around 2039. The current Glencore policy recommends that social impact assessments be conducted as a component of closure planning five years prior to the end of the mine life. It has therefore been assumed, as a part of normal company procedure, that BCM would undertake a social impact assessment to better understand and manage the impacts on the community of operational closure/transition, further minimising population change impacts. This planning will involve consultation with local and regional stakeholders and would explore the potential for future land uses of the site.

Project planning indicates that employment will reduce gradually over the operation's proposed four years of additional production, thus minimising the impact of withdrawal of the workforce on the wider Singleton population. Employees would also be supported and assisted in the transition from their current work roles into new employment opportunities, either within Glencore, other mining companies, or into other sectors.

7.2.1.3 Acquisition

In regard to acquisition, the Environment Protection Authority (EPA) has recently revised its policies for noise and air quality impacts. These changes triggered the DPE to complete a review of the Voluntary Land Acquisition Management Plan (2018) (VLAMP). As detailed by DPE, one of the key changes to the VLAMP included the tightening of air quality assessment criteria, with the annual assessment criteria for coarse particles(PM_{10}) changing from 30 ug/m^3 down to 25 ug/m^3, and the introduction of new criteria for fine particles ($PM_{2.5}$) at 25 ug/m^3 (24-hour average) and 8 ug/m^3 (annual average).

While the Proposed Modification isn't expected to increase air quality impacts, one property located to the north of the mine is predicted to trigger the new cumulative criterion (which has moved from 30 ug/m^3 to 25 ug/m^3). As such, this property may be afforded acquisition rights as a result of the change in cumulative air quality criteria, in accordance with the VLAMP.

In summary, given minimal change to the population relating to the Proposed Modification's predicted construction or operational workforce or any acquisition in relation to the Proposed Modification, as outlined in the sections above (**Section 7.2)**, the social impacts on the population are assessed as *unlikely* with *minimal* consequence, resulting in an overall mitigated social risk ranking of '***low****'.*

As previously noted, the level of community concern, as identified through engagement with key stakeholders, in relation to population change associated with the presence of the Proposed Modification's construction and operational workforces, was also perceived to be '***low***'.

7.2.2 Economic

The positive economic impacts associated with the presence of BCC in the region were highly acknowledged throughout the consultation process, with proximal landholders expressing confidence that the economic stability of the local community would likely continue in the form of extended employment and procurement opportunities associated with the Proposed Modification.

The NSW Mineral Council's latest release of its annual mining contributions survey, the NSW Mining Jobs and Expenditure Survey 2017/2018 provides an overview of the impacts of mining in the region more generally. The survey indicated that the 28 surveyed mining companies in the Hunter injected $4.3 billion to the region's economy, equating to an estimated 18% of the Gross Regional Product. This included $1.6 billion in the wages of 14,045 full-time employees and $2.6 billion in purchases from local businesses.

Within the Maitland LGA, $830 million was spent in 2017-18, with $265 million in wages and $565 million in local business purchases. In the Muswellbrook LGA, surveyed companies spent over $437 million, including nearly $230 million in wages, and purchases with local businesses totalling nearly $208 million; and in the Singleton LGA, over $400 million in wages and $380 million in local business expenditure was received, with total input at nearly $780 million. The survey also found that direct mining spend in the Newcastle LGA totalled over $1 billion in 2017-18, including $155 million in wages and $968 million in purchases with local businesses (NSW Minerals Council, 2019).

Many employees of BCC reside in the local government areas of Maitland (40%) followed by Singleton (22%) and Cessnock (17%), with approximately 19% of the workforce residing in the local government areas of Newcastle, Central Coast, Port Stephens, or Lake Macquarie, approximately one hour's drive from the mine site.

The TRC analysis (Fenton, Coakes and Marshall, 2003), utilising employee and supplier data provided by Glencore, reveals that BCM's current operations specifically make a significant economic contribution to local communities through:

- employment (direct impact)
- business expenditure (direct impact)
- employees' household expenditure (indirect impact)
- suppliers' business expenditure (direct and indirect impact).

A number of these economic contributions are summarised below in **Table 7.5** for key towns that are significantly impacted.

Table 7.5 Summary of TRC Results for BCC Across Key Locations

	Cessnock (LGA)	Singleton (LGA)	Maitland (LGA)	Newcastle (LGA)
Number of BCC employees	119	155	277	80
Employees' annual household expenditure (estimated)	$7.30 mil	$9.51 mil	$16.97 mil	$4.92 mil
BCC expenditure on suppliers	$26.585 mil	$58.13 mil	$12.50 mil	$26.84 mil

Source: BCC (2019)

The Proposed Modification would prolong the life of the mine, and would facilitate these social and economic linkages as identified in **Section 4.1** between BCC and the communities within the Singleton LGA and the Hunter Region, for a further four years.

It is expected that the current economic benefits associated with company, workforce and supplier expenditure will continue for the proposed mine life, with the majority of employment and business opportunities flowing to the surrounding region, with the communities of Maitland, Singleton and Cessnock the key beneficiaries, as highlighted in **Section 4.0**.

As part of the Proposed Modification, an Economic Impact Assessment has also been undertaken by Cadence Economics. This assessment provides a detailed analysis of the financial contribution that the Proposed Modification will make to the wider region. The economic assessment concluded that the Proposed Modification would result in a net benefit to the NSW community. These benefits include:

- continued employment of approximately 700 full time equivalent employees
- the Proposed Modification is estimated to provide a net benefit of $410.6 million to NSW, in net present value terms
- the Proposed Modification is estimated to generate $231.6 million (in net present value terms) in corporate taxes, of which $74.5 million is attributed to NSW
- the Proposed Modification is estimated to generate $104.5 million in royalties
- the Proposed Modification is estimated to provide a net benefit of $81.3 million to the region in net present value terms.

Consequently, the social impact of the operation on the local economy of Singleton and NSW more broadly as a result of the Proposed Modification is considered to result in a '***moderate'*** positive social impact (*likely* to occur, with a *moderate* consequence). Economic benefits of the Proposed Modification were perceived by proximal landholders as a '***high'*** positive social impact of the Project.

7.2.3 Rehabilitation and End Land Use

Rehabilitation and concerns regarding future land use post mining were raised during consultation, with 11 landholders questioning the effectiveness of existing rehabilitation strategies. Landholders were particularly concerned with the final void and suggested that future uses could include landfill or water catchment areas. Landholders expressed concern regarding the quality of land post mining, fearing that environmental degradation due to mining may result in land being inadequate for other uses, specifically agricultural purposes.

The overall rehabilitation strategy for the Proposed Modification is consistent with what is currently approved for the BOP and will include a single void which will remain in the final landform, that will be located to the south east of the site. Internal dump heights will increase from 150 mRL to 160 mRL, with select areas to 175 mRL to provide topographical relief. This increased height reduces the need to apply for additional out-of-pit emplacements areas which would result in additional land disturbance. Overburden emplacement visible to the community will be rehabilitated as a priority.

Land Use and Management is seen as a key issue in the region, with the Upper Hunter Mining Dialogue (2018) established in 2011, conducting investigations into the possible benefits and uses for final voids in the Upper Hunter. The progressive nature of rehabilitation, during mining, allows exposed areas to be backfilled, shaped and revegetated during the life of the mine. The Dialogue process, through dedicated working groups, is *'currently looking into the various ways mine voids can be rehabilitated to make a contribution to the region long after mining has ended. Our study into the achievable beneficial uses for mine voids will help the community to envisage the post mining future of these areas of the region, give the community a say about possible uses and provide the industry with realistic options'* .

The first part of the project will involve a review of re-uses of voids worldwide and look at potential options in light of environmental, economic, social and regulatory context of the Upper Hunter. Outcomes from the review are yet to be released. The Upper Hunter Strategic Regional Land Use Plan (2012) outlines that the final landform post mining activity should be naturalistic and revegetated with local flora. BCM has committed to the progressive rehabilitation of areas disturbed as part of the Proposed Modification, with the objective of returning the Proposed Modification area to a suitable state conducive for a range of vegetation communities and habitat types, wildlife corridors, and the potential for some ongoing grazing use.

The currently approved final land uses are to form replacement treed habitat and some grazing land. This aligns with the State Governments strategic planning documents, noted above, in proposing that the final landform should be naturalistic and revegetated with local flora; and that the community should be included in the design of the rehabilitation program so that they have a sense of ownership over the final landform (Upper Hunter Strategic Regional Land Use Plan, 2012).

The Proposed Modification is unlikely to have any material impact on the final land use options for the site other than potentially enhancing the viability of the final void for use as a pumped hydroelectricity generation facility. Notwithstanding, there has been an increased focus on final land use options for mine sites since the approval of the BOP with additional focus on the usability of final voids. Post mining land use options are detailed in the SEE and provide a high-level analysis of potential post mining land uses for the Proposed Modification.

In addition, the proposed ecological offset area to be located adjacent to the mine (known as the proposed Vere Offset), may also provide opportunities for alternate land uses such as bush walking and mountain biking, which could be further enhanced with other adventure sport activities on the rehabilitated post mining landform. Bulga Open Cut could provide strategic opportunities for a variety of potential final land uses, given the extensive infrastructure and accessibility. These final land use options are considered as potential land uses however will be considered closer to mine closure and will be dependent on market

demand for products at the time, and technology available near to closure. There are several potential options for beneficial use of the final void. Whether or not the void is used directly as an asset as part of the final land use (e.g. future mining, pumped hydro electricity generation, recreation activities, aquaculture etc.), the existence of the void and predicted pit lake water quality should not constrain the range of potential land uses, provided appropriate access and safety considerations are in place, in accordance with standard mine closure requirements. Ultimately, the presence of the void and associated pit lake is considered to provide significant opportunities for high value (and high employment generating) land use options providing economic diversity into the future beyond mining.

Based on the perceptions outlined above, the impact of continued mining activities on land management and uses in the Singleton area is ranked as a '***high'*** stakeholder perceived issue.

With regard to rehabilitation and end land use management, it is not expected that the Proposed Modification will increase land management issues in the area and consequently this issue been ranked as a '***moderate'*** unmitigated social risk (*possible* with *minor* consequence).

7.2.4 Air Quality – Dust

Dust was identified by stakeholders as one of the key issues of concern, with fears of increased dust impacting on social amenity and health, due to the Proposed Modification.

The majority of concerns raised by near neighbours/proximal landholders in relation to dust refer to the impacts of dust on social amenity and lifestyle. Residents expressed concern regarding the effective operation of solar panels and swimming pool filtration systems, as an ongoing issue of existing operations; with landholders noting the subsequent costs associated with cleaning these amenities to ensure efficiency and recreational use. An increase in domestic cleaning as a result of dust was also a notable social impact expressed by proximal landholders. Some landholders expressed a sense of entrapment in their own homes by not being able to open windows or doors to enjoy the breeze, due to poor air quality.

Given the prevalence of mining activity in the area, proximal landholders noted the cumulative impacts of dust from multiple operations in the region.

Impacts of dust on health and wellbeing was identified by some consulted landholders. Impacts included reduced quality of drinking water, respiratory health concerns, and decreased social amenity associated with the cleanliness of residential properties. In addition, landholders held concerns for their psychosocial health, including stress and anxiety associated with living with potential health impacts.

The wider Singleton community echoed proximal landholder sentiment surrounding physical health outcomes for the region, with many stakeholders concerned the cumulative effects of mining in the region may impact their physical health.

The World Health Organisation (WHO) defines health as "*a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity*" (World Health Organisation, 2012). The health status of an individual and/or a community is therefore determined by a range of interactions between human biology and the environment. **Figure 7.2** identifies some of the many factors that act within and across these two spheres to trigger negative and positive health outcomes.

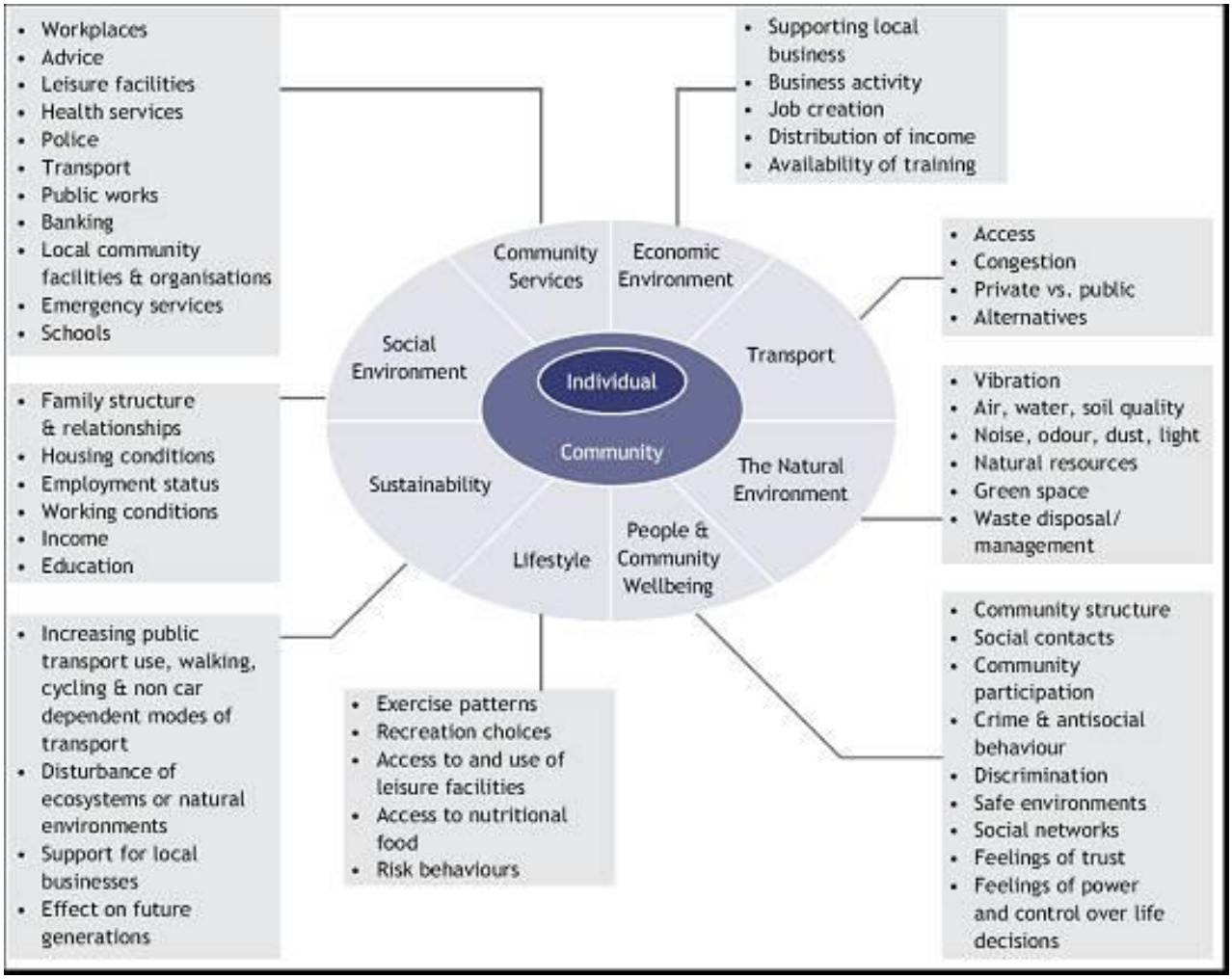

Figure 7.2 Determinants of Health

Source: (Department of Health, 2007)

It is important to note that these determinants of health are interconnected. The health status of an individual and a community is typically due to the combined effect of health determinants and their composite factors. Understanding health determinants can help to identify why certain populations and environments may be healthier than others. This information can then be used to predict health trends within and across populations.

The Hunter Research Foundation Wellbeing Watch (2016) report, based on a cross-sectional telephone survey of 649 Hunter residents aged 18 years and over, indicates that perceived wellbeing in the Hunter has remained high in 2016 with a mean score of 4.06 out of 5 (refer to **Figure 7.3)**. As the figure illustrates, there has been no significant change in the overall Hunter index since the program began in 2006, indicating a stable level of perceived wellbeing among Hunter residents. Results also indicated that in 2016 Upper Hunter residents were slightly less positive than residents in the Lower Hunter in relation to their health.

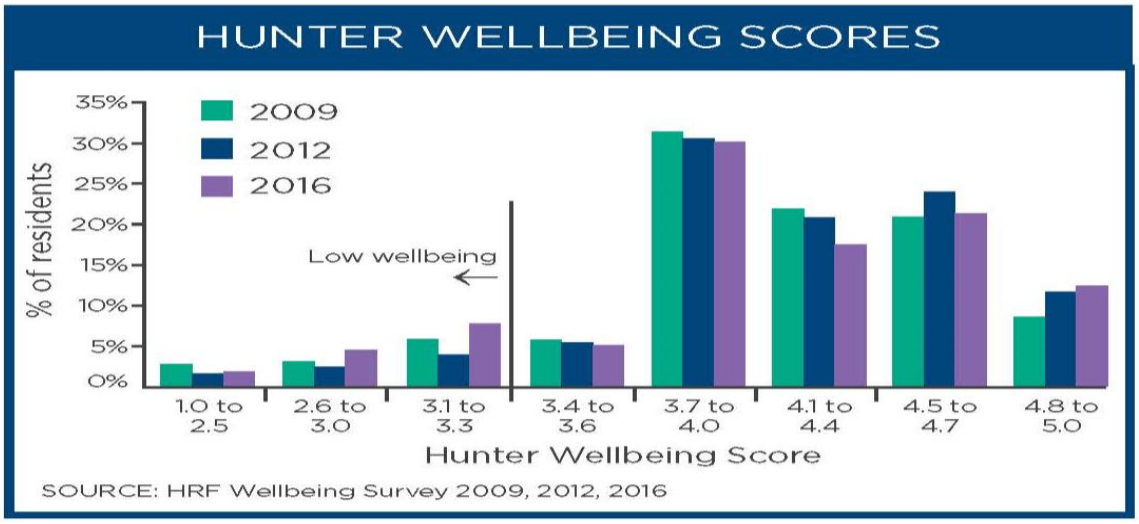

Figure 7.3 HRF Wellbeing Survey Results (2009, 2012, 2016)

Outcomes of the technical air quality assessment has suggested that with the adoption of a range of mitigation measures, that reduce the potential for dust to leave the site, relevant air quality criteria will mostly be met during both construction and operation phases of the Proposed Modification.

There are no private residences that are predicted to experience exceedances of annual average $PM_{2.5}$ Total Suspended Particles (TSP) or dust deposition criteria at any stage of the operations.

As mentioned earlier, one property is predicted to exceed the new annual cumulative criterion in one or more future years. This exceedance is associated with the change in criteria (from 30 µg/m^3 to 25 µg/m^3) and not an increase in PM_{10} dust emissions from the Proposed Modification.

In considering the above, the impact of dust on amenity has been determined as a ***'moderate'*** perceived social risk by proximal landholders and has also been categorised as a ***'moderate'*** unmitigated social risk (*likely* with a *moderate* consequence).

7.2.5 Trust and Engagement

As highlighted in **Section 6.1.4** near neighbours/landholders expressed an overall positive sentiment towards BCM's engagement practices outlining their satisfaction with the level of information being provided by the company and their trust in the company to 'do the right thing' by the community, providing opportunities for engagement.

Many landholders noted the importance of the biannual community BBQs as a means for information provision relating to current and proposed operational plans, as well as a mechanism to foster and facilitate a sense of community and trust between the Company and the community.

Respondents of the Glencore Perception survey expressed that of all Glencore operations within the Hunter Valley, engagement efforts from 2015 to 2018 have become more positive and have increased perceptions of trust between the local community and the BCC, with an average trust score of 3.54 out of 5 in 2018 compared to the Hunter Valley average of 3.29.

Consequently, positive impacts relating to trust and engagement with the company were perceived by proximal landholders as of a ***'medium'* positive** interest, resulting in a ***'high' positive*** benefit from a social perspective (*likely* to occur with a *moderate* consequence).

7.2.6 Noise

Landholders were most concerned regarding operational noise affecting their quality and duration of sleep, with the majority of responses pertaining to machinery being more audible at night or when climatic changes such as wind carries noise further. This is consistent with the review of complaints received by BCM (**Figure 7.4**) which illustrates that the vast majority of complaints received related to noise, many of which were lodged at night.

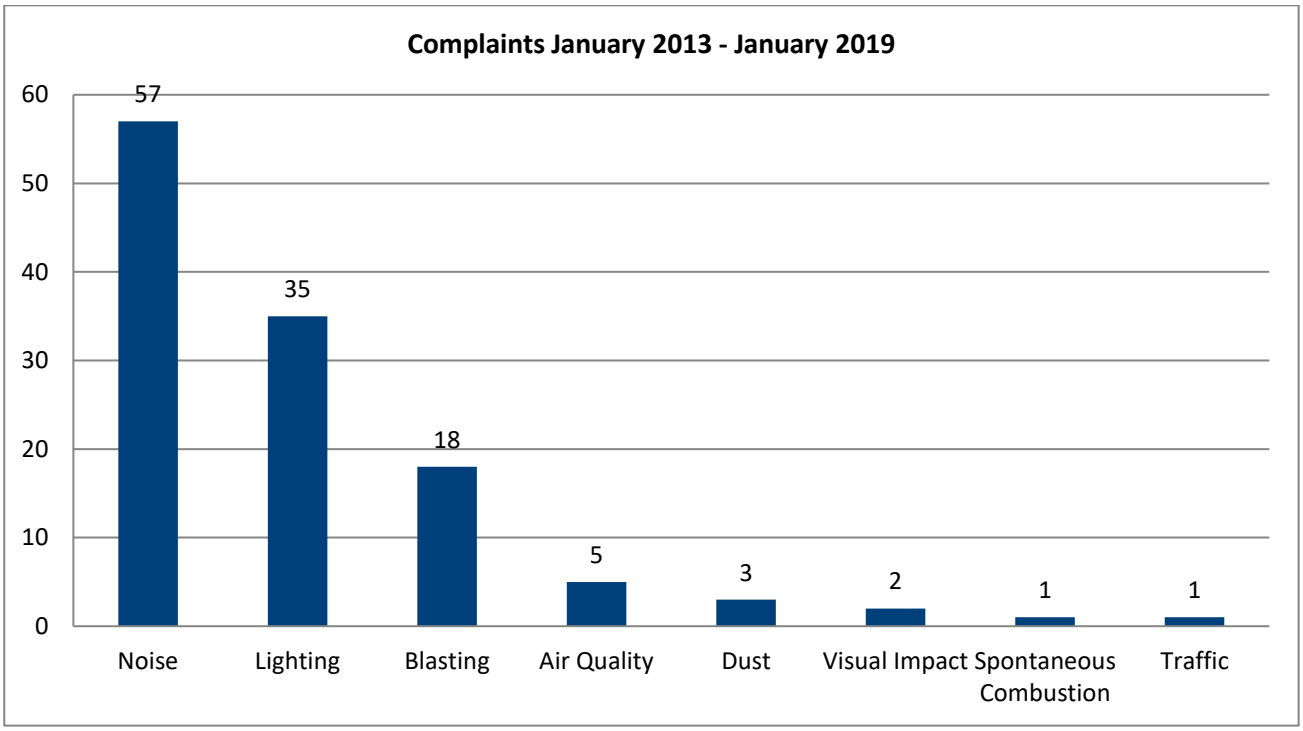

Figure 7.4 Complaint Themes for BCM January2013 – January 2019 (N=122)

Source: Bulga Coal Complaints database (2019)

Night noise impacts were reported more frequently mentioned by proximal landholders in Bulga than in Broke, consistent with the geographical proximity of each locality to existing operations. Trustworthiness of noise monitoring systems did not appear to be an issue for the respondents of Broke or Bulga in 2018, as was the case for landholders surveyed in the BOP SIOA (Coakes Consulting , 2013).

A detailed Noise Impact Assessment (NIA) was undertaken which demonstrates that the Proposed Modification will be able to comply with the current approved noise limits of 35 dB(A) at all residential receptor locations, throughout all stages of the mining; however a number of project design features have also been considered to reduce noise impacts over the life of the Proposed Modification; these include:

- modifications of operations to ensure activity remain within the noise criteria by:
    - either shutting down equipment; or
    - moving to shielded work locations
- construction activities to be limited, and any noise impacts will be managed to comply with the approved noise limits.

To inform proximal landholders of the outcomes of the noise modelling and the strategies to be employed to reduce noise impacts associated with the Proposed Modification, BCC has held individual meetings with landholders whose properties fall within any significant and marginal zones. The community information session, held in Broke in April 2019, also provided further information of the outcomes of key environmental studies and provided opportunities for community members to meet with the Project Team. As part of these meetings some proximal landholders noted an increase in operational noise due to a recent change in mining activity (the completion of the noise and visual bund outface dump), however no issues were raised in regard to the potential noise associated with the Proposed Modification.

Given that noise from the Proposed Modification is *likely* to have an impact on proximal landholders, with a *moderate* consequence the unmitigated social impact of noise from the proposed modification on social amenity is also ranked as ***'moderate'*** with a ***'moderate'*** perceived social impact.

7.2.7 Ecological Impacts

The identification of offset areas was also raised by a small number of landholders (3), concerned that the ecological sustainability of fauna and fauna in the region would not adequately benefit from this mitigation measure.

The majority of the Proposed Modification is contained within the current mining footprint; however, the modification will result in an additional disturbance area of approximately 20.2 hectares (consisting of 19.2 hectares of native vegetation communities) of which 16.4 hectares is listed as the Commonwealth Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC).

The disturbed area will be sequentially rehabilitated during stages of the Proposed Modification and to compensate for the unavoidable loss of ecological values, BCM have committed to providing 154 hectares of biodiversity offset area, known as the proposed Vere Offset, located between the mine and Broke.

The offset management plan will propose the area be able to be used for sympathetic nature, recreational and cultural activities, with no direct predicted impacts on the Warkworth Sands Endangered Ecological Community.

Based on stakeholder perceptions outlined in **Section 6.0,** the impact of continued mining activities on ecological sustainability and uses in the Singleton area is ranked as a ***'low'*** stakeholder perceived issue. Given the extent of the disturbance area (20.2 hectares), the unmitigated social risk has been ranked as ***'moderate'*** impact (*possible* with a *moderate* consequence).

7.2.8 Community Sustainability

Stakeholder perceptions regarding community sustainability were primarily raised in regard to a desire for great economic diversity in the region, during and post mining. The cyclic nature of the mining sector was largely seen to be driven by economic and environmental circumstances, with the consequences during mining booms and busts, significantly impacting small communities.

Industry, agriculture and tourism have coexisted within the Hunter Valley since the early 1800s, however when compared to other industries, mining contributes the greatest revenue for the Singleton region by a significant margin (REMPLAN, 2019), highlighting the high economic dependence of the region on the industry, given its social and economic contribution.

The NSW State Government has recognised the potential for land use conflict in and around coal mining in the Upper Hunter and developed the *Strategic Regional Land Use Plan* (SRLUP) (2012) which seeks to resolve some of these land use issues through the identification and prioritisation of prime geographic areas for each land use. This has been achieved through the identification and mapping of prime

geographic areas that illustrate differing agricultural land uses across the landscape (e.g. prime agricultural land) and strategic industry clusters (i.e. viticulture and equine workings). This has been a welcome initiative at a community level, to ensure that prime areas, where particular land uses are critical, are acknowledged and considered.

The community suggested specific management measures to address community sustainability that included: encouraging greater cooperation across industry sectors to facilitate the implementation of regional projects; and development of education and training programs, through partnerships with organisations such as TAFE, to develop young people seeing employment and facilitate youth employment at the community level.

BCC, as part of Glencore, has a comprehensive Community Investment program, supporting a range of organisations delivering services and initiatives across key investment areas of health, environment, education and training, enterprise development and economic diversity. In addition, BCM supports several projects, events and organisations in the local community including the Broke Fordwich Wine and Tourism Association, Broke Public School, Broke Village Fair, and Broke Bulga Landcare.

Recently, the introduction of a free, family friendly health initiative, "Yoga in the Park", was introduced by BCM to encourage healthy lifestyle choices for residents of Broke and Bulga. BCM aims to encourage a sense of community in the local region with the program offering a fun and inclusive environment for men, women and children of all ages to participate. The initiative has been well received, with up to 15 community members attending the sessions. Consulted landholders were asked to rate the effectiveness of BCM in mitigating community sustainability impacts as a result of their operations, with the company's strategy to annually contribute to local events scoring the highest average effectiveness rating (4.14 out of 5).

As part of the BOP approval, a VPA is in place with the Singleton Council which includes contributing $985,000 towards local community projects in Broke and Bulga and $985,000 for projects in Singleton. Through consultation with Singleton Council, BCM ensures that community investment and capacity building initiatives that are supported are in line with the Council's Community Strategic Plan.

Given only a small number of landholders (3) expressed concern that the local community would not benefit directly from the modification, this issue was perceived as a ***'low'*** social impact in relation to the Proposed Modification. The social impact of the operation on community sustainability is considered to result in a '***moderate'*** unmitigated social impact *(likely t*o occur, with a *moderate* consequence*),* given the company's involvement in its proximal communities to date and likely continued input to community events, organisations/groups and processes that contribute to community sustainability in the medium to long term.

7.2.9 Water

Similar to social impacts identified in the BOP (2013), impacts affecting water quality as a result of mining operations was raised as a concern for proximal landholders. Of most concern to those consulted were issues relating to potential water contamination, water quality and changes to groundwater as a result of mining; and the potential for future water use. Perceived social impacts arising from water contamination include loss of recreation and the health risks associated with contaminated water reservoirs.

Technical assessments have been undertaken for both surface and ground water and the results are explained in detail in the respective sections of the SEE. In summary, it is not anticipated that the Proposed Modification will result in significant impacts on downstream water quality, flows, flooding or future water use.

Based on modelling, it is anticipated that BCC will require additional water access licences to meet operational water demands associated with the Proposed Modification during early years of the Proposed Modification when tailings relocation is occurring. However, to minimise surface water impacts, BCC has designed the Proposed Modification to maximise water recycling and reduce external water import and releases. This approach will minimise adverse effects on water quality from mining operations to downstream waterways. Project design will result in no new significant water storages for the Proposed Modification, with only minor modifications required to existing water storage facilities located within the path of planned open cut operations.

In relation to groundwater, although an increase in depressurisation of deep coal seams has been identified as a result of an increase in the depth of the mine pit of 60 meters, this is not predicted to impact on the alluvial aquifer system or on any alluvial aquifer groundwater bores, and has not had any appreciable impact on the already approved leakage from the alluvial aquifer system to the underlying Permian coal measures.

In summary, no significant changes to groundwater are expected as a result of the Proposed Modification, with the water management plan ensuring minimal impacts to surface water. Stakeholder perceptions in relation to potential social impacts on water, suggest the unmitigated social risk is ***'moderate'*** (*possible* with a *minor* consequence); with proximal landholders rating this impact as ***'low'.***

7.2.10 Visual Amenity

Residents of Bulga specifically, perceived negative changes to their natural surrounds and vista as a result of mining in the area, with the Proposed Modification expected to contribute to visual amenity impacts and loss of rural lifestyle.

Consistent with mining best practices, BCM creates visual bunds as natural in design as possible, with natural revegetation cover. The Proposed modification will result in-pit emplacement areas increasing in height from 150 mRL to 160 mRL, with select areas to 175 mRL to provide topographical relief. This increased height reduces the need to apply for additional out-of-pit emplacements areas which would result in additional land disturbance.

The Noise and Visual Bund will remain in place and will prevent visual impacts to the south and west of the site. As a result, there will only be minor changes to the visibility of the active and inactive overburden areas in some elevated areas, most notably from the north-west.

Visual amenity impacts, as a result of night operations, were also noted by near neighbours/proximal landholders regarding light spill from operations. According to BCC's complaints database (2019), lighting spill was the second most identified impact registered by complainants between 2017 and 2019 (refer to **Figure 7.4**). It should however be noted, that while it was the second most identified impact, there were only six complaints registered over this period across a total of two complainants (one in Bulga and one in Broke) and primarily related to the positioning of lighting towers and intrusive lighting from the complex in general.

Given the analysis of complaints and consultation undertaken, the perceived social impacts of visual amenity by landholders is considered ***'low'***, with a ***'low'*** social risk ranking obtained in relation to the Proposed Modification (*possible* but *minimal* consequence).

7.2.11 Cumulative Impacts

Cumulative impacts of mining within the region were commonly noted by landholders and included the impact of dust and noise from mining operations on social amenity. The possibility of increased coal production and cumulative dust during transportation via rail was also noted. Stakeholders commonly outlined that the source of these impacts was often indiscernible; however, the combined effects were perceived to be widespread throughout the community.

Cumulative impacts were also discussed during the BOP 2013 consultations, with stakeholders concerned that not enough was being done within the region in relation to these issues.

Stakeholder perceptions concerning cumulative impacts appear to continue, despite a history of industry and agency programs focused on reducing cumulative impacts within the region, that include:

- Monitoring of social impacts such as noise, blasting and dust through the implementation of joint consent conditions across operations, developed to encourage effective monitoring, reporting and complaints management associated with these impacts.

- Upper Hunter Air Quality Monitoring Network – monitors air quality in the Upper Hunter from Merriwa in the northwest to near Broke in the southeast, across the local-government areas of Upper Hunter, Muswellbrook and Singleton. The Upper Hunter Air Quality Monitoring Network was created by OEH, in partnership with the Upper Hunter coal and power industries, in response to community concern about the effect of coal mining on air quality in the region. It provides the community of NSW, including the Upper Hunter, with accurate and up-to-date information about air quality.

- Upper Hunter Mining Dialogue – development of working groups to address cumulative impact concerns and to collaborate with industry to develop an understanding and solutions-based framework for cumulative impacts.

Nine open cut coal operations exist within 40 km to the north-west of the BCC, with Mount Thorley Warkworth Mine (Yancoal) the closest, at approximately 5 km. Current mining lease expiration dates vary across the nine operations, with Mount Thorley Warkworth and Ravensworth due to expire in 2023; and the longest lease set to cease in 2033, at Mount Owen.

A review of past and present modification applications across all nine mining operations reveal stakeholder concerns surrounding existing and proposed projects that relate to the cumulative impacts of living in proximity to a number of mining operations. Social impacts identified often include noise, air quality and the availability or quality of water supply.

As outlined in **Section 7.2.4**, while the Proposed Modification isn't expected to generate more dust, cumulative dust impacts, at one property located to the north of the mine, will trigger the new cumulative criterion and as a result acquisition under the VLAMP process.

In regard to noise, the Proposed Modification will be able to comply with approved noise limits at all receptor locations throughout mining progression, with an appropriate level of noise mitigation applied during periods of adverse meteorological conditions. Therefore, future contributions to cumulative noise levels from the Proposed Modification should not exceed the model predictions presented in the Bulga Revised and Amended Project NIA.

Outcomes of previously prepared cumulative noise impact assessments for the BOP and Warkworth Continuation Project NIAs remain unchanged, and compliance with acceptable amenity noise levels is expected to continue.

The NIA that the Proposed Modification will be able to continue to operate within approved operational noise criteria. Therefore, future contributions to cumulative noise levels from the Proposed Modification should not exceed the model predictions presented in the Bulga Revised and Amended Project NIA. Outcomes of previously prepared cumulative noise impact assessments for the BOP and Warkworth Continuation Project NIAs remain unchanged, and compliance with acceptable amenity noise levels is expected to continue.

Given the level of community respondents concern for the cumulative impacts of dust and noise as a result of the presence of mining operations within the local area, perceived social impacts in relation to cumulative dust and noise impacts is considered a ***'moderate'*** perceived impact with a ***'moderate'*** social risk ranking (*likely* but *moderate* consequence).

7.3 Predicted Impact Summary

The following table provides a summary of the predicted unmitigated social risks in relation to the Proposed Modification. As previously mentioned, fears and aspirations relate to one or a combination of the social impacts identified; and for the purpose of this assessment, it is suggested that all of the identified impacts fall within the fears and aspirations category

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Table 7.6 Summary of Predicted Social Impacts

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Community engagement	Decision making systems and engagement	Decision making systems Way of life Fears and aspirations	Increased trust Increased knowledge of the project Opportunities for engagement and feedback	Proximal localities – Broke, Bulga, Milbrodale	Near neighbours/ proximal landholders Key stakeholders Singleton LGA community	Project life – additional four years	*High (positive benefit)*	*High (positive benefit)*
Construction and operational workforce change	Population change	Community Access to and use of infrastructure, and services and facilities	No additional influx of construction or operational workforce No impact on community infrastructure and services	Singleton LGA	Near neighbours/ proximal Landholders LGA residents Service Providers	>3months	Low	Low
Exceedance of noise and air quality criteria	Population change (due to property acquisition)	Personal and property rights Way of life Community	Acquisition of one property as a result of cumulative air quality criteria only	Property at Mt Thorley	Near neighbour / proximal landholder	Project life – additional four years	Low	Low
Mining in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Singleton LGA	Proximal landholders Singleton LGA residents	Project Life – additional four years	High	Moderate
Presence of operation	Dust	Surroundings Health and wellbeing Way of life	Social amenity - dust	Bulga Broke Singleton LGA	Near neighbours / proximal landholders LGA residents	Project life - additional four years	Moderate	Moderate

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Presence of operation	Noise	Surroundings Health and wellbeing Way of life	Social amenity - noise	Bulga Broke Singleton LGA	Near neighbours / proximal landholders LGA residents Local business/tourism operators	Project life – four additional years	Moderate	Moderate
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Bulga Broke	Near neighbours /proximal landholders	Project life – additional four years Ongoing	Low	Moderate
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Singleton LGA	Singleton LGA residents	Project Life – additional four years Possibly ongoing	Moderate	Moderate
Presence of operation	Access to water – surface and ground	Surroundings Way of life	Access to water Livelihood Health	Bulga Broke	Proximal landholders Private bore owners	Project life Possibly ongoing	Low	Moderate
Presence of operation	Visual amenity	Surroundings Way of life	Impact on rural amenity as a result of visibility of: - Operational bunds - Overpass - Lighting spill from operations - Rehabilitation	Bulga Broke	Proximal landholders Singleton LGA residents Visitors to the area	Permanent – declining with rehabilitation progress	Moderate	Low

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Extent	Affected Parties	Duration	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)
Presence of operation and proposed modification	Economic – livelihoods	Way of life Community Personal and property rights	Sustained employment and local procurement / positive contribution to resident and employee livelihoods for an additional four years	Singleton LGA and surrounding region Local residents Local businesses	Existing employee workforce Local business Service providers Indigenous and non-Indigenous population	Project life - additional four years	*High (positive benefit)*	*Moderate (positive benefit)*
Presence of operation Final Void	Rehabilitation and end land use	Surroundings Way of life	Future access to and use of land and water resources (e.g. for agriculture, tourism etc.).	Bulga Broke Singleton LGA Visitors to the area	Proximal landholders to operation Singleton LGA residents Tourists/visitors to the Hunter Valley	Permanent	High	Moderate
Presence of operation Offsets	Ecological resilience and sustainability	Surroundings Health and wellbeing Way of life	Natural environment and rural amenity	Bulga Broke	Proximal landholders to operation and offset areas	Permanent	Low	Moderate
Presence of other mining operations in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Singleton LGA	Proximal landholders Singleton LGA residents	Project life – additional four years	Moderate	Moderate

8.0 Management and Monitoring of Social Impacts

This section provides a summary of the potential strategies that may be implemented in response to the predicted social impacts associated with the Proposed Modification as outlined in **Section 7.0** and relates to those impacts that have been evaluated as significant unmitigated social impacts and ranked as moderate or high as a result of their respective likelihood and consequence ratings.

While this section focuses on the mitigation of negative social impacts, strategies to enhance positive social impacts in relation to the Proposed Modification, particularly in the local community and surrounding region where the Proposed Modification is located, are also presented. The strategies proposed also include measures to address any impacts that are of 'high' concern to potentially affected people and groups, but which are not considered significant from a technical perspective.

As noted in the SIA Guideline (DPE, 2017), strategies need to be developed to ensure that there is a clear connection between the measure proposed and the significant social impact being mitigated or enhanced. Strategies to be implemented may differ in their effectiveness and/or ability to alleviate impacts, with some residual social impacts remaining, in the case of negative impacts. The acceptability of any residual impact remaining post implementation will also be discussed. Furthermore, certain measures may collectively address a number of different negative social impacts and potentially enhance positive impacts.

The SIA Guideline (DPE, 2017), outlines that mitigation measures may be:

- performance-based – identify performance criteria that must be complied with to achieve an appropriate outcome, but do not specify how the outcome is to be achieved, demonstrating why the performance criteria are appropriate
- prescriptive – that outlines actions that need to be taken or things that must be done, with justification as to why this approach is appropriate by providing scientific evidence, or referencing relevant guidelines or case studies
- management-based – where potential impacts can be satisfactorily avoided or mitigated by implementing known management approaches.

Given that the Proposed Modification relates to the continuation of the existing BCC operations, BCM has a number of existing management-based strategies and approaches in place that would continue to be applied should the Proposed Modification proceed. As such, the predicted social impacts associated with the Proposed Modification have been primarily rated as low, when these existing mitigation measures are in place.

Furthermore, it should be noted that in relation to the management of impacts, significant changes have been made to the Proposed Modification design, as was the case in the BOP (2013), to minimise these impacts as much as possible as part of the assessment process. Such design changes have included modification of the mine design to minimise noise and other impacts.

Table 8.1 identifies which specific predicted social impacts are addressed by the implementation of the strategies proposed, with further detail provided on the proposed strategies in the sub-sections below. As has been noted above, each of the strategies proposed may address the social risk to varying degrees.

Additional social criteria have also been considered in the development of relevant strategies, including an assessment of the vulnerability of key stakeholders, particularly local landholders in close proximity to the Project Area.

Table 8.1 Proposed Strategies by Significant (Moderate and High) Predicted Social Impacts

Strategy	Strategy Term	Strategy Type	Rehabilitation and End Land Use	Social Amenity	Community Sustainability	Economic	Cumulative
Environmental Management Plans - Noise, Air Quality, Blasting	Project Life	Management-based	■	■			■
Existing and Proposed Landholder Mitigation Strategies	Project Life	Management-based		■			
Employment and Procurement Policy	Project Life	Performance - based				■	
VPA	Project Life	Prescriptive	■	■			
Post Mining Land Use Strategy	Post Closure	Prescriptive	■	■		■	
Glencore and BCM Community Investment Program	Project Life	Prescriptive	■	■			
Stakeholder Engagement Plan	Project Life	Prescriptive	■	■	■	■	■
New Proposed Strategies							
Nature and Culture Trail	Project Life and Project Closure	Prescriptive	■		■	■	
Strategic Framework for Mine Closure	Project Closure	Prescriptive	■		■		■

The following sections outline each of these strategies in further detail.

8.1 Existing and Proposed Mitigation and Enhancement Strategies

BCM has in place a range of existing mitigation approaches to address environmental and social impacts associated with their mining operations, including a VPA with Singleton Council.

In relation to environmental impacts of the operations, predicted impacts are defined by performance-based criteria and applied through the VLAMP process for acquisition and mitigation. As noted in in the SEE and **Section 7.2**, it is anticipated that one additional property will be afforded voluntary acquisition rights as a result of the change in the cumulative air quality criteria.

To date, as part of BCC's existing operations, a range of management strategies have been applied to residences in the current operation's active management zone to mitigate noise and dust impacts to further reduce impacts of the operations. Strategies are also in place to enhance sense of community.

BCM already has a Stakeholder Engagement Strategy that outlines how and when they communicate with stakeholders, including their directly impacted near neighbours. It is suggested that this document continue to be reviewed annually and adjusted with changes in community sentiment.

Furthermore, BCM also have an existing employment and procurement strategy that they will continue to employ as part of the Proposed Modification.

Throughout the engagement process, landholders and key stakeholders were asked to suggest potential mitigation strategies they would like to see considered by BCM in the development of the Proposed Modification. Stakeholders consistently reported the need to:

- consider post mining land use both individually and collectively, in collaboration with other stakeholders, to ensure the early development of strategic management plans to address land use post mining, with particular attention given to the consideration of community transition and sustainability once operations cease
- consider and assess a range of uses for the final void – e.g. a water storage catchment in times of drought; and implementation of further research to assess the effects of mining on surface and groundwater aquifers
- reduce the heights of overburden and visual bunds by spreading the waste soil over larger areas
- continue to support local community events and facilitate capacity building and economic diversification in the region.

A summary of the potential mitigation and enhancement measures identified by stakeholders through the course of the SIA engagement are provided in **Table 8.2**, along with existing or proposed mitigation and enhancement measures that have been identified as part of this SIA**.**

Table 8.2 Stakeholder Identified Potential Mitigation and Enhancement Strategies

Impact / Opportunity Area	Potential Mitigation and Enhancement Measures – Stakeholder Suggestions	Existing or Proposed Mitigation and Enhancement Measures
Rehabilitation and End Land Use	Development of an End Land Use Strategic Management Plan, in consultation with key community stakeholders, including landholders, businesses, community groups and government agencies Continued progressive development of noise and visual bunds and overburden emplacement areas and community engagement in this regard Monitoring of visual change over time	Nature and Culture Trail: Endeavour to provide access to Bulga Coal offset areas for the benefit of the local community and visitors for recreation. Investigate linking the offset areas with a trail for mountain bikes, walking, horse trails Mine Closure Planning (it is noted that a detailed mine plan is to be developed no less than two years prior to planned cessation of mining, conceptual planning no less than five years) Rehabilitation Management Plan (part of Mine Operations Plan)
Visual Impacts	Minimise bund and overburden heights Spread material over larger topographical areas to reduce heights of permanent bunds Monitoring of visual change over time	Visual Impact Management Plan

Impact / Opportunity Area	Potential Mitigation and Enhancement Measures – Stakeholder Suggestions	Existing or Proposed Mitigation and Enhancement Measures
Dust – Social Amenity	Continued use of dust suppression measures, including water trucks during night and day operations	Air Quality Management Plan
Water Impacts	Detailed report to landholders outlining the quality and quantity of water in local catchments	BCM currently report on water quality as part of an annual review for DPE which is available on their website, provided to the CCC, summarised in quarterly environment reports (also available on the website). *
Noise	Maintenance of noise criteria and adjusting operations where relevant, particularly during night operations	Noise Management Plan
Engagement	Continued engagement with local community through bi-annual community meetings/BBQs, personalised contact with affected stakeholders on a needs basis, and distribution of newsletters	Stakeholder Engagement Plan
Community Sustainability	Continued support of local events VPA contributions Volunteer initiatives	Nature and Culture Trail and use of offsets for recreation for the benefit of community and tourists VPA Glencore Community Investment Program

**denotes proposed additional mitigation and enhancement measure*

8.2 Nature and Culture Trail

In line with Council and Regional strategic plans to ensure economic diversity post mining, BCM have committed to address the issues raised by stakeholders outlined in **Section 6.0** surrounding the perceived concerns regarding end land use and rehabilitation (post mining), and improve the health, wellbeing and sustainability of the local community. BCM will develop a nature and cultural trail to provide access to Bulga Coal offset areas for the benefit of the local community and visitors.

The proposed trail and access has been developed through an understanding of the local setting and potential opportunities for Bulga Coal to provide recreational opportunities. There are a number of examples where these sorts of trail had added value to the community including:

- The Convict Trail (NSW, Australia)
- Fernleigh Track, Newcastle and Lake Macquarie City Councils, (NSW Australia)
- Lundin Mining (Southern Portugal)

Further information relating to these case studies can be found in **Appendix E**.

8.3 Mine Closure Planning

If the Proposed Modification proceeds, Bulga Open Cut operations are expected to extend operations to the end of 2039. The conceptual mine closure process will commence five years prior to planned cessation of mining with a detailed closure plan finalised no less than two years prior to planned cessation of mining. When the detailed mine closure planning process commences in more than 10 years from now, there will be a need for further consideration of the final land use, based on State and Local Government strategic planning and Glencore strategic requirements, the economy and the demand/need for uses being considered at the time.

There are a number of potential options for beneficial use of the final void. Whether or not the void is used directly as an asset, or as part of the final land use (e.g. future mining, pumped hydro electricity generation, extreme recreation activities, aquaculture etc.), the existence of the void and predicted pit lake water quality should not constrain the range of potential land uses, provided appropriate access and safety considerations are in place, in accordance with standard mine closure requirements. Ultimately, the presence of the void and associated pit lake is considered to provide significant opportunities for high value (and high employment generating) land use options providing economic diversity for a future beyond mining.

It is understood that Singleton Council intends to implement a strategy and policy position that provides a framework for how Council can respond to and support the management and mitigation of the impacts of mining, including final land use, not only of the land but also the infrastructure that may be utilised for a future alternative industrial or business use. The policy will be interrelated to Singleton Council's Community Strategic Plan to ensure alignment with the desires of the community.

Singleton Council plans to create a Singleton Community and Economic Development Fund ('Future Fund') to focus on the sustainable growth of the social and economic capital of the community and provide for future economic development planning and ultimately the creation of a stronger community.

BCM will work with relevant groups, including Singleton Shire Council, to create a strategic framework for mine closure, ensuring that:

- a range of potential final land uses are considered as part of the cessation of mining
- engagement is carried out with key stakeholders in a timely and collaborative manner
- the strategy aligns with the strategic vision of Singleton Council.

8.4 Voluntary Planning Agreement

As part of the BOP approval, BCM has a VPA in place with the Singleton Council which currently includes the allocation $985,000 towards local community projects in Broke and Bulga and $985,000 for projects in Singleton.

To help inform consultation and allocation of funding in relation to the VPA, BCM utilised outcomes of the BOP SIOA (Coakes Consulting, 2013) and key findings of a community visioning project, undertaken with stakeholders across the villages of Bulga, Milbrodale and Broke.

The objectives of the visioning project were to:

- identify community views for the future of the villages and create momentum to realise a shared community vision

- support community development and future planning;
- ensure alignment with Singleton Council's Community Strategic Plan and other regional planning efforts.

A total of $128,000 was allocated to community contributions by BCM in 2017 and 2018, of this amount, $50,000 was contributed as part of the VPA and included sponsorship of community events held by the Broke Fordwich Wine and Tourism Association, the funding of teaching aide and future focused furniture at the Broke School and sponsorship of the Broke Fair.

BCM proposes to continue its existing VPA commitments, for the duration of the Proposed Modification, to facilitate continued and ongoing support for a range of community and environmental projects within the communities of Broke, Bulga and Milbrodale and the wider Singleton LGA community.

8.5 Summary of Social Impacts

Table 8.3 provides an overall summary of all social impacts associated with the Proposed Modification and their corresponding strategies and rankings of unmitigated and mitigated social risk.

Table 8.3 Summary of Mitigation and Enhancement Strategies for the Proposed Modification

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Community engagement	Decision making systems and engagement	Decision making systems Way of life Fears and aspirations	Increased trust Increased knowledge of the project Opportunities for engagement and feedback	Near neighbours / proximal landholders Key stakeholders Singleton LGA community	High (positive benefit)	High (positive benefit)	Stakeholder Engagement Plan	High (positive benefit)
Mining in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Proximal landholders Singleton LGA residents	High	Moderate	Management plans Continued participation in the Upper Hunter mining dialogue	Low
Presence of operation	Dust	Surroundings Health and wellbeing Way of life	Social amenity - dust	Near neighbours / proximal landholders LGA residents	Moderate	Moderate	Air Quality Management Plan	Low
Presence of operation	Noise	Surroundings Health and wellbeing Way of life	Social amenity - noise	Near neighbours / proximal landholders LGA residents Local business/tourism operators	Moderate	Moderate	Noise Management Plan	Low

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Near neighbours / proximal landholders	Low	Moderate	Nature and Culture Trail Strategic framework for mine closure	Low
Presence of operation	Community resilience and sustainability	Community Way of life	Community dependence on the mining industry Lack of economic diversity	Singleton LGA residents	Moderate	Moderate	Nature and Culture Trail Strategic framework for mine closure	Low
Presence of operation	Access to water – surface and ground	Surroundings Way of life	Access to water Livelihood Health	Proximal landholders Private bore owners	Low	Moderate	Licensing agreements Water Management Plan	Low
Presence of operation	Visual amenity	Surroundings Way of life	Impact on rural amenity as a result of visibility of: Operational bunds Overpass Lighting spill from operations Rehabilitation	Proximal landholders Singleton LGA residents Visitors to the area	Moderate	Low	Visual Impact Management Plan Mine Operations Plan (Rehabilitation Plan)	Low

Project Aspect	SIA Impact Theme	SIA Category	Social Impact	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Unmitigated)	Proposed Social Mitigation Strategies	Social Impact Ranking (Mitigated)
Presence of operation and proposed modification	Economic – livelihoods	Way of life Community Personal and property rights	Sustained employment and local procurement / positive contribution to resident and employee livelihoods for an additional four years	Existing employee workforce Local business Service providers Indigenous and non-Indigenous population	High (positive benefit)	Moderate (positive benefit)	Nature and Culture Trail Employment and procurement strategy	Moderate (positive benefit)
Presence of operation Final Void	Rehabilitation and end land use	Surroundings Way of life	Future access to and use of land and water resources (e.g. for agriculture, tourism etc).	Proximal landholders to operation Singleton LGA residents Tourists/visitors to the Hunter Valley	High	Moderate	Nature and Culture Trail Mine closure process Mining Operations Plan	Low
Presence of operation Offsets	Ecological resilience and sustainability	Surroundings Health and wellbeing Way of life	Natural environment and rural amenity	Proximal landholders to operation and offset areas	Low	Moderate	Biodiversity Management Plan	Low
Presence of other mining operations in the region	Cumulative	Surroundings Health and wellbeing Way of life	Impact of dust and noise on social amenity	Proximal landholders Singleton LGA residents	Moderate	Moderate	Management plans Continued participation in the Upper Hunter mining dialogue	Low

8.6 Monitoring of Social Impacts

The social impacts associated with the Proposed Modification are not expected to be new or different in terms of scale and/or intensity to those that have been approved under the original consent for the operation.

As has been noted previously, BCM have strong and established relationships in the community and the ongoing monitoring and adaptive management relating to social impacts, associated with the Proposed Modification, will only build on the strong foundations put in place by the company to date.

BCM will collect social data to monitor commitments made in this SIA namely:

- Key areas of predicted impact, including perceived and experienced social impacts, through ongoing regular engagement with near neighbours and other proximal landowners, to determine if the experience of impacts are in line with predicted impacts (as outlined in **Section 7.3**).
- Evaluation of community contributions to ensure benefits to local stakeholders e.g. local community organisations, schools and tourism events.

BCM also has a current community investment program that provides contributions to local community groups and organisations. This program is complemented by Glencore's broader Corporate Community Investment Program which takes a more regional focus to involvement and investment. As previously noted, Glencore also currently undertake a community perception survey, currently every three years, to inform engagement and investment activities at the operational and corporate level.

9.0 Conclusion

Many communities in the Hunter Valley have been built around the economic activity generated by mining, which continues to comprise a significant part of the Hunter's economy, injecting $6 billion in wages and payments to local businesses each year (Mining Dialogue, 2019). While the growth of mining in the Upper Hunter results in economic growth, it also brings with it challenges and impacts for the local community.

The SIA has identified that social impacts from the Proposed Modification are primarily consistent with those of the currently approved operations at BCC, with the social impacts predicted to be low or moderate.

Given the limited life of additional mining (approximately four years) and BCM's pre-emptive mine planning approach, to avoid and minimise impacts, the social impacts of the Proposed Modification have been minimised through project design and proposed management and enhancement approaches.

One key focus from a social impact perspective is the growing community interest in the transitioning process associated with the closure of mines and end land use. The SIA confirm that BCM implement a Mine Closure Plan that explores potential final land uses, aligns with the strategic visions of Singleton Council and other relevant regional plans; and provides a collaborative framework for engaging with key stakeholders. In line with this approach, it is recommended that BCM continue their good work at a community level, in considering the feasibility of the development of a Nature and Cultural Trail that connects key local villages and provides both recreational, health and economic benefits to the proximal communities of Broke, Bulga and Milbrodale, and the region more broadly.

On this basis, it would be reasonable to consider, that with the continued implementation of the management and mitigation strategies already in place by BCM, and the ongoing commitment by the BCM team to build on the strong existing relationships that exist within their respective proximal communities, there will be minimal additional social impacts to the local or the wider Singleton community as a result of the Proposed Modification.

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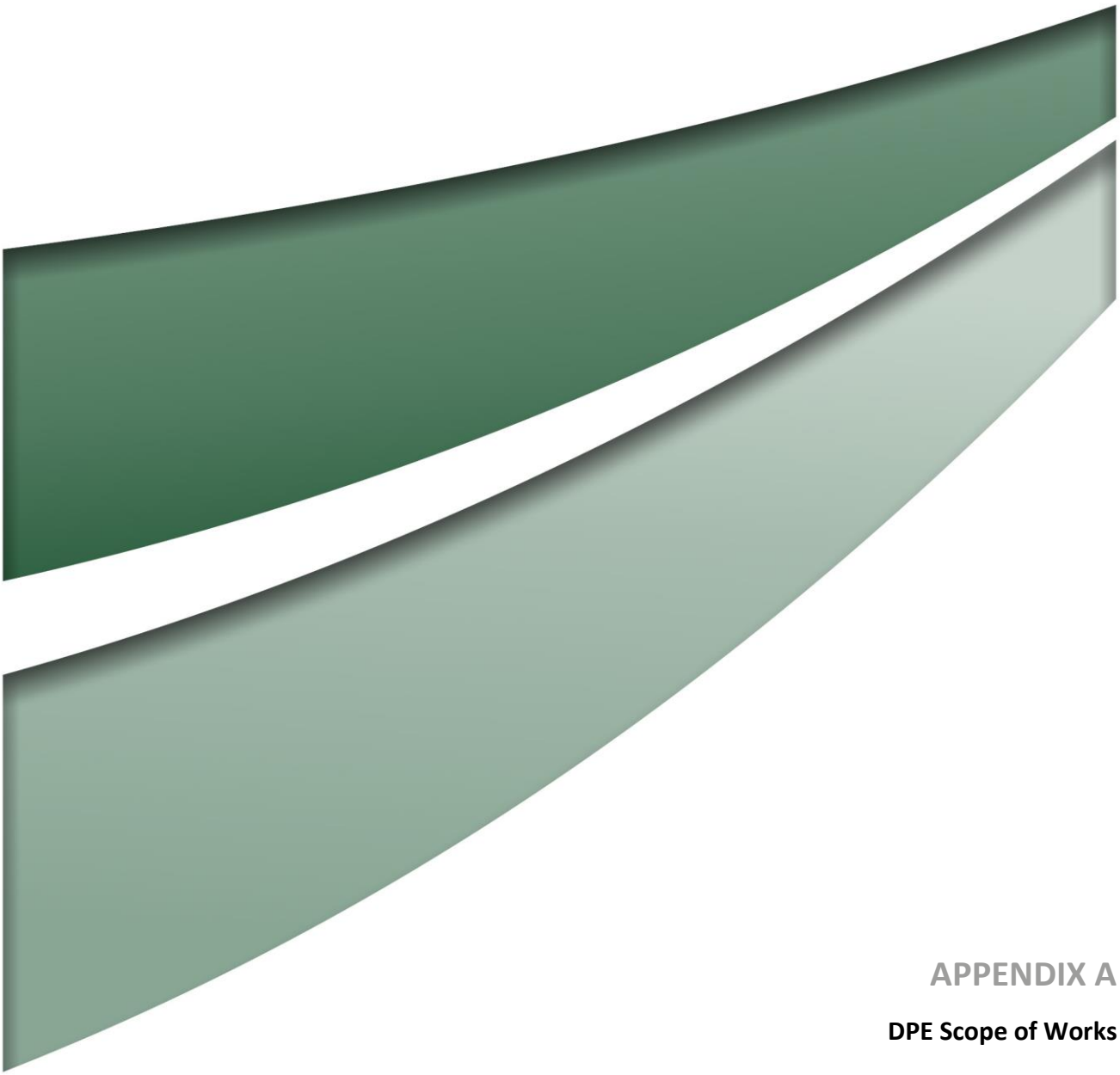


APPENDIX A

DPE Scope of Works

NSW GOVERNMENT | Planning & Environment

Geoff Kelly
Operations Manager
Bulga Coal Management Pty Ltd
Private Mail Bag 8
Singleton NSW 2330

Dear Mr Kelly

Bulga Optimisation Project (SSD 4960)
Modification 2 – Approval Pathway and Requirements

I refer to your letter of 13 October 2017 seeking confirmation of the approval pathway and the environmental assessment requirements for a proposed modification to the development consent for the Bulga Optimisation Project (SSD 4960 MOD 2). The Department understands that the proposed modification largely includes extending the approved mining area to the south into the Deep Pit area to recover an additional 64 million tonnes of coal. The proposal would also include relocating and reprocessing tailings from the Deep Pit tailings storage facility, disturbing an additional 21 hectares of land and extending the approved mine life by a further 4 years (to 2039).

Based on the information provided in your letter, I can confirm that the proposed modification falls within the scope of section 96(2) of the *Environmental Planning and Assessment Act 1979.* With respect to the supporting Statement of Environmental Effects (SEE), the Department is satisfied with your company's identification of key issues and supports the proposed assessment approach, which includes:

- detailed air quality, noise, blast, surface water and groundwater impact assessments;
- ecology and Aboriginal cultural heritage assessments for the additional surface disturbance area;
- an updated social impact assessment; and
- visual, economic and greenhouse gas and energy assessments.

With regards to the air quality impact assessment, please ensure it is undertaken in accordance with the EPA's 2016 *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.*

With regards to the ecology assessment, I note that you substantially commenced the assessment for this modification prior to 25 August 2017 and therefore anticipate that the modification can be assessed under OEH's 2014 *NSW Biodiversity Offsets Policy for Major Projects* and the *Framework for Biodiversity Assessment,* in accordance with the *Biodiversity Conservation (Savings and Transitional) Regulation 2017.*

With regards to the social impact assessment, I note your proposal is to build on the previous 2014 Social Impact and Opportunities Assessment rather than undertake a new comprehensive assessment. The Department considers this to be an acceptable approach. However, I request that you have regard to the Department's 2017 *Social impact assessment guideline for State significant mining, petroleum production, and extractive industry development.*

Notwithstanding the above, I remind you that all potential impacts of the modification must be assessed.

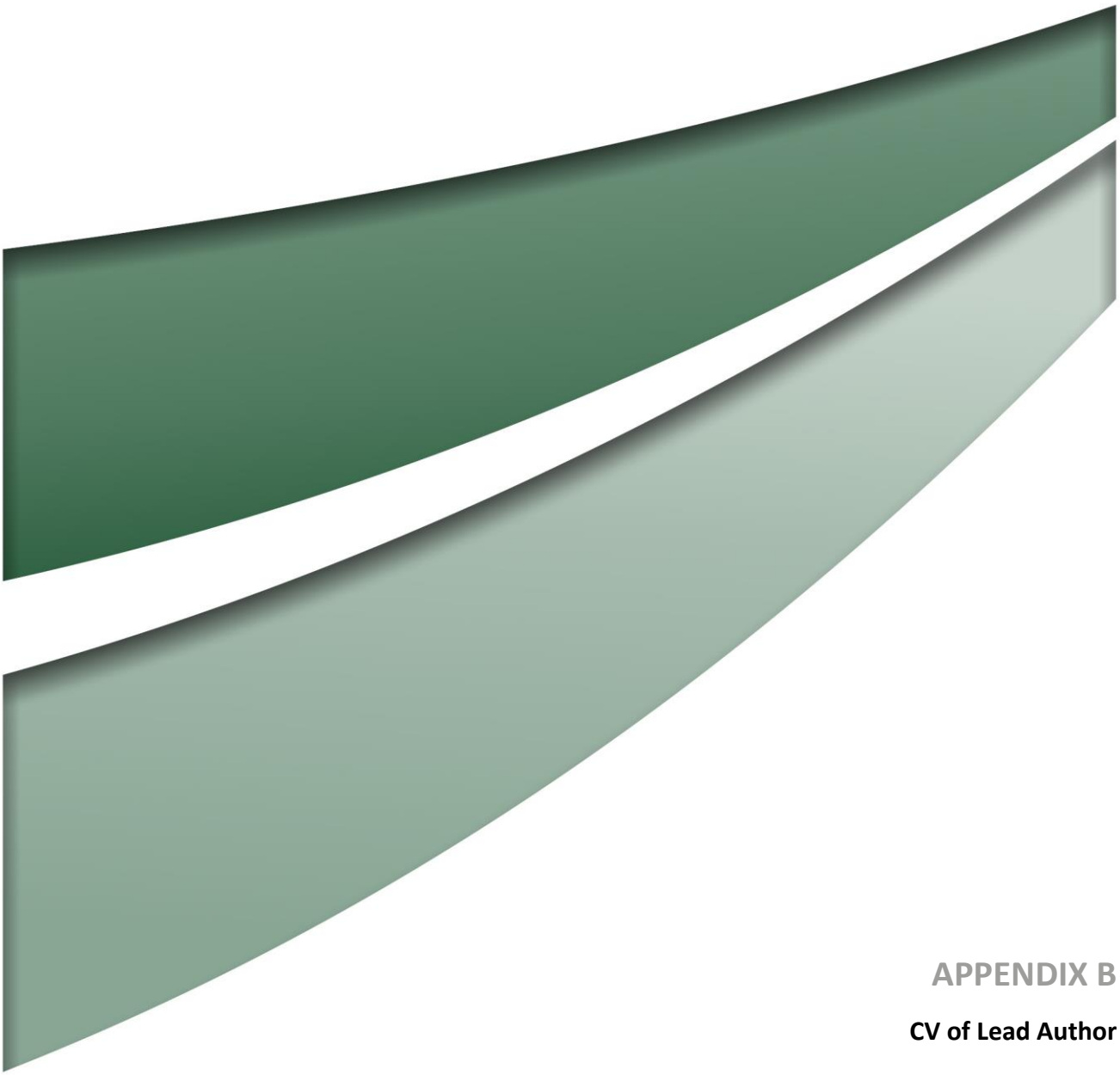
Please contact the Department at least two weeks before you plan to submit the modification application and supporting SEE. This will enable the Department to provide lodgement instructions, confirm the applicable fee, determine the required number of copies of the SEE and discuss exhibition periods.

Should you have any questions in relation to the above, please contact Megan Dawson, Team Leader – Resource Assessments, on 9274 6391.

Yours sincerely

Howard Reed

Howard Reed 17.10.17
Director Resource Assessments



APPENDIX B

CV of Lead Author

umwelt Environmental & Social Consultants



Dr Sheridan Coakes

Practice Leader – Social Impact Assessment and Community Engagement Team

Dr Sheridan Coakes (Sherie) has over 25 years of research and applied experience in the areas of social impact assessment (SIA), stakeholder engagement and community involvement. A leader in her field, Sherie has developed and refined a unique approach to SIA practice that has been applied in numerous large scale and controversial public and private sector projects across Australia, in diverse sectors such as fisheries, viticulture, dairy deregulation, water resources cultural heritage, health, agriculture, biotechnology, linear infrastructure development, quarrying, oil and gas, open cut and underground mining, carbon capture, waste management and human service planning and delivery

With a strong methodological background in the social sciences – both quantitative and qualitative – Sherie has developed a range of innovative approaches that afford the effective collection, analysis, interpretation and use of social and community data to effectively inform program/project assessment and operational planning; and to involve stakeholders in decision making processes

In 1997, Sherie established Coakes Consulting, a specialist social consultancy developed to address social and community issues within a resource management context. The company was developed largely out of a need for companies and agencies to address social and economic issues and concerns in project and policy development planning, and followed on from Sherie's role with the Commonwealth Government in designing and implementing the social assessment methodology for the Australian Regional Forest Agreement Process – one of the most significant applications of SIA and community engagement by government at a national level. In late 2013, Coakes Consulting merged with Umwelt and Sherie was appointed in the role of Social Practice Lead.

As a recognised thought leader, Sherie has published and presented papers and seminars on social assessment and community engagement in a variety of different forums, contributing to four international texts on SIA and engagement practice. She is often invited to speak at key conferences in her field of expertise and has facilitated numerous specialist training courses in SIA, stakeholder and community engagement, risk communication and outrage management.

Qualifications/Affiliations:	Doctor of Philosophy – Psychology , Honours First Class – Psychology, Bachelor of Applied Science - Psychology
Years Experience:	>25
Specialisation:	Social and economic impact assessment (SEIA), Health impact assessment (HIA), Social impact management planning, Stakeholder and Community engagement, Social Research, Social performance evaluation and monitoring, Social investment planning, Outrage management, Community visioning, needs and infrastructure Assessment, Community perception and attitude assessment, Program/Project evaluation
Key Clients:	Glencore, Sydney Motorway Corporation, PWCS, Landcorp

Relevant Project Experience

Sydney Motorway Corporation | New M5 WestConnex Project | 2016-current | Project Director | Development of a Community and Social Management Plan and associated Community Cohesion Plan including consultation with internal and external stakeholders.

Landcorp | Shenton Park Hospital Site | 2017 – current | Project Director | SIA and community engagement for the redevelopment of the Shenton Park Hospital Site, Shenton Park, WA.

Port Waratah Coal Services (PWCS) | T4 Project | 2017-current | Project Director | Housing and Local Procurement Study; SIA for the T4 Project, Newcastle NSW; Community Engagement Strategy for the Carrington and Kooragang operations: Dust Profile Community Program.

BHP Billiton | Nickel West Project | 2016 | Project Director | SIA and community planning framework for operations in Kwinana, Kalgoorlie, Leinster, Leonora and Wiluna; Social monitoring framework; Community Health Partnership recommendations for the Wiluna Community.

Glencore | Various Projects | 2011-current | Project Director | SIA, community needs assessment and stakeholder engagement for a range of Glencore mines in the Hunter Valley; Community Visioning Project – 'Our Villages - Our Vision' Hunter Valley NSW; 'Viewpoint Program' assessment of community perceptions of social performance across the company's operations in NSW; Baal Bone Closure Plan - SEIA, Western Coalfields NSW; Social Investment framework development.

Department of Regional Development and Lands (WA) | RfR Fuel Card Survey | 2016 | Project Director | Evaluation of the Royalties for Regions (RfR) Fuel Card Scheme and Housing Evaluation for RfR funded housing projects across WA.

BHP Billiton (Iron Ore) | Pilbara Growth Planning | Project Director | SIA for growth planning in the Pilbara, WA; Community Needs Assessment to guide social investment; social performance monitoring and evaluation; review of the Pilbara Community Partnership Program.

Department of State Development (WA) | Kimberley LNG Project | Project Director | Review of social impact components for the Strategic Assessment Review (SAR) of the Kimberley LNG Project, James Price Point, Broome

Macquarie Generation | Bayswater and Liddell coal fired Power Stations | Project Director | Community involvement program for the development of an industry zone associated with the Bayswater and Liddell coal fired Power Stations, Hunter Valley, NSW; Community consultation associated with potential wind farm developments in the northern tablelands and southern highlands of NSW.

BHP Billiton | Nickel West Project | Project Director | SIA and community planning framework for operations in Kwinana, Kalgoorlie, Leinster, Leonora and Wiluna; Social monitoring framework; Community Health Partnership recommendations for the Wiluna Community.

BHP Billiton (Iron Ore) | Pilbara Growth Planning | Project Director | SIA for growth planning in the Pilbara, WA; Community Needs Assessment to guide social investment; social performance monitoring and evaluation; review of the Pilbara Community Partnership Program.

BHP-Billiton | Hunter Valley Coal, Illawarra Coal, Caroona Project | Project Director | SIA and Community involvement programs for various operations in NSW; Community Needs Assessment to identify focus areas for project investment.

Department of State Development (WA) | Kimberley LNG Project | Project Director | Review of social impact components for the Strategic Assessment Review (SAR) of the Kimberley LNG Project, James Price Point, Broome.

Commonwealth Department of Climate Change | Assessment of Social and Economic Impacts of Climate Change Scenarios on the Oil and Gas Sector in WA | Project Director | Application of Social analysis and community sensitivity methodologies to demonstrate local level socio-economic flow-on of climate change impacts on the Pilbara oil and gas sector

Chevron (Australia) | Wheatstone Project | 2008–current | Project Director | Since 2008, Umwelt has undertaken some key projects for Chevron in WA in the project development and construction phases of the Wheatstone Project, located in Onslow on the north west coast of WA. Key studies have included Integrated Social, Health and Aboriginal Impact Assessment; Community Values Assessment and Visioning Project; Community Infrastructure Study; and Annual community attitude survey (6th year of administration since Project inception).

INPEX | Ichthys Project | Project Director | 2011-2013. Social Impact Management Plan (SIMP) development for the Ichthys Project, Darwin NT.

BHP-Billiton | Hunter Valley Coal, Illawarra Coal, Caroona Project | Project Director | SIA and Community involvement programs for various operations in NSW; Community Needs Assessment to identify focus areas for project investment.

Fortescue Metals Group | Solomon Hub Project | Project Director | SIA for the Solomon Hub project and expansion of the company's Port Hedland operations.

Kimberly Diamond Company | Closure Planning Study| Project Director | Assessment of existing community needs and potential mine closure impacts in the Kimberley region, WA.

Oakajee Port and Rail (WA) | Mid-West Social Profile| Project Director | Social scan and regional profile.

Cameco | Kintyre Uranium Project | Project Director | SHIA for the Kintyre Uranium Project, Pilbara region, WA.

Department of Planning (WA) | Mid-West and Gascoyne Social Infrastructure Study | Project Director | Mid-West and Gascoyne Social Infrastructure Assessment, planning for future social infrastructure requirements.

Department of Primary Industries (VIC) | Social and Economic Impact Assessment of Changes in Forest Policy on Victorian Forest Communities | Project Director | Application of town resource cluster analysis (TRC-Analysis) in identifying potential social and economic impacts of changes in forest policy on Victoria communities.

Natural Resources Commission (NSW) | Social Assessment of the River Red Gum and Cypress Forest | Project Director | Socio-economic capacity building and advisory services to assist CMA's in achieving better natural resource and investment decisions; Social assessment of the River Red Gum and Cypress Forest Assessments.

Office of Environment and Heritage (NSW) | Community Attitudes to Native Vegetation Act | Project Director | Analysis of community attitudes survey relating to the application of the *Native Vegetation Act* in NSW.

Zinifex/Nyrstar, DoH, EPA and PPRC | Ten by10 Community Health Study | Project Director | 10 by10 Community Health study relating to elevated blood lead levels in Port Pirie, SA.

Referee 1

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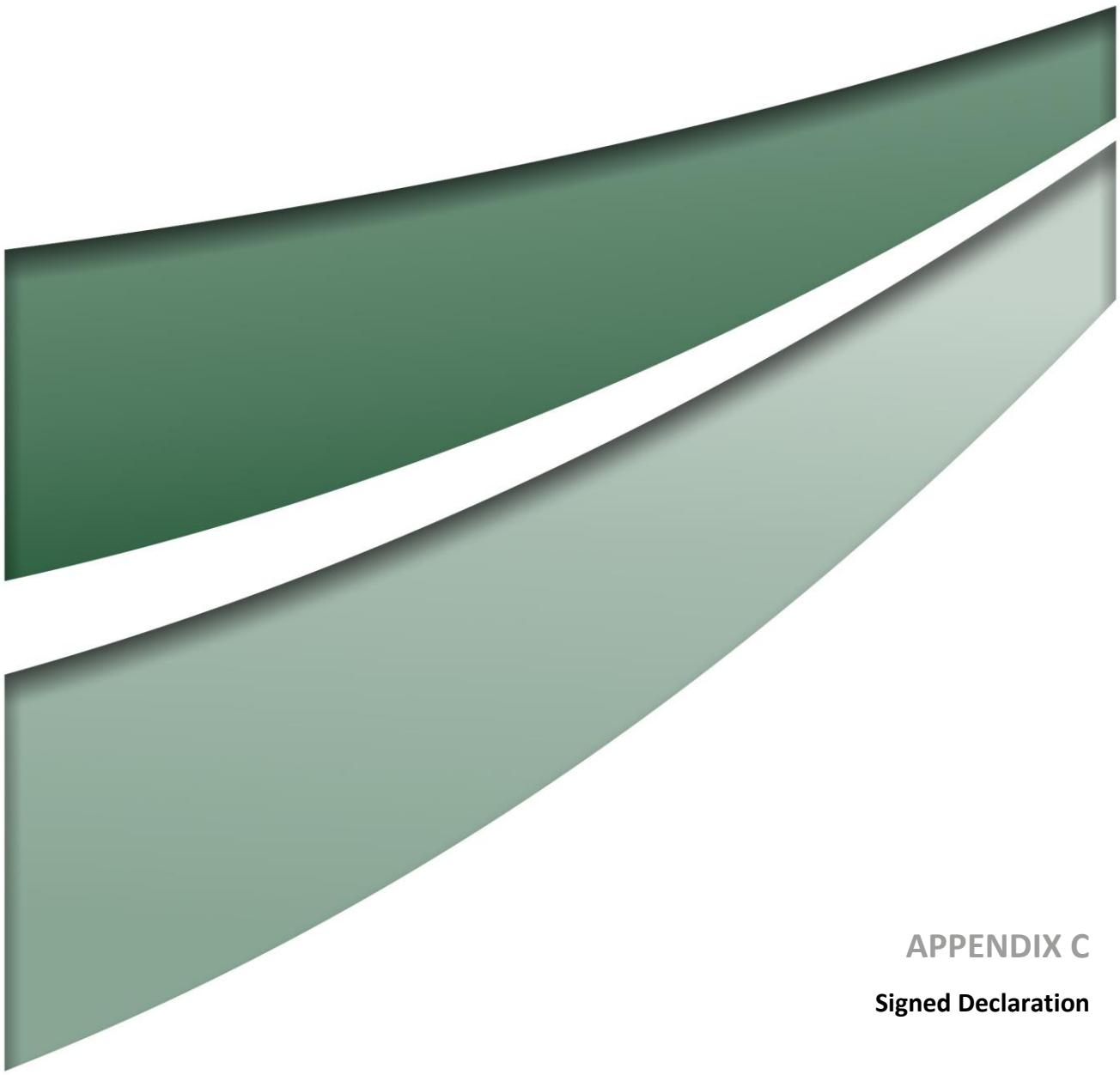


APPENDIX C

Signed Declaration

umwelt
Environmental & Social Consultants

Inspired People
Dedicated Team
Quality Outcomes

Social Impact Statement Declaration

SIA Prepared by:

Name	Umwelt Australia Pty Ltd - Social Team
Project Director	Dr Sheridan Coakes Practice Lead - Social Impact Assessment & Community Engagement
Qualifications	Doctor of Philosophy – Psychology Honours First Class – Psychology Bachelor of Applied Science – Psychology

In Respect of:

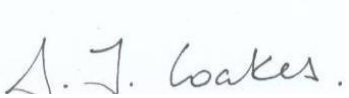
Proponent Name	Bulga Coal Complex
Proposed Development	Bulga Optimisation Project Modification 3

Declaration

I, Dr Sheridan Coakes, declare that the information contained within the Social Impact Assessment for Bulga Optimisation Project Modification 3:

- Is in accordance with the Environmental Impact Assessment (EIA) process under the Environmental Planning and Assessment Act 1979 (EP&A Act);
- Meets the form and content requirements of the Department of Environment and Planning's Social Impact Assessment Guideline for State significant mining, petroleum production and extractive industry development (DPE, 2017);
- Is neither false nor misleading.

Signature



Dr Sheridan Coakes

Date Tuesday, 28 May 2019

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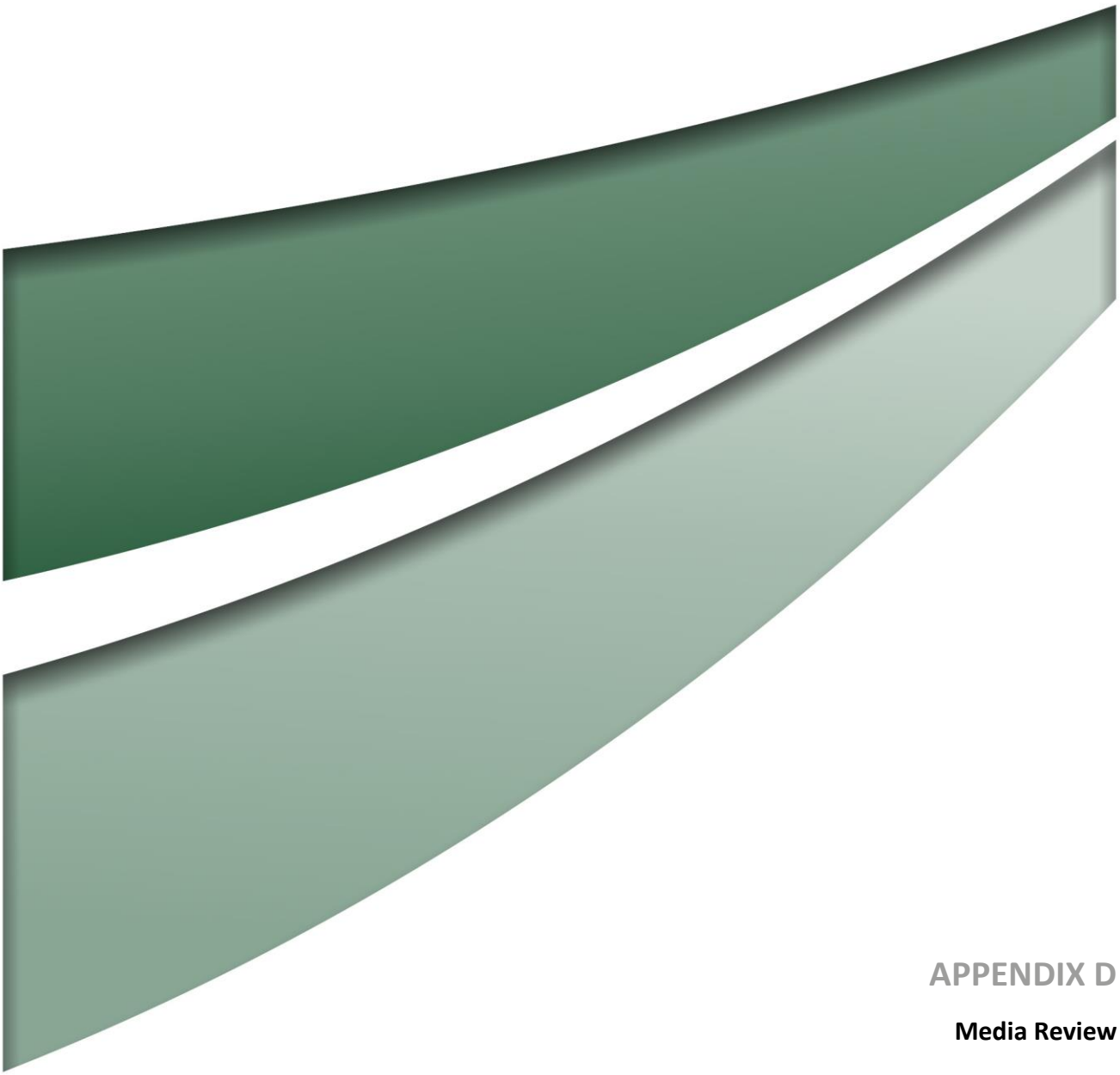


APPENDIX D

Media Review

Date	Headline	Brief Description/Summary of Article	Source
Economic Diversification			
18 January 2019	**Muswellbrook bio-renewables research facility the first of its kind in Southern Hemisphere**	*"Works are officially underway in Muswellbrook for the first bio-renewables research facility of its kind in the Southern Hemisphere, making the Hunter a national hub for exploration, development and commercialisation. Mr Johnsen said the electorate – and the wider Hunter – was a powerhouse for the Australian energy market, continuing to deliver visionary ways to power industry and households, while supporting new jobs in NSW.* *The Hunter Pilot Biorefinery has the potential to revolutionise the way we create energy here in Australia," he explained."*	Muswellbrook Chronicle
2 January 2019	**Mining economy**	*"The Hunter's long-term economic fortunes remain perilously linked to the boom and bust cycle of the mining industry. Now economists have expressed concern about the ongoing effect the mining industry's infamous 'boom-bust' cycle is having on regional economic sustainability.* *This cycle has impacts on employment, investment and housing."*	Newcastle Herald
28 November 2018	**Plenty of mine projects planned**	*The NSW Minerals Council is excited to promote the fact the Hunter has nine projects in the pipeline which they claim would deliver over $1.5 billion in investment and maintain or create over 3,400 jobs for the region.*	Singleton Argus
7 November 2018	**Coal's 'drive-in' workforce**	*A hearing held in Singleton on Monday was told by Singleton Council's General Manger, Jason Linnane that an estimated 9000 workers drive-in each day to run the region's coal mining industry.*	Singleton Argus
6 August 2018	**Singleton Junior Golf Open attracting players from all over the region thanks to attractive prize pool**	*Under their junior sports development program, Glencore is on board as the major sponsor of the 2018 Singleton Junior Golf Open, with over $3500 worth of prizes on offer.*	Singleton Argus
28 June 2018	**Demand for Australian coal escalates, building on last year's turnaround**	*Minerals Council of Australia predicts a 400 million tonne increase in annual demand by 2030.*	ABC News

Date	Headline	Brief Description/Summary of Article	Source
25 June 2018	**Denman recognised as the fast-developing centre of Upper Hunter's tourism industry**	*"The Council has allocated $2.5 million to the Denman Town Centre Upgrade Concept in the 2018-2019 budget and $1.94 million to the reconstruction of Denman Memorial Hall. Creating improved public spaces, enhancement of the heritage character of the town centre and construction of off-street parking are key focuses.* *Upgrades planned for Memorial Park, is critical to the concept, including improved green space for events, a new children's playground, picnic facilities, landscaping and public amenities. "Denman is recognised as the fast-developing centre of Upper Hunter's tourism industry," Muswellbrook Shire Council's director community infrastructure Derek Finnigan said. "*	Muswellbrook Chronicle
20 March 2018	**Strong global demand delivering additional mining positions in NSW, says Coal Services data**	*The most recent figures from Coal Services show there were just over 20,872 coal production jobs in NSW as at December 2017, nearly 2000 more than this time in 2016, helping to boost the Hunter economy, particularly in mining communities such as Singleton. This is the highest number since July 2014.*	Hunter Valley News
12 December 2017	**Upper Hunter country tourism on track with new guide**	*A new 2018 Upper Hunter Visitor Guide was launched yesterday, at the Upper Hunter Country Tourism (UHCT) annual general meeting which was held at the Linga Longa Inn in Gundy. The 68 page visitor guide promotes events, attractions, and activities from festivals to National Parks, in the Muswellbrook and Upper Hunter shires and also includes town maps, accommodation listings and a business directory featuring local tourism operators who are UHCT members.*	Upper Hunter Country
14 November 2017	**NSW coal mining jobs at highest point since March 2015**	*Figures from Coal Services show there were just over 20,600 coal production jobs in NSW as at July 2017 – over 1300 more than at the same time last year, and the highest number since March 2015. Many of the new coal mining jobs are in the Hunter Valley region, with over 1000 more positions in the region than a year earlier, helping to boost its economy, particularly in mining communities like Singleton and Muswellbrook*	Australian Mining
19 October 2017	**Singleton Reginal Livestock Market gets $7.73 million upgrade**	*Funded by a $6 million grant under the State Government's Resources for Regions program and an additional $1.73 million from Singleton Council. "This project is a significant investment in the economic diversity of our local government area and a demonstration to the wider agricultural industry that Singleton intends to continue its long tradition of supporting primary producers," Anthony Egan, Council's Director Corporate and Community said.*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
2 Aug 2017	**More than 300 jobs could be protected, as Glencore seeks extension approval at Mangoola**	*Glencore are seeking approval to extend their operations beyond life of the existing mine which could result in more than 300 jobs being safe-guarded for a further six years. If approved, the life of the mine would be extended until approximately 2029.* *All key stakeholders will be engaged to ensure their feedback on environmental and social issues, which forms part of their environmental assessment studies.*	Muswellbrook Chronicle
18 June 2017	**Small villages bear the brunt of mining expansions**	*Historic villages are being displaced by mining activities. A solution is needed to allow the two to co-exist. Dr Askland from the University of Newcastle is calling for greater emphasis to be placed on social impact assessments.*	Muswellbrook Chronicle
5 January 2017	**Muswellbrook Shire Council has proposed three big projects to make the town a regional centre**	*Muswellbrook Shire Council has proposed the first general rate special variation in 10 years to fund projects including a water park linked to replacing its 87-year-old swimming pool, a Muswellbrook regional convention and performance centre and Denman town upgrade.*	Newcastle Herald
4 November 2016	**Reserve Bank calls end of the mining bust**	*The bank observed that the recent rally in coal and iron ore prices had lifted the terms of trade for the first time in two-and-a-half years. That prompted the bank to tentatively call the bottom of Australia's commodity price bust.* *The bank also observed that the steep fall in mining investment over the past few years appears to be slowing and might be close to a trough.*	ABC News
28 April 2014	**Re-positioning Muswellbrook after the coal downturn**	*Muswellbrook in the heart of the NSW Hunter Valley is now feeling the after effects of a major coal mining boom that took the town and its residents to unprecedented levels of wealth and prosperity.* *When the party lights were dimmed in 2013 as resource related investment slowed, it sent shock waves through the community and businesses.* *It brought the region's vulnerability into focus underlining the lack of diversity.*	ABC Rural
Drought			
7 January 2019	**Drought relief milk to be extended**	*"A bid to help drought-stricken dairy farmers stay afloat amid crippling drought has seen $3.1 million in relief payments split between farms.* *Dairy Connect CEO and Drought Relief Committee member Shaughn Morgan said farmers had used the money to help with the cost of buying in feed for their cows."*	Maitland Mercury

Date	Headline	Brief Description/Summary of Article	Source
10 February 2018	**'As dry as it's ever been': Upper Hunter farmers battle through testing conditions**	*Bureau of Meteorology data shows that parts of the Upper Hunter, around the Scone area, are going through a one-in-20-year rainfall deficiency. Most of the remainder of the valley is experiencing a once in a decade deficiency. As the drought gripping the region rolls on, farmers are being forced to offload thousands of head of livestock because conditions are too harsh.*	Illawarra Mercury
20 April 2018	**Buy A Bale Hunter hay relief on the way after $200,000 donation**	*The first hay trucks – paid for with Glencore's $200,000 contribution to the Buy A Bale Hunter campaign – will arrive in the Upper Hunter this weekend.* *"This is a significant amount of money and it will provide assistance with fodder and other services Rural Aid is providing to the farmers.* *"There are still a few loads going to the Lower Hunter but the majority of the need now is in the Upper Hunter around the Scone area." Rural Aid CEO and co-founder Charles Alder.*	Maitland Mercury
24 August 2018	**Singleton Council's drought assistance hub will be operational on Monday**	*Singleton Council has partnered with a range of stakeholders to be a conduit between Singleton farmers and the services available to rural producers to make finding help easier. "With 100 per cent of NSW now in drought, and a range of government packages now available to farmers as well as an overwhelming response to community fundraising, the difficulty for farmers is often knowing where to start to find the help available to them," Singleton mayor Sue Moore said.*	Singleton Argus
Infrastructure and Services			
30 January 2019	**NSW Government delays Muswellbrook Bypass by a further 6-8 years in new plans**	*"In yet another setback for the Muswellbrook Bypass, the NSW Government has revealed the project will be delayed for at least another six-to-eight years.* *Muswellbrook Shire Council was informed last November that its timeline of having it completed by 2020 was "unrealistic", as it is currently only in the "preferred route" phase.*	Muswellbrook Chronicle
19 December 2018	**Council commits to town centre**	*"Singleton Council has reaffirmed its commitment to Singleton's Town Centre, resolving to co-fund stage two of the revitalisation project by making provisions in its 2019/2020 loan borrowing program at its final meeting of 2018 earlier this week.* *""This project will make a significant difference to the people who live and work in Singleton, including improved road safety, property appreciation and wider economic benefits that will contribute to a creative, vibrant, economically diverse and healthy community."""*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
19 December 2018	**Announcement good start to festive season**	*"Announcement of $2,787,000 for an arts and cultural centre in Townhead Park; talks of increased passenger trains between the Upper Hunter and Maitland.* *Push for mining royalties to be returned to the LGA in which the minerals were mined."*	Singleton Argus
18 December 2018	**School grants to help early learning**	*"A STATE government initiative to improve the environment and services at preschools will benefit 12 schools in the Upper Hunter.* *""A total of $141,387.30 has been invested in community preschools in the Upper Hunter,"" he said, with the money used to pay for improvements to grounds and buildings as well as specialised educational programs for children."*	Newcastle Herald
11 December 2018	**Sports clubs share in $4 million state government funding**	*SPORT and recreation clubs across the electorate have been successful in securing $49,960 in funding from the NSW Government for new equipment, facilities and programs through the Local Sport Grants Program.*	Muswellbrook Chronicle
12 October 2018	**Rail noise walls for Muswellbrook lines**	*Work on a rail noise abatement project at Muswellbrook will start in November. Muswellbrook Shire Council awarded a tender to build three walls along the shire's rail line at Simpson Park and near Campbell Corner, building on a state government grant of $1.9 million towards designing and delivering the project.*	The Newcastle Herald
28 August 2018	**New England Highway from Singleton to Muswellbrook enjoys million-dollar windfall**	*The Upper Hunter electorate will benefit from the Saving Lives on Country Roads Program with nine upgrades to begin this financial year. "The Saving Lives on Country Roads Program aims to reduce the number of people killed and seriously injured on our roads by addressing high risk curves and installing safety features to prevent driver fatigue and lane departure crashes," Upper Hunter MP Michael Johnsen said.*	Hunter Valley News
28 August 2018	**Draft Plan of Management for Lake St Clair recreation ground on display**	*"A new kiosk, playground and multi-purpose meeting facility are some of the possibilities included in a draft Plan of Management for the Lake St Clair recreation ground unveiled for public exhibition from Wednesday, August 29 until Friday, October 12.* *Singleton Council is encouraging feedback on the draft plan, which provides guidelines for the planning, development and care of the Lake St Clair Recreation Park. A public hearing will also be held for members of the community to find out more information on Thursday, September 13."*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
4 August 2018	**Plans released for New England Highway Muswellbrook Bypass**	*The Roads and Maritime Services (RMS) has released its preferred plan for the New England Highway Muswellbrook Bypass.* *In its July 2018 Options Report, five routes were considered to combat the heavy influx of vehicles, which pass through the town on a daily basis.* *The RMS stated the following objectives were specific to a bypass of Muswellbrook: improve network efficiency on the New England Highway, particularly travel times for long haul freight movements; improve safety for all road users in the town centre, particularly relating to heavy and light vehicle interactions; and, improve the amenity of the Muswellbrook township.*	The Muswellbrook Chronicle
1 August 2018	**Singleton Shire Council has sold Wallaby Scrub Road to a coal mine for $27.5 million, but residents aren't happy**	*NSW legislation requires that all proceeds from the road closure must be invested in the Singleton local government area road network. The council's decision lapses if the closure is not gazetted by September 28.* *Mr Krey said the gazettal deadline made no sense because the coal company needed the road closure to continue mining the Mount Thorley project.* *"What's going to happen if that deadline passes? Yancoal walks away? It can't continue mining without the closure which is why we are so angry with this decision. The council could easily have got $100 million from the company in our view," Mr Krey said.*	The Newcastle Herlad
19 June 2018	**Singleton Heights Pre-school expansion plans given green light**	*"The Council has given the go ahead for a non-for-profit community-based centre located on Dorsman Drive which will offer 40 more places to local families, with increase access and participation for Aboriginal and Torres Strait Islander families.* *The program is managed by the Department of Education and is aimed at not-for-profit community based providers hoping to expand their services when there is a shortage demand.*	Singleton Argus
19 June 2018	**Clearer pathways for job hunters with a disadvantages in the Hunter**	*Not-for-profit organisation Workskil Australia has formed a dedicated team of caring Disability Employment Services specialists in the Upper Hunter in NSW and on July 1 will open its doors to assist disadvantaged local job seekers. From July 1, major changes come into effect to the Australian Government's existing Disability Employment Services (DES) program aimed at helping more people with a disability, injury or mental health condition find and maintain employment.*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
3 May 2016	**Singleton's conventional TAFE campus is undergoing a $4.9 million dollar transformation**	*"It will be an absolute game changer for education in our area with the new centre opening a whole new variety of opportunities for our local students; combining the very best of modern technology and the traditional face to face teaching TAFE NSW is famous for," Upper Hunter MP Michael Johnsen said.*	Singleton Argus
5 May 2017	**PCYC Muswellbrook is calling on the community for help**	*PCYC Muswellbrook must find $236,000 to give its car park a complete overhaul, with work scheduled to start on June 1*	Muswellbrook Chronicle
17 April 2018	**Singleton Council plans to spend $27 million on capital works 2018/19**	*There is a predicted expenditure of $82 million for the financial year 2018/19 by the Singleton Council. As part of that expenditure Council is planning to spend $27m on capital works with a focus on water and sewer infrastructure. Contained in the Draft are words talking about the journey in 'creating the community's vision for Singleton as vibrant, sustainable, progressive, connected and resilient'.*	Singleton Argus
5 March 2018	**Muswellbrook bypass debate rears its head again after weekend incident at town's overhead rail bridge**	*THE need for a Muswellbrook bypass was highlighted at the weekend when a wide-load vehicle found itself stuck under the town's overhead rail bridge.* *This caused the south-bound lanes to be blocked and a traffic diversion was put in place. During the reversing process, both sides of the New England Highway were stopped for about five minutes, causing further frustration among drivers.*	Muswellbrook Chronicle
30 August 2017	**Cessnock and Singleton Councils celebrate opening of Hermitage Road and Broke Road upgrade and cycleway**	*Opening of a multi-million dollar upgrade to Broke and Hermitage Roads. The project included improvements to Hermitage Road and Broke Roads, a 10.6 kilometre cycleway and installation of tourist facilities including an information bay. The councils combined to submit a successful funding application for $16.7 million from the NSW Government's Resources for Regions program, which delivers improved infrastructure in mining-affected communities.*	The Advertiser
3 February 2017	**Conservation Volunteers Australia plants an office in Muswellbrook**	*CVA has just opened an office in Muswellbrook. And, this Sunday, February 5, at 6pm, the public is invited to join in on their volunteer session to find out more about volunteering on great projects coming up.*	Muswellbrook Chronicle
12 January 2017	**Singleton Council investigating management options for Lake St Clair**	*"Lake St Clair is a popular location for water-based activities, day tripping and camping. Singleton Council reviewed the current caretaker and investigated management options to improve the state of the grounds.* *The recent installation of a new caretaker facilities, and a boom gate at the entry to the grounds and car parking near the caretaker facility. "*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
Government Funding			
26 June 2018	**First it was Resources for Regions now the state budget - why?**	*Singleton provides millions and millions of dollars year in year out from mining royalties – we are the epitome of a mining impacted region but our requests for support appear to be falling on deaf ears. The NSW Minerals Council state that mining royalties will deliver a record $1.8billion in this year alone, and another record $2b next year into the state's coffers.*	Singleton Argus
5 June 2018	**Muswellbrook and Cessnock Councils receive millions Singleton Council gets absolutely nothing**	*"Our neighbouring councils Muswellbrook and Cessnock have just received a total of $13.5 million in funding through the Resources for Regions Program but Singleton Council did not get one cent. At about the same time Parliamentary Secretary for the Hunter, Scot MacDonald MLC, was in the Cessnock Local Government Area (LGA) delivering the good news that the Cessnock CBD is about to undergo a huge $3.5m revitalisation.* *In Singleton we waited hoping it would soon be our turn to hear some good news from a program designed specifically to assist mining affected communities."*	Singleton Argus
14 June 2017	**Singleton Shire Council's just been upgraded, but no one knows why**	*A NSW tribunal decision that could cost Singleton ratepayers an extra $100,000 a year in councillor fees and more than double Mayor Sue Moore's take-home pay to nearly $62,000 which could be challenged after questions about the council upgrade that bumped up councillor pay. The tribunal Singleton upgrade in particular, with a councillor pay boost from $8750 to $19,310 per year, and mayor Sue Moore's from $27,389 to $61,430 that has raised questions about the assessment process.*	Newcastle Herald
Impacts of Mining			
8 February 2019	**Respected Upper Hunter doctor Robert Vickers believes Upper Hunter Air Quality Monitoring Network data 'alarming'**	*""Any GP in town will tell you when people with chronic respiratory diseases leave the area, their symptoms improve.* *"It's frustrating, from my perspective, because there is so much information out there – and people choose to ignore it.* *"Average levels of coarse particle pollution in the Hunter Valley have increased at a rate higher than the rest of NSW, with the biggest witnessed at Muswellbrook."* *Dr Vickers said a total of nine sites exceeded the national standard of PM10 particle levels.* *Dr Vickers believes existing environmental and planning safeguards were not*	Muswellbrook Chronicle

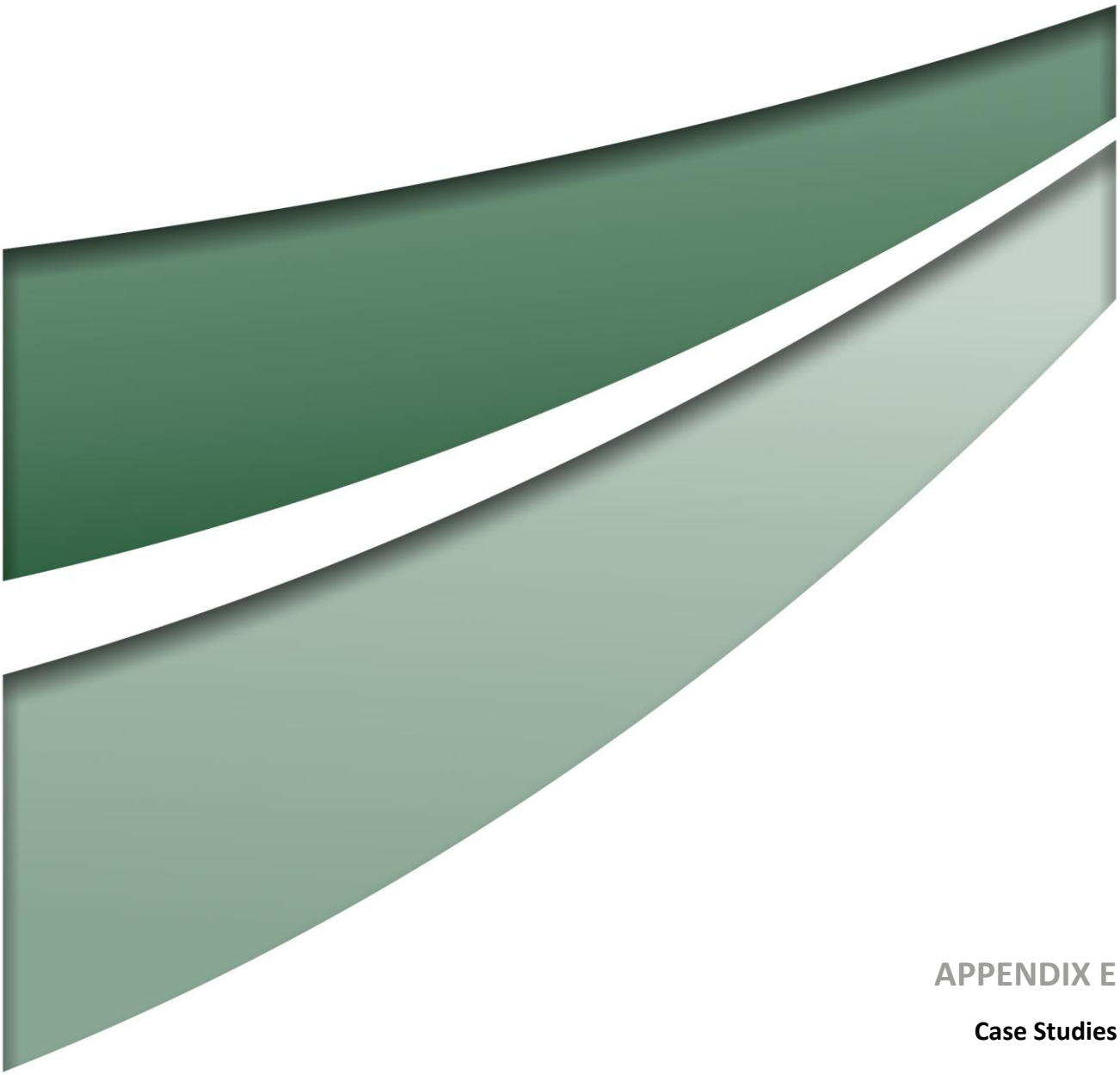
Date	Headline	Brief Description/Summary of Article	Source
		protecting the health of people living in the region. *"The NSW and Australian economies have profited from the Hunter Valley's natural resources, but that time is coming to an end whether we like it or not.* *"If we don't plan for this transition period and continue relying on mining for local jobs, the Hunter risks being left with high rates of unemployment.* *"If we don't act on air pollution now, we are putting the Hunter region at risk of the negative health effects.""*	
8 January 2019	**Shooters, Fishers and Farmers Party's candidate for Upper Hunter Lee Watts meets with concerned Wybong community**	*THE Shooters, Fishers and Farmers Party's candidate for Upper Hunter, Lee Watts, is calling on the Mine Subsidence Board to "move with the times".* *"It needs to incorporate all [mining] impacts and administer compensation with greater flexibility to buy out neighbours who feel stuck," she said.* *"When a mine like Mangoola expands, there are some properties the company must legally offer to purchase because of their impacts.* *"However, there is the next line of properties they don't have to buy.* *"The property value then falls, there are no buyers and the owners have to live with increasing dust and noise.* *"When I met with some of the Wybong community, they weren't angry, they were just disillusioned, trying to find a way for their families to live the lifestyle they have planned and worked so hard for."*	Hunter Valley News
12 December 2018	**Upper Hunter records worst ever air quality**	*"The Hunter Valley is on track to record its worst air quality since monitoring began due to increasing levels of coarse particulate matter (PM10).* *Five Hunter towns and villages are tracking to record PM10 levels that exceed national standards, according to data from the Office of Environment and Heritage.* *So far, 2018 has been the worst recorded year for air quality since the Upper Hunter air quality monitoring network started measurements in 2012."*	Newcastle Herald

Date	Headline	Brief Description/Summary of Article	Source
19 October 2018	**Horses, vineyards should be off-limits to coal: poll**	*NEARLY two-thirds of people polled in the mining areas of Singleton and Muswellbrook say critical horse-breeding and wine growing areas of the Hunter should be off limits to coal mining. The ReachTEL poll of 253 people was commissioned by Lock the Gate as it campaigns to stop three greenfield mines in the Hunter and Central Coast areas, including the KEPCO Bylong mine between Denman and Mudgee.*	Newcastle Herald
17 October 2018	**Information day on wild dog control**	*Hunter Local Land Services is calling on local landholders interested in wild dog control to attend a free information day at Mount Olive Community Hall near Singleton, on Saturday, November 3. The information day is being run in conjunction with North East Singleton Wild Dog Association.*	Singleton Argus
11 September 2018	**Hunter Valley coal miners targeted during drought**	*"In particular, mines must take extra care during harsh dry weather conditions to prevent dust affecting the surrounding communities," Upton said.* *"The current dry drought conditions, especially on windy days, mean that mines should be taking extra precautions to control the amount of dust generated on site.* *"People living near mines should be protected by tough regulations and mine operators have a duty at law to improve their environmental performance."*	Mining Monthly
30 July 2018	**Air quality alerts night after night as PM 10 levels exceed national standards**	*"Upper Hunter air quality network monitors around Singleton are issuing warnings night after night as PM10 levels in the district exceed national air quality standards. The night time, in particular after midnight, appears to be the worse time for air quality in the local area as six times in the two weeks between four and six monitors have recorded concerning levels of dust pollution. "A couple of days later the setting was covered in the dust which I know comes from the surrounding mines and the two powered electricity generators Bayswater and Liddell just up the road.* *"There is a terrible drought throughout the state but the dust is not red or drown dirt from the bush its black and its hurting everyone who breathes it." Mrs Bowman said authorities will say it is wood smoke or due to the drought which she described as absolute rubbish."*	Singleton Argus

Date	Headline	Brief Description/Summary of Article	Source
27 July 2018	**Singleton community demands answers from Defence over the use of PFAS at Singleton Army Base**	*"I've been raising this (concerns about contamination) for few years now. It just falls on deaf ears; they just ignore you," Singleton horse breeder Brad McNamara said. Health officials maintain there is no consistent evidence between PFAS, classified as an emerging contaminant, and adverse health impacts in humans.*	Singleton Argus
6 June 2018	**Massive impact: Coal mining's effects on the Hunter water tallied**	*" A federal government study found the existing 40-plus open-cut and underground coal mines had affected an area of 4307 square kilometres, or about a quarter of the overall Hunter region. The 22 new projects would expand that impact – assessed as at least of a 5 per cent chance of groundwater levels dropping 0.2 metres – out to about 30 per cent.* *Surface water impacts from the additional projects had the potential to affect 1228 kilometres of streams. Water losses included a 50 per chance of a 4.5 gigalitre per year loss of flow at Singleton, the report said. A spokesman for the Department of Planning and Environment reported "All new mine proposals are subject to rigorous assessment and approval processes under the EP&A Act"*	Sydney Morning Herald
6 April 2018	**Glencore's Global Head of Coal engages with protesters outside of Hunter Coal Festival Mining Leaders Lunch**	*A small group of passionate protesters gathered outside of Club Singleton prior to the Hunter Coal Festival Mining Leaders Lunch. The protestors voiced their concerns about what they perceive to be the government's reluctance to initiate the transition from fossil fuels to renewable energy in Australia. They called for "no new coal" and "clean air, soil and water for the children."*	Singleton Argus
4 April 2018	**Advertising feature: Hunter Coal Festival Community**	*Celebrating the co-existence between community and mining from April 6-15, the festival has a packed line-up, including the likes of a mining leader's lunch, singleton community day and parade and community updates meetings. The festival is supported by Muswellbrook Chamber of Commerce and Industry, Muswellbrook Shire Council and Singleton Shire Council.*	Singleton Argus
21 February 2018	**Singleton Hospital emergency admissions jump as air quality falls in the upper hunter**	*"Upper Hunter residents have sought an urgent meeting with the NSW Environment Protection Authority after data showing a dramatic spike in Singleton emergency department admissions in 2017 coinciding with declining air quality.* *Singleton hospital admissions jumped by 28.6% between July-September 2016 and July-September 2017."*	Newcastle Herald

Date	Headline	Brief Description/Summary of Article	Source
13 December 2017	**Glencore says enterprise agreements reached at all Hunter mine sites**	*Following six months of industrial action and negotiations, Glencore and the mine workers' union have signed off on a string of Hunter mine enterprise agreements, which have been registered with the Fair Work Commission, including Mangoola open cut, Ravensworth open cut, Ravensworth coal handling and preparation plant, Mount Owen coal handling plant, Glendell open cut, Liddell open cut, Liddell coal plant, Bulga open cut and Bulga underground mine.*	The Newcastle Herald
11 October 2017	**Shocking' spike in Hunter Valley's coal-linked air pollution fails to prompt action**	*Air pollution from the Hunter Valley coal mines has become increasingly worse, with Wendy Wales calling neighbors warning them of a bushfire, mistaking the dust for smoke. Pollution monitors in the area picked up readings of 103.4 PM10 (particulates of 1 micrometers or less in diameter) at Warkworth near open cut coal mines.*	Sydney Morning Herald
7 July 2017	**Two-day strike planned for Glencore's seven Upper Hunter operations**	*"Workers from seven Glencore operations including five open cut mines will meet at Singleton Showground on Monday morning to hear from Construction Forestry Mining and Energy Union (CFMEU) representatives on the state of negotiations between the union and the company on new Enterprise Bargaining Agreements (EBA).* *Voting on a new EBA was recently held at Glendell mine and Mr Jordan said 96-97 per cent voted against that EBA."*	Singleton Argus
16 February 2017	**Mining report finds 60,000 abandoned sites, lack of rehabilitation and unreliable data**	*"More than 60,000 mines have been abandoned across Australia, according to a report that raises concerns about how land rehabilitation is managed as the mining boom ends.* *Muswellbrook's Mayor Martin Rush said BHP's operations stand in stark contrast to what is happening on the other side of town at the Glencore Mangoola mine.* *"Best practice is really what is happening at Mangoola," he said. "It can be done. It should be done and increasingly the community will be expecting it to be done."*	ABC News

Date	Headline	Brief Description/Summary of Article	Source
15 February 2017	**Wind farm impacts have received significant government attention, but not coal mines**	*"Community groups in Upper Hunter mine areas say governments have spent many millions of dollars investigating the noise impacts of wind farms, but little on the impacts of open cut coal mine noise in rural areas, despite evidence of the health impacts of industrial noise and years of complaints about noise from Hunter mines.* *In 2015 Glencore barred a Muswellbrook couple from making verbal complaints and put them on a "complaints only in writing" basis, after years of complaints about noise from Mangoola mine led them to call a Glencore community manager a "bastard", and 10 months later an "idiot"."*	Newcastle Herald
Community Investment			
16 May 2018	**Muswellbrook Shire Council allocates more than $3 million towards projects in Denman**	*Mangoola Coal contributed $500,000 to Muswellbrook Shire Council for community improvement strategies. The council will allocate funds to improving Denman Main street, the Denman Memorial Hall, the Denman Geothermal baths and an RV dump point.*	Muswellbrook Chronicle
8 May 2018	**Muswellbrook residents embrace Coffee with a Cop concept**	*Mangoola Coal funded a community initiative to encourage residents to get to know their on-the-ground police officers to improve interactions between police and locals – fostering stronger community engagement and understanding.*	Muswellbrook Chronicle
6 March 2018	**Muswellbrook, Denman volunteers roll up their sleeves**	*Mangoola Coal provided helpers and resources in Denman for Clean Up Australia Day. Community volunteers and local businesses collected 60 bags of rubbish and removed a range of larger items from the environment to show support for a cleaner environment.*	Muswellbrook Chronicle
11 July 2017	**Mangoola CHPP tops up Where There's A Will's funding basket**	*The Mangoola CHPP team presented Upper Hunter-based support group, Where There's A Will, with a cheque for $6500, the proceeds of a "fire sale" with a difference. Used centrifuge baskets and conveyor belting from the CHPP were for sale offered to employees and contractors working across the open cut operation. Glencore has provided $100,000 for the WTAW organisation to undertake mental health first aid training across the Upper Hunter*	Muswellbrook Chronicle



APPENDIX E

Case Studies

Case Studies - the development of a nature and cultural trail

1. The Convict Trail

The Convict Trail Project has been in existence since the early 1990s. It was initiated by the Bucketty and Wollombi communities (population 150 and 300 respectively) due to concerns about the degradation that was occurring to relics of the convict built Great North Road. The degradation was as a result of neglect, vandalism, lack of awareness of the significance of the relics and the absence of a management or conservation plan in the area (www.convicttrail.com.au, 2019).

In the absence of an organisation or agency which was responsible for managing the Road, local community members took the initiative and began restoring damaged sites under the guidance of a historical archaeologist, and with the assistance of their local council.

Realising that similar situations were probably happening elsewhere along the 240 km Road, in 1994 the groups began to involve other organisations with an interest in, or responsibility for, conservation, management and promotion of the Great North Road. To date over 30 groups have joined the Convict Trail Project, ranging from councils, community groups, regional tourist organisations, government agencies, academic institutions and heritage organisations (www.convicttrail.com.au, 2019).

The Great North Road traverses over a dozen local government areas, including Singleton LGA, each with a responsibility for managing heritage sites in their area. Parts of the Road also come under the jurisdiction of the National Parks and Wildlife Service, and the NSW Roads and Traffic Authority. By bringing together all these organisations with a responsibility for managing the Great North Road, and a range of community groups with an interest in its conservation and promotion, the Convict Trail Project has provided a unique forum for long term management of an area of relevance and significance.

Relics such as stone retaining walls, wharves, culverts, bridges and buttresses can still be seen along the entire length of the Great North Road – in Sydney suburbs like Epping and Gladesville, at Wisemans Ferry or Wollombi, Bucketty (refer **Figure 1**) or Broke, or when walking in the Dharug and Yengo National Parks



Figure 1 The Convict Trail, Cnr Great North Road and George Downes Drive, Bucketty NSW

Source: www.visitwollombi.com.au

2. The Fernleigh Track

The Fernleigh Track is a popular shared pathway, built along a former railway line between the cities of Lake Macquarie and Newcastle. The track can be used by walkers and cyclists, however motorised travel is prohibited. Users can absorb the history of the Fernleigh Track through numerous railway relics preserved along its length. Old sleepers, signage and former stations have been adapted to create interpretational features and welcoming rest areas (refer **Figure 2**).

For an estimated 6,000 years, the area around the Fernleigh Track area was home to the Indigenous Awabakal people. They lived amongst the rich natural environment and utilised the resources of the open and rocky coastline, swamp land and hilly forests. Rail construction began in the late 1880s, and the Adamstown to Belmont railway line was opened for traffic early in the 1890s. The rail line was used to transport coal from the mines in Lake Macquarie to the port of Newcastle and the Newcastle steel works. In addition to coal haulage, a passenger service existed between Belmont and Newcastle. The trip took around one hour and was frequently used for weekend excursions from the city.

When coal transportation began to decline, the service and maintenance of the line decreased. In 1967, a switch from steam to diesel rail motors was made, before the scheduled passenger service was finally terminated in 1971. Throughout the 1980s, closures of coal mines along the line increased. After the Lambton Colliery closed in 1991, use of the line ceased completely. (Newcastle City Council, Fernleigh Track Brochure, date unknown).

Guided by the Fernleigh Track Committee the transformation from former rail corridor to community asset began in 1994, after the joint purchase of the land by the Lake Macquarie and Newcastle City Councils. In 1999, the development of a shared pathway was proposed. Funding from both Councils and the NSW State

and Federal Governments allowed construction to commence with a significant focus on restoration and preservation.

Key features of the track include:

- heritage railway relics along the track, including former stations, signage and old rail sleepers
- a restored 181-metre-long, curved rail tunnel that marks the connecting point between the cities of Lake Macquarie and Newcastle
- the track is built along a green corridor, taking in wetland, coastal and bushland environments.
- paved and gentle grading of the track for people of all fitness levels
- facilities along the pathway include numerous access points, public toilets, drinking fountains and parking, with cafés, takeaways and local shops located close by.



Figure 2 Fernleigh Loop, Adamstown - Belmont railway line, early 1970s and the present day

Source: Fernleigh Track Brochure, Newcastle City Council

3. Lundin Mining – Nurturing Economic Diversification

Lundin Mining is a diversified Canadian base metals mining company with operations in Chile, the United States of America, Portugal and Sweden, primarily producing copper, nickel and zinc. In addition, Lundin Mining holds an indirect 24 percent equity stake in the Freeport Cobalt Oy business, which includes a cobalt refinery located in Kokkola, Finland.

Lundin Mining works directly with communities to mitigate the effects of the boom-and-bust economic impact of mining. Neves-Corvo is a 28 year-old lead-copper-zinc mine in the Baixo Alentejo region of southern Portugal. For more than 30 years, the area around Neves-Corvo has continually relied on the mining economy (refer Figure 3 Neves-Corvo lead-copper-zine mine in the Baixo Alentejo region of Portugal**Figure 3**).

Working with the Lundin Foundation, Lundin Mining and Neves-Corvo are supporting and providing economic diversification projects for regional development outside of mine activities. This support focuses on empowering entrepreneurs to leverage other great assets in the region, such as nature tourism.

An opportunity was presented to Lundin Mining due to a host municipality becoming a UNESCO Biosphere in 2017. Neves Corvo has positive relationships with a Non-Government Organisation (NGO) (*Liga para a Proteção da Natureza*) that lobbied for the Biosphere and the potential for tourism linked to the Biosphere reserve (especially for birdwatching) arose. This had the potential to demonstrate that biodiversity conservation and mining can co-exist.

During April and November 2018, a participatory feasibility study was undertaken that looked at supply and demand. The supply activities included:

- individual stakeholder meetings
- a prioritisation workshop
- consensus on an integrated nature route, with complementary products e.g. walking paths, biking, birdwatching, gastronomy, old industrial and mining sites, dark sky and creative tourism
- mapping and gap analysis of existing infrastructure and resources.

The demand side analysis included:

- desktop research of the international nature tourism market
- interviews and trial-run of draft route and brand strategy by 10 national and local tourism operators working with the target market.

Implementation of the project is now underway based on a detailed 10-year feasibility plan. The project will include birdwatching, hiking, cycling, 'soft nature' (driving) trails (refer **Figure 4**) connecting key villages, with start-up funding from Lundin Foundation, an exit strategy and the establishment of a robust local association governance structure.



Figure 3 Neves-Corvo lead-copper-zine mine in the Baixo Alentejo region of Portugal

Source: Ana Maria Esteves (2019)

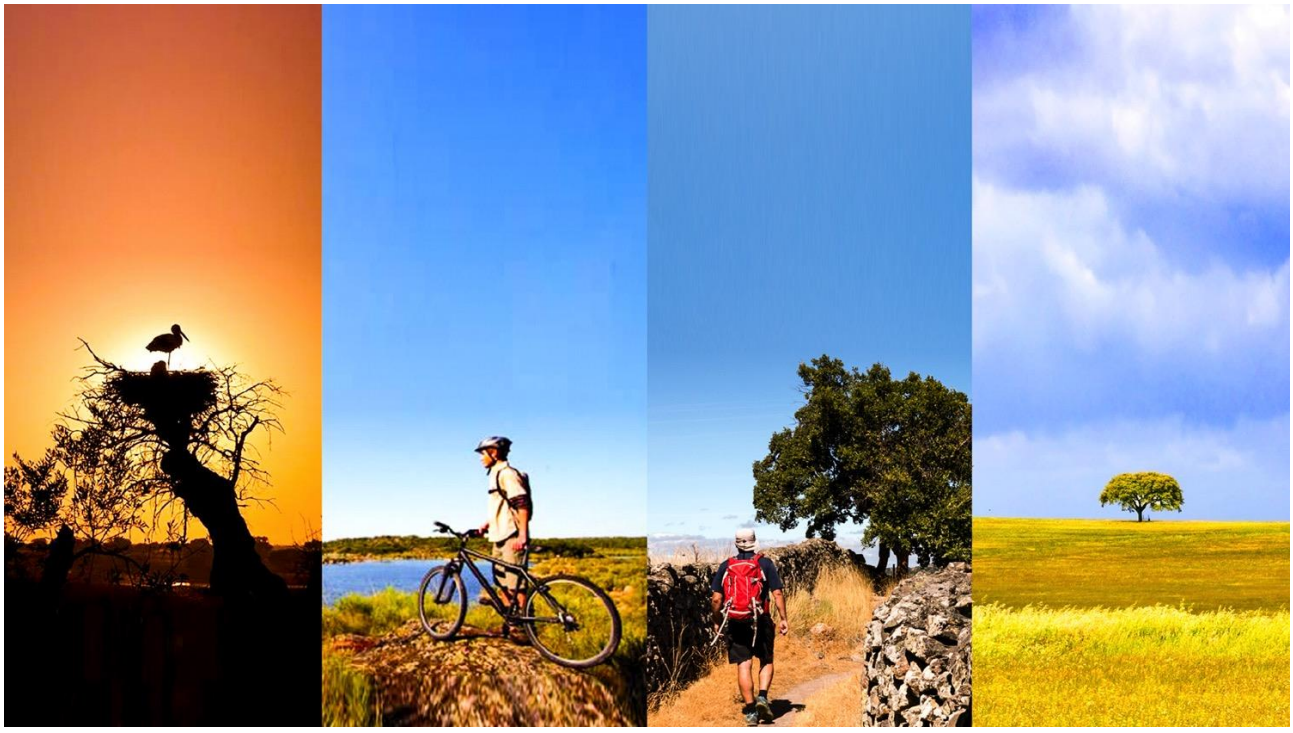


Figure 4 Birdwatching, hiking, cycling, 'soft nature' (driving) trails

Source: Ana Maria Esteves (2019)



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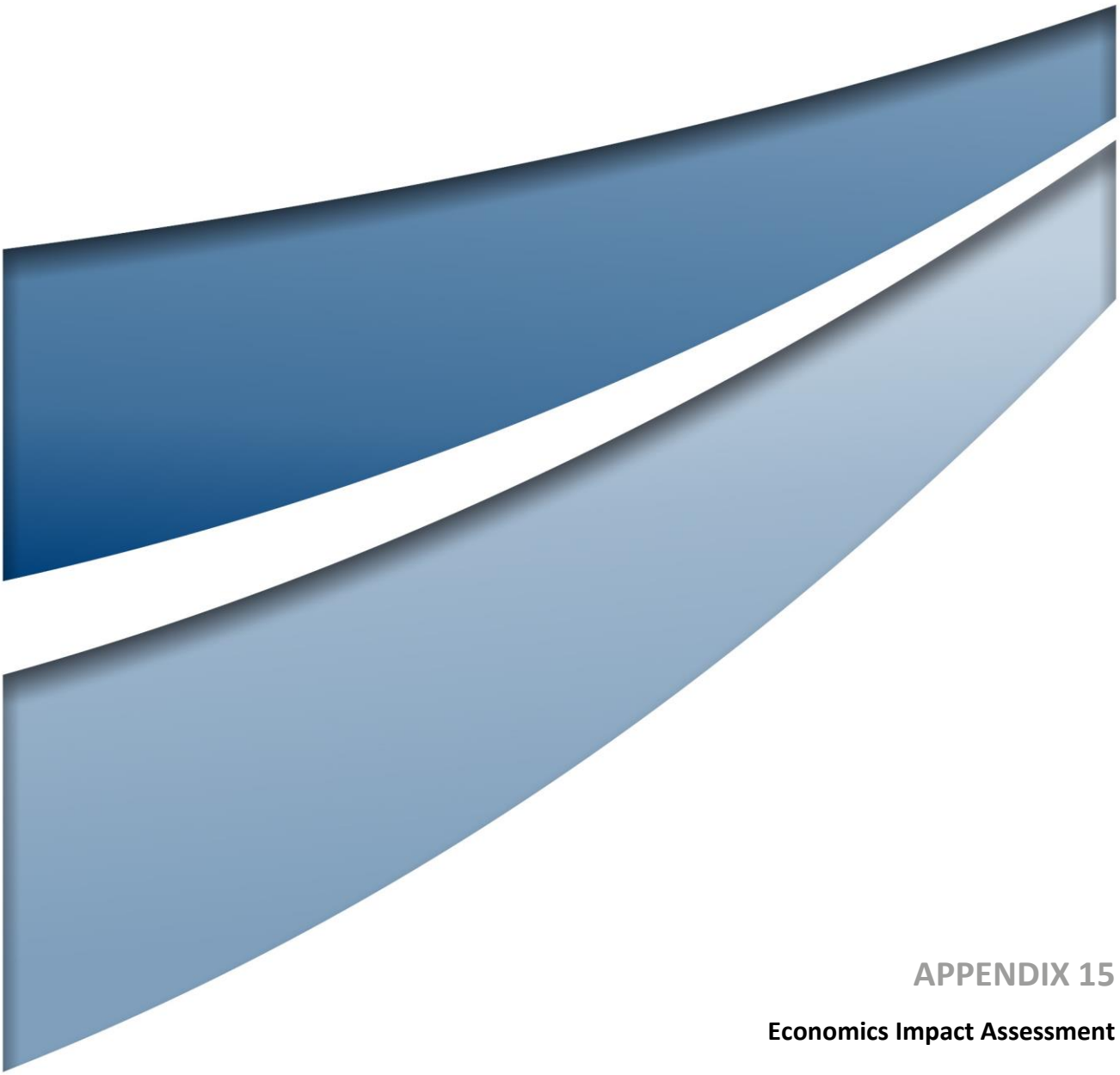

APPENDIX 15

Economics Impact Assessment

cadence|economics

ECONOMIC IMPACT ASSESSMENT OF THE BULGA OPTIMISATION PROJECT MODIFICATION 3

BULGA COAL COMPLEX

BULGA COAL MANAGEMENT PTY LTD 2019

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General reliance restriction

This report is prepared for Bulga Coal Management Pty Ltd. The purpose of this report is to provide an economic impact assessment of the Bulga Optimisation Project Modification 3 to NSW and to the local community. You should not use the advice for any other purpose. This report should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. Due to the uncertain nature of economic data, Cadence Economics does not warrant the completeness or accuracy of the analysis or estimates provided in this report.

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Executive summary

Bulga Coal Management (BCM) operates the Bulga Coal Complex (BCC), which includes both open cut and underground coal extraction operations. The open cut operations at the BCC are currently undertaken in accordance the Bulga Optimisation Project consent (SSD 4960) (Approved operations). Under current Approved operations, planned operations over the period 2019 to 2035, will extract 151.0 Mt of ROM coal.

BCM is seeking approval for the Bulga Optimisation Project Modification 3 (the Modification) to extract an additional approximately 63 Mt of ROM coal and extend operations by 4 years to approximately to 2039.

Approval for the Modification will be sought under Section 4.55(2) of the Environmental Planning & Assessment (EP&A) Act, which requires BCM to prepare a Statement of Environmental Effects (SEE) to support the Modification.

The Modification will maximise resource recovery within the currently Approved Area by extending the open-cut operations to the south east into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit. The extension of the pit to the southeast will also enable the extraction of additional deeper resources below parts of the currently approved Bulga open-cut operations.

In addition, the Modification will reduce the operating costs of the Bulga Surface Operations, through reduced stripping ratios and extend the life of the existing operation to 2039 providing for ongoing employment opportunities for the existing Bulga workforce.

Bulga Surface Operations will use existing mining facilities, including the coal handling and preparation plant and train loading facilities for the life of the operations. The Modification maximises the use of previously disturbed and previously mined areas and the approved disturbance areas, thereby minimising the additional disturbance area. The Modification will not impact the Bulga Underground Operations, which are currently in care and maintenance.

This analysis

BCM has provided Cadence Economics with the information required to complete an economic analysis of the Modification. This data includes capital costs, employment and the costs to mitigate against potential environmental impacts. In addition, BCM has provided the project physicals for the Modification to estimate extraction costs. The extraction costs have been estimated using the econometric modelling outlined by Shafiee (2009). The Shafiee modelling estimates the extraction costs as a function of the deposit average thickness, the stripping ratio, capital costs and the daily production rate.

This report provides an Economic Impact Assessment (EIA) for the Modification and follows the economic assessment framework set out in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the New South Wales (NSW) Government in December 2015.

In addition, the Guidelines requires an estimate of the potential costs generated by the Modification. These costs may include residual public infrastructure costs and environmental, social and transport-related costs.

To estimate the environmental, social and transport-related costs, the EIA uses the methods outlined in the *Technical Notes supporting the guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*.[1]

Consistent with these Guidelines, the EIA includes a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA). The CBA provides an estimate of the net benefits of the Modification to NSW. The LEA is based on analysis for the Lower Hunter region (as defined by the Australian Bureau of Statistics SA3 10604 region).

Results of the CBA

The Modification is estimated to provide a net benefit to NSW.

This net benefit is estimated to be $410.6 million in net present value (NPV)[2] terms, as shown in Figure 1. This net benefit is comprised of $195.4 million and $215.2 million in direct and indirect benefits respectively. Indirect costs of the Modification are $0.02 million.

These estimates are based on central case assumptions in relation to the proposed $145.3 million capital expenditure in NPV terms and average real coal prices of $139.2 and $95.2 Australian dollars per tonne of semi soft coking coal and thermal coal respectively.

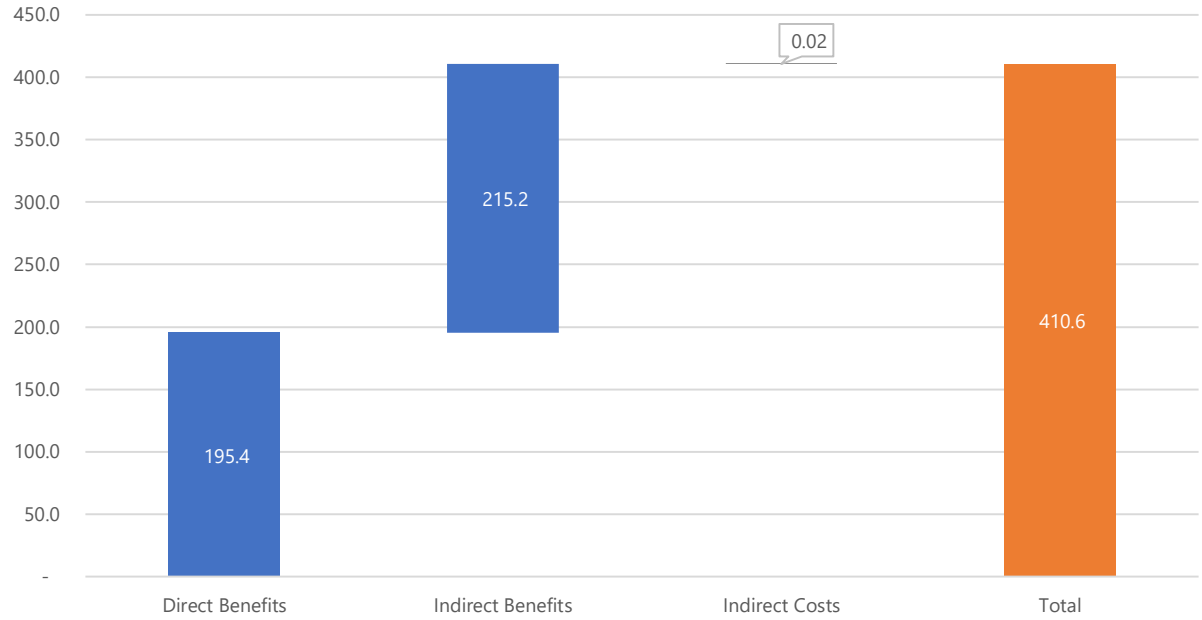
The ***direct benefits*** of the Modification are a function of its profitability which, in turn, depends on the prevailing coal price. The analysis shows that the combination of relatively low capital requirement, extraction and processing costs underpins the economic viability of the Modification. As a result, the Modification is predicted to generate:

- Total corporate taxes of $231.6 million in NPV terms for Australia, of which $74.5 million is attributed to NSW; and
- $120.9 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $104.5 million, Council rates and land taxes of $1.2 million and net payroll taxes of $15.2 million.

[1] Department of Planning and Environment (2018)

[2] All NPV figures reported are in 2019 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

Figure 1: CBA summary of net benefits under central case assumptions, ($ million NPV*)



* Net Present Value in 2019 Australian dollars calculated over the period 2019 to 2039 using a 7 per cent real discount rate.
Source: Cadence Economics estimates based on the Environmental Impact Statement. and information provided by BCM.

The ***indirect benefits*** of the Modification are related to the linkages that it will have to the NSW economy through both the labour market and suppliers. The analysis shows that of the $215.2 million in estimated indirect benefits:

- Worker benefits are estimated to be $164.9 million in NPV terms, additional ongoing employment attributable to the Modification of 700 FTE workers for approximately 4 years; and
- Supplier benefits are estimated to be $50.3 million in NPV terms based on total supplier inputs over the life of the Modification of $287.2 million.

The ***indirect costs*** are related to the costs borne on the NSW community through the generation of externalities by the Modification. The incremental costs of the Modification are related to greenhouse gas emissions ($0.02 million in NPV terms). As outlined in the report, other environmental costs are included in the operational costs of the Modification.

Consistent with the Guidelines, systematic sensitivity analysis of the estimated net benefits is undertaken in this report. This sensitivity analysis shows that the estimated net benefits are ***robust*** in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

In isolation, the estimated net benefit of the Modification is most sensitive to the coal price assumptions, but even assuming coal prices are 25 per cent lower than under the central case assumptions the net benefits are estimated at $354.9 million in NPV terms.

The lower bound estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits, yields an estimated net benefit of $319.1 million in NPV terms.

The upper bound estimate of net benefits, based on the most optimistic assumptions, is $480.4 million in NPV terms.

Results of the LEA

The LEA considers the costs and benefits of the Modification on residents of the Lower Hunter region of NSW. The analysis shows an estimated net benefit of $81.3 million to the region in NPV terms. This is driven largely by:

- Benefits to local workers of $64.7 million in NPV terms based on BCM employment data that 39 per cent of the mine's direct employees continue to be drawn from the region;
- Benefits to local suppliers of $15.4 million in NPV terms which is based on information from BCM that 27 per cent of the inputs to production are suppled from the region; and
- The payment of local council rates totalling $1.2 million in NPV terms.

Again, the report shows that the estimated local effects are **robust** under the sensitivity analysis conducted with a lower bound estimate of net benefits of $86.3 million and upper bound estimate of $67.3 million in NPV terms.

Economy-wide modelling of the Modification

In total the Modification is projected to provide significant positive economy-wide impacts to both the Lower Hunter SA3 and to NSW. The net economic impacts of the Modification are shown in Table 1. In the Lower Hunter region, the Modification is projected to increase GRP by $746.1 million in NPV terms. GRI or regional welfare, is projected to increase by $737.6 million in NPV terms. The projected increase in GRI is significant to the relatively small Lower Hunter region. In total, the Project is projected to increase welfare for each person in the Lower Hunter by $6,498 in NPV terms.

For NSW, the projected increase in GSP is $885.5 million in NPV terms. GSI is projected to increase by $1,414.7 million.

Table 1: Project economy-wide impacts of the Project, 2019 – 2039

Variable	Description	Lower Hunter	NSW Total
Real GRP/GSP^	NPV* - $m	746.1	885.5
Real GRI/GSI^	NPV* - $m	737.6	1,414.7
Employment	Average - FTE^^	196.1	221.1
Real Wages	Average – Per cent^^	0.99	0.013
Real GRI per person^	NPV* - Dollars	$6,498	$138

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2019 to 2039.

Total employment in the Lower Hunter region is projected to increase by almost 196.1 FTE workers on average, across NSW, employment is projected to increase by 221.1 FTE.

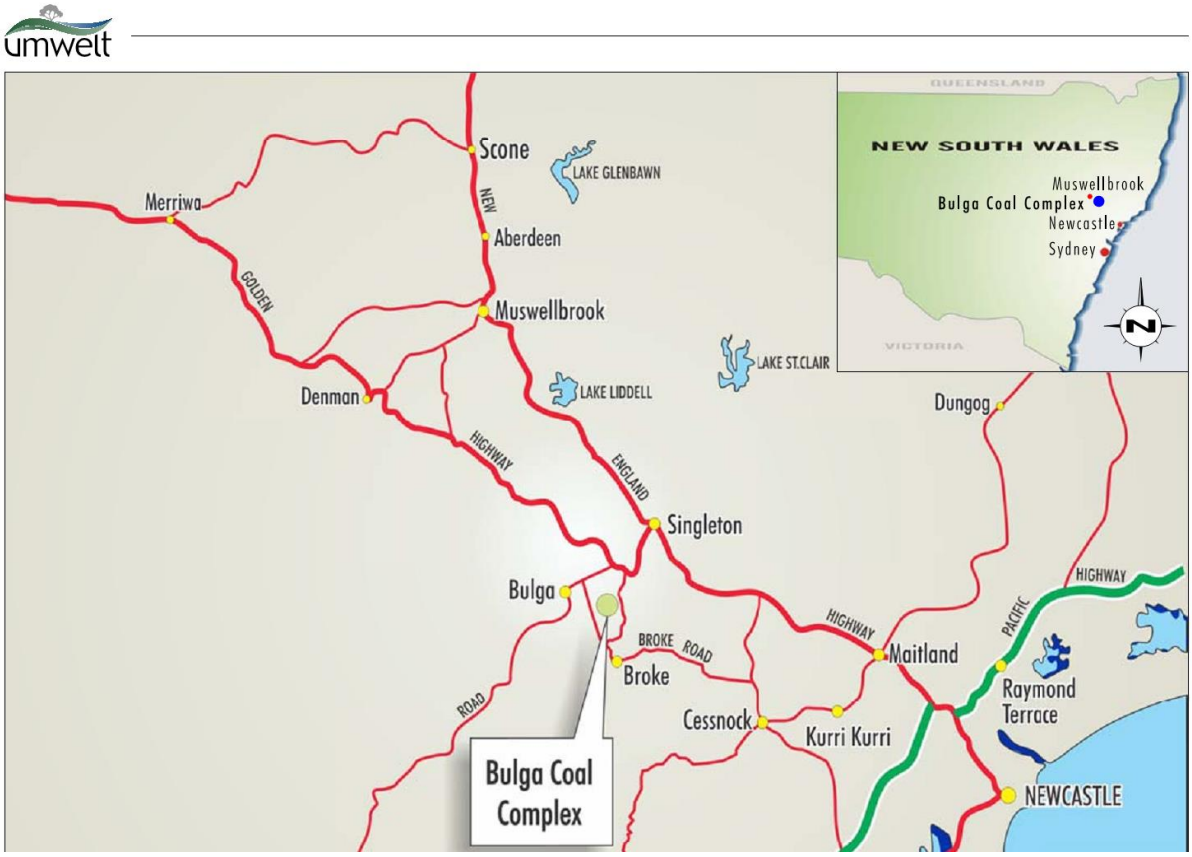
As outlined in Chapter 4 the Computable General Equilibrium (CGE) modelling takes into account the capital expenditure, the coal output, the migration of workers into the region and the payment of royalties from the Lower Hunter into the Rest of NSW and the repatriation of profits overseas.

1 Introduction

Cadence Economics was commissioned by Bulga Coal Management Pty Ltd (BCM) to undertake an Economic Impact Assessment (EIA) of the Bulga Optimisation Project Modification 3 (the Modification). BCM operates the Bulga Coal Complex (BCC) on behalf of the Bulga Joint Venture, which consist of Glencore plc and other 100% foreign owned companies, including JX Nippon Oil & Energy (Australia) Pty Limited and Nippon Steel Australia.

The BCC consists of two existing coal mining operations: the open cut operations (Bulga Surface Operations) and the underground operations (Bulga Underground Operations). The BCC is located approximately 4 kilometres (km) to the south-east of the Bulga township, approximately 4 kilometres to the north of Broke and is approximately 15 kilometres south-west of Singleton (see Figure 2).

Figure 2: Bulga Coal Complex



Source: Umwelt

Open cut mining was approved at the BCC in 1981 and has been carried out since 1982. BCM was granted approval for the Bulga Optimisation Project (SSD 4960) on 1 December 2014 which allowed ongoing operation of the Bulga Surface Operations until 31 December 2035. SSD 4960 has subsequently been modified twice since it was approved, SSD 4960 Mod 1 in January 2017 to facilitate a revised Eastern Emplacement Area (EEA) design and a revised tailing management strategy, and SSD 4960 Mod 2 in August 2018 to extend the period to complete the outer face of the Noise and Visual Bund.

1.1 The Modification

Open-cut operations at the BCC are currently undertaken in accordance the Bulga Optimisation Project consent (SSD 4960) (Approved operations). Over the period 2019 to 2035, Approved operations will see 151 Mt of ROM coal extracted. The Modification will seek approval to extract approximately 63 Mt of additional ROM coal resources extending the mining life by approximately 4 years to 2039.

Approval for the Modification will be sought under Section 4.55(2) of the Environmental Planning & Assessment (EP&A) Act, which requires BCM to prepare a Statement of Environmental Effects (SEE) to support the Modification.

The Modification will maximise resource recovery within the currently Approved Area by extending the open cut operations to the south east into a former open cut mining area occupied by the current Tailings Storage Facilities (TSF) known as Deep Pit and Bayswater Pit. The extension of the pit to the southeast will also enable additional deeper resources below parts of the currently approved Bulga open cut to be extracted.

In addition, the Modification will reduce the operating costs of the Bulga Surface Operations, through reduced stripping ratios and extend the life of the existing operation to 2039 providing for ongoing employment opportunities for the existing Bulga workforce.

Bulga Surface Operations will continue to utilise the existing mining facilities, including the coal handling and preparation plant (CHPP) and train loading facilities for the life of the operations. The Modification maximises the use of previously disturbed and previously mined areas and the approved disturbance areas, thereby minimising the additional disturbance area. The Modification will not impact the Bulga Underground Operations, which are currently suspended.

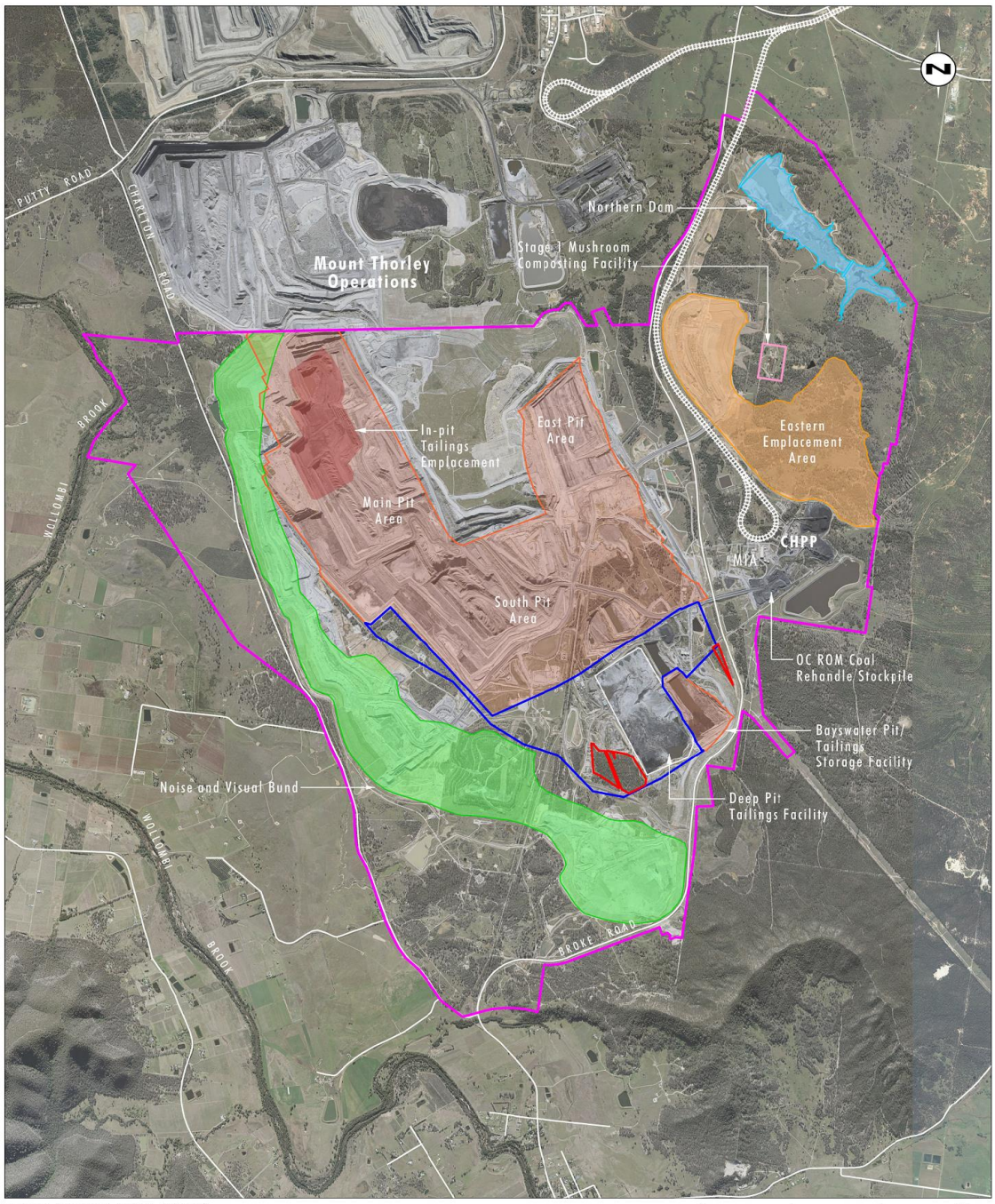
The optimisation of productivity from the existing infrastructure will assist to minimise impacts. The modification generally comprises:

- open cut mining at up to the same rate as that currently approved (12.2 Million tonnes per annum (Mtpa) of ROM coal) using truck and excavator mining methods;
- The extension is required to access additional resources in the proposed extension area, as well as accessing deeper resources within the currently approved mining area, as shown in Figure 3;
- an additional disturbance of 20.2 hectares within the proposed extension area;
- utilisation of existing coal handling and coal processing infrastructure located in the eastern extent of the Project Area;
- removal and relocation of the tailings material currently stored in the existing Tailings Storage Facility (TSF) to the Main Pit TSF. The capacity of the currently approved Main Pit TSF will be expanded to receive the relocated tailings;
- construction of infrastructure associated with the relocation of tailings from the existing Deep Pit and Bayswater Pit tailings facilities and reprocessing infrastructure;
- relocation of infrastructure servicing the open cut and underground operations including workshops, gas infrastructure, fuel and oil storage;
- construction of new water management facilities to manage site surface water catchments; and

- the use of all existing or approved infrastructure and equipment for the BCC with some minor additions to the existing mobile equipment fleet over the life of the operations.

Figure 3: Key features of the proposed Modification

umwelt



Source: Umwelt

A detailed assessment of the likely economic impacts of the development was undertaken, paying particular attention to the:

- Significance of the resource;
- Costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW; and
- Demand for the provision of local infrastructure and services.

This EIA is based on a cost benefit analysis (CBA) and local effects analysis (LEA) prepared under the framework established in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the New South Wales (NSW) Government in December 2015.[3] The CBA requires an assessment of the net benefits that accrue to the proponent, government, workers and suppliers of the Modification.

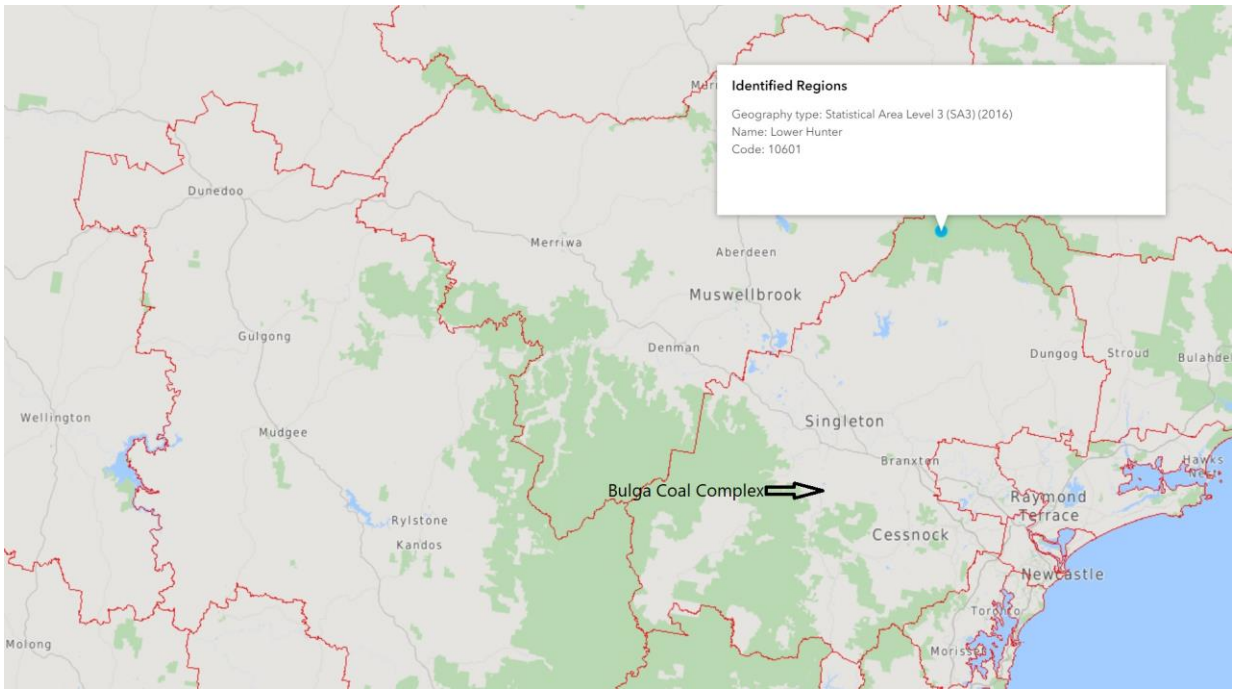
In addition, the Guidelines require an estimate of the potential costs generated by the Modification. These costs may include residual public infrastructure costs and environmental, social and transport-related costs. To estimate the environmental, social and transport-related costs, we have incorporated into our analysis the *Technical Notes supporting the guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*.[4]

The CBA presented in Chapter 2 measures the net benefits of the Modification to the NSW community. The LEA, which focusses on the benefits accruing to the region (the Lower Hunter Statistical Area, as defined by the Australian Bureau of Statistics), is presented in Chapter 3. In addition to the CBA and LEA, the report also contains an assessment of the economic impacts of the Modification on the region based on computable general equilibrium (CGE) modelling. This modelling is presented in Chapter 4.

[3] New South Wales Government (2015).

[4] Department of Planning and Environment (2018)

Figure 4: Lower Hunter SA3



Source: Australian Bureau of Statistics, MapData Services, stat.abs.gov.au/itt/r.jsp?ABSMaps

2 Cost-Benefit Analysis

The Guidelines set out the CBA framework to measure the net benefits of the Modification to the NSW community. Table 2 provides a summary of how these net benefits are measured.

Table 2: Cost Benefit Analysis framework as defined in the Guidelines

Direct Benefits	Indirect Benefits	Indirect Costs
The net benefits that accrue to NSW from the direct operations of the proposed mine	The net benefits that are generated for parties that economically interact with the proposed mine	Social costs generated by the proposed mine, borne by the NSW community
Includes: • Net producer surplus attributable to NSW • Royalties payable • Company tax attributable to NSW	Includes: • Net economic benefits to landowners • Net economics benefits to NSW employees • Net economic benefits to NSW suppliers	Includes: • Net environmental, social and transport-related costs • Net public infrastructure costs • Loss of surplus to other industries

Source: NSW Government (2015).

The direct benefits are those that accrue to the proponent in terms of both producer surplus and payments made to government that can be attributed to NSW.

The indirect benefits are those that accrue to economic agents that engage with the project proponent. These include employees, suppliers and land owners.

The indirect costs are the costs borne by the community of NSW, through environmental and social impacts or public infrastructure costs.

The data inputs for the analysis presented in this report are derived primarily from:

- Financial and other information provided by BCM, which includes the Modification physicals, ROM coal, saleable coal by type and relative quality, operating and capital costs and employment.
- Assessment findings arising from the Statement of Environment Effects (SEE) prepared by Umwelt and various environmental technical consultant reports including the:
    - Greenhouse Gas and Energy Assessment (GGA) undertaken by Umwelt in the *Greenhouse Gas and Energy Assessment Bulga Optimisation Project Modification 3 (DRAFT)* (January 2019).
    - Air Quality Impact Assessment (AQA), by Jacobs, *Bulga Coal Complex Modification 3 Air Quality Impact Assessment (DRAFT)* (January 2019).
    - Biodiversity Assessment Report (BAR), by Umwelt, *Bulga Optimisation Project Modification (DRAFT)*, (January 2019).
    - Aboriginal Cultural Heritage Assessment (ACHA), by Ozark EHM, *Aboriginal Cultural Heritage Assessment Bulga Optimisation Project Modification 3 (DRAFT)*, (February 2019).
    - Noise Impact Assessment (NIA), by Global Acoustics, *Bulga Extension Project Noise Impact Assessment* (March 2019).

    - Groundwater Impact Assessment, by Klohn Crippen Berger *Groundwater impact Assessment Bulga Optimisation Project Modification 3 (DRAFT)*, (February 2019).
    - Surface Water Impact Assessment, by Engeny Water Management *Bulga Extensions Project Surface Water Impact Assessment* (April 2019).
- SEE and the Social Impact Assessment, where standalone technical reports were not conducted including visual impact assessment and the traffic and transport assessment.
- *Energy & Metals Consensus Forecast*, March 2019, Consensus Economics.
- *Resources and Energy Quarterly* (June 2018), Office of Chief Economics, Department of Industry, innovation and Science.
- Various data from the Australian Bureau of Statistics (ABS) including most recent Census data.

The information underpinning this assessment therefore is a combination of publicly available information and commissioned expert studies assessing the environmental impacts of the Modification.

Cadence Economics has not verified the information in the studies provided as they have been prepared by relevant experts in the field. Where there is uncertainty around key assumptions, such as the coal price, sensitivity analysis has been conducted to test the robustness of the assessment to these key assumptions.

As outlined above BCM has provided Cadence Economics with operating costs, which includes the cost of extraction, processing, distribution and selling, overheads, decommissioning, rehabilitation and the cost of environmental management for the Approved and Modification cases.

BCM advised that extraction, processing and distribution and selling and overheads were confidential. To estimate these costs, we have taken the approach that has been used in other open cut operations in NSW. The extraction costs have been estimated using the econometric modelling outlined by Shafiee (2009). This modelling estimates the extraction costs as a function of the deposit average thickness, the stripping ratio, capital costs and the daily production rate. To estimate the extraction costs, BCM provided the mine physicals information required to estimate the extraction costs.

In our view, the Shafiee econometric model confirmed the confidential financial information provided by BCM, that the Modification case has lower extraction costs in comparison to the Approved operations. This is largely driven by the lower stripping ratios for the Modification case. The current Approved operations have a stripping ratio of 11.7 (tonnes of overburden per tonne of ROM coal), compared to 10.0 for the Modification. On average the extraction costs for the Approved operations is $33.50 per ROM tonne, compared to $29.70 for the Modification.

To estimate the free-on-board (FOB) costs the following assumption were made:

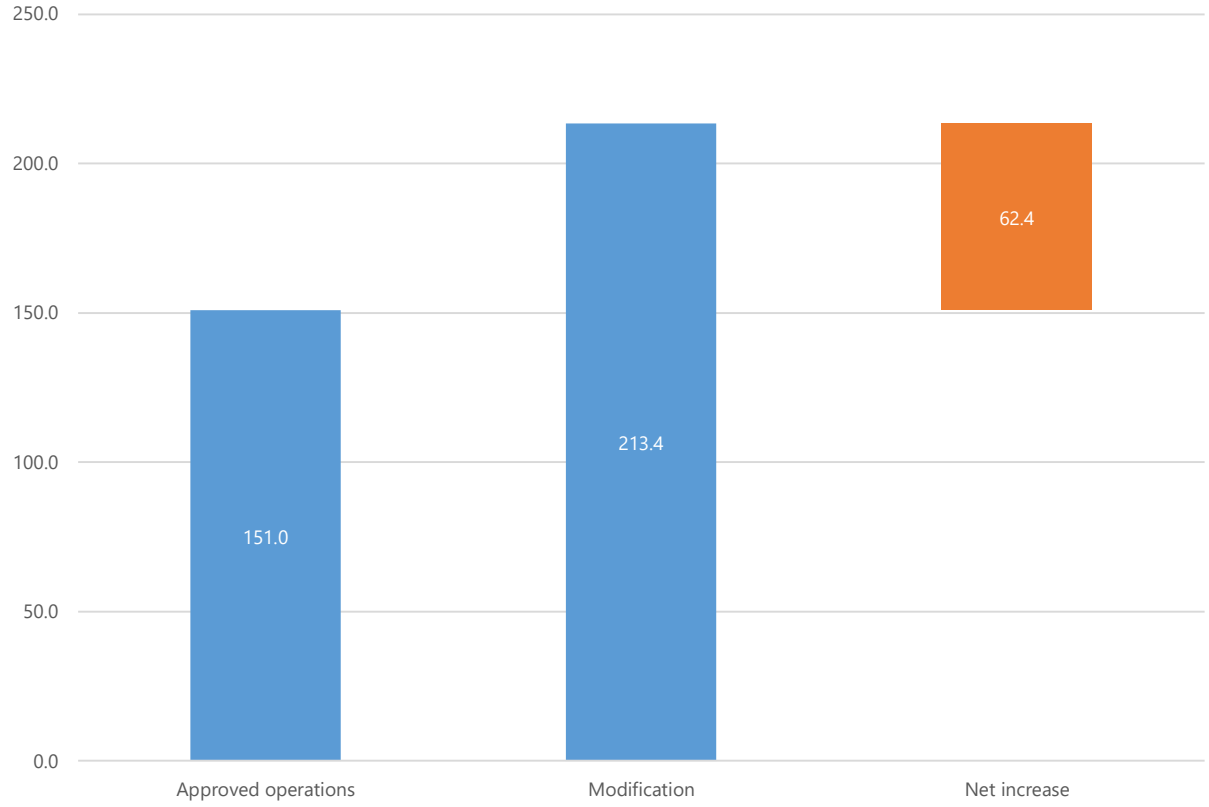
- CHPP costs of $6.60 per product tonne.
- Overheads $5.30 per product tonne.
- Distribution and selling expenses of $10.60 per product tonne.

These costs are similar to those used in previous economic assessment for Glencore-controlled mines and have been adopted with guidance from BCM.

2.1 Approved operations, the Modification and net output

To evaluate the net benefits of the Modification, the economic analysis needs to consider the counterfactual or baseline operations. In this case the counterfactual is the Approved operations of the Bulga Surface Operations. The Approved operations are planned to extract 151.0 Mt of ROM coal over the period 2019 to 2035. This baseline activity will generate potential costs and benefits and should be excluded from the analysis. The Modification seek to extract 213.4 Mt of ROM coal over the period 2019 to 2039, or 62.4 Mt of additional ROM coal, as summarised in Figure 5

Figure 5: Approved operations, Approval case, and net increase ROM coal output (Mt)



Source: Data provided by BCM

2.2 Modification – central case assumptions

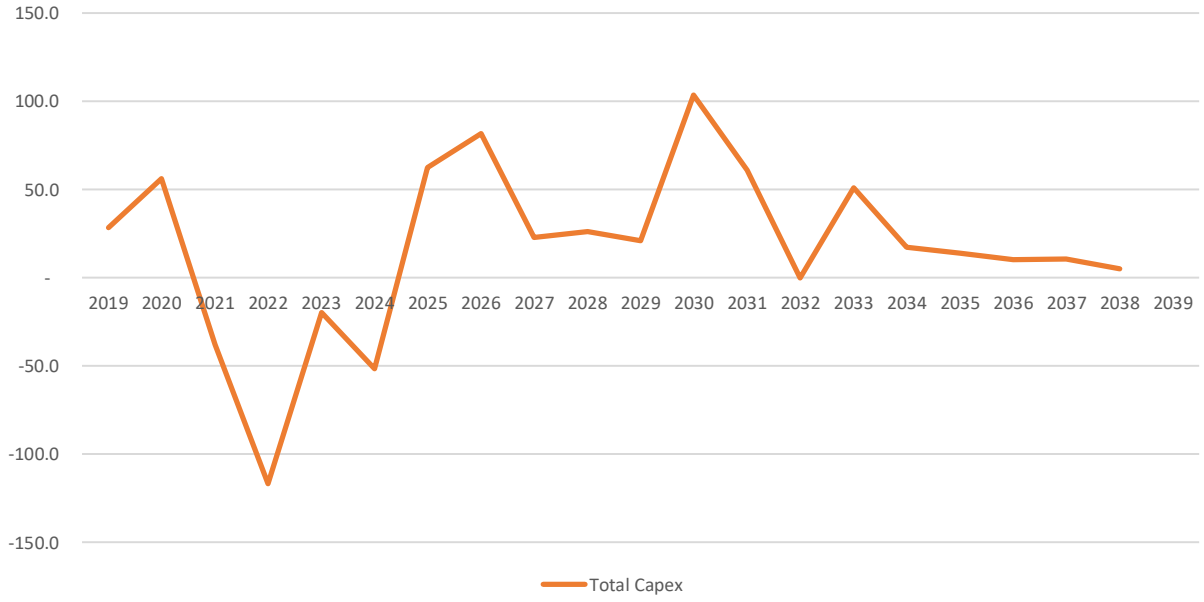
The following analysis sets out the financial assumptions underpinning the Modification, including the capital expenditure, the output and price assumptions and the operating cost assumptions, including labour input costs and intermediate inputs. These assumptions are used to estimate the direct and indirect benefits to NSW, and also form the basis of the LEA presented later in the report.

2.2.1 Capital costs

BCM provided Cadence Economics with the capital expenditure profile of both the Approved operations and Modification case. In net terms, the Modification will require $145.3 million (in NPV terms) of capital expenditure over the period 2019 to 2038, or $343.8 million undiscounted. Figure 6, provides a summary of capital expenditure.

The Modification case allows for the delay of capital expenditure compared to the Approved operations. Over the period, 2021 and 2024, the net capital expenditure of the Modification is lower than the Approved operations, beyond 2025 net capital expenditure increases, peaking at just over $103 million in 2030.

Figure 6: Modification - Capital expenditure, 2019 – 2039 (2019 dollars)



Source: Data provided by BCM

The operations of the Modification will also be supported by capital that is currently in-use, including the site administration office, workshop and warehouse and the utilisation of existing coal handling and coal processing infrastructure located in the eastern extent of the Project Area.

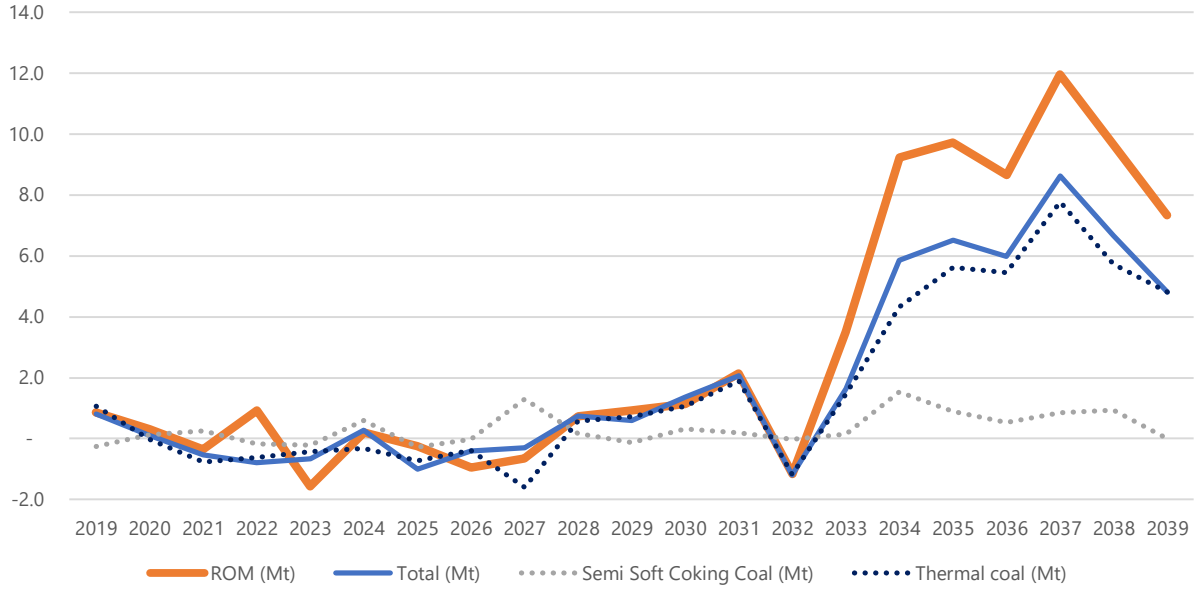
2.2.2 Production assumptions

In net terms, the Modification will generate 62.4 Mt of additional ROM coal, 41.2 Mt of additional saleable coal. Most of the additional sales are from 2034, as outlined in Figure 7.

In some years of the Modification, saleable coal is actually lower than the currently Approved operations, this is driven by a number of factors, including mine plan prioritisation and pit yield, such as 2022.

Most of the additional sales, 34.4 Mt is of thermal coal, where the remaining, 6.8 Mt is of semi-soft coking coal.

Figure 7: Key production figures under the Modification (Mt)



Source: Data provided by BCM

2.2.3 Price assumptions

BCM did not provide Cadence Economics with its internal price forecasts for the two coal outputs, thermal coal and semi-soft coking coal (due to the commercial sensitivity of this information). Over the life of the Modification, BCM advised Cadence Economics that;

- semi soft coking coal sells for 77 per cent of the hard coking coal reference price; and,
- thermal coal sells for an average discount of $2.29 (real 2019 Australian dollars) from the reference price.

This information was used along with information from Consensus Economics and the Office to Chief Economist to estimate the coal price assumptions.

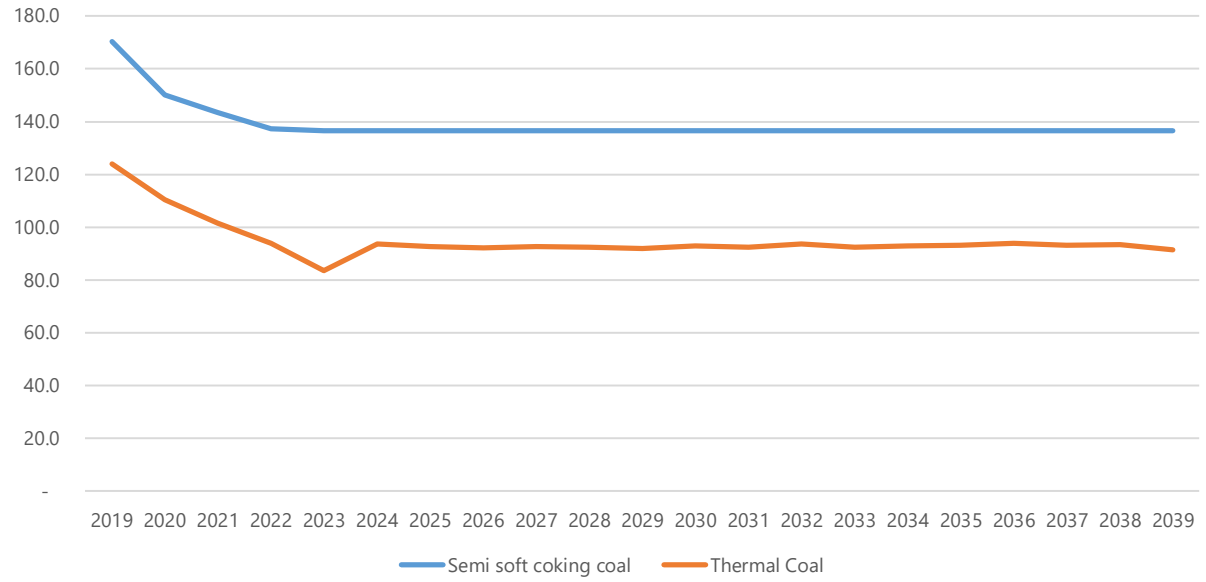
Consensus Economics (March 2019) publish a thermal price forecast in nominal US dollars out to 2028. The nominal US dollar thermal coal price forecast is converted to real 2019 Australian dollars. The conversion is completed using the exchange rate and inflation rate forecasts from *Resources and Energy Quarterly* (June 2018) produced by the Office of the Chief Economist Department of Innovation and Science Resources and Energy. The *Resources and Energy Quarterly* (June 2018) publication forecasts exchange rates and inflation out to 2023. Beyond 2023, we assume both exchange rates and inflation remain at the 2023 Department of Industry forecast.

Over the life of the Modification, the modelling assumes an exchange rate of $0.79 US dollars per Australian dollar and an inflation rate of 2.4 per cent.

Figure 8 provides an account of the prices used for the economic analysis. On average, over the life of the Modification the thermal coal price is $95.2 dollars per tonne. The price peaks in 2019 at $123.9

declining to about $93 per tonne from 2024. On average, the semi soft coking coal price is $139.2 dollars per tonne. The price peaks in 2019 at $170.3 declining to about $136.6 per tonne from 2024.

Figure 8: Bulga Modification, output prices, real 2019 Australian dollars, 2019 to 2039



Source: Cadence Economics estimates

2.3 Projected revenue and Modification financials

Based on the production assumptions outlined in Figure 7 and the real price assumptions in Figure 8, the Modification is expected to generate additional real revenue of just over $4,152.6 million over the 20 years in undiscounted 2019 Australian dollars. This equates to $1,319.4 million real revenue in NPV terms based on a 7 per cent real discount rate as shown in Table 3. In the context of this analysis, these are deemed to be ***central case assumptions***, and subject to sensitivity analysis.

Table 3: Central case assumptions – coal production, real prices^ and total revenue

	Total	2022	2026	2028	2037
Production (Mt)					
Semi soft coking coal		-0.2	0.0	0.2	0.9
Thermal coal		-0.6	-0.4	0.6	7.8
Real price (2019 Australian dollars)					
Semi soft coking coal		137.2	136.6	136.6	136.6
Thermal coal		93.8	92.3	92.4	93.1
Total Sales Revenue	4,152.6	-80.9	-37.6	77.3	841.1
Total Sales Revenue - NPV	1,319.4				

Source: Cadence Economics estimates ^ Real prices in 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

Based on information provided by BCM, the incremental operating costs of the Modification are summarised in Table 4. Total costs are, $769.3 million, which includes operating costs of $565.3 million in NPV terms. The year-on-year revenue and operating costs are driven by a number of factors, including saleable coal yields, and the relative cost of operation of the Modification compared to the

Approved operations. In 2022, the saleable coal yield is lower for the Modification case compared to the Approved operations, as a result revenue is lower, while total operating costs are slightly higher. In 2026, both revenue and costs are lower, as a result of the lower output in the Modification case.

After the Approved operations end, the additional coal sales attributable to the Modification increase significantly, peaking in 2037 at $841.1 million.

Royalties are based on standard NSW Government royalty rates of 8.2 per cent ad valorem for open cut mines. A discount of $3.50 per ROM tonne is applied for washing as is allowed by the NSW Government. The Modification includes $39.2 million in NPV terms to reduce the potential environmental cost of the operations.

The Modification has several cost items where approval will delay costs, resulting in a reduction of costs in NPV terms. For example, decommissioning costs are $6.6 million lower under the Modification case compared to the Approved operations. Over the life of the Modification, rehabilitation costs increase by $38.2 million in NPV terms, although these cost are delayed from 2034 to beyond 2039.

Based on this data, the Modification is estimated to generate $593.7 million in profit in NPV terms. These are deemed to be ***central case assumptions***, and subject to sensitivity analysis.

Table 4: Central case assumptions – Modification project financials ($ million^)

	NPV	2022	2026	2028	2037	2040
Revenue						
Revenue from coal sales	1319.43	-80.9	-37.6	77.3	841.1	0.0
Residual value of capital	43.59	0.0	0.0	0.0	0.0	0.0
Total Revenue	1363.02	-80.9	-37.6	77.3	841.1	0.0
Costs						
Operating	565.32	3.9	-69.6	12.7	428.1	0.0
Royalties	104.55	-6.4	-3.0	6.1	66.5	0.0
Decommissioning	-6.56	0.0	-0.9	-1.2	-0.1	23.5
Rehabilitation	38.23	1.4	3.4	2.9	5.0	35.0
Management, Monitoring and Mitigation	39.20	2.3	0.0	1.0	16.0	0.0
Council rates	1.19	0.0	0.0	0.0	0.6	0.0
Depreciation	27.22	-13.7	-41.9	-22.6	34.5	0.0
Contribution of planning agreements	0.13	0.0	0.0	0.0	0.1	0.0
Total costs	769.29	-12.6	-112.0	-1.0	550.7	58.4
Profit	593.74	-68.3	74.4	78.3	290.4	-58.4

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. ^^ Includes intermediate inputs and labour costs, * NPV in 2019 Australian dollars based on a 7 percent real discount rate.

2.4 Direct Benefits

Based on the Guidelines, the direct benefits to NSW of the Modification are derived from three sources:

- The net producer surplus generated by the Modification that is attributable to NSW (estimated using **cash** outlays and revenues).

- The share of company tax payments that are attributable to NSW.
- Other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

Each of these direct benefits are dealt with below.

2.4.1 Net producer surplus attributable to NSW

Consistent with the Guidelines, the net producer surplus of the Modification represents the private benefit, or operating surplus, generated that is attributable to NSW.

The Modification is estimated to generate an operating surplus of $475.7 million in NPV terms, see Table 5. The operating surplus is estimated using cash earnings and cash cost – cash costs are made up of both capital expenditure and operating costs (excluding depreciation). As outlined in the section below, $231.6 million in NPV terms is payable in the form of corporate taxes, leaving a net producer surplus of $244.1 million in NPV terms.

In this case, the net producer surplus that is attributable to NSW is assumed to be zero, as it is 100 per cent foreign owned. The majority is owned by Glencore PLC which is a foreign company (listed on the London, Hong Kong and South African exchanges). While it is possible that NSW residents have some ownership of these shares, it is not possible to ascertain the level of this ownership (which is, in all likelihood, relatively small).

Table 5: Central case - estimate of net producer surplus attributable to NSW ($ million^)

Key data	NPV*
Total revenue	1,363.02
Cash costs	887.35
Operating surplus	475.7
Company tax^^	231.6
Net Producer Surplus	244.1
NSW share of Project ownership	0%
Value of net producer surplus attributable to NSW	-

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. ^^ Based on a 30 per cent company tax rate. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.4.2 Company tax attributable to NSW

Consistent with the Guidelines, the company tax payments made to the Australian Government are levied on the profits generated for the Modification as summarised in Table 6. A company tax rate of 30 per cent is used to estimate the tax payments made to the Australian Government under the assumption that all the profit generated by the mine is subject to company tax in Australia (for example, ignoring financing costs).

Consistent with the Guidelines, company tax is attributable to NSW is based on the State's share of the national population, which is 32 per cent.

As summarised in Table 6, it is estimated the Modification will generate $593.7 million in total profit in NPV terms over the period 2019 to 2039. At a company tax rate of 30 percent, the company tax estimate is $231.6 million in NPV terms, of which $74.5 million is attributable to NSW.

Table 6: Central case - company income tax attributable to NSW ($ million^)

Company tax attributable to NSW	NPV*
Total profit	593.7
Company tax^^	231.6
NSW Share^^^	74.5

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. ^^ Based on a 30 per cent company tax rate. ^^^ Based on a 32 per cent population share. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.4.3 Payments to the State and the local Council

Under the Modification, various payments will be made to the NSW Government and Singleton Council to extract and process coal in the State.

These are made up of three types of payments: coal mining royalties and payroll tax paid to the NSW Government and council rates paid to the Singleton Council. Over the life of the Modification, a total of $120.9 million in payments are made, in NPV terms, see Table 7. This is comprised of $104.5 million of royalty payments and $15.2 million in net payroll tax. A further $1.2 million is paid in the form of council rates.

Table 7: Central case - total payments to State government and local Council ($ million^)

Corporations tax paid to NSW	NPV*
Coal sales revenue	1,319.4
Total Royalties paid	104.5
Payroll tax	15.2
Council rates and land tax	1.2
Total Payments	120.9

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

The Modification will also generate further, voluntary planning agreements (VPA), payments of $0.1 million in NPV terms. These payments are made by BCM to Singleton Council to manage and mitigate against potential costs to Council-maintained infrastructure like roads. As a result, the VPA is excluded from the benefits analysis above.

2.4.4 Summary of direct benefits to NSW

Based on the central case assumptions, revenue and cost data described above, the Modification is estimated to generate $195.4 million in total direct Benefits to NSW in NPV terms, as outlined in Table 8. These benefits are comprised of $74.5 million in company tax attributable to NSW and $120.9 million in NPV terms paid to the State government and Singleton Council, in the form of coal royalties, payroll tax, council rates and land taxes.

Table 8: Central case - summary of the direct benefits of the Project ($ million^)

Net financial benefit	NPV*
Net producer surplus attributable to NSW	-
Company income tax attributable to NSW	74.5
Payments to the NSW and local Government	120.9
Total financial benefit attributable to NSW	195.4

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.5 Indirect Benefits to NSW

Based on the Guidelines, the indirect benefits to NSW of the Modification are derived from three sources:

- The net economic benefit to workers in NSW.
- The net economic benefit to suppliers in NSW.
- Any land owner premiums attributable to the project.

2.5.1 Benefit to workers

Consistent with the Guidelines, a key factor in determining the benefit to workers are defined as the:

- Wages earnt in the mine.
- Minus the opportunity cost of labour for working in the mining sector, that is compared to working in non-mining sectors (or being unemployed).
- Minus the wage difference due to skills and the disutility to work in the mining industry.

BCM provided Cadence Economics with the full-time equivalent employment under both the Approved operations and Modification, as well as the average wages paid per employee.

Over the period 2022 to 2029 BCM advises that the Modification will employ additional FTEs compared to the Approved operations. During this period, the additional employment increase by 50 FTE in the years 2025 to 2027. Once the Approved operations cease, the employment attributable to the Modification increases to approximately 700 FTEs, as outlined in Table 9.

The average wage for a full-time equivalent employee at the BCC is expected to earn $178,263 per annum before income tax on average over the life of the Modification. The total of wages paid to employees is estimated at $245.8 million in NPV terms.

Table 9: Central case – wages paid to those employed under the Modification

Employees	NPV*	2022	2026	2028	2037
Employment (FTEs)		20.0	50.0	20.0	700.0
Average wage ($ per annum^)		176,122.6	174,816.8	176,469.5	182,301.1
Total wages paid ($ million^)	245.8	3.5	8.7	3.5	127.6

Source: BCM, ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

To measure the ***opportunity cost*** compared to the non-mining sector, the wages earnt by BCC workers was compared to the average wage paid on average in NSW. This implies that should the approval not

go ahead, those who would have been employed by BCM would find alternative work at the average wage paid in NSW. The average wage across NSW is $67,465 per annum based on the 2016 Census data (updated to 2019 dollars).

Assuming no disutility of working in mining, this results in an estimated worker benefit of $164.9 million, in NPV terms, over the life of the Modification, as shown in Table 10.

Table 10: Central case – estimated NSW worker benefit

Employees	NPV*	2022	2026	2028	2037
Average wage ($ per annum^)	-	67,465	67,465	67,465	67,465
Mining wage ($ per annum^)	-	176,123	174,817	176,469	182,301
Total wages based on average wage ($ million^)	98.1	1.3	3.4	1.3	47.2
Total mining wages paid ($ million^)	263.0	3.5	8.7	3.5	127.6
Estimated worker benefit ($ million^)	164.9	2.2	5.4	2.2	80.4

Source: BCM, ABS Census (2016) Occupational Total Personal Income (Weekly) by Hours Worked, and Cadence Economics estimates. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

As shown above, there is a significant premium incorporated in mining wages compared with the average wage paid in NSW and the local region. There are a number of likely reasons for this premium that might be explained by relative skill and productivity levels. In relation to the latter, mining employees are more productive than workers in other industries as they operate with higher levels of capital (for example, based on capital stock figures produced by the ABS, miners work with over 10 times the amount of capital than average employees across Australia).

Any metrics around the disutility of working in mining are very difficult to ascertain in both an absolute (mining specific) or relative (compared with other industries) way. One source of information considered in this analysis was any documented 'hardship' allowances recognised in mining awards. However, these allowances appear to be relatively minor. For example, the Black Coal Mining Industry Award 2010 does provide for the payment of an Underground allowance (Electrical/ Mechanical) of 0.23% per day or shift (above the standard rate/ reimbursement) to an adult employee who works underground on any shift. In addition, there is a Confined space allowance of 0.08% and a Dirty work allowance of 0.23%, that may apply to underground workers. To put this into context, First Aid Officer Allowance is 0.76% per day or shift above the standard rate.

In addition, a further consideration is whether workers would experience more or less disutility being employed by BCM compared with any alternate employment. In this context, as the assumption is made that any worker employed in the Modification would find alternative employment if the project did not go ahead it is the relative disutility of mine work versus non-mine work that is a key consideration. Given the minor allowances for working in a coal mines and the measurement difficulties associated with measuring these disutilities generally, we have assumed the disutility for workers under Modification case is zero. This implies, effectively, that those workers employed by the Modification experience no additional disutility from working in the mine compared with any alternative employment they would have secured in the absence of the project.

2.5.2 Benefit to suppliers

Consistent with the Guidelines, the economic benefit to suppliers is estimated as a producer surplus generated from goods and services provided from NSW firms to the Modification. As summarised in

Table 11, the Modification is estimated to require $287.2 million (in NPV terms) in intermediate inputs. BCM has advised that currently, almost 86.8 per cent of the inputs to the mine are sourced from NSW-based suppliers, or $249.2 million (in NPV terms) for the Modification.

The estimated economic benefit to suppliers (producer surplus) is based on the Cadence Economics Regional Input-Output Model (CERIOM). This model was customised to generate a NSW-specific Input-Output table so as to not include benefits generated in other Australian states.

The producer surplus estimates are based on Type I multipliers which limit the benefit to direct value added generated by NSW suppliers. This methodology does not account for second round, nor induced consumption effects that are captured within the CGE modelling. Using this relatively conservative technique, the total supplier benefits are estimated to be $50.3 million in NPV terms.

Table 11: Central case – estimated supplier benefits

Indirect benefits –suppliers	NPV*
Total intermediate inputs ($ million^)	287.2
Share from NSW	86.8
Total intermediate inputs ($ million^)	249.2
Gross operating surplus ratio	0.2
Total benefits to suppliers (NPV*)	50.3

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.5.3 Summary of indirect benefits to NSW

Consistent with the Guidelines, the indirect benefits of the Modification is summarised in Table 12. The total indirect benefits are estimated to be $215.2 million in NPV terms. The main source of these benefits is the $50.3 million in benefits to suppliers and $164.9 million in benefits to employees in NPV terms. There are no anticipated benefits to land owners as a result of the Modification.

Table 12: Summary of indirect benefits ($ million^)

Indirect benefits	NPV*
Net economic benefit to workers	164.9
Net economic benefit to suppliers	50.3
Land owner premiums (land sales made above market rates)	-
Total indirect benefit	215.2

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.6 Indirect Costs to NSW

Consistent with the Guidelines, the indirect costs of the Modification are classified as:

- Net public infrastructure costs,
- Estimated loss of surplus to other industries,
- Net environmental, social and transport-related costs,
- Net environmental costs.

2.6.1 Net environmental, social and transport-related costs

The Modification is expected to generate minor environmental, social and transport-related costs, above those generated by the Approved operations. Table 13 provides a summary of the environmental impacts predicted by the technical assessments undertaken for the Modification.

Table 13: Summary of environmental impacts

Scope of environmental costs	Discussion	NPV*
Greenhouse gas emissions	Based on scope 1 and 2 greenhouse gas emissions generated by the Modification.	0.02
Management, monitoring and mitigation costs		
Air quality	BCM is taking steps to reduce the potential air quality impacts through several management and mitigation steps. The Modification will also contribute to the potential acquisition of one property that will experience particulate matter exceedances during the operation of the Modification, due to a change in criteria.	24.8
Ambient noise impact	The Modification will operate in accordance with the currently Approved operations. BCM will incur some management, monitoring and mitigation costs.	3.4
Surface water	The Modification will have a minimal impact on water quality. The operating costs of the mine include the operation of the currently approved Water Management System (WMS) to reduce the potential impacts of the operations.	1.1
Groundwater	Costs of mitigating against the potential groundwater impacts are included in the WMS.	
Transport/ traffic impacts	The operation of Broke Road is expected to accommodate future traffic growth. The Modification is not expected to generate significant traffic impacts over those in the approved operations.	
Biodiversity impact	The disturbance area of the Modification is 20.2 hectares. The Modification will require 931 biodiversity credits that are proposed to be generated through currently owned Glencore land or property acquisition.	2.1
Aboriginal cultural and historical heritage	The Modification will impact four low archaeological value sites. The cost of salvaging these four sites are included in the Other management, monitoring and mitigation costs. The Modification will generate nil historical heritage impacts	
Visual amenity	The Modification will generate minor changes to the visual amenity. The potential visual amenity impacts are reduced through the currently approved (and constructed) noise and visual bund and through the costs of progressive rehabilitation (which are included in the operating costs).	
Other	BCM will also incur environmental-management cost that are not allocated directly to a control measure. These costs include mining operations plans, auditing, fieldwork and rehabilitation area maintenance, like weeding, erosion repair.	7.8
Sub total		39.2
Other costs		
Loss of surplus to other industries	The Modification is not expected to generate any loss of surplus to other industries.	Nil
Net public infrastructure cost	The Modification is not expected to generate public infrastructure costs. Included in the operating costs of the Modification is the planned annual VPA payment to compensate for any potential impacts.	Nil
Residual value of land	The Modification disturbance area is 20.2 hectares, it is a small parcel of land surrounded by mining activity. Where the Modification does not proceed the residual value of the land will not materially change.	Nil
Total		39.2

Source: Based on information provided in the EIS and various consultant reports. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.6.2 Greenhouse gas emissions

Consistent with Australia's international obligations under the United Nations Framework Convention on Climate Change the level of greenhouse gas (GHG) emissions attributable to the Modification is measured by the:

1. Scope 1 emissions, representing the direct GHG emissions from, for example, the use of diesel in plant and equipment and fugitive emissions; and
2. Scope 2 emissions, representing the indirect emissions from purchases of inputs, generally associated with the purchase of electricity.

The Greenhouse Gas and Energy Assessment (GHGEA) of the Modification was undertaken by Umwelt Australia, their findings are outlined in *Greenhouse Gas and Energy Assessment, Bulga Optimisation Project Modification 3* (January 2019).

In total Umwelt estimates that the Modification will generate 4.72 Mt of scope 1 and scope 2 emissions, see Table 14. To price the GHG emission we have applied the latest carbon price resulting from the most recent (December 2018) auction undertaken by the Clean Energy Regulator (CER) under the Emissions Reduction Fund (ERF).[5] The results of this auction yielded an average carbon price of $14.00 (in 2019 Australian dollars) per tonne of CO_2e abated. While this is an average figure, it represents a useful proxy to the marginal cost of abatement under Australia's current emission abatement policy represented by the ERF.

The externalities arising from GHG emissions associated with the Modification are derived by taking the year-on-year emissions and multiplying these figures by the $14.00 carbon price under the ERF over the life of the Modification.

The impact of GHG emissions are global in nature, as a result, apportioning the whole costs of CO_2e associated with the Modification overstates the cost to NSW. To estimate the impacts on NSW, it is appropriate to apportion a component of the total global costs to NSW. The approach adopted is to apportion the global GHG costs estimated to NSW using the ratio of NSW population to global population.

On a global basis, the total estimated GHG cost is $21.4 million in NPV terms. Attributing the GHG costs based on the NSW population, consistent with the Guidelines, results in an attributed GHG cost of $0.024 million to NSW in NPV terms.

[5] The results of this auction are summarised at http://www.cleanenergyregulator.gov.au/ERF/Auctions-results/december-2018 which was accessed in May 2019 for this analysis.

Table 14: Greenhouse gas emissions attributable to the Modification

	NPV*	Total	2022	2028	2037	2039
Tonnes of GHG (Mt)						
Scope 1	-	4.33	0.06	0.05	0.83	0.51
Scope 2	-	0.39	0.01	0.00	0.08	0.05
Total	-	4.72	0.07	0.06	0.90	0.55
Price Path ($ per tonne^)	-	14.0	14.0	14.0	14.0	14.0
Global Impact ($ million^)	21.4	66.3	1.0	0.8	12.7	7.8
NSW ($ million^)	0.024	0.07	0.0	0.0	0.0	0.0

Source: Cadence Economics estimates based on Umwelt, *Greenhouse Gas and Energy Assessment, Bulga Optimisation Project Modification 3* (January 2019).

^ Real 2019 Australian dollars.

* NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

2.6.3 Air quality

Jacobs has undertaken an Air Quality Impact Assessment (AQIA) for the Modification, the findings of their analysis is outlined in *Bulga Coal Complex Modification 3, Air Quality Impact Assessment (DRAFT)* (January 2019).

The AQIA outlined the potential air quality issues of the Modification, including, dust from general mining activities, fume from blasting and emissions of subsidence from machinery exhaust. The AQIA assessed the potential impacts to $PM_{2.5}$, PM_{10}, total suspended particulates (TSP) and also includes Nitrogen dioxide from diesel emissions.

The AQIA concludes that the annual emissions to air for the Modification are expected to be lower than those estimated for the previously approved Bulga Optimisation Project.

Regarding PM_{10}, the AQIA concludes that due to a number of factors, including background conditions, and contributions from other mines in the area, the maximum 24-hour average cumulative PM_{10} concentrations may continue to exceed EPA criteria. Modelling predictions indicated there may be up to two days each year when the BCC (as modified) would contribute to exceedances. The AQIA notes that this is not a significant change as it is within the range of historical measured conditions. One property will be entitled to voluntary acquisition in the future, as the annual average rate of PM_{10} exceeds the EPA cumulative criteria in 2022, 2026 and 2031.

The AQIA concludes that, there are no private sensitive locations which are predicted to experience exceedances of the $PM_{2.5}$, TSP or dust deposition criteria at any stage of the Modification. In addition, there will be no change from post-blast fume impacts and on-site diesel use is not expected to result in any adverse air quality impacts.

The AQIA notes that there are a number of management measures in place that will continue to be adopted as part of the Modification. These include:

- watering of haul roads and restricting vehicle speeds;
- fleet optimisation to reduce vehicle kilometres travelled;
- ceasing operations when visible dust is generated;
- minimising fall distances during unloading and loading;

- water sprays and partial enclosure to unload coal to ROM hopper;
- enclosed coal processing and covered/ some enclosed belt cleaning for conveyors; and,
- water sprays to control wind erosion from ROM and product coal stockpiles.

In addition, BCM implements both proactive and reactive dust control strategies. Proactive measures include the management and planning of activities in advance of potentially adverse conditions, including plant operator training, providing personnel with daily forecasts, and the modification of planned mining activities to minimise or avoid potential dust impacts.

Reactive air quality managements include the modification or suspension of activities in response to specific triggers outlined in the BCM Air Quality Management Plan, including:

- visual conditions, such as dust from trucks above wheel height as observed;
- meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors; or,
- ambient air quality conditions.

During the operation of the Modification BCM has provided the cost of minimising the potential air quality impacts through management and mitigation steps. As outlined above, it is anticipated that one property will be entitled to voluntary acquisition in the future, as the annual average rate of cumulative PM_{10} exceeds to EPA criteria in 2022, 2026 and 2031. The property is currently entitled to acquisition rights for noise impacts as a result of the operations from Mt Thorley Warkworth. The Modification will contribute a minor contribution of PM_{10} to the Mt Thorley Warkworth impacts, however conservatively, we have included the total costs of acquisition within the management and mitigation steps of the Modification. In total over the life of the project, the cost of these management and mitigation steps are $24.8 million in NPV terms.

2.6.4 Ambient noise impact

Global Acoustics has undertaken a Noise Impact Assessment (NIA) for the Modification. Their findings are outlined in the report, *Bulga Extension Project Noise Impact Assessment Draft* (March 2019). The stated objective of the NIA is to evaluate the noise emission differences between the Approved Operations and the proposed Modification, and to determine whether the Modification can continue to operate in accordance with approved noise limits.

The NIA concludes that the Modification will be able to continue to operate in accordance with noise limits set out for the Approved operations through the implementation of feasible and reasonable noise controls. These costs are included in the mitigation costs outlined above. In total, the cost of mitigating against the potential noise impacts of the Modification is $3.4 million, in NPV terms over the life of the Modification. These mitigation costs include the cost of continuous noise monitoring, blast monitoring, site forecasting, and replacing noise attenuation on mobile equipment. The Modification will also make use of the noise and visual bund that has recently been constructed as part of the Approved operations.

Regarding construction noise, the NIA stated that is highly unlikely that construction noise will be audible over and above the on-going open cut mining operations. In addition, there are no changes to road traffic and rail noise over the Approved operations.

The Modification does not generate additional mitigation or acquisition rights for property owners adjacent to the BCC. BCM will continue to afford voluntary mitigation and acquisition rights to receptors currently afforded these rights in accordance with Approved operations.

2.6.5 Surface Water

Engeny Water Management undertook a Surface Water Impact Assessment (SWIA) of the Modification, the findings of the assessment are outlined in *Bulga Extension Project Surface Water Impact Assessment* (April 2019). The SWIA considers the impacts to water catchment areas and watercourses, to water quality and the potential water impacts of the final landform.

The report considers the existing Water Management System (WMS) and the various water monitoring currently in operation for the Approved operations.

The report outlines that the WMS for the Approved operations will continue to be utilised, and the WMS for the Modification additional disturbance area will be integrated into the existing WMS. The WMS will be used to manage runoff, and the existing approved clean water diversions will continue to divert runoff as required. In addition, the Modification is anticipated to require one additional sediment dam to replace an existing dam and additional pump and pipe infrastructure to support the management of existing and new water management storage.

The SWIA considers the impacts to Wollombi Brook and Loders Creek. Regarding Wollombi Brook, the SWIA concludes that, the Modification will reduce net leakage into the alluvium, when compared to the Approved operations. Analysis of Loders Creek indicates negligible changes to velocities within the Modification compared to the pre-mining scenario. The report also concludes that the Modification will have a minimal impact on water quality in downstream watercourses.

The costs of the water management and water monitoring (such as water balance calibration, and stream health/ channel stability monitoring) are included in the mitigation costs of the Modification. In total, the costs of these measures are $1.1 million in NPV terms over the life of the Modification.

2.6.6 Groundwater impact

Klohn Crippen Berger undertook a Groundwater Impact Assessment (GIA) of the Modification, the findings are outlined in the *Groundwater Impact Assessment Bulga Optimisation Project Modification 3 (Draft)*. The GIA provides an assessment of the Modification's potential groundwater impacts, including the likely impacts to Wollombi Brook and Monkey Place Creek alluvial, and the interface of groundwater with the surface drainage systems, local bores and groundwater dependant ecosystems.

The GIA concludes that Modification impacts will include:

1. The majority of the groundwater drawdown impacts arise from the already-approved mining operations. The change in drawdown due to the Proposed Modification from the approved case is small and almost entirely constrained to weathered or deeper Permian strata.
2. The development of a substantial groundwater sink, although, the mine inflow rates into the void are generally low due to the shadow of dewatering from the underground operations and

the low permeability of the strata being mined. However, this does slightly decrease groundwater flow to Nine Mine Creek

3. A degree of saturation in the spoil pile creating a local mound of groundwater, although vertical losses are not expected to be high.
4. Incremental impacts of the Modification on the Alluvial Water Source of Wollombi Brook, including nearby registered private bores, are not predicted to cause exceedances of the Minimal Impact Considerations of the NSW Aquifer Interference Policy.
5. On average, cumulative water inflow production across the remainder of the mining life (Approved mines plus Modification impacts) is predicted to average approximately the amount of current approved hard rock allocation.
6. Glencore holds significant quantities of transferable hard rock aquifer allocations at other mining operations in the upper Hunter Valley which will be available to transfer to BCM if increased water extraction is required beyond current allocation volumes.

The report also outlines mitigation and monitoring strategies which may need to be deployed. These include monitoring of water levels and pressure heads and geochemical sampling. The GIA also proposes an update to the Bulga Coal Water Management Plan to consider future needs, including a more detailed mapping of potential alluvium, hydrogeological ground-truthing and additional locations for the groundwater quality data collection program. The cost of implementing these are included in the surface water management costs and are not individually identifiable.

2.6.7 Transport/traffic impacts

The SEE provides some discussion of the potential construction-related and operational traffic and transport impacts of the Modification. As outlined in the SEE, the construction activities will be for a limited period and will not require a significant workforce. It also notes that the Bulga Underground Operations are not currently operating and will provide capacity in the local road network.

The SEE states that traffic modelling for the Broke Road is expected to accommodate future traffic growth until 2028 and beyond, including a 100 per cent increase in traffic staff movements at the Bulga Open cut during peak hours.

As a result, it is expected that the ongoing employment beyond the Approved operations, as outlined in section 2.5.1, will be accommodated by Broke Road.

The Modification is not expected to generate significant traffic impacts over those included in the Approved operations, and as a result have been assessed to have nil economic impact.

2.6.8 Biodiversity and ecological impacts

A Biodiversity Assessment Report (BAR) has been carried out by Umwelt, the findings from the analysis are outlined in *Bulga Optimisation Project Modification Project Biodiversity Assessment Report Draft (January 2019)*. The BAR notes that the Modification maximises the use of previously disturbed and mined areas and the approved disturbance area of the Approved operations, thereby minimising the

additional disturbance area. As a result, the Modification will require an additional disturbance area of 20.2 hectares.

To minimise the potential impacts of the Modification the report includes the BCM implementation of a comprehensive biodiversity mitigation strategy to minimise unavoidable impacts. A number of management measures will also continue to be implemented including, landform rehabilitation, salvage of biodiversity features, weed management and feral animal control and environmental works to control erosion and sediment.

The BAR concludes the Modification will result in biodiversity impacts that are unavoidable and will require offset credits to mitigate against the cost of loss of ecology values. Table 15, provides a summary of the ecosystem off-set credits required to compensate the ecological loss of the Modification. In total the development of the Modification will require 931 credits, which is largely made up of, the 868 credits required to offset the losses to the Narrow-leaved Ironbark, Bull Oak and Grey Box Shrub.

Table 15: Biodiversity credit requirements

Ecosystem credits	Credits Required
Zone 1 HU564/PCT922 *Melaleuca decora* Low Forest of the Central Hunter Valley, Sydney Basin Bioregion	55
Zone 2 HU564/PCT922 Melaleuca decora Low Forest of the Central Hunter Valley, Sydney Basin Bioregion	8
Zone 3 HU817/1603 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower Hunter	868
Total	931

Source: Biodiversity Assessment Report

The costs of the biodiversity mitigation strategy and the cost to generate the biodiversity credits are included in the operating costs of the Modification. To generate the required 931 offsets BCM has identified property to meet these obligations, the value of this offset land is $0.4 million in NPV terms. The cost of implementing the biodiversity management strategies is included in the Management, Monitoring and Mitigation costs of the Modification, these costs are $1.7 million in NPV terms. In total the incremental costs included in the operating cost are $2.1 million in NPV terms.

2.6.9 Aboriginal Cultural Heritage

Ozark Environmental and Heritage Management has undertaken an Aboriginal Cultural Heritage Assessment (ACHA) for the Modification. The findings of the ACHA are outlined in the *Aboriginal Cultural Heritage Assessment Report Bulga Optimisation Project Modification 3* (DRAFT February 2019). The ACHA concentrates on a study area that incorporates the:

- additional disturbance area of 20.2 hectares; the land areas of the Modification that are not included in the previously approved BOP disturbance footprint; and
- infrastructure study area of 7.5 hectares;

The ACHA identifies four isolated find sites, of low archaeological value, within the study area. The ACHA concludes that all four sites will be directly harmed by the Modification. One site has been partially savaged under the current BOP Salvage Program, while the remainder will either be totally impacted or at risk of being impacted by the Modification.

The ACHA makes a number of recommendations to mitigate against the impacts outlined above. This includes the collection of all visible artefacts and the revision of the Aboriginal Cultural Heritage Management Plan in consultation with the Aboriginal community to include the impacts associated with the Modification.

The costs of incorporating these recommendations into the Modification are included in the operating costs of the Project.

Any loss of scientific value from these sites are qualitatively acknowledged in the economic assessment.

2.6.10 Historical heritage

The SEE provides a discussion of the Modifications potential impact on historical heritage. The SEE notes that a comprehensive historical heritage assessment was undertaken for the Approved operations. That assessment only identified one item, in the vicinity of the additional disturbance area of the Modification. Identified as item PS7 – Post and Rail Fence it comprises an approximately 130 metre length of semi-derelict post-and-two-rail-and-wire fence. The SEE notes that item PS7 has no significance and no research potential. The item will be impacted by the Modification and will require removal.

As a result, the historical heritage impacts of the Modification are nil.

2.6.11 Visual amenity

The Modification will result in minor changes to visual amenity to the surrounding region. The SEE states that the vicinity of the BCC is generally comprised of mined surfaces, coal related infrastructure, other built infrastructure with a backdrop of wooded areas. The BCC currently includes a noise and visual bund, which is approximately 9.5 kilometres long and up to 70 metres above the natural ground surface.

As outlined in the SEE, the Modification has the potential to result in visual impacts through, raising the main central overburden emplacement 10 metres (15 metres to incorporate micro-relief) above its current approved height and rehabilitation activities.

As outlined in the SEE, views of the site from many of the public viewing locations are currently obscured by the approved Noise and Visual Bund and there will be either no increase or only minor changes to the visibility of the active and inactive overburden areas

The visual assessment has indicated that, over the various stages of the Modification, minor changes to overburden emplacement will occur which will result in the overburden areas being visible from some locations, although this change is minor relative to the approved operations.

The Modification will continue to use controls in place for the Approved operations. These include progressive rehabilitation, on-going management of mobile night lighting to reduce night glow. The cost of progressive rehabilitation is included in the operating costs of the mine. There are no additional costs for the on-going management of mobile lighting.

2.6.12 Loss of surplus to other industries

The Modification is not expected to generate any loss of surplus to other industries. Loss of surpluses to other industries may be generated where the Modification uses resources like water or land to displace activity by other sectors. The Modification is not expected to generate water access limitations to other sectors. Regarding land, the Modification increases the disturbance area of the BCC by 20.2 hectares. This land is currently surrounded by other mining activity and is not suited for agriculture or other uses.

As a result, the Modification is expected to generate nil loss of surpluses to other industries.

2.6.13 Net public infrastructure costs

The Modification is not expected to generate public infrastructure costs. The Modification will include the continued use of the BCC facilities and the construction of a new water management facilities. In addition, BCM currently makes annual recurrent payments of $0.07 million per year to the local council under a Voluntary Planning Agreement. It is assumed that then payments, will continued for the life of the Modification and result in additional payments of $0.13 million in NPV terms. These costs are included in the operating costs of the Modification.

As a result, the Modification is expected to generate nil net public infrastructure costs.

2.6.14 Residual value of land

As outlined above the Modification disturbance area by 20.2 hectares, it is a parcel of land that is surrounded by mining activity and is not suited for alternative use. It is likely that where the Modification does not proceed the residual value of that land will not materially change as it is not suited for other land use.

As a result, the Modification is expected to generate nil residual value of land costs.

2.7 Net Benefits Analysis results

Consistent with the Guidelines, the CBA is based on comparing the net direct and indirect benefits and subtracting the indirect costs of the Modification compared against the baseline scenario or the Approved operations where the Modification does not occur. The results are summarised in

Table 16.

Based on the CBA methodology outlined in the Guidelines, and information provided by BCM, the Modification is estimated to provide a net benefit to NSW. This net benefit is estimated to be

$410.6 million in net present value (NPV)[6] terms. This is comprised of $195.4 million and $215.2 million in direct and indirect benefits respectively. The incremental indirect costs of the Modification are estimated to be $0.02 million.

Table 16: Central case - estimated net benefits of the Modification ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
Net producer surplus attributed to NSW	-		
Royalties, payroll tax and Council rates	120.9		
Company income tax apportioned to NSW	74.5		
Total direct benefits	195.4	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
Net economic benefit to landholders	-	Greenhouse gas emissions	0.02
Net economic benefit to NSW workers	164.9	Air quality	24.8
Net economic benefit to NSW suppliers	50.3	Noise impact	3.4
		Surface Water	1.1
		Groundwater	-
		Transport impact	-
		Biodiversity impact	2.1
		Aboriginal cultural and Historical heritage	-
		Visual amenity	-
		Loss of surplus to other industries	-
		Net public infrastructure cost	-
		Residual value of land	-
		Other costs	7.8
Total indirect benefits	215.2	**Indirect Costs**	39.2
Total Project economic benefit	410.6	**Incremental Indirect Cost**	0.02
NPV of project - ($m)	410.6		**-**

Source: Cadence Economics estimated based on information from various sources. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

These estimates are based on central case assumptions of the Modification, as outlined above.

The ***direct benefits*** of the Modification are a function of its profitability which, in turn, depends on the prevailing coal price. The analysis shows that the combination of relatively low additional capital requirement, extraction cost savings and processing costs underpins the economic viability of the Modification. As a result, the Modification is predicted to generate:

- Total corporate taxes of $231.6 million in NPV terms for Australia, of which $74.5 million is attributed to NSW; and

[6] All NPV figures reported are in 2019 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

- $120.9 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $104.5 million with council rates and land taxes of $1.2 million and payroll taxes contributing $15.2 million.

The ***indirect benefits*** of the Modification are related to the linkages that it will have to the NSW economy through both the labour market and suppliers. The analysis shows that of the $215.2 million in estimated indirect benefits:

- Worker benefits are predicted to amount to $164.9 million in NPV terms for the directly employed workers over the period 2019 to 2039, in net additional terms, Modification employment peaks at 700 FTE workers; and
- Supplier benefits are predicted to amount to $50.3 in NPV terms based on total supplier inputs over the life of the Modification of $287.2million.

The Modification is expected to result in minor incremental indirect costs on the NSW community of $0.02 million in NPV terms, through greenhouse gas emissions.

2.8 Net Benefits – Sensitivity analysis

Consistent with the Guidelines, this section outlines a summary of the systematic sensitivity analysis undertaken for the Modification. The sensitivity analysis considers all key areas of the CBA, particularly coal prices, key costs (both capital expenditure and operating costs) as well as worker benefits. Where there are considered to be higher levels of uncertainty with the figures, a range of plus/minus 25 per cent is used. In areas where the figures are deemed more certain, a range of plus/minus 10 per cent is used. The sensitivity analysis is comprised of the following:

- Revenue sensitivity
    - Higher price assumptions, where coal prices are increased by 25 per cent over the central case assumptions for the life of the Modification
    - Lower price assumptions, where coal prices are decreased under the central case assumptions by 25 per cent
- Cost-base sensitivity
    - Higher operational expenditure (increased by 10 per cent over the central case)
    - Lower operational expenditure (decreased by 10 per cent under the central case)
    - Higher capital expenditure (increased by 10 per cent over the central case)
    - Lower capital expenditure (decreased by 10 per cent under the central case)
- Worker and Supplier assumptions
    - Increased disutility of mining wage premium by 25 per cent on central case assumptions
    - Reduced supplier benefits of 10 per cent from central case assumptions
- Environmental impact costs, increased by 10 per cent over the central case
- Discount rate sensitivity, using a 4% and a 10% real discount rate (see Appendix A).

In addition, upper and lower bound estimates are undertaken which assume:

- ***'Worst-case' scenario***, the coal price is reduced by 25 per cent, operational and capital expenditure are increased by 10 per cent, the disutility of the mining wage premium is set to 25

per cent and supplier benefits are lowered by 10 per cent compared with central case assumptions. Environmental costs are increased by 10 per cent over the central case.

- ***'Best case' scenario***, the coal price is increased by 25 per cent, operational and capital expenditure are decreased by 10 per cent, the disutility of the mining wage premium is set to zero and supplier benefits are increased by 10 per cent compared with central case assumptions. Environmental costs are decreased by 10 per cent over the central case.

Consistent with the Guidelines, the revenue sensitivity undertaken considers the impact of higher or lower prices on the results of the CBA denominated in Australian dollars. There are two main factors effecting the price assumptions. First is the US dollar price of coal prevailing in international markets. Second is the exchange rate between the Australian and US dollar. A decrease in the price of coal can either reflect a reduction in world prices or an appreciation of the Australian dollar relative to the US dollar. As such, a 25 per cent reduction in coal prices can either be interpreted as:

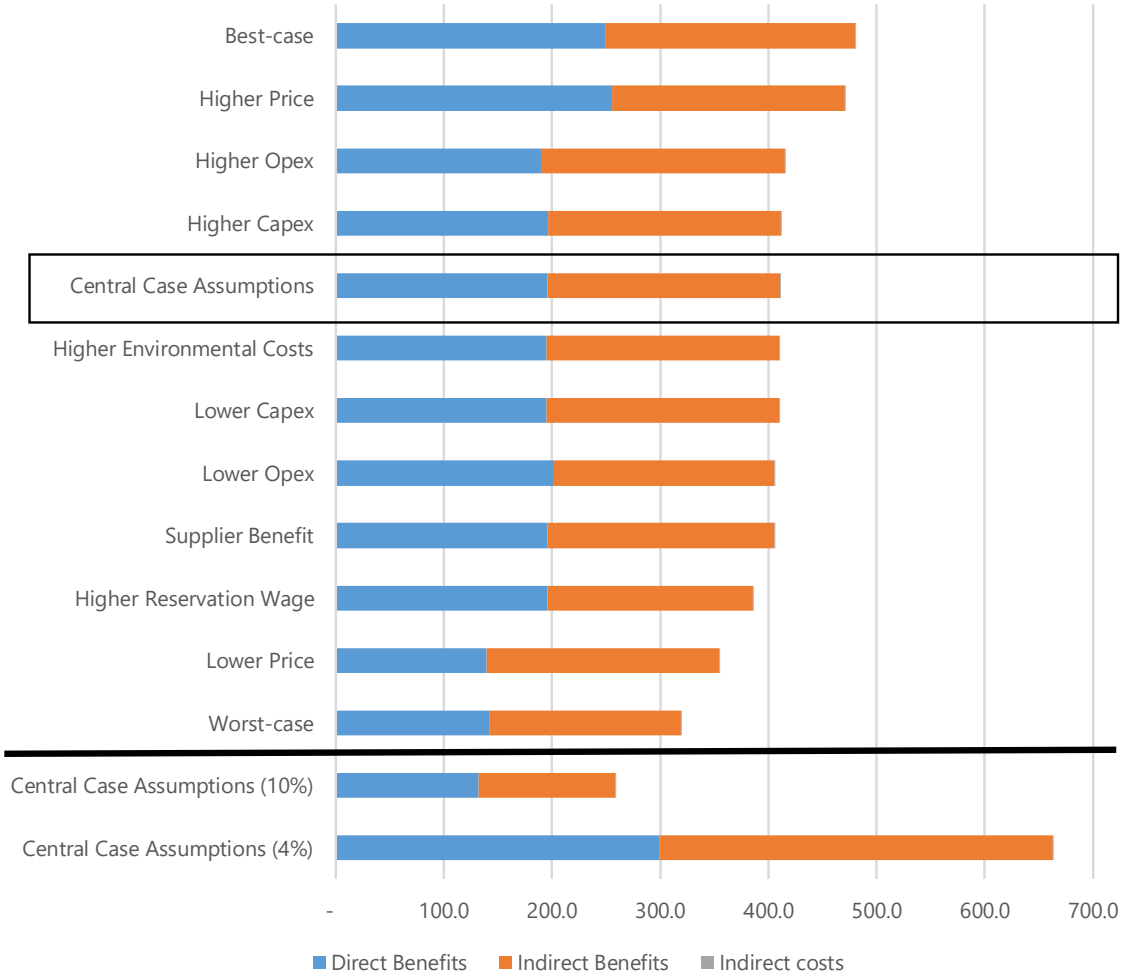
- A 25 per cent reduction in the prevailing international coal price (denominated in US dollars with no change to the exchange rate); or
- A 25 per cent appreciation in the Australian dollar relative to the US dollar (with the prevailing international price of coal unchanged); or
- Some combination of both.

2.8.1 Results of sensitivity analysis

The results of the systematic sensitivity analysis are summarised in Figure 9. This sensitivity analysis shows that the estimated net benefits are robust in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

In isolation, the estimated net benefit of the Modification is most sensitive to the coal price assumptions underpinning the analysis, but even assuming coal prices are 25 per cent lower than under the central case assumptions the net benefits are estimated at $354.9 million in NPV terms.

Figure 9: Systematic sensitivity analysis of the CBA to key assumptions (NPV*, $ million^)



Source: Cadence Economics estimated based on information from various sources. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

The lower bound estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits, yields an estimated net benefit of $319.1 million in NPV terms.

The upper bound estimate of net benefits, based on the most optimistic assumptions, is $480.4 million in NPV terms. In isolation, assuming higher coal prices of 25 per cent, to those in the central case, the net benefits of the Modification is $470.4 million in NPV terms.

The robustness of the results to the sensitivity analysis is a reflection of the relatively low operating costs, the relatively low capital costs required to extract the resource and the relatively low level of indirect costs (externalities) attributable to NSW.

It can also be inferred from the sensitivity analysis how large the qualitatively assessed negative externalities would need to be before the Modification is no longer a net benefit to the NSW community.

Using the most conservative estimate, the worst-case assumptions, these externalities would need to be $319.1 million in NPV terms before the Modification would return a net negative return to NSW. Although, as outlined in section 2.6.1, the qualitative assessment is limited, and as a result the qualitatively assessment negative impacts are likely to be small.

As a result of the majority of incremental benefits accruing after Approved operations cease, the net benefits are sensitive to the discount rate used for the analysis. Under the Central case assumptions the Modification is expected to generate $410.6 million of net benefit using a 7 per cent discount rate. Using a 4 per cent discount rate increases the net benefit to $662.8 million, conversely a 10 per cent discount decreases the net benefit to $258.5 million.

3 Local Effects Analysis

Consistent with the Guidelines, the local effects analysis (LEA) uses a similar framework to the CBA presented in the previous section but is focussed on the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. In the case of the Modification the location used for the LEA is the Lower Hunter SA3.

3.1 The Lower Hunter region

The Lower Hunter region is located to the west of Newcastle and circles the regional Centre of Maitland. The SA3, includes Singleton and Cessnock, and towns like Wollombi in the southern end of the region and Chichester in the north.

The Lower Hunter is part of the Hunter Valley coal producing region, which has a several coal mines producing mainly thermal coal for export and electricity generation. The coal producing region includes several open cut coal mines, such as, the Bulga Coal Complex and Mount Thorley Warkworth mines, in the southern end and extending all the way to the upper Hunter towns like Muswellbrook and the Bengalla and Mount Pleasant coal operations in that area.

The Bulga Coal Complex is located to the north west of Cessnock and to the south west of Singleton, in the central western sector of the Lower Hunter SA3.

3.1.1 Regional characteristics

As outlined above the Lower Hunter SA3 is part of the Hunter Valley coal region. As a result, the region is heavily reliant on the coal mining, of the residents in the region almost 12 per cent work directly within the coal mining sector, as outlined in Table 17, compared to 0.6 per cent in NSW and 0.4 per cent Australia-wide.

As a result, a high proportion of workers in the region are in occupations that are typically found within both the coal mining sector and industries that supply that sector. Technicians and trades workers make up almost 18 per cent of the Lower Hunter labour force compared to 12.7 per cent in NSW and machinery operators and drivers account for 14.0 per cent of the regional economy compared to 6.1 per cent state-wide.

These occupation outcomes are also reflected in the educational outcomes within the region, 27.8 per cent of residents report certificate level III and IV as their highest educational attainment, compared to 17.3 per cent in NSW.

Table 17: Education and employment characteristics

	Lower Hunter	New South Wales	Australia
Level of highest educational attainment	%	%	%
Advanced Diploma and above	18.5	37.7	35.9
Certificate III and IV	27.8	17.3	18.2
Year 10 to 12	38.0	35.1	36.5
Other	15.7	9.9	9.4
Occupation	%	%	%
Technicians and Trades Workers	17.9	12.7	13.5
Machinery Operators and Drivers	14.0	6.1	6.3
Labourers	12.5	8.8	9.5
Professionals	11.9	23.6	22.2
Community and Personal Service Workers	11.3	10.4	10.8
Clerical and Administrative Workers	11.2	13.8	13.6
Managers	10.4	13.5	13
Sales Workers	9.2	9.2	9.4
Industry of employment, top responses	%	%	%
Coal Mining	11.9	0.6	0.4
Aged Care Residential Services	2.6	2.0	2.0
Takeaway Food Services	2.5	1.7	1.8
Hospitals (except Psychiatric Hospitals)	2.5	3.5	3.9
Supermarket and Grocery Stores	2.3	2.2	2.4

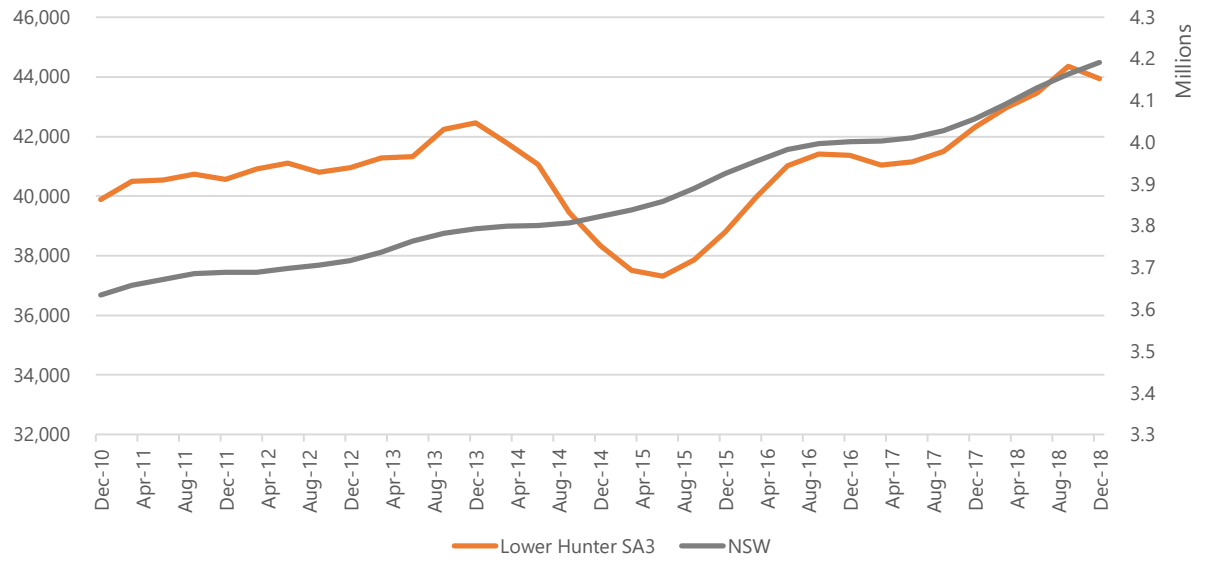
Source: 2016 Census QuickStats, Australian Bureau of Statistics

3.1.2 Employment outcomes

Employment outcomes in the Lower Hunter region are highly variable, in part impacted by coal mining activity. Figure 10 shows total employment for Lower Hunter SA3 and the NSW residents, covering the period December 2010 to December 2018 (the most recent data). Employment for residents of the region peaked in September 2018 at about 44,400.

Since August 2015 employment growth in the Lower Hunter has been strong, growing at an annualised rate of 2.3 per cent, compared to 1.8 per cent for NSW.

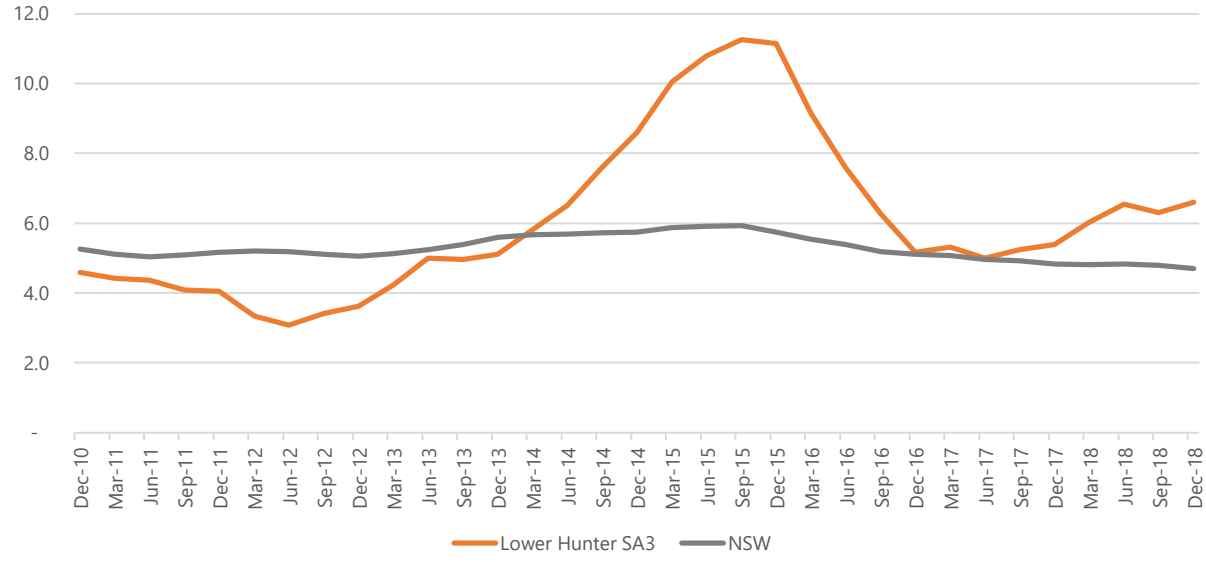
Figure 10: Employment, Lower Hunter SA3 and New South Wales



Source: *SA2 Data tables – Small Area Labour Markets – December quarter 2018* Department of Employment (March 2019)

As shown in Figure 11, unemployment in the region has followed the broad trends as those outlined above. Unemployment in the region was as low as 3.1 per cent in June 2012, the unemployment rate rose to over 11 per cent by December 2015. Between December 2015 and June 2017 employment fell to about the state-wide average, more recently though unemployment has trended higher as labour supply growth was higher than employment growth.

Figure 11: Unemployment rate (per cent), Lower Hunter SA3 and New South Wales



Source: *SA2 Data tables – Small Area Labour Markets – December quarter 2018* Department of Employment (March 2019)

3.2 Local Effects Analysis

The LEA accounts for the economic benefits to the Lower Hunter region only. It does not include any economic benefits that may accrue to the major regional centres that are located adjacent, including Maitland and Newcastle or the broader Hunter region.

Given the nature of coal operations and export ports located in Newcastle, many of the inputs may be supplied from the broader Hunter region. In addition, BCM has advised that for the currently approved operations 27 per cent of the supplier inputs are sourced from Lower Hunter based businesses and 39 per cent of workers live locally.

Underpinning the LEA are the assumptions that:

- No net producer surplus accrues to the region;
- No company income tax accrues to the Lower Hunter SA3 region;
- Based on information supplied by BCM, we have assumed for the proposed Modification that 39 per cent of the workforce requirement of the Modification and 27 per cent of intermediate inputs will be supplied from the SA3 region.
- The average wage in the Lower Hunter SA3 is $67,358 per annum

As a result of these assumptions, it is expected the Modification will generate additional indirect benefits to local suppliers and employees of $15.4 million and $64.7 million respectively in NPV terms above the Approved operations, as outlined in Table 18.

The incremental indirect costs of the Modification are minor, accounting for $260 of greenhouse emission costs, apportioned to the region.

Based on these assumptions, the Modification is estimated to confer a net benefit on the Lower Hunter SA3 region of $81.3 million in NPV terms.

Table 18: Estimated Local Effects Analysis of the Modification ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
Net producer surplus attributed to NSW	-		
Royalties, payroll tax and Council rates	1.2		
Company income tax apportioned to NSW	-		
Total direct benefits	1.2	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
Net economic benefit to landholders	-	Greenhouse gas emissions	0.0
Net economic benefit to NSW workers	64.7	Air quality	24.8
Net economic benefit to NSW suppliers	15.4	Noise impact	3.4
		Surface Water	1.1
		Groundwater	-
		Transport impact	-
		Biodiversity impact	2.1
		Aboriginal cultural and Historical heritage	-
		Visual amenity	-
		Loss of surplus to other industries	-
		Net public infrastructure cost	-
		Residual value of land	-
		Other costs	7.8
Total indirect benefits	80.1	**Indirect Costs**	39.2
Total Project economic benefit	81.3	**Incremental Indirect Cost**	0.0
NPV of project - ($m)	81.3		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate.

3.3 Sensitivity analysis

As outlined above the LEA relies on a number of modelling assumptions. Consistent with the Guidelines, Figure 12 provides a summary of the systematic sensitivity analysis undertaken for the Modification. The sensitivity analysis tests the same assumptions outlined in the CBA.

The main drivers for the regional impact are the supplier and employee benefits. Those sensitivities that change the supplier benefits through lower operational costs, lower supplier benefit or employee benefit have the greatest impact on the regional net benefit.

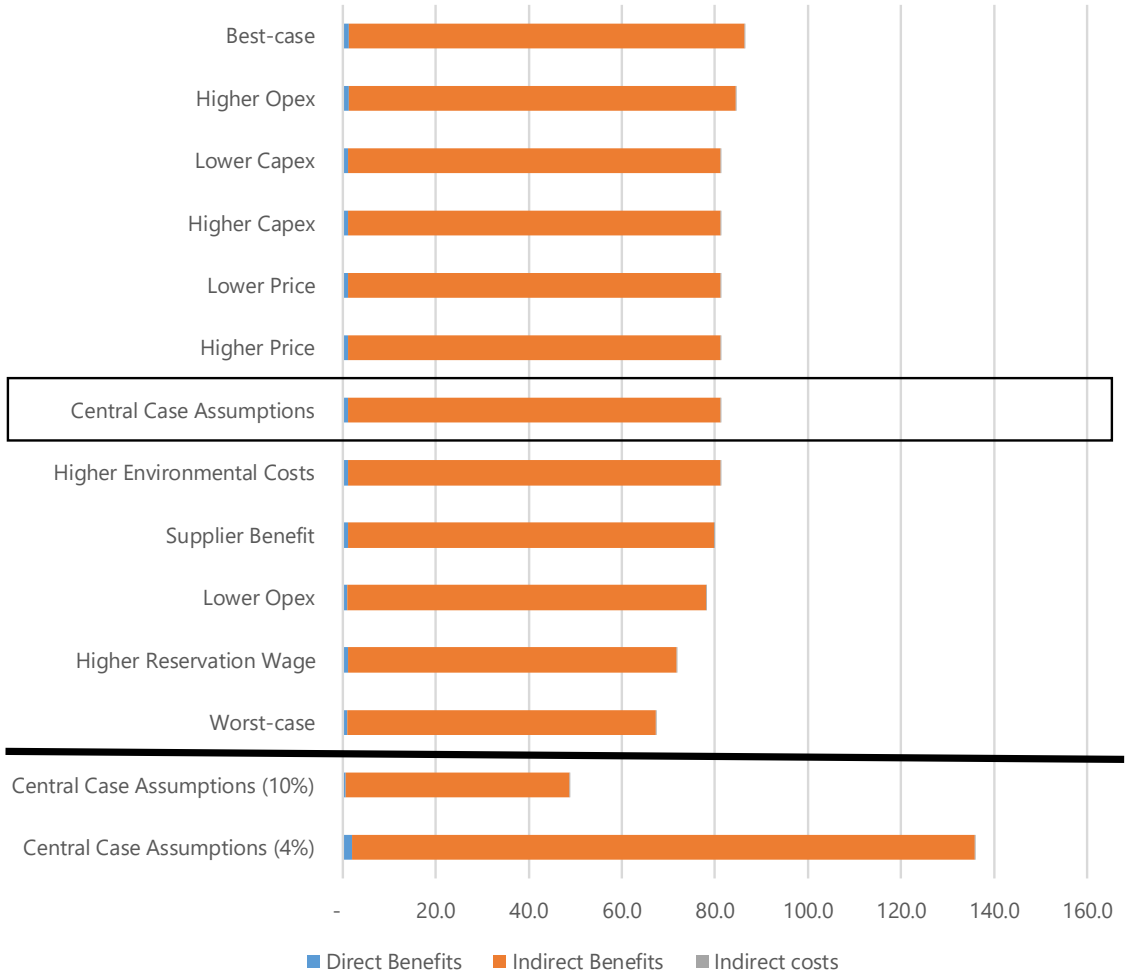
The results of the systematic sensitivity analysis are summarised in Figure 11. This sensitivity analysis shows that the estimated net benefits are ***robust*** in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis. Full detail of the sensitivity analysis is presented in Appendix A.

The lower bound, or worst-case, estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits,

yields an estimated net benefit of $67.3 million in NPV terms. The upper bound, or best-case, estimate based on the most optimistic assumptions, is $86.3 million in NPV terms.

As a result of the majority of incremental benefits accruing after the Approved operations cease the net benefits are sensitive to the discount rate used for the analysis. Under the Central case assumptions the Modification is expected to generate $81.3 million of net benefit to the local area using a 7 per cent discount rate. Using a 4 per cent discount rate increases the net benefit to $135.9 million, conversely a 10 per cent discount decreases the net benefit to $48.7 million.

Figure 12: Systematic sensitivity analysis of the LEA to key assumptions (NPV*, $ million^)



Source: Cadence Economics estimated based on information from various sources. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

4 CGE modelling

The economy-wide impacts of the proposed development have been undertaken using a CGE model of the regional and NSW economy.

The aim of an economic impact study based on applied CGE modelling is to estimate the net benefit of the proposed development on economic activity and the living standards of those residing within the Lower Hunter SA3, the same region used for the LEA analysis, and in NSW.

CGE modelling is the preferred technique to assess the impacts of large projects as they are based on a more detailed representation of the economy, including the complex interactions between different sectors of the economy.[7] As a CGE model is able to analyse the impacts of the proposed development in a comprehensive, economy-wide framework meaning the modelling captures:

- ***Direct increases in demand*** associated with the proposed development (short term construction activity) as well as the assumed increases output attributable to increased coal production.
- ***Indirect increases in demand***, or flow-on effects associated with increased economic activity relating to both the construction phase of development and additional coal production.
- ***Labour market displacement*** caused by the direct increase in demand from a project of this nature (and the associated investment) on other sectors of the economy bidding up wages and 'crowding out' other sectors of the economy.
- ***Revenue leakage*** associated with the expropriation of profits from the Project to overseas interests (in this case, Glencore).

4.1 About Cadence Economics' CGE model

The estimates are based on the Cadence Economics General Equilibrium Model (CEGEM). CEGEM is a large scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the Lower Hunter SA3 and the NSW economy. CEGEM is based on a substantial body of accepted microeconomic theory.

The model projects change in macroeconomic aggregates such as real gross state product (real GSP) which is an output measure of the NSW economy and real gross state income (real GSI) which is a welfare measure for NSW residents. At a regional level the model projects change in real gross regional product (real GRP) and real gross regional income (real GRI). The model also projects state-wide and regional employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced. A brief description of the model is presented in Box 1.

[7] See for example the Policy & Guidelines Paper produced by the NSW Treasury (2009).

Box 1: An overview of CEGEM

CEGEM is a multi-commodity, multi-region, dynamic model of the world economy. Like all economic models, CEGEM is a based on a range of assumptions, parameters and data that constitute an approximation to the working structure of an economy. Its construction has drawn on the key features of other economic models such as the global economic framework underpinning models, such as GTAP and GTEM, with state and regional modelling frameworks such as Monash-MMRF and TERM.

Labour, capital, land and a natural resource comprise the four factors of production. On a year-by-year basis, capital and labour are mobile between sectors, while land is mobile across agriculture. The natural resource is specific to mining and is not mobile. A representative household in each region owns all factors of production. This representative household receives all factor payments, tax revenue and interregional transfers. The household also determines the allocation of income between household consumption, government consumption and savings.

Capital in each region of the model accumulates by investment less depreciation in each period. Capital is mobile internationally in CEGEM where global investment equals global savings. Global savings are made available to invest across regions. Rates of return can differ to reflect region specific differences in risk premiums.

The model assumes labour markets operate in a model where employment and wages adjust in each year so that, for example, in the case of an increase in the demand for labour, the real wage rate increases in proportion to the increase in employment from its base case forecast level.

CEGEM determines regional supplies and demands of commodities through optimising behaviour of agents in perfectly competitive markets using constant returns to scale technologies. Under these assumptions, prices are set to cover costs and firms earn zero pure profits, with all returns paid to primary factors. This implies that changes in output prices are determined by changes in input prices of materials and primary factors.

In terms of specifying the elasticity of labour supply, Cadence follow the lead of the Australian Treasury and use a labour supply elasticity assumption of 0.15, which indicates a relatively 'inelastic' response from workers.

Importantly, in terms of interpreting the results as well as for consistency with the CBA analysis, real GSI represents the preferable welfare measure to the commonly reported change in real GSP (a measure of production). As a measure of income, Pant et al (2000) show how the change in real GSI is a good approximation to the ***equivalent variation*** welfare measure in global CGE models such as CEGEM. This measure is widely used by practitioners and can also be decomposed into various components to assist in the analysis of results. Real GSI is computationally more convenient than (say) an equivalent variation, and a more familiar concept to explain to decision makers (Layman, 2004).

As noted by Pant et al (2000), in considering welfare results in global CGE such as CEGEM, the main components are the change in; output (measured by real GSP), terms of trade and payments to foreigners. Of relevance in the discussion around estimating the net benefits of the proposed development are the terms of trade effects. These can be closely linked to changes in labour market

conditions because any increase in real wages as a result of higher levels of coal exports will result in an improvement in the terms of trade and, hence, welfare.

That noted, real GSI does not capture some non-market effects that can impact on the living standards of NSW residents. These could include impacts such as the noise impacts for residents or pollution as considered in the detailed CBA above.

CEGEM is a recursive dynamic model that solves for each year over a specified timeframe, in this case each year from 2019 to 2039. The model is used to project the relationship between variables under different scenarios over a predefined period. A typical scenario is comprised of a reference case projection (or the Base case scenario) that forms the basis of the analysis. In this instance, the reference case assumes no proposed development investment or coal output from the Modification. Set against this scenario is the policy scenario (or the Modification case) under consideration.

4.1.1 Overview of scenarios

The economy-wide impacts outlined in the below use the central case assumptions used the in the CBA analysis above, including:

- Capital expenditure of $145.3 million in NPV terms; and
- Coal output of $1,319.4 million in NPV terms.

Cadence have also factored into our scenarios the benefits that flow from the Modification outside of the Lower Hunter region and the NSW economy. This includes, the repatriation of profits out of the region to foreign shareholders, along with wages and the payments out of the region for royalties to the NSW Government and corporations tax to the Australian Government. Cadence have conservatively assumed these royalty payments accrue to the rest of NSW.

In addition, Cadence have factored into our scenarios the level of migration of workers from the rest of NSW into the Lower Hunter SA3. As outlined above, 39 per cent of the workers at the Bulga Mine reside in the Lower Hunter SA3, where the remainder are sourced from the Rest of NSW. This represents a migration into the region, increasing the labour supply in the Lower Hunter and reducing the labour supply in the Rest of NSW.

4.2 Economy-wide modelling of the proposed development

The key macroeconomic variables projected for the scenario is shown in Table 19. In the Lower Hunter region, the Modification is projected to increase GRP by $746.1 million in NPV terms. GRI or regional welfare, is projected to increase by $737.6 million in NPV terms. The projected increase in GRI is significant to the relatively small Lower Hunter region. In total, the Project is projected to increase welfare for each person in the Lower Hunter by $6,498 in NPV terms.

For NSW, the projected increase in GSP is $885.5 million in NPV terms. GSI is projected to increase by $1,414.7 million.

Table 19: Project economy-wide impacts of the Project, 2019 – 2039

Variable	Description	Lower Hunter	NSW Total
Real GRP/GSP^	NPV* - $m	746.1	885.5
Real GRI/GSI^	NPV* - $m	737.6	1,414.7
Employment	Average - FTE^^	196.1	221.1
Real Wages	Average – Per cent^^	0.99	0.013
Real GRI per person^	NPV* - Dollars	$6,498	$138

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2019 to 2039.

Total employment in the Lower Hunter region is projected to increase by almost 196.1 FTE workers on average, across NSW, employment is projected to increase by 221.1 FTE.

The analysis above outlines the impacts of the Modification over the whole time scale of the proposed development. Table 20, provide an account of the economy-wide impacts for selected years of the Modification for the Lower Hunter region. During the initial phase, as represented by the selected years 2020 and 2028, the net additional coal output of the Modification is relatively small compared to the Approved operations. Once the Approved operations are complete and the coal output is attributable to the Modification, as represented by the selected year 2035 and 2037, the net benefits of the Modification are higher.

Table 20: Modification economy-wide impacts to the Lower Hunter SA3, selected years

Variable	Description	2020	2028	2035	2037
Real GRP	Deviation (%)	0.34	0.48	3.37	3.91
	$million (real 2019)	24.2	42.3	361.8	444.2
Real GRI	Deviation (%)	0.61	0.60	5.36	5.65
	$million (real 2019)	42.9	51.4	567.2	628.5
Employment	Deviation (%)	0.10	0.13	1.56	1.65
	FTE	35.6	50.9	680.1	736.9
Real wages	Deviation (%)	0.644	0.610	3.921	4.705
Real GRI per Capita	Dollars (real 2019)	456.7	502.9	5,258.1	5,755.3

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2019 to 2039.

Table 21 outlines the economy-wide impacts to NSW during each phase of the Project.

Table 21: Modification economy-wide impacts to NSW, selected years

Variable	Description	2020	2028	2035	2037
Real GRP	Deviation (%)	0.01	0.01	0.05	0.06
	$million (real 2019)	34.2	49.5	450.3	588.2
Real GRI	Deviation (%)	0.01	0.01	0.10	0.11
	$million (real 2019)	66.7	96.8	914.0	1,082.2
Employment	Deviation (%)	0.001	0.001	0.008	0.009
	FTE	51.0	62.0	781.4	854.4
Real wages	Deviation (%)	0.009	0.008	0.053	0.063
Real GRI per Capita	Dollars (real 2019)	8.2	10.7	93.1	107.8

Source: Cadence Economics estimates based on information provided by BCM. ^ Real 2019 Australian dollars. * NPV in 2019 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2019 to 2039.

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APPENDIX A: SENSITIVITY ANALYSIS – CBA AND LEA

Table 22: Sensitivity analysis of the net benefits of the Modification (NPV*, $ million)**

	Central Case	Higher Price	Lower Price	Higher Opex	Lower Opex	Higher Capex	Lower Capex	Higher Reservation Wage	Lower Supplier Benefit	Higher Environ. Costs	Worst-case	Best-case	Central Case (4%)	Central Case (10%)
Direct Benefits	195.4	255.2	139.8	190.1	200.7	196.3	194.6	195.4	195.4	195.1	142.5	249.4	299.3	131.8
1. Net producer surplus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Royalties, payroll tax and Council rates	120.9	147.9	93.9	121.0	120.8	120.9	120.9	120.9	120.9	120.9	93.7	148.1	194.9	76.4
3. Company income tax apportioned	74.5	107.3	45.9	69.1	80.0	75.4	73.7	74.5	74.5	74.2	48.7	101.3	104.5	55.4
Indirect Benefits	215.2	215.2	215.2	225.1	205.3	215.2	215.2	190.6	210.1	215.2	176.7	231.1	363.5	126.8
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	164.9	164.9	164.9	164.9	164.9	164.9	164.9	140.3	164.9	164.9	140.3	164.9	262.7	106.0
3. Net economic benefit to Local suppliers	50.3	50.3	50.3	60.2	40.4	50.3	50.3	50.3	45.3	50.3	36.4	66.2	100.9	20.8
Indirect (Environmental costs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Benefits	410.6	470.4	354.9	415.1	406.0	411.4	409.7	386.0	405.5	410.2	319.1	480.4	662.8	258.5

Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project case less the Baseline case. ** NPV in 2019 dollars based on a 7 percent real discount rate.

Table 23: Sensitivity analysis of the net regional benefits of the Modification (NPV*, $ million)**

	Central Case	Higher Price	Lower Price	Higher Opex	Lower Opex	Higher Capex	Lower Capex	Higher Reservation Wage	Lower Supplier Benefit	Higher Environ. Costs	Worst-case	Best-case	Central Case (4%)	Central Case (10%)
Direct Benefits	1.2	1.2	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.3	2.0	0.7
1. Net producer surplus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Royalties, payroll tax and Council rates	1.2	1.2	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.3	2.0	0.7
3. Company income tax apportioned	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Benefits	80.1	80.1	80.1	83.1	77.1	80.1	80.1	70.5	78.6	80.1	66.2	85.0	134.0	48.0
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	64.7	64.7	64.7	64.7	64.7	64.7	64.7	55.1	64.7	64.7	55.1	64.7	103.1	41.6
3. Net economic benefit to Local suppliers	15.4	15.4	15.4	18.4	12.4	15.4	15.4	15.4	13.9	15.4	11.1	20.3	30.9	6.4
Indirect (Environmental costs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Benefits	81.3	81.3	81.3	84.5	78.2	81.3	81.3	71.7	79.8	81.3	67.3	86.3	135.9	48.7

Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project case less the Baseline case. ** NPV in 2019 dollars based on a 7 percent real discount rate.

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